Chapter 11
Fish and Aquatic Resources

11.0 Readers' Guide and Summary of Effects

11.0.1 Readers' Guide

Chapter 11, *Fish and Aquatic Resources* describes the environmental setting and potential impacts of the BDCP on covered and non-covered fish and aquatic species in and upstream of the Sacramento-San Joaquin Delta. The chapter provides the results of the evaluation of the effects of implementing 16 of the BDCP conservation measures on 20 fish and aquatic species under a no action alternative and 15 different project alternatives. This guide is intended to help the reader understand the organization of the chapter and more easily identify the existing conditions information and impact analysis of species of interest.

11.0.1.1 Species Evaluated in Chapter 11

The chapter analyzes 20 fish and aquatic species – 11 of which are covered species and 9 of which are non-covered species.

Covered fish species are those identified as endangered, threatened, or at risk of being listed as endangered or threatened during the BDCP permit term, for which BDCP will provide conservation and management. The covered fish species analyzed in Chapter 11 are:

- Delta smelt
- Longfin smelt
- Winter-run Chinook salmon
- Spring-run Chinook salmon
- Fall-run/Late fall-run Chinook salmon
- Steelhead
- Sacramento splittail
- Green sturgeon
- White sturgeon
- Pacific lamprey
- River lamprey

The non-covered fish and aquatic species are identified by state or federal agencies as special status or of particular ecological, recreational, or commercial importance. The non-covered fish and aquatic species analyzed in Chapter 11 are:

- Striped bass
- American shad

- Largemouth bass
- Sacramento–San Joaquin roach
- Hardhead
- Sacramento perch
- Sacramento tule perch
- Threadfin shad
- California bay shrimp

11.0.1.2 Relationship of Chapter 11 to the BDCP Effects Analysis

Chapter 5 of the BDCP is the Effects Analysis. The Effects Analysis describes how the BDCP will affect ecosystems, natural communities, and covered species, including the covered fish species analyzed in Chapter 11. The Effects Analysis presents conclusions regarding expected outcomes from implementing the BDCP conservation strategy and covered activities. The effects analysis was compiled using an extensive amount of monitoring data, scientific investigation, and analysis of the Delta. The appendices to the Effects Analysis contain a full technical description of all of the methods and results.

The methods used to analyze impacts to covered and non-covered fish and aquatic species in Chapter 11 rely on the models and data included in the Effects Analysis. Chapter 11 references specific sections of the Effects Analysis, including Appendix 5.B, *Entrainment;* Appendix 5.C, *Flow, Passage, Salinity, and Turbidity;* Appendix 5.D, *Contaminants;* Appendix 5.E, *Habitat Restoration; and* Appendix 5.F, *Biological Stressors on Covered Fish.* Readers are directed to specific sections of the Effects Analysis that are referenced in Chapter 11. An understanding of the Effects Analysis will help inform a review of Chapter 11. In some instances the description of fish species life stage timing and distribution varies between the Effects Analysis and EIR/EIS. These differences are in the process of being updated to match one another, consistent with the agency input received during development of the analyses. These updates are not anticipated to result in changes to conclusions in either document.

11.0.1.3 NEPA and CEQA Conclusions

The analysis in Chapter 11 has been prepared in accordance with NEPA and CEQA. In some instances, the NEPA and CEQA conclusions differ for a particular impact discussion because NEPA and CEQA have different points of comparison (or "baselines" in CEQA terms). The NEPA point of comparison for each alternative is based on the comparison of the late long-term action alternative (Alternatives 1A through 9) with the late long-term no action alternative. The CEQA baseline is based on the comparison of the late long-term action alternative (Alternatives 1A through 9) with EBC1 (Existing Conditions, defined not to include Fall X2). Additionally, the NEPA point of comparison is assumed to occur during the late long-term implementation period and accounts for anticipated climate change conditions during that period, whereas the CEQA baseline is assumed to occur during existing climate conditions. Therefore, differences in model outputs between the CEQA baseline and the action alternative (Alternatives 1A through 9) are due primarily to both the impacts of proposed alternative and future climate change conditions (sea level rise and altered precipitation patterns).

11.0.1.4 Chapter Organization

The chapter is broken out into three parts, the last of which contains the analysis of environmental impacts:

1. Environmental Setting and Affected Environment
2. Regulatory Setting
3. Environmental Consequences

The list of references used to support the environmental setting and impact analysis is contained in Chapter 34, References.

Environmental Setting and Affected Environment, Section 11.1

The first part of the chapter is the Environmental Setting and Affected Environment section. The section's 120 pages provide a general description of the existing environment, including the following:

- Areas of Potential Environmental Effects (Section 11.1.1), which describes the geographic region where potential effects may be expected to occur with implementation of the alternatives
- Natural Communities (Section 11.1.2), which describes the natural communities, such as tidal perennial aquatic natural communities, tidal freshwater emergent wetlands, and tidal mudflats that could be affected by implementation of the alternatives
- Species Evaluated in the EIR/EIS (Section 11.1.3) are the species that could be affected by the alternatives, which were previously listed in this introduction
- Ecological Processes and Functions (Section 11.1.4) provides an overview of activities throughout the San Francisco Bay-Delta watershed in order to provide an understanding of current conditions and the interconnectedness of hydrology throughout the system
- Stressors (Section 11.1.5) describes actions, environmental characteristics or organisms that may negatively affect fish and aquatic resources, ecological processes, and habitats.

Regulatory Setting, Section 11.2

The second part of the chapter, Regulatory Setting, describes the legal and regulatory setting applicable to the BDCP, and aquatic resources in particular.

Environmental Consequences, Section 11.3

The third part of the chapter describes the anticipated environmental consequences of each of the 15 action alternatives. This part of the chapter is divided into five sections. The first three sections (Sections 11.3.1 through 11.3.3) provide an important foundation for the analysis of the environmental effects. The fourth section contains the analysis of each alternative's impacts as well as associated environmental commitments and mitigation measures that would be implemented to reduce those impacts. The final section discusses cumulative effects. The five sections are as follows:

- Impact Mechanisms (Section 11.3.1), which provides a general discussion of the construction, operations and maintenance activities and processes associated with each group of conservation measures, and the associated stressors that could potentially affect fish and other aquatic species.

- Methods of Analysis (Section 11.3.2), which presents information on how entrainment; flow, passage, salinity, and turbidity; biological stressors such as invasive aquatic vegetation and fish predation; contaminants; and habitat restoration are addressed.
- Determination of Effects (Section 11.3.3), which describes the criteria for determining whether the alternative creates an impact or effect.
- Effects and Mitigation Approaches (Section 11.3.4), which provides a full discussion by alternative (no action alternative and 15 project alternatives) of impacts and mitigation approaches of the BDCP conservation measures on covered and non-covered fish and aquatic species. ***Important information about the organization of the Effects and Mitigation Approaches section is provided below***.
- Cumulative Effects on Fish and Aquatic Resources (Section 11.3.5) addresses the potential for the BDCP alternatives to act in combination with other past, present, and probable future projects or programs to create a cumulatively significant adverse impact.

11.0.1.5 Important Information about the Organization of the Effects and Mitigation Approaches Discussion, Section 11.3.4

The Effects and Mitigation Approaches section (Section 11.3.4) contains the analysis of the impacts and mitigation on covered and non-covered fish and aquatic species for each alternative section begins with an analysis of the No Action Alternative and is then followed by the action alternatives. The alternatives and their section numbers are listed below. A discussion of cumulative effects is included as a standalone section (Section 11.3.5) after Alternative 9.

- No Action Alternative (Section 11.3.4.1)
- Alternative 1A (Section 11.3.4.2)
- Alternative 1B (Section 11.3.4.3)
- Alternative 1C (Section 11.3.4.4)
- Alternative 2A (Section 11.3.4.5)
- Alternative 2B (Section 11.3.4.6)
- Alternative 2C (Section 11.3.4.7)
- Alternative 3 (Section 11.3.4.8)
- Alternative 4 (Section 11.3.4.9)
- Alternative 5 (Section 11.3.4.10)
- Alternative 6A (Section 11.3.4.11)
- Alternative 6B (Section 11.3.4.12)
- Alternative 6C (Section 11.3.4.13)
- Alternative 7 (Section 11.3.4.14)
- Alternative 8 (Section 11.3.4.15)
- Alternative 9 (Section 11.3.4.16)

The discussion of Alternative 1A contained in Section 11.3.4.2, beginning at page 238, contains a detailed discussion of the impacts of the 16 BDCP conservation measures analyzed in this chapter.

To the extent there are similarities between Alternative 1A and the other alternatives, the subsequent alternative analyses refer back to the Alternative 1A analysis. This approach allows the analysis of Alternatives 1B through Alternative 9 to minimize redundancy and emphasize those aspects of the alternatives that are different from Alternative 1A. Hence, readers wishing to gain a better understanding of the impacts and mitigation for Alternatives 1B through 9 should first become familiar with the presentation of impacts and mitigation for Alternative 1A. Alternatives ending in 'B' or 'C' are different from the corresponding 'A' variant of the alternatives. The difference is the physical type and/or location of water conveyance infrastructure. In all other respects, including water operations, the 'B' and 'C' variants are identical to the corresponding 'A' variant. For example Alternative 1B is different from Alternative 1A in that Alternative 1A would convey water from the north Delta to the south Delta through pipelines/tunnels, while Alternative 1B would convey water through a surface canal. The effects on covered and non-covered species do not differ otherwise, so the analysis of the 'B' and 'C' alternatives is condensed and refers the reader back to the corresponding 'A' alternative for specific details.

Restoration and Other Conservation Measures are the same among all but two of the alternatives. The exceptions are Alternatives 5 and 7. Under Alternative 5, 25,000 acres of tidal habitat would be restored, compared to 65,000 acres for Alternative 1A. Under Alternative 7, there would be 20,000 acres of seasonally inundated floodplain and 40 miles of channel enhancement, versus 10,000 acres of seasonally inundated floodplain and 20 miles of channel margin enhancement under Alternative 1A. For the alternatives other than Alternatives 5 and 7, the reader is referred back to Alternative 1A for details. To help guide the reader, bookmark their location in the chapter, and maintain consistency with Alternative 1A, the impact headers (i.e., Effects of construction of restoration measures) are retained in these other alternatives and followed by a general summary in some instances and cross reference to appropriate analysis located elsewhere in the chapter.

The 16 BDCP conservation measures (see Table 3.3 Summary of Proposed BDCP Conservation Measures of All Action Alternatives in Chapter 3, *Description of Alternatives*) that are analyzed for each species under each alternative are treated in 4 distinct categories for purposes of impact analysis. Those categories are as follows:

- Potential impacts resulting from construction and maintenance of Conservation Measure (CM) 1 (CM1 provides for the development and operation of a new water conveyance infrastructure and the establishment of operational parameters associated with both existing and new facilities).
- Potential impacts resulting from water operations of CM1.
- Potential impacts resulting from restoration activities (CM2, CM4–CM7, and CM10 – which are primarily habitat restoration measures that provide for the protection, enhancement and restoration of habitats and natural communities that support covered species).
- Potential impacts resulting from other activities (CM12–CM19 and CM21 – which are primarily measures to reduce the direct and indirect adverse effects of other stressors on covered species).

The following conservation measures are not included in the analysis because they would not affect fish and aquatic resources: CM3 (*Natural Communities Protection and Restoration*), CM8 (*Grassland Natural Community Restoration*), CM9 (*Vernal Pool Complex Restoration),* CM11 (*Natural Communities Enhancement and Management)*, and CM20 (*Recreational Users Invasive Species Program)*.

Within each alternative discussion section, the impacts of the 16 BDCP conservation measures are analyzed on a species-by-species basis for covered species and non-covered species in the following order:

- Delta smelt
- Longfin smelt
- Chinook salmon, Sacramento River winter-run ESU
- Chinook salmon, Central Valley spring-run ESU
- Chinook salmon, Central Valley fall-and late-fall run ESU
- Steelhead, Central Valley DPS
- Sacramento splittail
- Green sturgeon, southern DPS
- White sturgeon
- Pacific lamprey
- River lamprey
- Non-covered fish and aquatic species

Unlike covered species, non-covered species are dealt with in a consolidated manner with one exception that is described below. The consolidated discussion for non-covered species is appropriate because the effects of construction and maintenance of CM1, restoration activities (CM2, CM4–CM7, and CM10), and other activities (CM12–CM19 and CM21) on non-covered fish and aquatic species would be similar for all non-covered fish species included in Chapter 11. The exception to this is under the discussion of Water Operations of CM1, which analyzes non-covered fish and aquatic species individually.

A sample outline of the organization of the analysis of the impact of a representative action alternative (Alternative 1A) on single covered species (delta smelt) is presented below. Two additional impact discussions come after the non-covered species analysis: the effects of water operations on reservoir coldwater fish habitat and the potential effects of water transfers on fish and aquatic resources. The analyses occur after the discussion of each individual covered fish species because they focus on fish and aquatic resources in general and not on a species-by-species basis.

11.3.4.2 Alternative 1A – Dual Conveyance with Pipeline/Tunnel and Intakes 1–5 (15,000 cfs; Operational Scenario A)

Delta Smelt

- Construction and Maintenance of CM1
  - Effects of construction of water conveyance facilities
  - Effects of maintenance of water conveyance facilities
- Water Operations of CM1
  - Effects on entrainment
  - Effects on spawning habitat
  - Effects on rearing habitat
  - Effects on migration conditions
- Restoration Measures (CM2, CM4–CM7, and CM10)
  - Effects of construction of restoration measures
  - Effects of contaminants
  - Effects of restored habitat conditions
- Other Conservation Measures (CM12–CM19 and CM21)
  - Effects of methylmercury management (CM12)
  - Effects of invasive aquatic vegetation management (CM13)
  - Effects of dissolved oxygen level management (CM14)
  - Effects of localized reduction of predatory fishes (CM15)
  - Effects of nonphysical fish barriers (CM16)
  - Effects of illegal harvest reduction (CM17)
  - Effects of conservation hatcheries (CM18)
  - Effects of urban stormwater treatment (CM19)
  - Effects of removal/relocation of nonproject diversion (CM21).

This approach is then followed for each of the remaining species listed above and non-covered species as a consolidated group. Finally, the analysis of each alternative concludes with a discussion of the effects of water operations on reservoir coldwater fish habitat and the potential effects of water transfers on fish and aquatic resources.

Longer impact discussions that address several subjects, such as five or six waterways for example, are broken out by subheaders. The subheaders are meant to help the reader focus on the river or creek (or other subject matter). At the end of the discussion is an overall summary that ties to the NEPA conclusion. When the reader moves into the CEQA conclusion, the same subheaders are repeated and contain the CEQA analysis and ends with an overall CEQA conclusion. Many of these impact discussions appear repetitive, but the analysis is different to reflect the different NEPA and

CEQA points of comparison (or "baseline" in CEQA terms). These longer discussions are typically under the section "Water Operations of CM1" in Alternatives 2A, 3, 4, 5, 6A, 7, 8, and 9. An example of this header structure is provided below for steelhead; it is taken from Alternative 2A.

Impact AQUA-95: Effects of water operations on upstream fry and juvenile rearing habitat for steelhead

General statement about the effect of the alternative on rearing habitat relative to the NEPA point of comparison.

Sacramento River

Trinity River

Clear Creek

Feather River

American River

Summary of analysis and NEPA conclusion.

CEQA Conclusion: General statement about the effect of the alternative on rearing habitat relative to the CEQA baseline.

Sacramento River

Trinity River

Clear Creek

Feather River

American River

Summary of analysis and CEQA conclusion.

11.0.2 Summary of Effects

11.0.2.1 Alternative 1A—Summary of Effects

Overview

Alternative 1A would convey up to 15,000 cfs of water from the north Delta to the south Delta through pipelines/tunnels via five screened intakes (i.e., Intakes 1 through 5) on the east bank of the Sacramento River between River Mile (RM) 44 (south of Freeport) and RM 37 (north of the town of Courtland). Intakes 1 through 5 would introduce large, multi-story industrial concrete and steel structures approximately 55 feet in height from river bottom to the top of the structure with a length of 900–1,600 feet depending on the location.

Water supply and conveyance operations would follow the guidelines described as Scenario A, which does not include Fall X2 requirements. Conservation Measure (CM) 1–CM3 would manage the routing, timing, and amount of flow through the Delta. CM4–CM11 would restore, enhance, and manage physical habitats on a natural community scale. CM11–CM22 are designed to reduce *other stressors* on a species scale.

The following provides a summary of the major effects of Alternative 1A on covered and non-covered fish species related to constructing and maintaining CM1, operating CM1, implementing restoration measures (CM2, CM4–CM7, and CM10) and implementing other stress reducing conservation measures (CM12–CM19 and CM21).

Construction and Maintenance of CM1

In-water construction and maintenance activities have the potential to injure or kill fish through direct physical injury, or indirectly through behavioral or habitat alterations. In-water work activities with the most potential to affect fish would include installation of sheet pile cofferdams and foundation piles at each intake location, support piles at each barge landing, and placement of riprap to protect the stream banks adjacent to the intakes from erosion. Impact pile driving, in contrast to vibratory pile driving, can produce underwater impulsive sound pressure waves that can damage fish organs and tissues and result in injury or mortality. Fish can be trapped or stranded inside cofferdams and subject to dewatering or injury during rescue operations, and the placement of riprap can crush or trap fish. Although fish would likely avoid the noise and activity of pile installation, riprap placement, and other in-water construction work, these activities have the potential to result in direct injury or mortality.

Covered fish species could also be adversely affected by elevated underwater noise associated with impact pile driving and direct exposure to construction-related disturbance. The effects of exposure can range from temporary hearing loss to physical injury sufficient to cause direct mortality. The degree of effect is a function of the intensity of the sound, the distance from the source, the duration of exposure, the size of the fish exposed and the species-specific sensitivity. While the number of individuals affected would typically be minimized by adhering to approved in-water work windows, and installing the foundation piles inside dewatered or partially dewatered cofferdams, these would not completely avoid the potential for injury or mortality level exposures. Mitigation Measures AQUA-1a and AQUA-1b would avoid or minimize adverse effects from impact pile driving. Mitigation Measure AQUA-1a would involve installing piles by vibratory methods or other non-impact driving methods, wherever feasible; monitoring underwater sound levels to determine compliance with established underwater noise thresholds, when pile driving is required; and developing a noise monitoring plan, with appropriate corrective actions if the thresholds are exceeded. Mitigation Measure AQUA-1b would involve using an attenuation device to reduce the effects of pile driving and other construction-related underwater noise when pile driving is required.

In-water and near-shore construction activities also have the potential to cause adverse effects on covered species through water quality degradation from increased turbidity, inadvertent spills of hazardous materials, and disruption of contaminated sediments. However, these adverse effects will be effectively avoided and minimized by isolating much of the in-water work inside cofferdams, constructing in areas that have limited use by the covered species, adhering to the approved in-water work windows, activity-specific timing restrictions, and by implementing environmental commitments and Best Management Practices (BMPs). These commitments are described in Appendix 3B, *Environmental Commitments* which include *Conduct Environmental Training*; *Develop and Implement a Stormwater Pollution Prevention Plan* (SWPPP); *Develop and Implement an Erosion and Sediment Control Plan*; *Develop and Implement a Hazardous Materials Management Plan* (HMMP) that includes a *Spill Prevention, Containment, and Countermeasure Plan* (SPCCP); *Dispose of Spoils, Reusable Tunnel Material, and Dredged Material*; *Develop and Implement a Fish Rescue and Salvage Plan*; and *Develop and Implement a Barge Operations Plan*. These environmental commitments would reduce the amount of turbidity from in-water construction activities and would guide rapid and effective response in the case of inadvertent spills of hazardous materials. These environmental commitments would be expected to protect covered fish species from adverse water quality effects resulting from project construction.

Construction would not be expected to measurably increase predation rates, relative to baseline conditions, because any locally increased predator habitat and predation from temporary construction structures would not have population level effects.

While in-water construction activities would temporarily or permanently alter migration, spawning, and rearing habitat conditions in the vicinity of the construction activities, the extent of the overall available habitat affected, and the relatively poor quality of the affected habitat, is expected to limit the effects of construction and maintenance activities on most covered fish species. Thus the effects would not be limiting to population productivity.

In addition to the effects of habitat alterations, in-water construction activities could also result in behavioral effects. Such effects would include migration delays, displacement of fish from preferred habitats, and disturbance of spawning or foraging activities. As with other construction-related effects, these effects are expected to be limited, although they cannot be entirely discounted.

The potential for construction and maintenance activities to affect the covered fish species would typically be proportional to the number of north Delta intakes constructed, and the total area of habitat affected. Alternative 1A includes the construction of the five north Delta intake facilities and six temporary barge landings to support construction of six tunnel shafts and pipeline construction. The locations, dimensions, and construction footprints of the intakes considered in Alternative 1A are provided in Table 11-1A-SUM1.

Table 11-1A-SUM1. Number and Sizes of In-Water Structures and Area of Habitat Affected by Construction Activities by Alternatives

Alternatives	Intakes	Barge Landings	Temporary Construction Effects (acres)	Total Shoreline Habitat Permanently Affected by Intake (feet)	Total Intake Footprint (acres)	Offshore Habitat Dredged (acres)
1A	1–5	6	28.7	11,900	21.8	27.3
1B	1–5	1	28.7	11,900	21.8	27.3
1C	W1–W5	2	32.7	10,100	24.9	20.3
2A	1–5 or 1,2,3,6,7	6	27.1–28.7	11,350–11,900	7.1–7.7	26.0
2B	1–5 or 1,2,3,6,7	1	27.1–28.7	11,350–11,900	7.1–7.7	26.0
2C	W1–W5	2	32.7	10,100	24.9	20.3
3	1 and 2	6	11.0	4,450	8.3	10.2
4	1, 2, and 3	6	16.2	6,360	12.3	17.1
5	1	6	5.0	2,050	3.8	4.7
6A	1–5	6	28.7	11,900	21.8	27.3
6B	1–5	1	28.7	11,900	21.8	27.3
6C	W1–W5	2	32.7	10,100	24.9	20.3
7	2, 3, and 5	6	18.1	7,450	13.7	17.0
8	2, 3, and 5	6	18.1	7,450	13.7	17.0
9	None [a]	5	31.4[a]	4,800[a]	15.4[a]	56.9

[a] Aquatic habitat impacts for structures other than intakes.

At each Alternative 1A intake, between 1.2 and 6.9 acres of river area would be isolated behind cofferdams, and temporarily or permanently lost. During the in-water construction period, a total of up to about 28.7 acres of in-water habitat and 22,700 linear feet of primarily steep-banked and riprapped shoreline habitat would be affected by construction and dredging activities. This would result in the loss or alteration of low-quality spawning, rearing, and migration habitat for covered fish species. The barge landings would include in-water and over-water structures, each occupy approximately 15,000 square feet of shoreline habitat within their respective Delta channels.

In-water work activities at the north Delta intakes would include installation of sheet pile cofferdams at each intake location to isolate active construction activities from the Sacramento River and minimize potential for increases in turbidity. Although fish would likely avoid the noise and activity of sheet pile installation, cofferdams have the potential to entrap some fish. Overall effects would also be minimized through the implementation of environmental commitment *Fish Rescue and Salvage Plan* (see Appendix 3B, *Environmental Commitments*), with detailed procedures for fish rescue and salvage to minimize the number of fish stranded during placement and removal of cofferdams at the intake construction sites (see Appendix 3B, *Environmental Commitments*).

Once constructed, the new facilities will require periodic maintenance to function effectively, resulting in short-term effects on the environment that would occur at a variable frequency depending on planned and unplanned maintenance needs. The effects of maintenance activities are expected to be similar to those described for project construction. However, the scale of those effects will be commensurate with the nature and extent of the maintenance activities conducted during any given year. Project maintenance would include the same range of conservation measures and environmental commitments (see Appendix 3B, *Environmental Commitments*) BMPs used during project construction to avoid and minimize adverse effects on fish and aquatic habitats. The maintenance activity with the most potential to affect the covered fish species is periodic dredging adjacent to the intakes, which would reduce habitat quality, prey abundance and water quality conditions. As with the construction effects, these areas would recover relatively quickly and represent only a small portion of the available habitat in the Delta. Therefore, the effects would likely be limited to the areas at and immediately adjacent to location of the intakes.

In addition to the environmental commitments and BMPs discussed above, the potential effects of construction and maintenance activities would vary by species, based on their tolerance to the mechanisms of effect or their expected occurrence near the construction areas during the in-water construction window. For example, delta smelt, longfin smelt, Sacramento splittail, sturgeon, and lamprey are all tolerant of increased turbidity, thereby minimizing this potential construction and maintenance activity effect. The effects on delta smelt would also be limited by their distribution (primarily in the west Delta region) and expected occurrence in the construction areas during only the early portion of the work window (June and early July). Similarly, longfin smelt occur primarily downstream of the construction areas, thereby substantially limiting the potential for effects.

The in-water construction window would limit construction and maintenance activities to when the least number of salmonids would occur in the area, although some species or life stages could occur in greater numbers during portions of the construction window. Adult fall-run Chinook salmon would be migrating upstream during a substantial portion of the in-water construction window, and the primary mechanism of effect would be the noise generated by pile driving activities, which could result in migration delays. However, adult fall-run Chinook salmon are expected to be migrating relatively quickly through the area, and pile driving would occur intermittently through only about 8 hours per day, thereby limiting any potential for substantial migration effects.

The relatively poor habitat at the intake and barge landing locations, due to steep riprap banks and deep channels with little refuge or holding areas, would further limit the overall occurrence (abundance and/or duration) of both juvenile and adult salmonids. Despite the poor quality of the existing habitat, it is designated critical habitat for Chinook salmon and steelhead, and the construction and maintenance activities would further degrade the habitat either temporarily or permanently. However, implementation of CM6 *Channel Margin Enhancement* would enhance channel margin habitat along 20 miles of the Sacramento River, including the vicinity of the intake structures, and is designed to result in a net improvement in channel margin habitat function. Therefore, the temporary and permanent effects on rearing and migration habitat would not adversely affect Chinook salmon or steelhead populations. In addition, no spawning habitat occurs in the areas potentially affected by construction and maintenance activities, and ample rearing and migration habitat of the same quality is readily accessible in the area.

Despite adhering to the approved in-water work window timing restrictions, a moderate number of green and white sturgeon are expected to occur in the construction and maintenance areas, and potentially affected by the associated activities. In particular, pile driving noise could result in significant impacts to individual juvenile sturgeon, although implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of potential effects. As bottom oriented fish, sturgeon are also particularly susceptible to injury from dredging activities, although the infrequent occurrence of dredging activities and the limited numbers of sturgeon expected to occur in the area would result in a low potential for effects. Therefore, construction and maintenance activities are not expected to adversely affect green or white sturgeon.

Pacific and river lamprey are also expected to occur in the construction and maintenance areas during the typical in-water construction window, and could be affected by these activities. Due to the atypical hearing structures on lamprey, compared to other fish, and the behavior of ammocoetes to burrow into the substrate, the potential effects of pile driving noise is uncertain. The burrowing behavior of lamprey ammocoetes could also put them at particular risk from stranding within the intake cofferdams, although implementation of environmental commitment 3B.8-Fish Rescue and Salvage Plan would minimize potential effects. Lamprey are also expected to be susceptible to injury from dredging, although the infrequent occurrence and limited areas dredged would minimize the overall effects. The potential effects of Alternative 1A on the non-covered aquatic species of primary management concern would be generally similar to those discussed above for the covered species.

In summary, construction and maintenance activities would result in limited temporary and permanent effects on the covered fish species or their habitat. While these effects would vary by species and species life stages, the implementation of environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*), would reduce most of these construction effects to be not adverse and less than significant. In addition, the implementation of Mitigation Measures AQUA-1a and AQUA 1b would reduce the severity of pile driving noise effects on all the covered species, to be not adverse and less than significant. The implementation of habitat restoration activities, particularly CM6 *Channel Margin Enhancement*, would offset effects of habitat loss or alteration at the intake sites.

Water Operations of CM1

Water operations vary between the alternatives due to conveyance infrastructure differences (e.g., five north Delta intakes vs. one north Delta intake) and the flow scenario differences (e.g., higher or lower average annual exports, the point of diversion for those exports, and the seasonality of those exports). Consistent with the operational scenarios fully described in Chapter 3, Project Alternatives, water operations under Alternative 1A (operational Scenario A) could result in changes in flow, water quality, habitat, impingement, entrainment, and predation. Operational impacts on fish may include changes in spawning, migration, and rearing habitat associated with changes in Sacramento River and tributary flows due to reservoir operations, water diversions, and the consequent changes in water quality and circulation through the Delta. Overall changes in the rate of entrainment or impingement of fish would be associated with the north Delta intakes and the change in diversions at the south Delta facilities. Placement and operation of the north Delta intakes may also result in changes in fish predation. Following is a summary discussion of these types of effects based on the analysis of Alternative 1A.

Changes in Exports and Outflow

As discussed in Chapter 5, *Water Supply*, over the long term, average annual Delta exports under Alternative 1A are anticipated to increase by 312 thousand acre-feet (TAF) relative to Existing Conditions, and by 1,015 TAF relative to the No Action Alternative (NAA). Over the long-term, approximately 50% of the exported water will be from the new north Delta intakes, and average monthly diversions at the south Delta intakes would correspondingly decrease. These changes would increase the proportion of San Joaquin River water flowing throughout the South, West, and Interior Delta, and a corresponding decrease in the proportion of Sacramento River water.

Under Alternative 1A, long-term average annual Delta outflow is anticipated to decrease 323 TAF relative to Existing Conditions and by 1,072 TAF relative to the NAA. It is important to note that some outflow changes under Alternative 1A are greater relative to the NAA because the NAA includes operations to meet Fall X2, whereas Existing Conditions and Alternative 1A do not. This will vary among alternatives, as some alternatives do include operations to meet Fall X2.

As a result of changes in points of diversion and the quantity and timing of diversions (more water diverted December through mid-June and less water diverted mid-June through November), there would be beneficial, not adverse/less than significant, and adverse/significant and unavoidable effects/impacts on fish under Alternative 1A. Following is a summary of these effects as they relate to the key factors of entrainment and flow, which in turn affects fish survival and spawning, rearing, and migration habitat conditions.

Entrainment

Overall entrainment of delta smelt, longfin smelt, and splittail under Alternative 1A would be less than or similar to the levels experienced in the recent years. This is because the north Delta diversion operations would reduce reliance on south Delta export facilities (greater entrainment rates are expected to occur at south Delta facilities), along with additional minor benefits from decommissioning of agricultural diversions in restoration areas and implementation of an alternative intake for the North Bay Aqueduct. While some delta smelt and longfin smelt losses may occur from entrainment and impingement at the north Delta diversions, these would be relatively low due to the state-of-the-art positive barrier fish screens and these species primarily occur downstream of the diversion sites.

Similarly, overall entrainment losses of juvenile salmonids under Alternative 1A generally would be appreciably lower than under Existing Conditions because the north Delta diversion operations reduce reliance on south Delta export facilities. As a result, reduced entrainment of juvenile salmonids would occur in the majority of years under wetter conditions, and would be beneficial or not adverse, whereas in dry and critical water years overall entrainment is increased relative to that under current conditions, and would be adverse for some species (i.e., spring-run Chinook salmon). In contrast, the effects on entrainment of winter-run Chinook and steelhead would be beneficial.

Entrainment of white and green sturgeon at south Delta facilities under Alternative 1A will be substantially reduced in wetter water years and moderately reduced in drier water years. The negligible reductions in entrainment in agricultural diversions are not expected to affect sturgeon populations. While the potential entrainment of larval sturgeon at the north Delta facility raises some uncertainty of the overall change in entrainment rate, this uncertainty would be addressed through monitoring and adaptive management actions. Based on available information, overall entrainment effects on green sturgeon are not expected to substantially change under Alternative 1A. Finally, Alternative 1A is expected to slightly reduce Pacific and river lamprey entrainment due to reductions in south Delta exports and decommissioning agricultural diversions.

While the proposed north Delta intakes under Alternative 1A will have state-of-the-art fish screens to minimize entrainment, they will have the potential to affect some fish species through contact with the screens and/or increased predation around those facilities. However, these effects are considered to be not adverse.

In summary, entrainment is expected to remain at or below the levels currently experienced by most fish species and life stages in the Delta. There are some instances where there would be increases, but these would be at least partially offset by decreases during other periods. In addition, monitoring and adaptive management actions would be implemented to verify entrainment rates and modify operations or structures to minimize effects. Therefore, the overall the effects are not adverse and less than significant.

Flows

While San Joaquin River flows are not expected to be affected by Alternative 1A, flow changes are expected in the Sacramento River and its tributaries, as well as within the Sacramento-San Joaquin Delta. Changes in flow will result from changes in releases from upstream reservoirs, diversions from the south Delta, and reductions in flows downstream of the proposed north Delta intakes.

The area of fall abiotic habitat for juvenile delta smelt in the open-water areas of the Suisun Bay, Suisun Marsh, and West Delta subregions would be less under Alternative 1A than under NAA conditions that include the Fall X2 flows because of lower outflow. However, this area would increase in size relative to Existing Conditions without the Fall X2 flows. The reduction in fall abiotic habitat area in the open estuary would be offset by tidal marsh habitat restoration, assuming the intended habitat benefits are realized, when considered across all water year types, relative to both Existing Conditions and NAA, but not entirely for NAA. However, if the proposed habitat restoration does not produce the intended benefits to delta smelt, the abiotic habitat index under Alternative 1A would decrease 22% on average compared to NAA. Such reductions result from Operational Scenario A, which does not include Fall X2 requirements, while the NAA does. Based on these uncertainties, the overall effect is uncertain.

Decreased winter-spring outflows under Alternative 1A have the potential to contribute to decreases in longfin smelt abundance from reduced larval transport flows and spring habitat quantity and quality for larval and early juvenile longfin smelt in the Suisun Marsh and West Delta subregions. This analysis does not take into account any potential changes in spawning or rearing conditions related to non-operational components of Alternative 1A, including habitat restoration. As a result, the overall effects on rearing and migration conditions are uncertain.

With regard to salmonids, several issues were identified as described below, to be adverse. For example, Sacramento River attraction flows for migrating adult salmonids would be lower from operations of the north Delta diversions under Alternative 1A. Winter-run Chinook salmon would likely experience adverse effects to spawning, rearing and migration habitat conditions, with greater redd dewatering and lower weighted usable spawning area under Alternative 1A; the OBAN life cycle model also indicates potentially adverse effects on winter-run Chinook salmon from changes in upstream flow and water temperature. Proposed adaptive management mitigation measures have the potential to reduce the severity of the impacts, though not necessarily to a less than significant level.

Egg mortality for spring-run Chinook salmon in the Sacramento River would be higher under Alternative 1A, resulting in significant and adverse impacts. The through-Delta effects on juvenile spring-run Chinook salmon migration conditions would also be adverse due to predation and habitat loss associated with the five north Delta intake facilities. While implementation of the proposed conservation and mitigation measures would reduce the severity of effects, they would not necessarily reduce the impacts to a level considered not adverse or less than significant.

Despite some beneficial reductions in the entrainment of fall- and late fall-run Chinook salmon and steelhead, and no adverse effects on spawning conditions, Alternative 1A would result in significant and adverse reductions in adult and juvenile migration habitat conditions. The implementation of conservation measures and adaptive management mitigation measures would likely reduce the severity of these effects, although these would likely still be significant and/or adverse.

In addition to the benefits provided to salmonids, improved flow conditions over the Fremont Weir and in the Yolo Bypass provide substantial benefits to Sacramento splittail.

Alternative 1A would maintain upstream spring flows in the Sacramento River, where high flows have been positively correlated with improved recruitment of juvenile white sturgeon. However, Alternative 1A would also reduce April and May Delta outflow, which has been correlated with reduced year class strength of white sturgeon, in some water year types. However, this relationship was reached in the absence of north Delta intakes and the exact mechanism that causes this correlation is not known at this time. The scientific uncertainty regarding which mechanisms are responsible for the positive correlation between year class strength and river/Delta flow will be addressed through targeted research and monitoring to be conducted in the years leading up to the initiation of north Delta facilities operations. It was assumed that the same relationship applies to green sturgeon in the analysis. Because all other analyses for white sturgeon migration indicates that there was no adverse effect, the overall effects are uncertain due to the uncertainty of the Delta outflow relationship. Because other analyses indicate that there would be adverse effects on green sturgeon migration, the overall conclusion is that the effect would be adverse, relative to NAA. The effects on green sturgeon would also be significant and unavoidable, relative to Existing Conditions. .

Alternative 1A also has the potential to adversely reduce suitable spawning habitat and also the number of Pacific lamprey, as a result of egg mortality from increased dewatering risks and increased water temperatures. In contrast, Alternative 1A would not result in adverse effects on river lamprey spawning or incubation habitat conditions, although the reduced amount of rearing habitat and increased temperature-related ammocoete mortality would be adverse. Despite these significant and unavoidable effects, proposed adaptive management mitigation has the potential to reduce the severity of impact, though not necessarily to a less than significant level.

As evidenced by this summary, some changes in flow under Alternative 1A are adverse to fish species. Alternative 1A also includes conservation measures that provide substantial habitat improvements for fish, and adaptive management mitigation measures to reduce the overall severity of effects. These measures include habitat restoration measures and several other measures that reduce existing fish stressors in the Delta region (summary description provided in the following section). When the flow, habitat restoration, and adaptive management measures are considered together, the effects of Alternative 1A measures are primarily beneficial or not adverse and/or less than significant for most covered fish species. However, some effects remain adverse and/or significant and unavoidable, particularly for the salmonid species. Summary Table 11-1A-SUM2 presents the results of the flow related effects on fish.

Table 11-1A-SUM2. Results of Flow-Related Effects on Fish

Species	Entrainment	Spawning	Rearing	Migration
Delta smelt	B/LTS	NA/LTS	ND/LTS	ND/LTS
Longfin smelt	NA/LTS	ND/LTS (combined)		
Winter-Run Chinook salmon	B/B	A/SU	A/SU	A/SU
Spring-Run Chinook salmon	A/S	A/SU	NA/LTS	A/SU
Fall-Run/Late Fall-Run Chinook salmon	NA/B	NA/LTS	NA/LTS	A/SU
Steelhead	B/B	NA/LTS	NA/LTS	A/SU
Sacramento splittail	NA/LTS	NA/LTS	B/B	NA/LTS
Green sturgeon	NA/LTS	NA/LTS	NA/LTS	A/SU
White sturgeon	NA/LTS	NA/LTS	NA/LTS	ND/LTS
Pacific lamprey	NA/LTS	A/SU	NA/LTS	NA/LTS
River lamprey	NA/LTS	NA/LTS	A/SU	NA/LTS

Level of significance:

NEPA Conclusion	*CEQA Conclusion*
A = Adverse.	SU = Significant and Unavoidable.
NA = Not Adverse.	LTS = Less than Significant.
B = Beneficial.	B = Beneficial.
ND = No Determination.	S = Significant.

Restoration Measures (CM2, CM4–CM7, and CM10)

Alternative 1A restoration measures include: Yolo Bypass fisheries enhancement (CM2); 65,000 acres of restored tidal natural communities within BDCP Restoration Opportunity Areas (ROAs) (CM4); 10,000 acres of seasonally inundated floodplain habitat within the north, east, and/or south Delta ROAs (CM5); 20 linear miles of channel margin habitat enhancement in the Delta (CM6); 5,000 acres of restored native riparian forest and scrub habitat (CM7); and 1,200 acres of nontidal marsh restoration and 320 acres of managed wetlands (CM10).

The overall intent of Alternative 1A is to improve conditions for covered fish species. For NEPA and CEQA purposes all affects are not adverse or less than significant, respectively, or beneficial.

Construction of Restoration Measures

In-water and shoreline restoration activities may result in short-term adverse effects on covered and non-covered fish species through direct disturbance, short-term water quality impacts (turbidity, spills), and increased exposure to contaminants associated with the incidental disturbance of contaminated soils and sediments. These effects would be minimized by limiting construction of restoration activities to the approved in-water construction window, when the least numbers of covered fish species would be present in or near the restoration sites. The construction of restoration measures would not involve impact pile driving so those noise effects would not occur. Some noise would occur from boat and barge traffic and construction equipment; however the level of this noise would not adversely affect the covered fish species. Turbidity effects would be minimized by construction windows and implementation of environmental commitments described in Appendix 3B, *Environmental Commitments.* Additionally, delta smelt and longfin smelt have a high turbidity tolerance which is unlikely to be exceeded. Appendix 3B, *Environmental Commitments,* would also guide rapid and effective response in the case of inadvertent spills of hazardous materials thereby minimizing and containing their affect. With respect to incidental disturbance of contaminated soils and sediments, the effects on the bioavailability of contaminants is expected to be minimal, and if there are effects, they would likely be localized, sporadic, and of low magnitude. Additionally, implementation of the environmental commitments described in Appendix 3B, *Environmental Commitments*, would minimize or eliminate effects on covered and non-covered fish species. As a result, the effects of construction of restoration measures are not adverse and are less than significant for covered and non-covered fish species.

Contaminants Associated with Restoration Measures

Contaminants addressed include methylmercury, selenium, copper, and pesticides. Methylmercury likely would be generated by inundation of restoration areas, with highest concentrations expected in the Yolo Bypass, Cosumnes/Mokelumne Rivers, and at other ROAs closest to these source areas. However, implementation of CM12 *Methylmercury Management* would help to minimize increased mobilization of methylmercury at restoration areas. Modeling of water operations effects showed little change in methylmercury concentrations in water; however, methylmercury concentrations would continue to exceed criteria under the alternatives as they do under Existing Conditions. While substantial uncertainty surrounds the potential increase in methylmercury due to BDCP restoration actions, implementation of CM12 would likely reduce potential increases.

Covered fish species are expected to have low exposure to selenium from sources in the south Delta because of the limited frequency and duration and spatial extent of restoration activities. Although localized, short-term increases in copper concentrations are possible near ROAs, the length of time and the concentrations cannot be determined with available data. However, copper concentrations are generally low in Delta waters, and Alternative 1A is not expected to result in increased effects of copper on covered fish species. Further, no appreciable addition or mobilization of ammonia to the aquatic system would result from restoration activities. The removal of some agricultural areas through restoration activities would eliminate those sources and concentrations of copper and organophosphate and organochlorine pesticides, providing a long-term net benefit to the ecosystem although localized remobilization may occur and local evaluations would be necessary. In addition, implementing CM19 *Urban Stormwater Treatment* would provide for treatment of stormwater discharges, a major contributor of pyrethroids to the Delta. Thus BDCP may result in reduced loading of contaminants. Therefore, the effect of BDCP on these chemical contaminants would not be adverse and would be less than significant for covered fish species.

Restored Habitat Conditions

The effects of restored habitat conditions (CM2 *Yolo Bypass Fisheries Enhancement,* CM4 *Tidal Natural Community Restoration,* CM5 *Seasonally Inundated Floodplain Restoration,* CM6 *Channel Margin Enhancement, and* CM7 *Riparian Natural Community Restoration*) would be beneficial for all covered fish species because there would be an increase in the amount of habitat as well as food production in, and export from, the restored areas. CM10 *Nontidal Marsh Restoration* would provide a benefit to covered fish species through a small increase in food export from the restored areas. Additional information for each conservation measure is provided below. Note that despite the improvements in habitat and habitat functions in the Delta from these restored habitat conditions, habitat quality is expected to decline in the late long-term (LLT) primarily because of climate change. However, the overall effect of restoration activities is expected to remain beneficial for covered fish species.

CM2 *Yolo Bypass Fisheries Enhancement* would change the configuration and operation of Fremont Weir and the Yolo Bypass and restore to a considerable extent the south Delta floodplain. This would increase the duration and magnitude of seasonal floodplain inundation with an increase in frequency, duration and magnitude in the Yolo Bypass. Flow modeling results indicate that under Existing Conditions, at least 3,000 acres of the Yolo Bypass are inundated for at least seven days in about four out of every five years, on average, and about seven out of every eight years, on average under Alternative 1A. There would also be fish passage improvements at the Fremont Weir. The increased inundation would provide increased habitat and would increase production of periphyton, phytoplankton, zooplankton, macroinvertebrates, insects, and small fish that contribute to the Delta's pelagic foodweb. This increased food would be available in the Yolo Bypass and would also be exported and available downstream. Delta smelt and longfin smelt would primarily benefit from the downstream export of food to portions of the system used by them. Chinook salmon and possibly steelhead would benefit from the increased Yolo Bypass habitat as well as reductions in migratory delays and losses (via stranding or poaching) at the Fremont Weir. Pacific lamprey and river lamprey macropthalmia and adult passage would also be considerably improved at Fremont Weir. The enhancements would also improve passage and habitat for Sacramento splittail, green sturgeon, and white surgeon. For Sacramento splittail there would also be enhanced spawning and rearing habitat within the Yolo Bypass. The Yolo Bypass would potentially provide temporary habitat for green sturgeon and white sturgeon but would not be a substantial benefit. Pacific lamprey and river lamprey do not substantially use floodplains so the Yolo Bypass enhancements would have limited beneficial effect on them.

CM4 *Tidal Natural Channel Community Restoration* would provide 65,000 acres of habitat. This acreage provides substantial additional habitat and food production. Similar to the Yolo Bypass this additional food would be available within the restored areas and would also be exported to adjacent portions of the Delta. Delta smelt, Chinook salmon, and possibly steelhead would benefit from substantial increases in habitat and food production. Tidal habitat restoration may increase delta smelt exposure to the toxic blue-green alga microcystis and provide additional opportunities for invasive mollusks, including *Corbicula* and *Corbula*, to colonize in delta smelt habitat, affecting delta smelt food availability. A small proportion of late-stage longfin smelt larvae would benefit from shallow tidal environments and would experience direct benefits from habitat expansion and food production. Tidal restoration provides substantial increases in habitat for foraging juvenile salmonids and Sacramento splittail. Green and white sturgeon would benefit slightly from increased tidal habitat but would receive additional benefit from the export of food from the restored areas. Little is known about Pacific lamprey and river lamprey use of tidal communities; however increased food production is assumed to increase food for lamprey ammocoetes which are filter feeders.

CM5 *Seasonally Inundated Floodplain Restoration* would provide an additional 10,000 acres of seasonally inundated habitat. The effects would be similar to those summarized above for CM2 *Yolo Bypass Fisheries Enhancement* except that the inundated acreage and benefits would be proportionally greater.

CM6 *Channel Margin Enhancement* would provide 20 miles of channel margin improvement in the Delta by improving channel geometry, restoring associated habitats on the waterside of levees along channels, and improving habitat complexity. Delta smelt would get limited benefits from channel margin enhancements because they are largely found offshore and downstream of these enhancement areas. Longfin smelt would get access to some additional spawning and rearing habitat but this would be minimal because they tend to occur away from shore and are largely found downstream of the main channels where enhancement would occur. This enhanced channel margin provides beneficial rearing and outmigration habitat for juvenile salmonids (Chinook salmon, steelhead). Chinook salmon fry have a high affinity for channel margins and the enhancements would provide important refuge from high flows and cover from predators. Sacramento splittail would also benefit from enhanced channel margins during migration and from the refuge during high flows. Green sturgeon and white sturgeon would benefit from increased rearing habitat and improved migration conditions. However, the benefits for the sturgeons are expected to be minimal because they spend relatively short periods in these shallow near-shore areas. Although little is known about Pacific lamprey and river lamprey use of channel margin habitat, the species may benefit from enhancement that increases the area of non-revetted substrate into which ammocoetes can bury.

Channel margin habitat enhancement also has the potential to increase habitat for nonnative fishes such as largemouth bass that prey on or compete with covered fish species, particularly delta smelt, longfin smelt, Chinook salmon, and steelhead. Enhancement of channel margins with inundated vegetation or woody material may also increase predation risk if other features of the habitat support predatory fish (e.g., relatively steep slopes and deeper water). Monitoring from bank protection projects and other future studies will inform site designs to limit the potential increase in nonnative fishes.

CM7 *Riparian Natural Community Restoration* would provide 5,000 acres of restored native riparian forest and scrub habitat along river channels. This restoration would provide shading and associated thermal refugia; nearshore habitat complexity, including downed wood for resting and refuge; and would potentially increase food availability through provision of terrestrial insects and particulate organic matter. Delta smelt and longfin smelt would receive limited benefit because they occur offshore but they would benefit from food production, and longfin smelt would have access to some additional rearing habitat. Chinook salmon, steelhead and Sacramento splittail would benefit from the improved habitat and food production along migration corridors. Green sturgeon and white sturgeon rely on riparian habitats and juvenile sturgeon would particularly benefit from the improved habitat quality and quantity as well as the food production. Pacific lamprey and river lamprey would benefit from additional food production but it is uncertain if they would directly benefit from the improved riparian habitat.

CM10 *Nontidal Marsh Restoration* would provide 1,200 acres of nontidal marsh and 320 acres of managed wetlands. Since these are upland communities they would primarily provide indirect benefits to covered and non-covered fish species in the main river systems and Delta. Upland wetlands provide hydrologic and water quality functions (e.g., storing water during floods, filtering contaminants), and these sites would provide some additional food resources such as insects, zooplankton, phytoplankton and dissolved organic carbon when these upland areas are hydrologically connected to the river system. Although the contribution from the restored acreages would be small, it would be beneficial to covered and non-covered fish species

The overall effects of all restored habitat conditions would be beneficial for covered and non-covered fish species.

Other Conservation Measures (CM12–CM19 and CM21)

Methylmercury Management (CM12)

Under CM12 *Methylmercury Management*, the BDCP Implementation Office will minimize conditions that promote production of methylmercury in restored areas and its subsequent introduction to the foodweb, and to covered fish species in particular. It describes pre-design characterization, design elements, and best management practices to mitigate methylation of mercury, and requires monitoring and reporting of observed methylmercury levels. Modeling of Alternative 1A water operations effects show little changes in methylmercury concentrations in water or fish tissue, although methylmercury concentrations in both media would continue to exceed criteria under the BDCP alternatives as they do under Existing Conditions. Consequently, these effects would not be adverse and are less than significant.

Invasive Aquatic Vegetation Management (CM13)

Control of invasive aquatic vegetation (IAV) would reduce habitat that supports predatory fish in freshwater near-shore habitat in the Delta. Largemouth bass are strongly associated with dense IAV beds. A decrease in IAV in the Delta should open up near-shore habitats used by covered fish species while reducing their encounters with piscivorous predators like largemouth bass. Dense IAV cover has also been associated with reduction of water turbidity in the Delta. Removal of IAV may also provide increased turbidity, which is associated with reduced hunting success of visual predators like largemouth bass and striped bass.

The control of IAV would provide a benefit to covered fish species but in particular to Chinook salmon and steelhead which are especially affected by this predation. The benefit to green sturgeon and white sturgeon might be lower compared to other covered fish species because rapid sturgeon growth allows them to relatively quickly outgrow the size range where they are vulnerable to predation (Gadomski and Parsley 2005). Sturgeon also have a protective amour-like plating potentially making them unappealing to predators even at a young age (French et al. 2010).

Dissolved Oxygen Level Management (CM14)

CM14 *Stockton Deepwater Ship Channel Dissolved Oxygen Levels* management would improve the upstream migration conditions for fall-run Chinook salmon and steelhead in the San Joaquin River basin as well as for Pacific lamprey and river lamprey macropthalmia and adult passage and for green and white sturgeon. The other covered fish species occur in the channel and the increased dissolved oxygen levels also provide improved habitat conditions for them which would be a benefit. Consequently, the overall effects are beneficial.

Localized Reduction of Predatory Fish (CM15)

To the extent that localized predator control efforts of *CM15 Localized Reduction of Predatory Fish* reduce the overall abundance of fish predators in the Delta occupied by covered fish species, it is possible, but not assured that there would be some reduction in losses to predation, although little quantitative information is available regarding the current magnitude of loss to predation for many fish species. Due to these uncertainties, there would be no demonstrable effect of this conservation measure on covered fish species.

Nonphysical Fish Barriers (CM16)

CM16 *Nonphysical Fish Barriers (NPBs)* would be implemented to improve survival of out-migrating juvenile salmonids (Chinook salmon and steelhead) by using NPBs to direct fish away from channels in which survival is lower. Such barriers may use a combination of sound, light, and bubbles at the head of Old River, Delta Cross Channel (DCC), Georgiana Slough and possibly Turner Cut and Columbia Cut. NPBs at these locations have a high potential to deter juvenile salmonids from using specific channels/migration routes that contribute to decreased survival resulting from increased predation and/or entrainment or to direct juvenile salmonids to areas that may increase their survival such as Yolo Bypass. Other locations may be considered if future research indicates the likelihood of differential survival rates.

NPBs at the channel entrance upstream of Clifton Court Forebay (CCF) and the entrance to Delta-Mendota Canal (DMC) may also have the most potential to considerably reduce entrainment of juvenile salmonids and juvenile and adult Sacramento splittail. There is somewhat less potential to reduce entrainment of juvenile and adult smelts, primarily because of lower escape ability. Insensitivity of sturgeons and lampreys makes them unlikely to benefit from NPBs. The potential importance of NPBs is that fish would not be subject to the salvage process, which generally is quite inefficient. Pre-screen predation in CCF in particular results in the majority of fish not being salvaged.

The physical structures of the NPBs may attract piscivorous fish to the area and increase localized predation risks. Studies on the NPBs at the head of Old River indicate that the barrier is very effective at deterring salmon smolts from entering Old River. However, many predators were attracted and the predation rate was so high that the juvenile salmon survival rate was not statistically different whether the barrier was on or off.

Overall, the effects of NPBs would not be adverse and would be less than significant to slightly beneficial for Chinook salmon, steelhead, delta smelt, and longfin smelt. The overall effects of NPBs on Sacramento splittail would not be adverse and would be less than significant.

Green sturgeon, white sturgeon, Pacific lamprey, and river lamprey would encounter some NPBs but they are not deterred by sound and light barriers and would continue to enter the central Delta where higher predation rates occur. However, sturgeon grow rapidly and have armored external scales which reduce predation on them. The effect on green sturgeon and white sturgeon would not be adverse and would be less than significant. Pacific lamprey and river lamprey would experience some additional predation but it is expected to be low and the effect would not be adverse and would be less than significant.

Illegal Harvest Reduction (CM17)

CM17 *Illegal Harvest Reduction* would be applied to Chinook salmon, steelhead, green sturgeon, and white sturgeon and are expected to have positive effects on these species numbers so that the effect would be beneficial. Since this conservation measure is not applied to the other covered and non-covered fish species it would have no direct effect on them. However, since salmon and steelhead do prey on the other covered and non-covered fish species, higher numbers of these salmonids would result in some additional predation. The effect of this additional predation would not be adverse and would be less than significant because these species only occupy the Delta for short periods, they do not ingest large numbers of the other covered and non-covered fish species, and they are not the primary predators of the other covered and non-covered fish species.

Conservation Hatcheries (CM18)

CM18 *Conservation Hatcheries* would establish new and expand existing captive conservation propagation programs for delta smelt and longfin smelt. The principal purpose of this measure is to ensure the existence of refugial captive populations for these species thereby minimizing extinction risk. The population would also provide animals for experimentation to address uncertainties about their biology. Controlled laboratory experiments can provide important information that would contribute to better management. The effects would be beneficial for delta smelt and longfin smelt. There would be no effects on the other covered or non-covered fish species.

Urban Stormwater Treatment (CM19)

CM19 *Urban Stormwater Treatment* would reduce contaminants associated with urban areas because it provides for the treatment of stormwater discharges. Stormwater treatment would reduce urban loadings of pesticides (including pyrethroids), phosphorous, trace metals and other contaminants. These reductions would contribute to improved water quality in the Delta. Based on the improved overall water quality conditions and reduced pesticides the effect would be beneficial for all covered and non-covered fish species.

Removal/Relocation of Nonproject Diversions (CM21)

Alternative 1A has the potential to reduce entrainment related to agricultural diversions through conversion of agricultural lands into tidal habitat. Alternative 1A would restore 25,000 acres of tidal habitat in the Plan Area in the ELT and 65,000 acres in the LLT. There are more than 2,600 agricultural diversions in the Plan Area. The analysis estimated the removal of approximately 109 diversions by the ELT and approximately 236 by the LLT corresponding to approximately 4.2 and 12.4% of the total number of diversions, respectively. Modeling for delta smelt indicates that Alternative 1A would reduce overall entrainment of delta smelt larvae from approximately 0.08 to 0.34% in the ELT and from approximately 0.25 to 0.99% in the LLT. Longfin smelt generally exit the Delta earlier than delta smelt, thereby avoiding exposure to agricultural diversions when they are operating at capacity. Modeling representing longfin smelt larvae ranged from approximately 0 to over 10% with generally lower entrainment under Alternative 1A scenarios than baseline scenarios. For longfin smelt the average decrease in entrainment under Alternative 1A scenarios compared to baseline scenarios ranged from 2.3 to 3.5%, whereas the average increase under Alternative 1A scenarios was much less (0.0–0.1%). These effects would be beneficial for both delta smelt and longfin smelt. The effects on other covered and non-covered fish species would also be beneficial, although the amount of reduced entrainment for these covered and non-covered fish species is likely less than for the smelts.

Comparison of Alternative 1A to Alternative 4 (Proposed Project)

Alternative 1A would convey up to 15,000 cfs of water from the north Delta to the south Delta through pipelines/tunnels via five screened intakes on the east bank of the Sacramento River between Clarksburg and Walnut Grove (i.e., Intakes 1 through 5). While Alternative 4 would also consist of constructing similar intake and conveyance structures, in this same area of the river, it would include only three intakes, with a conveyance capacity of up to 9,000 cfs.

Operationally, Alternative 1A would follow Scenario A, while Alternative 4 would have different water conveyance operational criteria (Operational Scenario H), resulting in different patterns of water withdrawals from the north Delta, and potentially different effects on water quality and aquatic habitat conditions in the Plan Area. As fully described in Chapter 3, *Description of Alternatives,* Alternative 4 operations incorporate a decision tree process that results in four potential operational sub-scenarios, depending on the outcome of the decision tree process for spring outflow and Fall X2 operations.

Construction and Maintenance of CM1

The potential for construction and maintenance activities to affect the covered fish species would typically be proportional to the number of north Delta intakes constructed, and the total area of habitat affected. As a result, Alternative 1A would have a greater potential for effects because it includes the construction of two additional intakes (five), compared to only three for Alternative 4, along with the associated increase in dredging to re-contour the adjacent streambed. These additional intakes would result in a total of about 12.5 acres (77%) more in-water area affected by construction activities than for Alternative 4. In addition, the total length of shoreline permanently replaced by the intakes (11,900 feet) would be 87% greater than Alternative 4 (see Table 11-1A-SUM1). In addition to the effects of intake construction, Alternative 1A would require about 60% more (10.2 acres) of dredging to re-contour the streambed, offshore of the intake structure. However, both alternatives include a conveyance tunnel, and six barge landings to support tunnel construction. Each barge landing would include in-water and over-water structures, occupying approximately 15,000 square feet of nearshore habitat.

As discussed above, adverse effects would be effectively avoided and minimized by implementing environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*). These include pile driving minimization measures AQUA-1a and AQUA-1b, as well as isolating much of the in-water work inside cofferdams, constructing in areas that have limited use by the covered species, adhering to the approved in-water work windows, and activity-specific timing restrictions. While small numbers of covered fish species may be affected by construction activities, the effects would not limit overall population productivity.

In summary, construction and maintenance activities would result in limited temporary and permanent effects on the covered fish species and their habitat. While these effects would vary by species and species life stages, the implementation of environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*), would reduce most of these construction effects to be not adverse and less than significant. The implementation of habitat restoration activities, particularly CM6 *Channel Margin Enhancement*, would offset effects of habitat loss or alteration at the intake sites.

Water Operations of CM1

Water operations under Alternative 1A differ from Alternative 4 in a few ways. Alternative 1A utilizes five intakes in the north Delta that can convey up to 15,000 cfs while Alternative 4 utilizes three intakes and can only convey up to 9,000 cfs. As discussed in Chapter 5, *Water Supply*, average annual exports under Alternative 1A are anticipated to be 5,456 TAF while Alternative 4 has anticipated exports ranging from 4,414 (under H4) to 5,255 (under H1). Average annual outflows would typically be greater for the Alternative 4 operational scenarios than Alternative 1A (between 208 and 1,067 TAF greater). However, Alternative 1A would result in less annual average outflow than Existing Conditions (about 323 TAF less) and NAA (1,072 TAF less).

There are various benefits to entrainment and migration for some species under both alternatives, while Alternative 4 provides potentially greater beneficial effects on rearing conditions for Delta smelt, and lower potential for effects on longfin smelt rearing and migration, and green and white sturgeon migration.

Restoration Measures (CM2, CM4–CM7, and CM10)

With respect to restoration measures, Alternative 1A would be the same as Alternative 4. Consequently, the effects or these measures would also be the same.

Other Conservation Measures (CM12–CM19 and CM21)

With respect to other conservation measures, Alternative 1A would be the same as Alternative 4. Consequently, the effects associated with these other conservation measures would also be the same for both alternatives.

11.0.2.2 Alternative 1B—Summary of Effects

Overview

Alternative 1B would be nearly identical to Alternative 1A except that the up to 15,000 cfs of water routed from the north Delta to the south Delta would be conveyed by gravity through a canal along the east side of the Delta instead of through pipelines/tunnels. While the five intakes would be located and constructed on the east bank of the Sacramento River identical to those under Alternative 1A, the difference in the type of conveyance facility (e.g., canal) results in different construction details to a limited extent as they relate to potential impacts on fish. Specifically, eight culvert and three tunnel siphons would be utilized to divert canal water beneath existing water courses and their construction would occur within those water courses. Alternative 1B would also have one barge landing and 19 bridge crossings compared to six barge landings and no bridge crossings for Alternative 1A. Approximately 4,500 barge trips would occur during construction. Besides the primary difference of utilizing a canal rather than a tunnel, Alternative 1B would have other structural differences such as inclusion of an intermediate pumping plant and elimination of the intermediate forebay. However, these latter differences would not affect fish resources and are not evaluated further in this chapter. Overall, construction impacts from Alternative 1B would be similar to Alternative 1A but with additional in-water work.

Water supply and conveyance operations would follow the guidelines described as Scenario A, which is identical to those analyzed under Alternative 1A.

CM2, CM4–CM7, CM10, CM12–CM19, and CM21 would be implemented under this alternative, and these CMs would be identical to those under Alternative 1A.

Construction and Maintenance of CM1

As indicated above for Alternative 1A, the potential for construction and maintenance activities to affect the covered fish species would typically be proportional to the number of north Delta intakes constructed, and the total area of habitat affected. Alternative 1B includes the same five intakes as Alternative 1A, so the area affected by intake construction would be the same (see Table 11-1A-SUM1). Although Alternative 1B includes a conveyance canal instead of a tunnel, and only one barge landing instead of the six needed for Alternative 1A, most of the in-water construction activities would be the same.

Similar to Alternative 1A, between 1.2 and 6.9 acres of river area would be isolated behind cofferdams, and temporarily or permanently lost at each Alternative 1B intake, for a maximum estimated total of 28.7 acres. During the in-water construction period, a total of up to about 27.3 acres of in-water habitat would be affected by dredging activities, resulting in the loss or alteration of low-quality spawning, rearing, and migration habitat for covered fish species (see Table 11-1A-SUM1). Likewise, the footprint of the intake and transition wall structures would result in permanent loss of about 11,900 feet of primarily steep-banked and riprapped shoreline habitat. The barge landing would include in-water and over-water structures, occupying approximately 15,000 square feet of shoreline habitat, although this would be 83% lower than for Alternative 1A.

As discussed in detail for Alternative 1A, in-water and nearshore construction activities have the potential to cause adverse effects on covered species, although these adverse effects would be effectively avoided and minimized by implementing environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*). These include pile driving minimization measures AQUA-1a and AQUA-1b, as well as isolating much of the in-water work inside cofferdams, constructing in areas that have limited use by the covered species, adhering to the approved in-water work windows, and activity-specific timing restrictions.

While in-water construction activities would temporarily or permanently alter habitat conditions in the construction vicinity, the extent of the overall available habitat affected, and the relatively poor quality of the affected habitat, is expected to limit the effects of construction and maintenance activities on most covered fish species. While individual fish may be affected by construction activities, the effects would not limit overall population productivity.

In summary, construction and maintenance activities would result in limited temporary and permanent effects on the covered fish species or their habitat. While these effects would vary by species and species life stages, the implementation of environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*), would reduce most of these construction effects to be not adverse and less than significant. In addition, the implementation of Mitigation Measures Mitigation Measures AQUA-1a and AQUA 1b would reduce the severity of pile driving noise effects on all the covered species, to be not adverse and less than significant. The implementation of habitat restoration activities, particularly CM6 *Channel Margin Enhancement*, would offset effects of habitat loss or alteration at the intake sites.

Water Operations of CM1

With respect to water operations of CM1, Alternative 1B is the same as Alternative 1A. Consequently, all the effects associated with water operations of CM1 under Alternative 1B are the same as those described above under the Alternative 1A summary.

Restoration Measures (CM2, CM4–CM7, and CM10)

With respect to restoration measures, Alternative 1B is the same as Alternative 1A. Consequently, all the effects associated with restoration measures under Alternative 1B are the same as those described above under the Alternative 1A summary.

Other Conservation Measures (CM12–CM19 and CM21)

With respect to other conservation measures, Alternative 1B is the same as Alternative 1A. Consequently, all the effects associated with other conservation measures under Alternative 1B are the same as those described above under the Alternative 1A summary.

Comparison of Alternative 1B to Alternative 4 (Proposed Project)

Alternative 1B would divert up to 15,000 cfs of water from the north Delta via five screened intakes on the east bank of the Sacramento River between Clarksburg and Walnut Grove (i.e., Intakes 1 through 5). This water would be conveyed to the south Delta through an eastern diversion canal alignment, with invert culvert siphons needed to cross seven streams/sloughs along the route. While Alternative 4 would consist of constructing similar intakes structures, in this same area of the river, it would include only three intakes, with a conveyance tunnel/pipeline with a capacity of up to 9,000 cfs. While the Alternative 4 tunnel/pipeline structure would not require any culvert siphons, it would require five more barge landings (six total) to support the construction process, compared to Alternative 1B (one landing).

Alternative 1B would follow the same operational scenario as Alternative 1A (Operational Scenario A), while Alternative 4 would follow Operational Scenario H, resulting in different patterns of water withdrawals from the north Delta, and potentially different effects on water quality and aquatic habitat conditions in the Plan Area. As fully described in Chapter 3, *Description of Alternatives,* Alternative 4 operations incorporate a decision tree process that results in four potential operational sub-scenarios, depending on the outcome of the decision tree process for spring outflow and Fall X2 operations.

Construction and Maintenance of CM1

The potential for construction and maintenance activities to affect the covered fish species would typically be proportional to the number of north Delta intakes constructed, and the total area of habitat affected. As a result, Alternative 1B would have substantially greater potential for effects than Alternative 4, because it includes the construction of two additional intakes (five total). The additional intakes would also require additional dredging to re-contour the adjacent streambed. These effects would be the same as those described above for Alternative 1A (see Table 11-1A-SUM1).

In addition to the increased intake construction activities for Alternative 1B, the construction of seven invert culvert siphons to cross streams and sloughs along the conveyance canal route would require additional in-water construction work. These siphons could result in up to about 8 acres of additional in-water disturbance, compared to Alternative 4, which would tunnel under the water crossings without requiring in-water work at these crossings. In contrast to the additional in-water construction activities for the intakes and canal facilities, Alternative 1B would require five fewer barge landings to support construction, each with over-water structures occupying approximately 15,000 square feet of area.

As discussed above, adverse effects would be effectively avoided and minimized by implementing environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*). These include pile driving minimization measures AQUA-1a and AQUA-1b, as well as isolating much of the in-water work inside cofferdams, constructing in areas that have limited use by the covered species, adhering to the approved in-water work windows, and activity-specific timing restrictions. While individual fish may be affected by construction activities, the effects would not limit overall population productivity.

In summary, construction and maintenance activities would result in limited temporary and permanent effects on the covered fish species and their habitat. While these effects would vary by species and species life stages, the implementation of the environmental commitments, described above, would reduce most of these construction effects to be not adverse and less than significant. The implementation of habitat restoration activities, particularly CM6 *Channel Margin Enhancement*, would offset effects of habitat loss or alteration at the intake sites.

Water Operations of CM1

With respect to water operations, Alternative 1B would be the same as Alternative 1A. Please refer to the comparison of Alternative 1A to Alternative 4.

Restoration Measures (CM2, CM4–CM7, and CM10)

With respect to restoration measures, Alternative 1B would be the same as Alternative 4. Consequently, the effects or these measures would also be the same.

Other Conservation Measures (CM12–CM19 and CM21)

With respect to other conservation measures, Alternative 1B would be the same as Alternative 4. Consequently, the effects associated with these other conservation measures would also be the same for both alternatives.

11.0.2.3 Alternative 1C—Summary of Effects

Overview

Alternative 1C would be nearly identical to Alternative 1A except that the up to 15,000 cfs of water routed from the north Delta to the south Delta would be conveyed by gravity through a canal along the west side of the Delta instead of through pipelines/tunnels. This is similar to Alternative 1B, except that Alternative 1B utilizes canal conveyance on the east side of the Delta. Under Alternative 1C, the five intakes would be constructed on the west side of the Sacramento River rather than the east side as under Alternative 1A and Alternative 1B. Similar to Alternative 1B, while there would be the same types and number of intakes, the difference in the type of conveyance facility (e.g., canal) results in different construction details to a limited extent as they relate to potential impacts on fish. Specifically, nine culvert and no tunnel siphons would be utilized to divert canal water beneath existing water courses and their construction would occur within those water courses. Alternative 1C would also have two barge landings and 16 bridge crossings compared to six barge landings and no bridge crossings for Alternative 1A and one barge landing and 19 bridge crossings for Alternative 1B. Approximately 3,000 barge trips would occur during construction. Besides the primary difference of utilizing a canal rather than a tunnel, Alternative 1C would have other structural differences such as inclusion of an intermediate pumping plant and elimination of the intermediate forebay. However, these latter differences would not affect fish resources. Overall, construction impacts from Alternative 1C would be similar to Alternative 1A but with additional in-water work.

Water supply and conveyance operations would follow the guidelines described as Operational Scenario A, which is identical to those analyzed under Alternative 1A.

CM2, CM4–CM7, CM10, CM12–CM19, and CM21 would be implemented under this alternative, and these CMs would be identical to those under Alternative 1A.

Construction and Maintenance of CM1

As indicated above for Alternative 1A, the potential for construction and maintenance activities to affect the covered fish species would typically be proportional to the number of north Delta intakes constructed, and the total area of habitat affected. While Alternative 1C includes the same number of intakes (five) as Alternative 1A, they would be constructed on the opposite (west) shoreline of the Sacramento River, and the total area affected by intake construction would be about 14% greater than Alternative 1A (see Table 11-1A-SUM1). Although Alternative 1C includes a conveyance canal instead of a tunnel, and only two barge landings instead of the six needed for Alternative 1A, most of the in-water construction activities would be similar. Alternative 1C also includes 16 bridge crossing structures for the conveyance canal, compared to no bridge structures for Alternative 1A, although these structures are expected to include limited in-water construction activities.

At each Alternative 1C intake, between 1.4 and 7.8 acres of river area would be isolated behind cofferdams, and temporarily or permanently lost, for an estimated total of 32.7 acres. This would be slightly greater than for Alternative 1A. During the in-water construction period, a total of up to about 20.3 acres of low-quality spawning, rearing, and migration habitat for covered fish species would be affected by dredging activities. This is about 26% less loss or alteration than Alternative 1A (see Table 11-1A-SUM1). Likewise, the footprint of the intake and transition wall structures would result in permanent loss of about 10,100 feet of primarily steep-banked and riprapped shoreline habitat, or about 15% less than Alternative 1A. The two barge landings would include in-water and over-water structures, occupying approximately 15,000 square feet of shoreline habitat each, although this would be 67% less than for Alternative 1A.

While in-water construction activities would temporarily or permanently alter habitat conditions in the construction vicinity, the extent of the overall available habitat affected, and the relatively poor quality of the affected habitat, is expected to limit the effects of construction and maintenance activities on most covered fish species. Thus the effects would not measurably reduce potential population productivity.

In summary, construction and maintenance activities would result in limited temporary and permanent effects on the covered fish species or their habitat. While these effects would vary by species and species life stages, the implementation of environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*), would reduce most of these construction effects to be not adverse and less than significant. In addition, the implementation of Mitigation Measures Mitigation Measures AQUA-1a and AQUA 1b would reduce the severity of pile driving noise effects on all the covered species, to be not adverse and less than significant. The implementation of habitat restoration activities, particularly CM6 *Channel Margin Enhancement*, would offset effects of habitat loss or alteration at the intake sites.

Water Operations of CM1

With respect to water operations of CM1, Alternative 1C is the same as Alternative 1A. Consequently, all the effects associated with water operations of CM1 under Alternative 1C are the same as those described above under the Alternative 1A summary.

Restoration Measures (CM2, CM4–CM7, and CM10)

With respect to restoration measures, Alternative 1C is the same as Alternative 1A. Consequently, all the effects associated with restoration measures under Alternative 1C are the same as those described above under the Alternative 1A summary.

Other Conservation Measures (CM12–CM19 and CM21)

With respect to other conservation measures, Alternative 1C is the same as Alternative 1A. Consequently, all the effects associated with other conservation measures under Alternative 1C are the same as those described above under the Alternative 1A summary.

Comparison of Alternative 1C to Alternative 4 (Proposed Project)

Alternative 1C would convey up to 15,000 cfs of water from the north Delta to the south Delta through a surface canal on the west side of the Sacramento River, from five screened intakes constructed between Clarksburg and Walnut Grove (i.e., Intakes 1W through 5W). While Alternative 4 would construct similar intake facilities in this same portion of the river, it would include only three intakes (9,000 cfs combined capacity), and these intakes would be on the east side of the river. While Alternative 4 would tunnel under a number of waterways along the conveyance route, the surface canal for Alternative 1C would use culvert siphons to pass under nine waterways, requiring in-water construction. Alternative 1C would also have two barge landings and 16 bridge crossings along the canal route, compared to six barge landings and no bridge crossings for Alternative 4.

Alternative 1C would follow the same operational scenario as Alternative 1A (Operational Scenario A), while Alternative 4 would follow Operational Scenario H, resulting in different patterns of water withdrawals from the north Delta, and potentially different effects on water quality and aquatic habitat conditions in the Plan Area. As fully described in Chapter 3, *Description of Alternatives,* Alternative 4 operations incorporate a decision tree process that results in four potential operational sub-scenarios, depending on the outcome of the decision tree process for spring outflow and Fall X2 operations.

Construction and Maintenance of CM1

The potential for construction and maintenance activities to affect the covered fish species would typically be proportional to the number of north Delta intakes constructed, and the total area of habitat affected. As a result, Alternative 1C would have substantially greater potential for effects than Alternative 4, because it includes the construction of two additional intakes (five total). The additional intakes would also require about 17% more (3 acres) dredging to re-contour the adjacent streambed, compared to Alternative 4. The effects would be the similar to those described above for Alternative 1A (see Table 11-1A-SUM1).

In addition to the increased intake construction effects for Alternative 1C, the construction of nine invert culvert siphons for the water conveyance canal to cross stream and sloughs would have additional in-water effects. These siphons could result in up to about 6 acres of additional in-water disturbance, compared to Alternative 4, which would tunnel under the water crossings without requiring in-water work. In contrast to the additional in-water construction activities for the intakes and canal facilities, Alternative 1C would require four fewer barge landings than Alternative 4, each with over-water structures occupying approximately 15,000 square feet of area.

As discussed above, in-water and nearshore construction activities have the potential to cause adverse effects on covered species, although these adverse effects would be effectively avoided and minimized by implementing environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*). These include pile driving minimization measures AQUA-1a and AQUA-1b, as well as isolating much of the in-water work inside cofferdams, constructing in areas that have limited use by the covered species, adhering to the approved in-water work windows, and activity-specific timing restrictions. While individual fish may be affected by construction activities, the effects would not limit overall population productivity.

In summary, construction and maintenance activities would result in limited temporary and permanent effects on the covered fish species and their habitat. While these effects would vary by species and species life stages, the implementation of the environmental commitments, described above, would reduce most of these construction effects to be not adverse and less than significant. The implementation of habitat restoration activities, particularly CM6 *Channel Margin Enhancement*, would offset effects of habitat loss or alteration at the intake sites.

Water Operations of CM1

With respect to water operations, Alternative 1C would be the same as Alternative 1A. Please refer to the comparison of Alternative 1A to Alternative 4.

Restoration Measures (CM2, CM4–CM7, and CM10)

With respect to restoration measures, Alternative 1C would be the same as Alternative 4. Consequently, the effects or these measures would also be the same.

Other Conservation Measures (CM12–CM19 and CM21)

With respect to other conservation measures, Alternative 1C would be the same as Alternative 4. Consequently, the effects associated with these other conservation measures would also be the same for both alternatives.

11.0.2.4 Alternative 2A—Summary of Effects

Overview

Like Alternative 1A, Alternative 2A would consist of pipelines and tunnels generally located in the central Delta with an intermediate forebay; however, Alternative 2A could potentially entail two different intake and intake pumping plant locations. Currently, as an alternative to Intakes 1–5, intake locations 1, 2, 3, 6, and 7 are being considered. Selection of intake locations 6 and 7 would entail construction in the same region (north Delta) and would result in the same construction effects on fish species as discussed for Alternative 1A. In addition, some of the conveyance pipelines and the initial tunnel (Tunnel 1) between the intake pumping plants and the intermediate forebay would be adjusted depending on the intake locations. This alternative would convey water from five fish-screened intakes between Clarksburg and Walnut Grove (Intakes 6 and 7, if selected, would be downstream of Sutter and Steamboat Sloughs) to an intermediate forebay near the intakes, and then to a new Byron Tract Forebay adjacent to CCF. Construction effects for all fish species would be similar to those described for Alternative 1A.

Alternative 2A water conveyance operational criteria (Operational Scenario B) would be modified from those described for Alternative 1A. Like Alternative 1A, the Alternative 2A facilities could convey up to 15,000 cfs from the north Delta. Operational Scenario B includes incorporation of Fall X2 guidelines and more restrictive south Delta OMR flows, as described in Section 3.6.4.2, *North Delta and South Delta Water Conveyance Operational Criteria*. Operational Scenario B also includes north Delta diversion bypass flow criteria, flow criteria over Fremont Weir into Yolo Bypass, Delta inflow and outflow criteria, DCC gate operations, Rio Vista minimum instream flow criteria, operations for Delta water quality and residence criteria, and water quality criteria for agricultural and municipal/industrial diversions but would not include the San Joaquin River inflow/export ratio.

While the locations of the north Delta intakes could be different under this alternative than under Alternative 1A, the overall effects on fish are not expected to be measurably different, because of the distance between locations is small relative to the overall areas affected by operations under the alternative. CM2, CM4–CM7, CM10, CM12–CM19, and CM21 would be implemented under this alternative, and these CMs would be identical to those under Alternative 1A.

Construction and Maintenance of CM1

As indicated above for Alternative 1A, the potential for construction and maintenance activities to affect the covered fish species would typically be proportional to the number of north Delta intakes constructed, and the total area of habitat affected. Alternative 2A includes the same number of intakes (five) as Alternative 1A, and potentially the same intake locations. Therefore, the total area affected by intake construction would also be similar (see Table 11-1A-SUM1). Like Alternative 1A, Alternative 2A also includes a conveyance tunnel, and six barge landings, such that most of the in-water construction activities would be the same.

At each Alternative 2A intake, between 1.2 and 6.9 acres of river habitat would be isolated behind cofferdams, and temporarily or permanently lost, for an estimated maximum total of between 27.1 and 28.7 acres. During the in-water construction period, a total of up to about 26.0 acres of in-water habitat would be affected by dredging activities, resulting in slightly less loss or alteration of low-quality spawning, rearing, and migration habitat for covered fish species as Alternative 1A (see Table 11-1A-SUM1). Likewise, the footprint of the intake and transition wall structures would result in permanent loss of between 11,350 and 11,900 feet of primarily steep-banked and riprapped shoreline habitat. The six barge landings would include in-water and over-water structures, occupying approximately 15,000 square feet of shoreline habitat each.

While in-water construction activities would temporarily or permanently alter habitat conditions in the construction vicinity, the extent of the overall available habitat affected, and the relatively poor quality of the affected habitat, is expected to limit the effects of construction and maintenance activities on most covered fish species. Thus the effects would not measurably reduce potential population productivity.

In summary, construction and maintenance activities would result in limited temporary and permanent effects on the covered fish species or their habitat. While these effects would vary by species and species life stages, the implementation of environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*), would reduce most of these construction effects to be not adverse and less than significant. In addition, the implementation of Mitigation Measures Mitigation Measures AQUA-1a and AQUA 1b would reduce the severity of pile driving noise effects on all the covered species, to be not adverse and less than significant. The implementation of habitat restoration activities, particularly CM6 *Channel Margin Enhancement*, would offset effects of habitat loss or alteration at the intake sites.

Water Operations of CM1

The methods and analysis of Alternative 2A are the same as those previously described for Alternative 1A. However, Alternative 2A includes five intakes (1, 2, 3, 6, and 7) two of which are different than Alternative 1A (i.e., 6 and 7 rather than 4 and 5) and Alternative 2A uses water Operational Scenario B. The sizes of the conveyance infrastructures are similar while the water operations scenario differs with more restrictive OMR flow limits and an operational barrier at the head of Old River.

Changes in Exports and Outflow

As discussed in Chapter 5, *Water Supply*, over the long term, average annual Delta exports under Alternative 2A are anticipated to decrease slightly by 76 TAF relative to Existing Conditions, and increase by 627 TAF relative to the No Action Alternative. Over the long-term, approximately 58% of the exported water will be from the new north Delta intakes, and average monthly diversions at the south Delta intakes would correspondingly decrease. These changes would increase the proportion of San Joaquin River water flowing throughout the south, west, and interior Delta, and a corresponding decrease in the proportion of Sacramento River water.

Under Alternative 2A, long-term average annual Delta outflow is anticipated to increase 105 TAF relative to Existing Conditions and would decrease by 645 TAF relative to the NAA. It is important to note that some outflow changes under Alternative 2A are greater relative to Existing Conditions because Existing Conditions do not includes operations to meet Fall X2, whereas NAA and Alternative 2A do include Fall X2.

As a result of changes in points of diversion and the quantity and timing of diversions (more water diverted in August through mid-December and less water diverted mid-December through July), there would be beneficial, not adverse/less than significant, and adverse/significant and unavoidable effects/impacts on fish under Alternative 2A. Following is a summary of these effects as they relate to the key factors of entrainment and flow, which in turn affects fish survival and spawning, rearing, and migration habitat conditions.

Entrainment

Similar to Alternative 1A, overall entrainment of numerous species under Alternative 2A would be less than or similar to the levels experienced in the recent years. This is because the north Delta diversion operations would reduce reliance on south Delta export facilities (greater entrainment rates are expected to occur at south Delta facilities), along with additional minor benefits from decommissioning of agricultural diversions in restoration areas and implementation of an alternative intake for the North Bay Aqueduct. Additionally, the slightly reduced exports under Alternative 2A as compared to 1A provide further reductions in entrainment, resulting in some beneficial effects for delta smelt, longfin smelt, and some Chinook salmon.

Similar to Alternative 1A reduced entrainment of juvenile salmonids would occur primarily under the wetter conditions with little change under drier conditions.

Finally, Alternative 2A is expected to reduce Pacific and river lamprey entrainment due to reductions in south Delta exports and decommissioning agricultural diversions to an extent similar to Alternative 1A.

Since the proposed north Delta intakes under Alternative 2A are the same design as those proposed under Alternative 1A, the potential to affect some fish species through contact with the screens and/or increased predation around those facilities still exists at the same level as Alternative 1A. Regardless, these effects are considered to be not adverse.

In summary, entrainment is expected to remain at or below the levels currently experienced by fish in the Delta. There are very few instances where there would be increases, but these are substantially offset by decreases during other periods. Effects are at a minimum not adverse and less than significant, with effects being beneficial for many species.

Flows

While San Joaquin River flows are not expected to be directly affected by Alternative 2A, flow changes are expected in the Sacramento River and its tributaries, as well as within the Sacramento-San Joaquin Delta. Changes in flow will result from changes in releases from upstream reservoirs, diversions from the south Delta, and reductions in flows downstream of the proposed north Delta intakes. Also, more restrictive OMR flow limits and an operable barrier at the head of Old River will improve flow conditions in the south Delta.

The area of fall abiotic habitat for juvenile delta smelt in the open-water areas of the Suisun Bay, Suisun Marsh, and west Delta subregions would be larger under Alternative 2A than under NAA conditions. In contrast to Alternative 1A, this area would increase even more relative to Existing Conditions without the Fall X2 flows. The increase in fall abiotic habitat area in the open estuary is further enhanced by tidal marsh habitat restoration, when considered across all water year types, relative to both Existing Conditions and NAA. Assuming the expected benefits of habitat restoration are realized, the relative increase in abiotic habitat index would be at least 25% for all years combined, if not, there would be only minor changes in abiotic habitat index. Therefore, the overall effects on delta smelt are uncertain, until potential habitat restoration benefits are assessed. However, Alternative 2 may decrease sediment supply to the estuary by 8 to 9 percent, with the potential for decreased habitat suitability for delta smelt in some locations. In contrast, migration conditions are not expected to substantially change.

Decreased spring outflows under Alternative 2A have the potential to contribute to modest decreases in longfin smelt abundance from reduced larval transport flows and spring habitat quantity and quality for larval and early juvenile longfin smelt in the Suisun Marsh and west Delta subregions. However, habitat restoration could provide benefits through additional food production and export to longfin smelt rearing areas in Suisun Marsh, West Delta, and Cache Slough ROAs. Alternative 2A operations would be expected to result in 5–6% lower longfin smelt abundance compared to NAA, for all years combined.

With regard to salmonids, several issues were identified as described below with some of them resulting in adverse and/or significant effects. For example, Sacramento River attraction flows for migrating adult salmonids would be lower from operations of the north Delta diversions under Alternative 2A, but not to an adverse level. However, winter-run Chinook salmon would be adversely affected by an estimated 31% reduction in years with good spawning habitat availability, and a 45% decrease in the years with good juvenile stranding risks. Similarly, migration conditions for spring-run and fall-run/late fall-run Chinook salmon would be adversely affected as a result of reduced flows in the Feather River. Despite implementation of conservation and mitigation measures, which would reduce the severity of effects, these effects are likely to remain significant and unavoidable. While spring-run Chinook salmon rearing conditions would be affected to some degree, the overall effects cannot be determined with available modeling information, and additional modeling will be conducted to verify that an adverse effect is unlikely to occur. Steelhead would be adversely affected for several parameters under Alternative 2A. Compared to Existing Conditions, the quantity and quality of rearing and migration habitat would be substantially reduced due to decreases in flow and water temperatures elevated. Despite these significant and unavoidable effects, proposed adaptive management mitigation has the potential to reduce the severity of impacts to the salmonid species though not necessarily to a less than significant level.

Generally consistent with Alternative 1A, improved flow conditions over the Fremont Weir and in the Yolo Bypass provide substantial benefits to Sacramento splittail, primarily with regard to spawning and migration.

Alternative 2A would result in similar effects for green and white sturgeon as those described above for salmonids with respect to lower flows in the Feather River. Green sturgeon spawning, rearing, and migration habitat would be adversely affected. White sturgeon spawning and migration habitat would also be affected by reduced April and May Delta outflow, which has been correlated with reduced year class strength in some water year types. However, this relationship was reached in the absence of north Delta intakes and the exact mechanism that causes this correlation is not known at this time. This uncertainty would be addressed through targeted research and monitoring to be conducted in the years leading up to the initiation of north Delta facilities operations. These targeted investigations are expected to identify the primary mechanisms that drive sturgeon year-class strength, and the final determination of the overall effects of Alternative 2A relative to NAA.

Alternative 2A would not adversely affect spawning and egg incubation habitat for lamprey species, despite increased water temperatures on the Feather River and increased redd dewatering in the Sacramento and American rivers. Flow reductions on several waterways, including the Sacramento, Trinity, and American rivers, when compared to Existing Conditions, could affect lamprey rearing and migration habitat, although the differences would also not be significant or adverse.

As evidenced by this summary, some changes in flow under Alternative 2A are adverse to fish species. These flow changes are the result of upstream operational effects and would be largely independent of the range in locations for the five north Delta intakes under Alternative 2A. Alternative 2A also includes the same conservation measures as Alternative 1A, with habitat restoration that provide substantial habitat improvements for fish. When the flow and habitat restoration measures are considered together, many of the effects of Alternative 2A measures are beneficial or not adverse and/or less than significant. However, several effects resulting from changes in flows upstream of the Delta remain adverse and/or significant and unavoidable, particularly with regard to migration conditions for a number of covered fish species. Summary Table 11-2A-SUM1 presents the results of the flow related effects on fish.

Table 11-2A-SUM1. Results of Flow-Related Effects on Fish

Species	Entrainment	Spawning	Rearing	Migration
Delta smelt	NA/LTS	NA/LTS	ND/LTS	ND/LTS
Longfin smelt	B/B	ND/LTS (combined)		
Winter-Run Chinook salmon	B/B	A/SU	A/SU	A/SU
Spring-Run Chinook salmon	NA/LTS	ND/LTS	NA/LTS	A/SU
Fall-Run/Late Fall-Run Chinook salmon	NA/B	NA/LTS	NA/LTS	A/SU
Steelhead	NA/LTS	NA/LTS	A/SU	A/SU
Sacramento splittail	NA/LTS	NA/LTS	B/B	NA/LTS
Green sturgeon	NA/LTS	NA/LTS	NA/LTS	A/SU
White sturgeon	NA/LTS	NA/LTS	NA/LTS	ND/LTS
Pacific lamprey	NA/LTS	NA/LTS	NA/LTS	NA/LTS
River lamprey	NA/LTS	NA/LTS	NA/LTS	NA/LTS

Level of significance:

NEPA Conclusion	*CEQA Conclusion*
A = Adverse.	SU = Significant and Unavoidable.
NA = Not Adverse.	LTS = Less than Significant.
B = Beneficial.	B = Beneficial.
ND = Not Determined.	S = Significant.

Restoration Measures (CM2, CM4–CM7, and CM10)

With respect to restoration measures, Alternative 2A is the same as Alternative 1A. Consequently, all the effects associated with restoration measures under Alternative 2A are the same as those described above under the Alternative 1A summary.

Other Conservation Measures (CM12–CM19 and CM21)

With respect to other conservation measures, Alternative 2A is the same as Alternative 1A. Consequently, all the effects associated with other conservation measures under Alternative 2A are the same as those described above under the Alternative 1A summary.

Comparison of Alternative 2A to Alternative 4 (Proposed Project)

Alternative 2A would convey up to 15,000 cfs of water from five north Delta screened intakes on the east bank of the Sacramento River between Clarksburg and Walnut Grove, and pipeline/tunnel conveyance facilities to the south Delta. While Alternative 4 would construct similar intake and conveyance structures in this same area of the river, it would include only three intakes and a conveyance structure with a lower total capacity of 9,000 cfs.

Alternative 2A would follow Operational Scenario B, while Alternative 4 would follow Operational Scenario H, resulting in different patterns of water withdrawals from the north Delta, and potentially different effects on water quality and aquatic habitat conditions in the Plan Area. As fully described in Chapter 3, *Description of Alternatives,* Alternative 4 operations incorporate a decision tree process that results in four potential operational sub-scenarios, depending on the outcome of the decision tree process for spring outflow and Fall X2 operations.

Construction and Maintenance of CM1

The potential for construction and maintenance activities to affect the covered fish species would typically be proportional to the number of north Delta intakes constructed, and the total area of habitat affected. As a result, Alternative 2A would have a greater potential for effects because it includes the construction of two additional intakes (five), compared to only three for Alternative 4. These additional intakes would result in a total of up to about 12.5 acres (77%) more in-water area affected by construction activities than for Alternative 4. In addition, the total length of shoreline permanently replaced by the intakes (up to about 11,900 feet) would be 87% greater than Alternative 4 (see Table 11-1A-SUM1). In addition to the effects of intake construction, Alternative 2A would require about 52% more (8.9 acres) of dredging to re-contour the streambed, offshore of the intake structure. However, both alternatives include a tunnel/pipeline conveyance system, and six barge landings to support tunnel construction. Each barge landing would include in-water and over-water structures, occupying approximately 15,000 square feet of nearshore habitat.

As discussed above, in-water and nearshore construction activities have the potential to cause adverse effects on covered species, although these adverse effects would be effectively avoided and minimized by implementing environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*). These include pile driving minimization measures AQUA-1a and AQUA-1b, as well as isolating much of the in-water work inside cofferdams, constructing in areas that have limited use by the covered species, adhering to the approved in-water work windows, and activity-specific timing restrictions. While individual fish may be affected by construction activities, the effects would not limit overall population productivity.

In summary, construction and maintenance activities would result in limited temporary and permanent effects on the covered fish species and their habitat. While these effects would vary by species and species life stages, the implementation of environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*), would reduce most of these construction effects to be not adverse and less than significant. The implementation of habitat restoration activities, particularly CM6 *Channel Margin Enhancement*, would offset effects of habitat loss or alteration at the intake sites.

Water Operations of CM1

Water operations under Alternative 2A differ from Alternative 4 in several ways. Alternative 2A includes five intakes in the north Delta to convey up to 15,000 cfs, while Alternative 4 utilizes three intakes, and can only convey up to 9,000 cfs. As discussed in Chapter 5, *Water Supply*, average annual exports under Alternative 2A are anticipated to be 5,068 TAF, while Alternative 4 has anticipated exports ranging from 4,414 (under H4) to 5,255 (under H1). Changes in anticipated long-term average annual Delta outflow under Alternative 4 also vary between the operational scenarios (H1–H4). While the average annual outflows would typically be greater for the Alternative 4 operational scenarios than Alternative 2A (between 129 and 639 TAF greater), operational scenario H1 would result in about 220 TAF lower average annual outflow. Alternative 2A would also result in greater annual average outflow (about 105 TAF) than Existing Conditions, but about 644 TAF less than NAA.

There are various benefits to entrainment and rearing for some species under both alternatives. The substantive difference is that Alternative 2A results in adverse effects/significant and unavoidable impacts on spawning, rearing and migration of winter-run Chinook salmon; migration conditions for spring-run and fall-/late fall-run Chinook salmon; rearing and migration for steelhead; and migration for green sturgeon.

Restoration Measures (CM2, CM4–CM7, and CM10)

With respect to restoration measures, Alternative 2A would be the same as Alternative 4. Consequently, the effects or these measures would also be the same.

Other Conservation Measures (CM12–CM19 and CM21)

With respect to other conservation measures, Alternative 2A would be the same as Alternative 4. Consequently, the effects associated with these other conservation measures would also be the same for both alternatives.

11.0.2.5 Alternative 2B—Summary of Effects

Overview

Alternative 2B would include the same physical/structural water conveyance components, including a surface canal and eastern alignment, culvert and tunnel siphons, and bridges as Alternative 1B. Like Alternatives 1A and 1B, Alternative 2B would include five intake facilities on the Sacramento River. Intakes one through three would be in the same locations as Alternatives 1A and 1B, but the locations of the fourth and fifth intakes may be located downstream of the intakes described in Alternative 1A. Overall, construction impacts associated with Alternative 2B would be the same as those described for Alternative 1B.

Currently, as an alternative to Intakes 1–5, intake locations 1, 2, 3, 6, and 7 are being considered. Selection of intake locations 6 and 7 would entail construction in the same region (north Delta) and would result in the same construction effects on fish species as discussed for Alternative 1A. This alternative would convey water from five fish-screened intakes between Clarksburg and Walnut Grove (Intakes 6 and 7, if selected, would be downstream of Sutter and Steamboat Sloughs) to a new Byron Tract Forebay adjacent to CCF. Construction effects for all fish species would be similar to those analyzed for Alternative 1A.

Alternative 2B water conveyance operational criteria (Operational Scenario B) would be the same as Alternative 2A.

CM2, CM4–CM7, CM10, CM12–CM19, and CM21 would be implemented under this alternative, and these CMs would be identical to those under Alternatives 2A and 1A.

Construction and Maintenance of CM1

As indicated above for Alternative 1A, the potential for construction and maintenance activities to affect the covered fish species would typically be proportional to the number of north Delta intakes constructed, and the total area of habitat affected. Alternative 2B includes the same number of intakes (five) as Alternative 1A, and potentially the same intake locations, such that the total area affected by intake construction would be similar (see Table 11-1A-SUM1). Unlike Alternative 1A, Alternative 2B includes an east side conveyance canal, and one barge landing, such that most of the in-water construction activities would be about the same.

At each Alternative 2B intake, between 1.2 and 6.9 acres of river area would be isolated behind cofferdams, and temporarily or permanently lost, for an estimated maximum total of between 27.1 and 28. This range is the same as for Alternative 2A and similar to the areas affected by Alternative 1A. During the in-water construction period, a total of up to about 26.0 acres of in-water habitat would be affected by dredging activities, resulting in the loss or alteration of about 5% less low-quality spawning, rearing, and migration habitat for covered fish species than Alternative 1A (see Table 11-1A-SUM1). Likewise, the footprint of the intake and transition wall structures would result in permanent loss of between 11,350 and 11,900 feet of primarily steep-banked and riprapped shoreline habitat, which is similar to Alternative 1A. The barge landings would include in-water and over-water structures, occupying approximately 15,000 square feet of shoreline habitat.

As discussed in detail for Alternative 1A, in-water and nearshore construction activities have the potential to cause adverse effects on covered species, although these adverse effects would be effectively avoided and minimized by implementing environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*). These include pile driving minimization measures AQUA-1a and AQUA-1b, as well as isolating much of the in-water work inside cofferdams, constructing in areas that have limited use by the covered species, adhering to the approved in-water work windows, and activity-specific timing restrictions. While individual fish may be affected by construction activities, the effects would not limit overall population productivity.

In summary, construction and maintenance activities would result in limited temporary and permanent effects on the covered fish species or their habitat, and slightly less effects than Alternative 1A. While these effects would vary by species and species life stages, the implementation of environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*), would reduce most of these construction effects to be not adverse and less than significant. The implementation of habitat restoration activities, particularly CM6 *Channel Margin Enhancement*, would offset effects of habitat loss or alteration at the intake sites.

Water Operations of CM1

With respect to water operations of CM1, Alternative 2B is the same as Alternative 2A. Consequently, all the effects associated with water operations of CM1 under Alternative 2B are the same as those described above under the Alternative 2A summary.

Restoration Measures (CM2, CM4–CM7, and CM10)

With respect to restoration measures, Alternative 2B is the same as Alternatives 2A and 1A. Consequently, all the effects associated with restoration measures under Alternative 2B are the same as those described above under the Alternative 1A summary.

Other Conservation Measures (CM12–CM19 and CM21)

With respect to other conservation measures, Alternative 2B is the same as Alternatives 2A and 1A. Consequently, all the effects associated with other conservation measures under Alternative 2B are the same as those described above under the Alternative 1A summary.

Comparison of Alternative 2B to Alternative 4 (Proposed Project)

Alternative 2B would divert up to 15,000 cfs of water from the north Delta via five screened intakes on the east bank of the Sacramento River between Clarksburg and Walnut Grove. This water would be conveyed to the south Delta through an surface canal east of the river, with invert culvert siphons needed to cross seven streams/sloughs along the route. While Alternative 4 would consist of constructing similar intake facilities, in this same area of the river, it includes only three intakes, with a total combined capacity of 9,000 cfs. While the Alternative 4 tunnel/pipeline structure would not require any culvert siphons, it would require five more barge landings (six total) to support the construction process, compared to Alternative 2B (one landing).

Alternative 2B would follow Operational Scenario B, while Alternative 4 would follow Operational Scenario H, resulting in different patterns of water withdrawals from the north Delta, and potentially different effects on water quality and aquatic habitat conditions in the Plan Area. As fully described in Chapter 3, *Description of Alternatives,* Alternative 4 operations incorporate a decision tree process that results in four potential operational sub-scenarios, depending on the outcome of the decision tree process for spring outflow and Fall X2 operations.

Construction and Maintenance of CM1

The potential for construction and maintenance activities to affect the covered fish species would typically be proportional to the number of north Delta intakes constructed, and the total area of habitat affected. As a result, Alternative 2B would have substantially greater potential for effects than Alternative 4, because it includes the construction of two additional intakes (five total). The additional intakes would also require dredging to re-contour the adjacent streambed. These effects would be the same as those described above for Alternatives 1A and 1B (see Table 11-1A-SUM1).

In addition to the increased intake construction effects for Alternative 2B, compared to Alternative 4, the construction of seven invert culvert siphons for the water conveyance canal to cross stream and sloughs would result in additional in-water construction work. These siphons could result in up to about 8 acres of additional in-water disturbance, compared to Alternative 4, and the same as discussed above for Alternative 1B. As with Alternative 1B, Alternative 2B would require five fewer barge landings than Alternative 4, each with over-water structures occupying approximately 15,000 square feet of area.

As discussed above, in-water and nearshore construction activities have the potential to cause adverse effects on covered species, although these adverse effects would be effectively avoided and minimized by implementing environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*). These include pile driving minimization measures AQUA-1a and AQUA-1b, as well as isolating much of the in-water work inside cofferdams, constructing in areas that have limited use by the covered species, adhering to the approved in-water work windows, and activity-specific timing restrictions. While individual fish may be affected by construction activities, the effects would not limit overall population productivity.

In summary, construction and maintenance activities would result in limited temporary and permanent effects on the covered fish species and their habitat. While these effects would vary by species and species life stages, the implementation of environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*), would reduce most of these construction effects to be not adverse and less than significant. The implementation of habitat restoration activities, particularly CM6 *Channel Margin Enhancement*, would offset effects of habitat loss or alteration at the intake sites.

Water Operations of CM1

With respect to water operations, Alternative 2B would be the same as Alternative 2A. Please refer to the comparison of Alternative 2A to Alternative 4.

Restoration Measures (CM2, CM4–CM7, and CM10)

With respect to restoration measures, Alternative 2B would be the same as Alternative 4. Consequently, the effects or these measures would also be the same.

Other Conservation Measures (CM12–CM19 and CM21)

With respect to other conservation measures, Alternative 2B would be the same as Alternative 4. Consequently, the effects associated with these other conservation measures would also be the same for both alternatives.

11.0.2.6 Alternative 2C—Summary of Effects

Overview

Alternative 2C would have the same physical/structural water conveyance components and west alignment as Alternative 1C. Overall construction impacts from Alternative 2C would be similar to Alternative 1A but with additional in-water work such as culvert siphons and bridge crossings that are described under Alternative 1C.

Water supply and conveyance operations would follow the guidelines described as Operational Scenario B. Therefore, Alternative 2C has the same diversion and conveyance operations as Alternative 2A; consequently, the analysis under Alternative 2A is applicable to Alternative 2C.

CM2, CM4–CM7, CM10, CM12–CM19, and CM21 would be implemented under this alternative, and these CMs would be identical to those under Alternatives 2A and 1A.

Construction and Maintenance of CM1

As indicated above for Alternative 1A, the potential for construction and maintenance activities to affect the covered fish species would typically be proportional to the number of north Delta intakes constructed, and the total area of habitat affected. Alternative 2C includes the same number of intakes (five) and the same intake locations as Alternative 1C. Therefore, the total area affected by intake construction would be similar to Alternative 1C. Both of these alternatives would also have similar overall effects as Alternative 1A, which also has the same number of intakes (see Table 11-1A-SUM1). Unlike Alternative 1A, Alternative 2C includes a west side conveyance canal, and two barge landings, such that most of the in-water construction activities would be about the same.

At each Alternative 2C intake, between 1.4 and 7.8 acres of river area would be isolated behind cofferdams, and temporarily or permanently lost, for an estimated maximum total of 32.7 acres. Although these areas vary by intake, the overall range of effects would be slightly (about 14%) greater than Alternative 1A. During the in-water construction period, a total of up to about 20.3 acres of in-water habitat would be affected by dredging activities, this loss or alteration of low-quality spawning, rearing, and migration habitat for covered fish species would be about 25% less than for Alternative 1A (see Table 11-1A-SUM1). Likewise, the footprint of the intake and transition wall structures would result in permanent loss of about 10,100 feet of primarily steep-banked and riprapped shoreline habitat, or about 15% less than for Alternative 1A. The barge landings would include in-water and over-water structures, occupying approximately 15,000 square feet of shoreline habitat, although this would be about 67% less than for Alternative 1A.

As discussed in detail for Alternative 1A, in-water and nearshore construction activities have the potential to cause adverse effects on covered species, although these adverse effects would be effectively avoided and minimized by implementing environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*). These include pile driving minimization measures AQUA-1a and AQUA-1b, as well as isolating much of the in-water work inside cofferdams, constructing in areas that have limited use by the covered species, adhering to the approved in-water work windows, and activity-specific timing restrictions. While individual fish may be affected by construction activities, the effects would not limit overall population productivity.

In summary, construction and maintenance activities would result in limited temporary and permanent effects on the covered fish species or their habitat. While these effects would vary by species and species life stages, the implementation of environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*), would reduce most of these construction effects to be not adverse and less than significant. The implementation of habitat restoration activities, particularly CM6 *Channel Margin Enhancement*, would offset effects of habitat loss or alteration at the intake sites.

Water Operations of CM1

With respect to water operations of CM1, Alternative 2C is the same as Alternative 2A. Consequently, all the effects associated with water operations of CM1 under Alternative 2C are the same as those described above under the Alternative 2A summary.

Restoration Measures (CM2, CM4–CM7, and CM10)

With respect to restoration measures, Alternative 2C is the same as Alternatives 2A and 1A. Consequently, all the effects associated with restoration measures under Alternative 2C are the same as those described above under the Alternative 1A summary.

Other Conservation Measures (CM12–CM19 and CM21)

With respect to other conservation measures, Alternative 2C is the same as Alternatives 2A and 1A. Consequently, all the effects associated with other conservation measures under Alternative 2C are the same as those described above under the Alternative 1A summary.

Comparison of Alternative 2C to Alternative 4 (Proposed Project)

Alternative 2C would convey up to 15,000 cfs of water from the north Delta to the south Delta through a surface canal on the west side of the Sacramento River, from five screened intakes constructed between Clarksburg and Walnut Grove (i.e., Intakes 1 through 5). While Alternative 4 would construct similar intake facilities in this portion of the river, it would include only three intakes (9,000 cfs combined total capacity), and the intakes would be on the east side of the river. While Alternative 4 would tunnel under a number of waterways along the conveyance route, the surface canal for Alternative 2C would use culvert siphons to pass under nine waterways, requiring in-water construction. Alternative 2C would also have two barge landings and 16 bridge crossings compared to six barge landings and no bridge crossings for Alternative 4.

Alternative 2C would follow Operational Scenario B, while Alternative 4 would follow Operational Scenario H, resulting in different patterns of water withdrawals from the north Delta, and potentially different effects on water quality and aquatic habitat conditions in the Plan Area. As fully described in Chapter 3, *Description of Alternatives,* Alternative 4 operations incorporate a decision tree process that results in four potential operational sub-scenarios, depending on the outcome of the decision tree process for spring outflow and Fall X2 operations.

Construction and Maintenance of CM1

The potential for construction and maintenance activities to affect the covered fish species would typically be proportional to the number of north Delta intakes constructed, and the total area of habitat affected. As a result, Alternative 2C would have substantially greater potential for effects than Alternative 4, because it includes the construction of two additional intakes (five total). The additional intakes would also require dredging to re-contour the adjacent streambed. These effects would be the similar to those described above for Alternative 1A and 1C (see Table 11-1A-SUM1).

In addition to the increased intake construction effects for Alternative 2C, the construction of nine invert culvert siphons for the water conveyance canal to cross stream and sloughs would have additional in-water effects. These siphons could result in up to about 6 acres of additional in-water disturbance, compared to Alternative 4, which would tunnel under the water crossings without requiring in-water work. In contrast to the additional in-water construction activities for the intakes and canal facilities, Alternative 2C would require four fewer barge landings than Alternative 4 each with over-water structures occupying approximately 15,000 square feet of area.

As discussed above, in-water and nearshore construction activities have the potential to cause adverse effects on covered species, although these adverse effects would be effectively avoided and minimized by implementing environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*). These include pile driving minimization measures AQUA-1a and AQUA-1b, as well as isolating much of the in-water work inside cofferdams, constructing in areas that have limited use by the covered species, adhering to the approved in-water work windows, and activity-specific timing restrictions. While individual fish may be affected by construction activities, the effects would not limit overall population productivity.

In summary, construction and maintenance activities would result in limited temporary and permanent effects on the covered fish species and their habitat. While these effects would vary by species and species life stages, the implementation of environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*), would reduce most of these construction effects to be not adverse and less than significant. The implementation of habitat restoration activities, particularly CM6 *Channel Margin Enhancement*, would offset effects of habitat loss or alteration at the intake sites.

Water Operations of CM1

With respect to water operations, Alternative 2C would be the same as Alternative 2A. Please refer to the comparison of Alternative 2A to Alternative 4.

Restoration Measures (CM2, CM4–CM7, and CM10)

With respect to restoration measures, Alternative 2C would be the same as Alternative 4. Consequently, the effects or these measures would also be the same.

Other Conservation Measures (CM12–CM19 and CM21)

With respect to other conservation measures, Alternative 2C would be the same as Alternative 4. Consequently, the effects associated with these other conservation measures would also be the same for both alternatives.

11.0.2.7 Alternative 3—Summary of Effects

Overview

Alternative 3 is the same as Alternative 1A except that it includes two intakes rather than five. Intakes 1 and 2 would be constructed instead of Intakes 1, 2, 3, 4, and 5. Alternative 3 also includes Operational Scenario A as does Alternative 1A. However, while Alternative 1A would divert up to 15,000 cfs in the north Delta, Alternative 3 would divert up to 6,000 cfs.

Construction and Maintenance of CM1

As indicated above for Alternative 1A, the potential for construction and maintenance activities to affect the covered fish species would typically be proportional to the number of north Delta intakes constructed, and the total area of habitat affected. Alternative 3 includes two intakes, which is three less than the five intakes for Alternative 1A. Therefore, the total area displaced by the intakes would be about 13.5 acres less for Alternative 3 (see Table 11-1A-SUM1). Similar to Alternative 1A, Alternative 3 includes a conveyance tunnel, with six barge landings.

At each Alternative 3 intake, between 1.2 and 6.0 acres of river area would be isolated behind cofferdams, and temporarily or permanently lost, for an estimated maximum total of 11 acres. Although these areas vary by intake, the overall range of effects would be slightly less than Alternative 1A. During the in-water construction period, a total of up to about 10.2 acres of in-water habitat would be affected by dredging activities, this loss or alteration of low-quality spawning, rearing, and migration habitat for covered fish species would be about 63% less than for Alternative 1A (see Table 11-1A-SUM1). Similarly, the footprint of each intake and transition wall structures would result in permanent loss of about 4,450 feet of primarily steep-banked and riprapped shoreline habitat, also about 63% less than for Alternative 1A. The barge landings would include in-water and over-water structures, occupying approximately 15,000 square feet of shoreline habitat.

As discussed in detail for Alternative 1A, in-water and nearshore construction activities have the potential to cause adverse effects on covered species, although these adverse effects would be effectively avoided and minimized by implementing environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*). These include pile driving minimization measures AQUA-1a and AQUA-1b, as well as isolating much of the in-water work inside cofferdams, constructing in areas that have limited use by the covered species, adhering to the approved in-water work windows, and activity-specific timing restrictions. While individual fish may be affected by construction activities, the effects would not limit overall population productivity.

In summary, construction and maintenance activities would result in limited temporary and permanent effects on the covered fish species or their habitat. While these effects would vary by species and species life stages, the implementation of environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*), would reduce most of these construction effects to be not adverse and less than significant. The implementation of habitat restoration activities, particularly CM6 *Channel Margin Enhancement*, would offset effects of habitat loss or alteration at the intake sites.

Water Operations of CM1

The methods and analysis of Alternative 3 are the same as those previously described for Alternative 1A. However, Alternative 3 includes two intakes rather than the five utilized in Alternative 1A, while Alternative 3 uses the same water Operational Scenario A as Alternative 1A. Since the size of the conveyance infrastructure and the water diversion differs, the effects are different.

Changes in Exports and Outflow

As discussed in Chapter 5, *Water Supply*, over the long term, average annual Delta exports under Alternative 3 are anticipated to increase by 227 TAF relative to Existing Conditions, and by 930 TAF relative to the No Action Alternative. Over the long-term, approximately 35% of the exported water will be from the new north Delta intakes, and average monthly diversions at the south Delta intakes would correspondingly decrease. These changes would increase the proportion of San Joaquin River water flowing throughout the south, west, and interior Delta, and a corresponding decrease in the proportion of Sacramento River water but not to the same extent as Alternative 1A.

Under Alternative 3, long-term average annual Delta outflow is anticipated to decrease 227 TAF relative to Existing Conditions and by 977 TAF relative to the NAA. It is important to note that some outflow changes under Alternative 3 are greater relative to NAA because Existing Conditions and Alternative 3 do not include operations to meet Fall X2, whereas NAA does include Fall X2.

As a result of changes in points of diversion and the quantity and timing of diversions (more water diverted in December through mid-June and less water diverted mid-June through November), there would be beneficial, not adverse/less than significant, and adverse/significant and unavoidable effects/impacts on fish under Alternative 3. Following is a summary of these effects as they relate to the key factors of entrainment and flow, which in turn affects fish survival and spawning, rearing, and migration habitat conditions.

Entrainment

Similar to Alternative 1A, overall entrainment of a number of species under Alternative 3 would be slightly less than or similar to the levels experienced in the recent years, except for longfin smelt and spring- and fall-/last fall-run Chinook salmon. This is because the north Delta diversion operations would reduce reliance on south Delta export facilities (greater entrainment rates are expected to occur at south Delta facilities), along with additional minor benefits from decommissioning of agricultural diversions in restoration areas and implementation of an alternative intake for the North Bay Aqueduct. Effects would be significant and adverse for these three species, primarily because of the increase in reverse OMR flows.

Since the proposed north Delta intakes under Alternative 3 are the same design as those proposed under Alternative 1A, the potential to affect some fish species through contact with the screens and/or increased predation around those facilities still exists but to a lesser extent because of the fewer number of intakes (two as compared to five). Regardless, these effects are considered to be not adverse.

In summary, entrainment is expected to remain at or below the levels currently experienced by fish in the Delta except for longfin smelt. There are very few instances where there would be increases, but these are substantially offset by decreases during other periods. Effects are at a minimum not adverse and less than significant.

Flows

While San Joaquin River flows are not expected to be affected by Alternative 3, flow changes are expected in the Sacramento River and its tributaries, as well as within the Sacramento-San Joaquin Delta. Changes in flow will result from changes in releases from upstream reservoirs, diversions from the south Delta, and reductions in flows downstream of the proposed north Delta intakes.

Rearing habitat conditions for juvenile delta smelt are considered with respect to a fall abiotic habitat index with and without the assumption that habitat restoration benefits are realized. Assuming habitat benefits are realized, the abiotic habitat index under Alternative 3 would be 25% lower than NAA in wet water year types, 8% lower in above normal water year types, but 24–35% greater than baseline in other water year types. The average abiotic habitat index for Alternative 3 with habitat restoration would be about the same as NAA assuming 100% habitat occupancy by delta smelt. However, migration conditions are not expected to substantially change under Alternative 3.

Under Alternative 3 longfin smelt relative abundance would be reduced 14–17% in above normal water year types, and reduced 13–15% in below normal water year types compared to NAA. However, longfin smelt might benefit from habitat restoration in Cache Slough, west Delta, and Suisun Bay, through potential additional food production and export to rearing areas.

With regard to salmonids, several issues were identified as described below with a number of them resulting in adverse and/or significant effects. For example, Sacramento River attraction flows for migrating adult salmonids would be lower from operations of the north Delta diversions under Alternative 3, but not to an adverse level. Winter-run Chinook salmon would be adversely affected by the reduced extent and quality of fry and juvenile rearing and migration habitat, as a result of reduced flows, although the effects on spawning and egg incubation conditions are currently uncertain. However, Alternative 3 would reduce spawning habitat conditions to an adverse level for spring-run salmonids, as well as migration conditions for meaningful portions of the fall-run and late fall-run Chinook salmon populations, although the potential effects on spring-run Chinook salmon migration conditions are uncertain.

Steelhead would be adversely affected for several parameters under Alternative 3. Compared to Existing Conditions, the quantity and quality of rearing and migration habitat would be substantially reduced due to decreases in flow in the Feather River and American River. Flows generally improve and are beneficial in the Trinity River and Clear Creek. However, due to uncertainties, the overall effects of Alternative 3 on steelhead migration conditions cannot be determined with available modeling data, but will be reassessed with future modeling results.

Generally consistent with Alternative 1A, improved flow conditions over the Fremont Weir and in the Yolo Bypass provide benefits to Sacramento splittail, primarily with regard to spawning and migration.

For green and white sturgeon, reduced upstream flows under Alternative 3 would result in some reductions in rearing, spawning, and migration habitat. While most of these effects would not be significant or adverse, a significant and unavoidable adverse impacts to green sturgeon migration habitat conditions would occur. While proposed mitigation has the potential to reduce the severity of impact, this would not necessarily result in a not adverse determination. However, based on an apparent positive correlation between Delta outflows and white sturgeon year-class strength, the effects of Alternative 3 on white sturgeon migration conditions are uncertain, as the exact mechanism driving this correlation is not known. These targeted investigations are expected to identify the primary mechanisms that drive sturgeon year-class strength, and the final determination of the overall effects of Alternative 3 relative to NAA.

Similar to sturgeon, Alternative 3 would affect spawning and egg incubation habitat for lamprey species as a result of increased water temperatures on the Feather River and redd dewatering in the Sacramento and American rivers. Flow reductions on several waterways, including the Sacramento, Trinity, and American rivers, when compared to Existing Conditions, would have an adverse effect on Pacific lamprey spawning and incubation conditions. While substantial flow changes would occur, these changes would not result in a significant impact on river lamprey because the differences are primarily the result of climate change, sea level rise and future water demand and not attributable to the alternative.

As evidenced by this summary, changes in flow under Alternative 3 are adverse to some fish species. Alternative 3 also includes the same conservation measures as Alternative 1A which provide substantial habitat improvements for fish. When the flow and habitat restoration measures are considered together, many of the effects of Alternative 3 measures are beneficial or not adverse and/or less than significant. However, several effects resulting from changes in flows upstream of the Delta remain adverse and/or significant and unavoidable. While adaptive management mitigation measures would also be implemented to reduce the severity of effects, such reductions would not necessarily reach a not adverse or less than significant level.

Summary Table 11-3-SUM1 presents the results of the flow related effects on fish.

Table 11-3-SUM1. Results of Flow-Related Effects on Fish

Species	Entrainment	Spawning	Rearing	Migration
Delta smelt	NA/LTS	NA/LTS	ND/LTS	ND/LTS
Longfin smelt	A/SU	ND/S (combined)		
Winter-Run Chinook salmon	B/B	ND/LTS	A/SU	A/LTS
Spring-Run Chinook salmon	A/S	A/SU	NA/LTS	ND/LTS
Fall-Run/Late Fall-Run Chinook salmon	A/S	NA/LTS	NA/LTS	A/SU
Steelhead	NA/LTS	NA/LTS	A/SU	ND/LTS
Sacramento splittail	NA/B	NA/LTS	B/B	NA/LTS
Green sturgeon	NA/LTS	NA/LTS	NA/LTS	A/SU
White sturgeon	NA/LTS	NA/LTS	NA/LTS	ND/LTS
Pacific lamprey	NA/LTS	A/SU	NA/LTS	NA/LTS
River lamprey	NA/LTS	NA/LTS	NA/LTS	NA/LTS

Level of significance:

NEPA Conclusion	CEQA Conclusion
A = Adverse.	SU = Significant and Unavoidable.
NA = Not Adverse.	LTS = Less than Significant.
B = Beneficial.	B = Beneficial.
ND = Not Determined.	S = Significant.

Restoration Measures (CM2, CM4–CM7, and CM10)

With respect to restoration measures, Alternative 3 is the same as Alternative 1A. Consequently, all the effects associated with restoration measures under Alternative 3 are the same as those described above under the Alternative 1A summary.

Other Conservation Measures (CM12–CM19 and CM21)

With respect to other conservation measures, Alternative 3 is the same as Alternative 1A. Consequently, all the effects associated with other conservation measures under Alternative 3 are the same as those described above under the Alternative 1A summary.

Comparison of Alternative 3 to Alternative 4 (Proposed Project)

Alternative 3 would convey up to 6,000 cfs of water from two screened north Delta intakes on the east bank of the Sacramento River near Clarksburg, and pipeline/tunnel conveyance facilities to the south Delta. While Alternative 4 would have a similar conveyance structure, it would have one additional intake (three total), with a total capacity of 9,000 cfs.

Alternative 3 would also have a different operating scenario (Scenario A) than Alternative 4 (Scenario H), resulting in different patterns of water withdrawals from the north Delta, and potentially different effects on water quality and aquatic habitat conditions in the Plan Area. As fully described in Chapter 3, *Description of Alternatives,* Alternative 4 operations incorporate a decision tree process that results in four potential operational sub-scenarios, depending on the outcome of the decision tree process for spring outflow and Fall X2 operations.

Construction and Maintenance of CM1

The potential for construction and maintenance activities to affect the covered fish species would typically be proportional to the number of north Delta intakes constructed, and the total area of habitat affected. As a result, Alternative 3 would have a lower potential for effects than Alternative 4 because it includes the construction of one less intake (two). This would result in up to about 5.2 acres (32%) less in-water area affected by construction activities than for Alternative 4. In addition, the total length of shoreline permanently replaced by the intakes (up to about 4,450 feet) would be 30% less than Alternative 4 (see Table 11-1A-SUM1). In addition to the effects of intake construction, Alternative 3 would require about 40% less dredging (about 6.9 acres) to re-contour the streambed adjacent to the intake structures. However, both alternatives include a tunnel/pipeline conveyance system, and six barge landings to support tunnel construction. Each barge landing would include in-water and over-water structures, occupying approximately 15,000 square feet of nearshore habitat.

As discussed above, in-water and nearshore construction activities have the potential to cause adverse effects on covered species, although these adverse effects would be effectively avoided and minimized by implementing environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*). These include pile driving minimization measures AQUA-1a and AQUA-1b, as well as isolating much of the in-water work inside cofferdams, constructing in areas that have limited use by the covered species, adhering to the approved in-water work windows, and activity-specific timing restrictions. While individual fish may be affected by construction activities, the effects would not limit overall population productivity.

In summary, construction and maintenance activities would result in limited temporary and permanent effects on the covered fish species and their habitat. While these effects would vary by species and species life stages, the implementation of environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*), would reduce most of these construction effects to be not adverse and less than significant. The implementation of habitat restoration activities, particularly CM6 *Channel Margin Enhancement*, would offset effects of habitat loss or alteration at the intake sites.

Water Operations of CM1

Water operations under Alternative 3 differ from Alternative 4 in several ways. Alternative 3 includes two intakes in the north Delta to convey up to 6,000 cfs, while Alternative 4 utilizes three intakes and can convey up to 9,000 cfs. As discussed in Chapter 5, *Water Supply*, average annual exports under Alternative 3 are anticipated to be 5,371 TAF, which is greater than anticipated exports under all four operational scenarios for Alternative 4 (4,414 to 5,255 TAF). Average annual exports under Alternative 3 would also be greater than Existing Conditions (5,144 TAF), as well as NAA (4,441 TAF).

Changes in anticipated long-term average annual Delta outflow under Alternative 4 also vary between the operational scenarios (H1–H4). The average annual outflows would be greater for all the Alternative 4 operational scenarios than Alternative 3 (between 113 and 972 TAF greater). Alternative 3 would result in lower annual average outflow (about 228 TAF) than Existing Conditions, but about 977 TAF less than NAA.

There are various benefits for some species under both alternatives; Alternative 4 provides beneficial effects on entrainment of longfin smelt, spring-run Chinook salmon, and Sacramento splittail migration, while Alternative 3 is beneficial to winter-run Chinook salmon and Sacramento splittail. The substantive difference is that while Alternative 3 results in adverse effects/significant and unavoidable impacts on longfin smelt entrainment, Alternative 4 would be beneficial. The effects on longfin smelt spawning, rearing, and migration conditions, are uncertain for both alternatives. Alternative 3 would also result in adverse effects/significant and unavoidable impacts on migration and rearing of winter-run Chinook salmon; migration for fall-/late fall-run Chinook salmon; steelhead rearing; migration for green sturgeon; and spawning for Pacific lamprey.

Restoration Measures (CM2, CM4–CM7, and CM10)

With respect to restoration measures, Alternative 3 would be the same as Alternative 4. Consequently, the effects or these measures would also be the same.

Other Conservation Measures (CM12–CM19 and CM21)

With respect to other conservation measures, Alternative 3 would be the same as Alternative 4. Consequently, the effects associated with these other conservation measures would also be the same for both alternatives.

11.0.2.8 Alternative 4—Summary of Effects

Overview

Alternative 4 is similar to Alternative 1A except that it includes three intakes rather than five. Intakes 2, 3, and 5 would be constructed instead of Intakes 1, 2, 3, 4, and 5. As a result, Alternative 4 would divert up to 9,000 cfs of water from the north Delta, compared to a maximum of 15,000 cfs under Alternative 1A. However, it includes the same number and location of barge landings as discussed above for Alternative 1A. As indicated above, Alternative 4 would follow Operational Scenario H, which incorporates a decision tree process (see Chapter 3, *Description of Alternatives*) that results in four potential operational sub-scenarios, depending on the outcome of the decision tree process for spring outflow and Fall X2 operations.

Construction and Maintenance of CM1

As indicated above for Alternative 1A, the potential for construction and maintenance activities to affect the covered fish species would typically be proportional to the number of north Delta intakes constructed, and the total area of habitat affected. Alternative 4 includes only three intakes, compared to the five intakes for Alternative 1A. Therefore, the total area affected by intakes would be about 16.7 acres less for Alternative 4 (see Table 11-1A-SUM1). Similar to Alternative 1A, Alternative 4 includes a conveyance tunnel, with six barge landings.

At each Alternative 4 intake, between 1.3 and 6.9 acres of river area would be isolated behind cofferdams, and temporarily or permanently lost, for an estimated maximum total of 16.2 acres. Although these areas vary by intake, the overall range of effects would be slightly lower than Alternative 1A. During the in-water construction period, a total of up to about 17.1 acres of in-water habitat would be affected by dredging activities, this loss or alteration of low-quality spawning, rearing, and migration habitat for covered fish species would be about 37% less than for Alternative 1A (see Table 11-1A-SUM1). Similarly, the footprint of each intake and transition wall structures would result in permanent loss of about 6,360 feet of primarily steep-banked and riprapped shoreline habitat, about 47% less than for Alternative 1A. The barge landings would include in-water and over-water structures, occupying approximately 15,000 square feet of shoreline habitat.

As discussed in detail for Alternative 1A, in-water and nearshore construction activities have the potential to cause adverse effects on covered species, although these adverse effects would be effectively avoided and minimized by implementing environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*). These include pile driving minimization measures AQUA-1a and AQUA-1b, as well as isolating much of the in-water work inside cofferdams, constructing in areas that have limited use by the covered species, adhering to the approved in-water work windows, and activity-specific timing restrictions. While individual fish may be affected by construction activities, the effects would not limit overall population productivity.

In summary, construction and maintenance activities would result in limited temporary and permanent effects on the covered fish species or their habitat. While these effects would vary by species and species life stages, the implementation of environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*), would reduce most of these construction effects to be not adverse and less than significant. The implementation of habitat restoration activities, particularly CM6 *Channel Margin Enhancement*, would offset effects of habitat loss or alteration at the intake sites.

Water Operations of CM1

The methods and analysis of Alternative 4 are the same as those previously described for Alternative 1A. However, Alternative 4 includes three intakes rather than the five utilized in Alternative 1A. Alternative 4 also includes different water conveyance operational criteria (Operational Scenario H) than Alternative 1A (Operational Scenario A), resulting in different patterns of water withdrawals from the north Delta, and potentially different effects on water quality and aquatic habitat conditions in the Plan Area. As fully described in Chapter 3, *Description of Alternatives,* Alternative 4 operations incorporate a decision tree process that results in four potential operational sub-scenarios, depending on the outcome of the decision tree process for spring outflow and Fall X2 operations. These alternative outflow scenarios for spring and fall have the potential to cause differences in upstream conditions or in-Delta flows in other seasons as well (i.e., summer and winter). The four potential operational outcomes of the decision tree are as follows:

- Scenario H1 – Low outflow scenario (LOS) excludes enhanced spring outflow and excludes Fall X2 operations.
- Scenario H2 - includes enhanced spring outflow, but excludes Fall X2 operations. This scenario lies within the range of the other scenarios.
- Scenario H3 – Evaluated starting operations (ESO) excludes enhanced spring outflow, but includes Fall X2 operations.
- Scenario H4 – High outflow scenario (HOS) includes enhanced spring outflow, and includes Fall X2 operations.

The intent of Alternative 4 is to use the decision tree to test operational scenarios in order to achieve results that are not adverse and are less than significant. The operations impact analysis compares late long term (LLT) results for Existing Conditions (CEQA) or no action (NEPA) with the range of outcomes from the operational sub-scenarios (H1–H4), and concludes with a single impact statement for each issue. Since the size of the conveyance infrastructure and the water diversion differs, the effects are different than those described for Alternative 1A.

CM2, CM4–CM7, CM10, CM12–CM19, and CM21 would be implemented under this alternative, and these CMs would be identical to those under Alternative 1A.

Changes in Exports and Outflow

As discussed in Chapter 5, *Water Supply*, over the long term, average annual Delta exports under Alternative 4 are anticipated to increase relative to Existing Conditions by 111 TAF under scenario H1 and decrease relative to Existing Conditions by 434 TAF (under scenario H2), 199 TAF (under scenario H3), and 730 TAF (under scenario H4). Relative to the No Action Alternative, average annual Delta exports are anticipated to increase by 814 TAF (under scenario H1), 269 TAF (under scenario H2), and 504 TAF (under scenario H3), while they are expected to decrease relative to the No Action Alternative by 27 TAF under scenario H4. Over the long-term, approximately 48% (H1:47%, H2:46%, H3:49%, H4:49%) of the exported water will be from the new north Delta intakes, and average monthly diversions at the south Delta intakes would correspondingly decrease. These changes would increase the proportion of San Joaquin River water flowing throughout the South, West, and Interior Delta, and a corresponding decrease in the proportion of Sacramento River water.

Under Alternative 4, long-term average annual Delta outflow would vary depending on time of year and operating scenario (H1–H4). Late-fall and winter outflows remain similar or show minor reductions in all four Alternative 4 scenarios compared to No Action Alternative. In the spring months, outflow would decrease under scenarios H1 and H3 as compared to No Action Alternative, while the enhanced spring outflow requirement under scenarios H2 and H4 would result in increased or similar outflow compared to No Action Alternative. SWP and CVP exports in summer months would increase and result in lower outflow under all four scenarios compared to No Action Alternative. In the fall months, outflow would reduce under Alternative 4 H1 and H2 compared to No Action Alternative, while it will increase or remain similar under scenarios H3 and H4 because of the Fall X2 requirement, in wet, above-normal and below-normal years. All four scenarios would show increased or similar outflow in September and October months of all year types because of the stringent south Delta export constraints.

Long-term average and wet year peak outflows would increase in winter months with a corresponding decrease in spring months because of the shift in system inflows caused by climate change and increased Delta exports. In other year types, scenarios H1 and H3 would result in lower or similar outflow in the spring months, while scenarios H2 and H4 would result in higher or similar outflow, because of the enhanced spring outflow requirements. In summer and fall months, all four scenarios would result in similar or higher outflow because of changes in export patterns and stringent fall south Delta export requirements, and also because of the Fall X2 requirements in scenarios H3 and H4. The incremental changes in Delta outflow between Alternative 4 (all scenarios) and Existing Conditions would be a function of both the facility and operations assumptions of Alternative 4 (including a total north Delta intake capacity of 9,000 cfs, more restrictive OMR, enhanced spring outflow and/or Fall X2 requirements) and the reduction in water supply availability due to sea level rise and climate change.

Based on results from all four possible outcomes of the Alternative 4, Delta outflow under Alternative 4 (all scenarios) would likely decrease or remain similar compared to the conditions without the project.

As a result of changes in points of diversion and the quantity and timing of diversions, there would be a range of effects/impacts on fish under Alternative 4. However, given the flexibility provided by the sub-scenarios and the primary intent of the decision tree to test operational scenarios in order to achieve results that are not adverse and are less than significant, the results of Alternative 4 would typically be either beneficial or not adverse/less than significant. Following is a summary of these effects as they relate to the key factors of entrainment and flow, which in turn affects fish survival and spawning, rearing, and migration habitat conditions.

Entrainment

Similar to Alternative 1A, overall entrainment of numerous species under Alternative 4 would be less than or similar to the levels experienced in the recent years. This is because the north Delta diversion operations would reduce reliance on south Delta export facilities (greater entrainment rates are expected to occur at south Delta facilities), along with additional minor benefits from decommissioning of agricultural diversions in restoration areas and implementation of an alternative intake for the North Bay Aqueduct. Additionally, the reduced exports under Alternative 4 as compared to 1A provide further reductions in entrainment, resulting in improved conditions for all covered species and beneficial effects for delta and longfin smelt, spring-run Chinook salmon, and Sacramento splittail.

While the degree of reduction in entrainment for longfin smelt would vary among the H1–H4 operational scenarios, beneficial reductions would occur under each scenario. These improvements would occur at the south Delta facilities as longfin smelt are unlikely to be present at north Delta facilities.

Since the proposed north Delta intakes under Alternative 4 are the same design as those proposed under Alternative 1A, the potential to affect some fish species through contact with the screens and/or increased predation around those facilities still exists but at a reduced level when compared to Alternative 1A because there are two fewer intakes. Regardless, these effects are considered to be not adverse.

In summary, entrainment is expected to remain at or below the levels currently experienced by fish in the Delta. There are very few instances where there would be increases, but these are substantially offset by decreases during other periods. Effects are at a minimum not adverse and less than significant, with effects being somewhat beneficial for some species.

Flows

While San Joaquin River flows are not expected to be affected by Alternative 4, flow changes are expected in the Sacramento River and its tributaries, as well as within the Sacramento-San Joaquin Delta. Changes in flow will result from changes in releases from upstream reservoirs, diversions from the south Delta, and reductions in flows downstream of the proposed north Delta intakes.

Overall, there would be minimal changes under Alternative 4 to upstream flows, reservoir storage, or water temperatures. The decision tree process will ensure the impacts of water operations on rearing habitat for delta smelt are not adverse and support a contribution to recovery of this species. In the event BDCP habitat restoration does not produce the desired benefits, the average fall abiotic habitat index across all years would be similar to NAA under Scenarios H3 and H4. Under Scenarios H1 and H2, which do not include Fall X2, the abiotic habitat index would be lower than NAA.

Recognizing the uncertainties of habitat restoration and disagreement regarding the magnitudes of spring outflow augmentation necessary to support the conservation of longfin smelt, the decision tree process will identify CM1 operations that are expected to meet the longfin smelt population growth objective. Those operations will ensure the impacts of water operations on rearing habitat for longfin smelt are not adverse and support a contribution to recovery of this species.

Limited effects are expected on spawning and egg incubation, rearing, and migration conditions for Chinook salmon species and steelhead. However, the overall modeling results currently support the finding that the effects are uncertain for winter-run and spring-run Chinook salmon spawning and egg incubation conditions, as well as migration conditions for winter-, spring-, fall-/late fall-run Chinook salmon and steelhead. Additional assessments will be needed to confirm that adverse effects are not reasonably expected to occur to these species under Alternative 4.

Small to moderate reductions in flow rates during some summer and fall months are expected in the Feather River, but these reductions would not have biologically meaningful effects on rearing habitat of any covered fish species (Table 11-4-SUM1).

Flow reductions below the north Delta intakes would not reduce available spawning habitat for delta smelt under any of the operating scenarios for Alternative 4. The area of fall abiotic habitat for juvenile delta smelt varies among the operating scenarios for Alternative 4. Without habitat restoration, operating scenarios H3 and H4 increase fall abiotic habitat area, while H1 results in a slight reduction compared to NAA. Alternative 4 under all flow operation scenarios would benefit delta smelt with inclusion of habitat restoration especially in the areas that are closer to delta smelt's main range. However, due to uncertainties regarding the magnitude of benefits of restored habitat, the overall determination is that Alternative 4 is not adverse and less than significant to delta smelt rearing habitat.

Winter-spring outflows under Alternative 4 are similar to baselines and do not result in appreciable decreases in longfin smelt abundance. The analyses conducted as a part of this evaluation did not include the benefits of habitat restoration, which would provide benefits to longfin smelt. As a result, rearing and migration conditions are not adversely affected.

Improved flow conditions over the Fremont Weir and in the Yolo Bypass provide substantial benefits to sturgeon, by reducing the stranding potential.

While some periods of flow would be higher and some lower, Alternative 4 operating scenarios would not substantially change conditions for sturgeon spawning, rearing, and migration relative to the NAA, except for apparent reductions in migration conditions. However, the uncertainty regarding which mechanisms are responsible for the positive correlation between white sturgeon year class strength and river/Delta flow will be addressed through targeted research and monitoring to be conducted in the years leading up to the initiation of north Delta facilities operations. If these investigations determine that in-Delta and through-Delta flow conditions are the primary mechanisms behind the positive correlation, then Alternative 4 could be adverse relative to NAA, but no substantial reductions would occur relative to Existing Conditions. There are also similar uncertainties regarding the overall effects of Alternative 4 on green sturgeon, relative to NAA.

As evidenced by this summary, a variety of changes in flow will occur under Alternative 4. Some of these changes are beneficial for fish while others are not. The decision tree component of Alternative 4 provides flexibility and the alternative is expected to eliminate or minimize adverse effects or significant impacts. Alternative 4 also includes conservation measures that provide substantial habitat improvements for fish. These measures include habitat restoration measures and several other measures that reduce existing fish stressors in the Delta region (summary description provided in the following section). When the flow and habitat restoration measures are considered together, the effects of Alternative 4 measures are either beneficial or not adverse and/or less than significant. Summary Table 11-4-SUM1 presents the results of the flow related effects on fish.

Table 11-4-SUM1. Results of Flow-Related Effects on Fish

Species	Entrainment	Spawning	Rearing	Migration
Delta smelt	B/LTS	NA/LTS	ND/LTS	ND/LTS
Longfin smelt	NA/B	ND/LTS (combined)		
Winter-Run Chinook salmon	NA/LTS	ND/LTS	NA/LTS	ND/LTS
Spring-Run Chinook salmon	NA/B	ND/LTS	NA/LTS	ND/LTS
Fall-Run/Late Fall-Run Chinook salmon	NA/LTS	NA/LTS	NA/LTS	ND/LTS
Steelhead	NA/LTS	NA/LTS	NA/LTS	ND/LTS
Sacramento splittail	NA/B	NA/LTS	NA/LTS	NA/LTS
Green sturgeon	NA/LTS	NA/LTS	NA/LTS	ND/LTS
White sturgeon	NA/LTS	NA/LTS	NA/LTS	ND/LTS
Pacific lamprey	NA/LTS	NA/LTS	NA/LTS	NA/LTS
River lamprey	NA/LTS	NA/LTS	NA/LTS	NA/LTS

Level of significance:

NEPA Conclusion	*CEQA Conclusion*
A = Adverse.	SU = Significant and Unavoidable.
NA = Not Adverse.	LTS = Less than Significant.
B = Beneficial.	B = Beneficial.
ND = Not Determined.	S = Significant.

Restoration Measures (CM2, CM4–CM7, and CM10)

With respect to restoration measures, Alternative 4 is the same as Alternative 1A. Consequently, all the effects associated with restoration measures under Alternative 4 are the same as those described above under the Alternative 1A summary.

Other Conservation Measures (CM12–CM19 and CM21)

With respect to other conservation measures, Alternative 4 is the same as Alternative 1A. Consequently, all the effects associated with other conservation measures under Alternative 4 are the same as those described above under the Alternative 1A summary.

11.0.2.9 Alternative 5—Summary of Effects

Overview

Alternative 5 is the same as Alternative 1A except that it involves only Intake 1 instead of Intakes 1, 2, 3, 4, and 5 and includes a different operational scenario. While Alternative 1A would divert up to 15,000 cfs and uses Operational Scenario A, Alternative 5 would only divert up to 3,000 cfs in the north Delta and uses Operational Scenario C. Alternative 5 has the same six barge facilities as Alternative 1A.

CM2, CM4–CM7, CM10, CM12–CM19, and CM21 would be implemented under this alternative, and these CMs would be identical to those under Alternative 1A.

Construction and Maintenance of CM1

As indicated above for Alternative 1A, the potential for construction and maintenance activities to affect the covered fish species would typically be proportional to the number of north Delta intakes constructed, and the total area of habitat affected. Alternative 5 includes only one intake, compared to the five intakes for Alternative 1A. Therefore, the total area displaced by the intake would be about 23.7 acres (83%) less for Alternative 5 (see Table 11-1A-SUM1). Similar to Alternative 1A, Alternative 5 includes a conveyance tunnel, with six barge landings.

At the one Alternative 5 intake, between 1.2 and 5.0 acres of river area would be isolated behind cofferdams and temporarily lost. During the in-water construction period, a total of up to about 4.7 acres of in-water habitat would be affected by dredging activities, this loss or alteration of low-quality spawning, rearing, and migration habitat for covered fish species would also be about 83% less than for Alternative 1A (see Table 11-1A-SUM1). Similarly, the footprint of the intake and transition wall structures would result in permanent loss of about 2,050 feet of primarily steep-banked and riprapped shoreline habitat, also about 83% less than for Alternative 1A. The barge landings would include in-water and over-water structures, occupying approximately 15,000 square feet of shoreline habitat.

As discussed in detail for Alternative 1A, in-water and nearshore construction activities have the potential to cause adverse effects on covered species, although these adverse effects would be effectively avoided and minimized by implementing environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*). These include pile driving Minimization Measures AQUA-1a and AQUA-1b, as well as isolating much of the in-water work inside cofferdams, constructing in areas that have limited use by the covered species, adhering to the approved in-water work windows, and activity-specific timing restrictions. While individual fish may be affected by construction activities, the effects would not limit overall population productivity.

In summary, construction and maintenance activities would result in limited temporary and permanent effects on the covered fish species or their habitat. Based on habitat loss or alteration, Alternative 5 would result in the potential for about 83% fewer impacts than Alternative 1A. While these effects would vary by species and species life stages, the implementation of environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*), would reduce most of these construction effects to be not adverse and less than significant. The implementation of habitat restoration activities, particularly CM6 *Channel Margin Enhancement*, would offset effects of habitat loss or alteration at the intake sites.

Water Operations of CM1

The methods and analysis of Alternative 5 are the same as those previously described for Alternative 1A. However, Alternative 5 includes one intake rather than the five utilized in Alternative 1A, and Alternative 5 uses water Operational Scenario C. Also, Alternative 5 only diverts up to 3,000 cfs from the north Delta intakes while Alternative 1A diverts up to 15,000 cfs. Since the size of the conveyance infrastructure and the water operations scenario differs, the effects are different.

Changes in Exports and Outflow

As discussed in Chapter 5, *Water Supply*, over the long term, average annual Delta exports under Alternative 5 are anticipated to decrease by 358 TAF relative to Existing Conditions, and increase by 345 TAF relative to the No Action Alternative. Over the long-term, approximately 25% of the exported water will be from the new north Delta intake, and average monthly diversions at the south Delta intakes would correspondingly decrease. These changes would slightly increase the proportion of San Joaquin River water flowing throughout the south, west, and interior Delta, and a corresponding decrease in the proportion of Sacramento River water.

Under Alternative 5, long-term average annual Delta outflow is anticipated to increase 401 TAF relative to Existing Conditions and to decrease by 349 TAF relative to the NAA. It is important to note that some outflow changes under Alternative 5 are greater relative to Existing Conditions because Existing Conditions do not includes operations to meet Fall X2, whereas NAA and Alternative 5 do include Fall X2.

As a result of changes in points of diversion and the quantity and timing of diversions (slightly more water diverted in mid-December to June/July and less water diverted July through mid-December), there would be beneficial, not adverse/less than significant, and adverse/significant and unavoidable effects/impacts on fish under Alternative 5. Following is a summary of these effects as they relate to the key factors of entrainment and flow, which in turn affects fish survival and spawning, rearing, and migration habitat conditions.

Entrainment

Similar to Alternative 1A, overall entrainment of numerous species under Alternative 5 would be slightly less than or similar to the levels experienced in the recent years. This is because the north Delta diversion operations would slightly reduce reliance on south Delta export facilities (greater entrainment rates are expected to occur at south Delta facilities), along with additional minor benefits from decommissioning of agricultural diversions in restoration areas and implementation of an alternative intake for the North Bay Aqueduct. Additionally, the reduced exports under Alternative 5 as compared to 1A provide further reductions in entrainment, resulting in beneficial effects for spring-run and fall-run and late fall-run Chinook salmon.

Reduced entrainment of juvenile salmonids would occur in the majority of years under all water year types relative to current conditions, whereas Alternative 1A reductions were only under the wetter conditions.

Since the proposed north Delta intake under Alternative 5 is the same design as those proposed under Alternative 1A, the potential to affect some fish species through contact with the screens and/or increased predation around those facilities still exists but to a lesser extent because of four fewer intakes. Regardless, these effects are considered to be not adverse or beneficial.

In summary, entrainment is expected to remain at or below the levels currently experienced by fish in the Delta. There are very few instances where there would be increases, but these are substantially offset by decreases during other periods. Effects are at a minimum not adverse and less than significant, with effects being beneficial for some species.

Flows

While San Joaquin River flows are not expected to be affected by Alternative 5, flow changes are expected in the Sacramento River and its tributaries, as well as within the Sacramento-San Joaquin Delta. Changes in flow will result from changes in releases from upstream reservoirs, diversions from the south Delta, and reductions in flows downstream of the proposed north Delta intakes.

Alternative 5 includes the USFWS BiOp Fall X2 requirements. Therefore, the area of fall abiotic habitat for juvenile delta smelt in the open-water areas of the Suisun Bay, Suisun Marsh, and west Delta subregions would be similar to NAA under Alternative 5, although habitat restoration has the potential to increase suitable areas of spawning and rearing habitat and is intended to supplement food production and export to other rearing areas. Alternative 5 is not expected to substantially affect delta smelt migration conditions.

Decreased spring outflows under Alternative 5 have the potential to contribute to decreases in longfin smelt abundance from reduced larval transport flows and spring habitat quantity and quality for larval and early juvenile longfin smelt in the Suisun Marsh and west Delta subregions. Modeling results based on Kimmerer et al. (2009) indicate that relative longfin smelt abundance averaged across all years would be similar under Alternative 5, compared to NAA. When analyzing individual water year types, longfin smelt abundances are 10-11% lower in critical years, and 7-9% lower in above normal water years compared to NAA. However, these analyses do not account for potential changes in spawning or rearing conditions related to non-operational components of Alternative 5, including habitat restoration.

With regard to salmonids, several issues were identified as described below with some of them resulting in adverse and/or significant effects. For example, Sacramento River attraction flows for migrating adult salmonids would be slightly lower from operations of the north Delta diversion under Alternative 5, but not to an adverse level. Winter-run Chinook salmon would be affected by reduced spawning and egg incubation habitat (higher egg mortality) and reduced extent and quality of fry and juvenile rearing habitat as a result of reduced flows, but not to an adverse level. While operation of the NDD intake could affect winter-run Chinook salmon migration conditions, the magnitude of effects is uncertain, and additional modeling assessments are needed to verify that no adverse effects are reasonably likely to occur.

Similar flow reductions would reduce spawning, egg incubation, and migration habitat for spring-run Chinook salmon, but the magnitude of effects is uncertain, Further evaluations would be needed to confirm that adverse and/or significant effects are not reasonably likely to occur. Flows in the American, Stanislaus, Mokelumne, and San Joaquin Rivers would be lower than flows under the CEQA baseline, which would adversely and significantly reduce migration habitat conditions for fall-/late fall-run Chinook salmon.

Steelhead rearing would be adversely affected under Alternative 5. Compared to Existing Conditions, the quantity and quality of rearing habitat would be substantially reduced due to decreases in flow during the summer months and in drier year types in the Feather River and American River. While there are some benefits to increased flows in some months and water years types they are not of sufficient magnitude to offset the negative effects in other months. Alternative 5 would also affect steelhead migration conditions, relative to NAA, although the magnitude of effects is uncertain. Additional modeling will be needed to determine adverse effects are reasonably likely to occur.

Generally consistent with Alternative 1A, improved flow conditions over the Fremont Weir and in the Yolo Bypass provide substantial benefits to Sacramento splittail, primarily with regard to rearing and migration conditions.

Alternative 5 would result in similar effects for green and white sturgeon as those described for Alternative 1A. Alternative 5 would reduce flows and increase water temperatures, resulting in increased egg mortality, and reduced rearing and migration habitat. However, the mechanisms behind the observed correlation between sturgeon year class strength and Delta outflow remain uncertain, but will be addressed through targeted research and monitoring conducted in the years leading up to the initiation of north Delta facilities operations. These targeted investigations are expected to identify the primary mechanisms that drive sturgeon year-class strength, and the final determination of the overall effects of Alternative 5 relative to NAA. The migration effects would be less than significant, relative to Existing Conditions.

Alternative 5 would affect spawning and egg incubation habitat for Pacific lamprey as a result of increased water temperatures on the Feather River and redd dewatering in the Sacramento and American rivers. Flow reductions on several waterways, including the American River at the Sacramento River confluence and in the Trinity River, when compared to Existing Conditions, would have an effect on lamprey rearing and migration habitat. While these flow changes as compared to Existing Conditions would be substantial, they would not result in a significant impact on lamprey species because the differences are primarily the result of climate change, sea level rise and future water demand and not attributable to the alternative.

As evidenced by this summary, some changes in flow under Alternative 5 are adverse to fish species. Alternative 5 also includes the same conservation measures as Alternative 1A. When the flow and habitat restoration measures are considered together, many of the effects of Alternative 5 measures are beneficial or not adverse and/or less than significant. However, several effects resulting from changes in flows upstream of the Delta remain adverse and/or significant and unavoidable. However, Alternative 5 includes adaptive management processes that include targeted investigations to identify appropriate mitigation measures to reduce the severity of effects, although such reductions would not necessarily result in a not adverse or less than significant determination. Summary Table 11-5-SUM1 presents the results of the flow related effects on fish.

Table 11-5-SUM1. Results of Flow-Related Effects on Fish

Species	Entrainment	Spawning	Rearing	Migration
Delta smelt	NA/LTS	NA/LTS	ND/LTS	ND/LTS
Longfin smelt	NA/LTS	ND/LTS (combined)		
Winter-Run Chinook salmon	NA/LTS	NA/LTS	NA/LTS	ND/LTS
Spring-Run Chinook salmon	B/LTS	ND/LTS	NA/LTS	ND/LTS
Fall-Run/Late Fall-Run Chinook salmon	B/LTS	NA/LTS	NA/LTS	A/S
Steelhead	NA/LTS	NA/LTS	A/SU	ND/LTS
Sacramento splittail	NA/LTS	NA/LTS	B/B	B/B
Green sturgeon	NA/LTS	NA/LTS	NA/LTS	ND/LTS
White sturgeon	NA/LTS	NA/LTS	NA/LTS	ND/LTS
Pacific lamprey	NA/LTS	A/SU	NA/LTS	NA/LTS
River lamprey	NA/LTS	NA/LTS	NA/LTS	NA/LTS

Level of significance:

NEPA Conclusion	*CEQA Conclusion*
A = Adverse.	SU = Significant and Unavoidable.
NA = Not Adverse.	LTS = Less than Significant.
B = Beneficial.	B = Beneficial.
ND = Not Determined.	S = Significant.

Restoration Measures (CM2, CM4–CM7, and CM10)

With respect to restoration measures, Alternative 5 is the same as Alternative 1A except that it includes only 25,000 acres of tidal natural community restoration (CM4) rather than the 65,000 acres of restoration in Alternative 1A. Consequently, all of the effects associated with Alternative 5 are the same as Alternative 1A except for those associated with the smaller amount of tidal natural community habitat creation or the smaller amount of habitat itself. The effects associated with the smaller amount of habitat creation and the smaller amount of habitat are summarized below. For a summary discussion of the effects of other restoration measures see the complete summary under Alternative 1A.

Effects of Construction of Restoration Measures

The types of effects related to construction of restoration measures for Alternative 5 would be the same as those described for Alternative 1A. The area of potential effects of restoration construction activities under Alternative 5 would be less than that described for Alternative 1A due to the smaller amount of tidal natural community restoration. However, the discussion under Alternative 1A still applies because the same in-water construction window, lack of impact pile driving, and implementation of Appendix 3B, *Environmental Commitments* would still occur. These measures would avoid or minimize any adverse or significant effects. As a result, the effects of construction of restoration measures are not adverse and are less than significant for covered and non-covered fish species.

Contaminants Associated with Restoration Measures

The types of effects related to contaminants from construction of restoration measures for Alternative 5 would be the same as those summarized for Alternative 1A. The area of potential effects of restoration construction activities under Alternative 5 would be smaller than that described for Alternative 1A due to the smaller amount of tidal natural community habitat enhancement. However, the discussion under Alternative 1A still applies and the effects would be the same. Contaminants associated with restoration measures would not be adverse and are less than significant for covered and non-covered fish species.

Restored Habitat Conditions

CM4 Tidal Natural Community Restoration

The effects under Alternative 5 of restored habitat conditions for CM2 *Yolo Bypass Fisheries Enhancement*, CM5 *Seasonally Inundated Floodplain Restoration*, CM6 *Channel Margin Enhancement*, CM7 *Riparian Natural Community Restoration*, and CM10 *Nontidal Marsh Restoration* would be the same as summarized under Alternative 1A. The types of effects of restored habitat for CM4 *Tidal Natural community Restoration* would also be the same as summarized for Alternative 1A except that a smaller amount of habitat would be created. For CM4 *Tidal Natural Community Restoration* only 25,000 acres would be created rather than 65,000 acres. This reduction in habitat amount would provide proportionally less benefit than that described under Alternative 1A but it would still be beneficial. Consequently, the effects would be the same as described under Alternative 1A. As summarized there, the overall effects would be beneficial for all covered and non-covered fish species.

Other Conservation Measures (CM12–CM19 and CM21)

With respect to other conservation measures, Alternative 5 is the same as Alternative 1A as described above under Other Conservation Measures (CM12–CM19 and CM21). Consequently, all of the effects associated with Alternative 5 are the same as Alternative 1A except for those associated with smaller amounts of habitat creation or the smaller amount of habitat itself. Therefore, the only conservation measure specifically addressed for Alternative 5 is CM12 *Methylmercury Management*. The effects associated with the smaller amount of habitat creation and the smaller amount of habitat are summarized below. For a summary discussion of the effects of other conservation measures see the complete summary under Alternative 1A.

Methylmercury Management (CM12)

The effects of CM12 *Methylmercury Management* would be the same as described under Alternative 1A except that they would be applied over a smaller area. Consequently, these effects would not be adverse and are less than significant.

Comparison of Alternative 5 to Alternative 4 (Proposed Project)

Alternative 5 would convey up to 3,000 cfs of water from one north Delta screened intake on the east bank of the Sacramento River near Clarksburg, and pipeline/tunnel conveyance facilities to the south Delta. While Alternative 4 would have a similar conveyance structure, it would have two additional intake (three total), with a total maximum capacity of 9,000 cfs. Alternative 5 would follow Operational Scenario C, while Alternative 4 would follow Operational Scenario H, resulting in different patterns of water withdrawals from the north Delta, and potentially different effects on water quality and aquatic habitat conditions in the Plan Area. As fully described in Chapter 3, *Description of Alternatives,* Alternative 4 operations incorporate a decision tree process that results in four potential operational sub-scenarios, depending on the outcome of the decision tree process for spring outflow and Fall X2 operations.

Construction and Maintenance of CM1

The potential for construction and maintenance activities to affect the covered fish species would typically be proportional to the number of north Delta intakes constructed, and the total area of habitat affected. As a result, Alternative 5 would have a much lower potential for effects than Alternative 4 because it includes the construction of only one intake, which is two fewer than Alternative 4. This would result in up to about 11.2 acres (69%) less in-water area affected by construction activities than for Alternative 4. In addition, the total length of shoreline permanently replaced by the intake (up to about 2,050 feet) would be 68% less than Alternative 4 (see Table 11-1A-SUM1). In addition to the effects of intake construction, Alternative 5 would require about 73% less dredging (4.7 acres) to re-contour the streambed adjacent to the intake. However, both alternatives include a tunnel/pipeline conveyance system, and six barge landings to support tunnel construction. Each barge landing would include in-water and over-water structures, occupying approximately 15,000 square feet of nearshore habitat.

As discussed above, in-water and nearshore construction activities have the potential to cause adverse effects on covered species, although these adverse effects would be effectively avoided and minimized by implementing environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*). These include pile driving minimization measures AQUA-1a and AQUA-1b, as well as isolating much of the in-water work inside cofferdams, constructing in areas that have limited use by the covered species, adhering to the approved in-water work windows, and activity-specific timing restrictions. While individual fish may be affected by construction activities, the effects would not limit overall population productivity.

In summary, construction and maintenance activities would result in limited temporary and permanent effects on the covered fish species and their habitat. While these effects would vary by species and species life stages, the implementation of environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*), would reduce most of these construction effects to be not adverse and less than significant. The implementation of habitat restoration activities, particularly CM6 *Channel Margin Enhancement*, would offset effects of habitat loss or alteration at the intake sites.

Water Operations of CM1

Water operations under Alternative 5 differ from Alternative 4 in a few ways. Alternative 5 utilizes one intake in the north Delta that can convey up to 3,000 cfs while Alternative 4 utilizes three intakes and can only convey up to 9,000 cfs. As discussed in Chapter 5, *Water Supply*, average annual exports under Alternative 5 are anticipated to be 4786 TAF while Alternative 4 has anticipated exports ranging from 4,414 (under H4) to 5,255 (under H1). Changes in anticipated long-term average annual Delta outflow under Alternative 4 also vary between the operational scenarios (H1–H4). While the average annual outflows would be less for two of the Alternative 4 operational scenarios compared to Alternative 5 (166 and 515 TAF less for H1 and H3, respectively), operational scenario H2 would result in about 4 TAF higher and operational scenario H4 would result in about 344 TAF higher average annual outflow. Alternative 5 would also result in different annual average outflow than Existing Conditions (about 400 TAF greater), but about 349 TAF less than NAA.

There are various benefits to entrainment and migration for some species under both Alternatives, with Alternative 5 having entrainment benefits for four species while Alternative 4 is beneficial for two species. Alternative 4 provides somewhat greater beneficial effects on rearing for Delta smelt. The substantive difference is that Alternative 5 results in adverse effects/significant and unavoidable impacts to Pacific lamprey spawning, fall-run/late-fall run salmon, and steelhead rearing, and fall-run/late-fall run salmon, whereas Alternative 4 doesn't result in any adverse effects/significant and unavoidable impacts.

Restoration Measures (CM2, CM4–CM7, and CM10)

With respect to restoration measures, Alternative 5 would be the same as Alternative 4 except that it includes only 25,000 acres of tidal natural community restoration (CM4) rather than the 65,000 acres of restoration in Alternative 4. Consequently, all of the effects associated with Alternative 5 are the same as Alternative 4 except for the reduced amount of tidal natural community habitat restored or the smaller amount of habitat itself. The effects associated with these differences, is the same as described above in the comparison of Alternative 5 with Alternative 1A, which is expected to result in fewer benefits to a number of covered fish species.

Other Conservation Measures (CM12–CM19 and CM21)

With respect to other conservation measures, Alternative 5 would be the same as Alternative 4. Consequently, the effects associated with these other conservation measures would also be the same for both alternatives.

11.0.2.10 Alternative 6A—Summary of Effects

Overview

While Alternative 6A uses the same five intakes as Alternative 1A, it is substantially different with respect to operations and flow. Alternative 6 uses Operational Scenario D which would eliminate the south Delta intakes. Alternative 6A would still divert up to 15,000 cfs from the Sacramento River, the same as Alternative 1A.

CM2, CM4–CM7, CM10, CM12–CM19, and CM21 would be implemented under this alternative, and these CMs would be identical to those under Alternative 1A.

Construction and Maintenance of CM1

As indicated above for Alternative 1A, the potential for construction and maintenance activities to affect the covered fish species would typically be proportional to the number of north Delta intakes constructed, and the total area of habitat affected. Alternative 6A includes the same intakes as Alternative 1A. Therefore, the total area affected by intake construction would be the same, at about 28.7 acres (see Table 11-1A-SUM1). Also similar to Alternative 1A, Alternative 6A includes a conveyance tunnel and six barge landings.

At the Alternative 6A intakes, between 1.2 and 6.9 acres of river area would be isolated behind cofferdams, and temporarily or permanently lost. During the in-water construction period, a total of up to about 27.3 acres of in-water habitat would be affected by dredging activities, this loss or alteration of low-quality spawning, rearing, and migration habitat for covered fish species would be the same as Alternative 1A (see Table 11-1A-SUM1). Similarly, the footprint of the intake and transition wall structures would result in permanent loss of about 11,900 feet of primarily steep-banked and riprapped shoreline habitat, also the same as Alternative 1A. The barge landings would include in-water and over-water structures, occupying approximately 15,000 square feet of shoreline habitat.

As discussed in detail for Alternative 1A, in-water and nearshore construction activities have the potential to cause adverse effects on covered species, although these adverse effects would be effectively avoided and minimized by implementing environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*). These include pile driving minimization measures AQUA-1a and AQUA-1b, as well as isolating much of the in-water work inside cofferdams, constructing in areas that have limited use by the covered species, adhering to the approved in-water work windows, and activity-specific timing restrictions. While individual fish may be affected by construction activities, the effects would not limit overall population productivity.

In summary, construction and maintenance activities would result in limited temporary and permanent effects on the covered fish species or their habitat. While these effects would vary by species and species life stages, the implementation of environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*), would reduce most of these construction effects to be not adverse and less than significant. The implementation of habitat restoration activities, particularly CM6 *Channel Margin Enhancement*, would offset effects of habitat loss or alteration at the intake sites.

Water Operations of CM1

The methods and analysis of Alternative 6A are the same as those previously described for Alternative 1A. Alternative 6 includes the same five intakes utilized in Alternative 1A, but Alternative 6A uses water Operational Scenario D which eliminates use of the south Delta intakes (i.e., there is only an isolated north Delta conveyance). While the volume associated with the conveyance infrastructure is the same, the water operations scenario differs and the effects are different.

Changes in Exports and Outflow

As discussed in Chapter 5, *Water Supply*, over the long term, average annual Delta exports under Alternative 6A are anticipated to decrease by 1,386 TAF relative to Existing Conditions, and by 683 TAF relative to the No Action Alternative. Because Operational Scenario D eliminates use of the south Delta intakes, 100% of the exported water will be from the new north Delta intakes. These changes would increase the proportion of San Joaquin River water flowing throughout the south, west, and interior Delta, and a corresponding decrease in the proportion of Sacramento River water.

Under Alternative 6A, long-term average annual Delta outflow is anticipated to increase 1,383 TAF relative to Existing Conditions and by 633 TAF relative to the NAA. It is important to note that some outflow changes under Alternative 6A are greater relative to Existing Conditions because Existing Conditions do not includes operations to meet Fall X2, whereas NAA and Alternative 6A do include Fall X2.

As a result of changes in points of diversion and the quantity and timing of diversions (more water diverted in February through May and less water diverted June through January), there would be beneficial, not adverse/less than significant, and adverse/significant and unavoidable effects/impacts on fish under Alternative 6A. Following is a summary of these effects as they relate to the key factors of entrainment and flow, which in turn affects fish survival and spawning, rearing, and migration habitat conditions. However, because of reliance on upstream flow, there are more adverse effects associated with Alternative 6A than Alternative 1A.

Entrainment

Similar to Alternative 1A, overall entrainment of numerous species under Alternative 6A would be substantially less than the levels currently experienced in the Delta. There would be additional minor benefits from decommissioning of agricultural diversions in restoration areas and implementation of an alternative intake for the North Bay Aqueduct. There would be beneficial effects for a number of covered fish species, including delta smelt, longfin smelt, and the salmonid species, and no adverse effects on other species.

Since the proposed north Delta intakes under Alternative 6A are the same design as those proposed under Alternative 1A, entrainment is expected to be substantially reduced compared to the entrainment currently occurring at the south Delta facilities, which would be eliminated under Alternative 6A. However, there is still the potential to affect some fish species through contact with the screens and/or increased predation around those facilities, which would be similar to Alternative 1A. As for Alternative 1A, these effects are considered to be not adverse.

In summary, entrainment is expected to be substantially reduced compared to the levels currently experienced by fish in the Delta. Effects are at a minimum not adverse and less than significant, with effects being beneficial for several species.

Flows

The non-utilization of the south Delta facilities will measurably alter the overall flow conditions in the Delta. Flow changes are expected in the San Joaquin and Sacramento Rivers and tributaries, as well as within the Sacramento-San Joaquin Delta. Changes in flow will result from changes in releases from upstream reservoirs, reductions in flows downstream of the proposed north Delta intakes, and improved OMR flows.

The area of fall abiotic habitat for juvenile delta smelt in the open-water areas of the Suisun Bay, Suisun Marsh, and west Delta subregions would be larger under Alternative 6A than under NAA conditions, without including potential habitat restoration benefits. Habitat restoration has the potential to increase spawning and rearing habitat and could supplement food production and export to rearing areas. However, the overall effects of habitat restoration and the mechanism of Fall X2 correlation are uncertain and current efforts (FlaSH studies) are underway to better understand the relationship between Fall Delta outflow, suitable rearing habitat for delta smelt, and delta smelt abundance. Migration conditions are not expected to change substantially under Alternative 6A.

Despite the growing body of evidence that supports the positive correlation between longfin smelt abundance and spring outflow, the specific timing and amount of outflow needed to conserve longfin smelt, are generally unknown. Averaged across all water year types, Delta outflow under Alternative 6A would be similar (<10% change) to NAA during the January–June period. Other components of Alternative 6A have the potential to increase recruitment per unit of flow. These analyses do not take into account any potential changes in spawning or rearing conditions related to non-operational components of Alternative 6A, including habitat restoration.

With regard to salmonids, several issues were identified with a number of them resulting in adverse and/or significant effects, although entrainment effects would largely be beneficial. For example, Sacramento River attraction flows for migrating adult salmonids would be lower due to operations of the north Delta diversions under Alternative 6A. While winter-run Chinook salmon would also be affected by reduced spawning and egg incubation habitat (higher egg mortality) and reduced extent and quality of fry and juvenile rearing habitat as a result of reduced flows, these effects would not be adverse. These effects are also largely the result of climate change, sea level rise, and future water demand, rather than the alternative.

Alternative 6A would however, result in adverse effects on winter-run, spring-run, fall-/late fall-run Chinook salmon, and steelhead migration conditions. Although the implementation of conservation and mitigation measures would reduce the severity of such effects, the result could still be adverse and significant. While these same flow reductions would typically not reduce spawning, rearing, and migration habitat conditions to an adverse level for spring-run or fall-run/late fall-run Chinook salmon in upstream areas, through-Delta migration habitat conditions would be adversely affected.

Generally consistent with Alternative 1A, improved flow conditions over the Fremont Weir and in the Yolo Bypass provide substantial benefits to Sacramento splittail, primarily with regard to spawning and migration.

Alternative 6A would result in similar effects for sturgeon as those described for Alternative 1A. Alternative 6A would reduce flows and increase water temperatures, resulting in increased egg mortality as well as reduced rearing and migration habitat. However, the uncertainties regarding the mechanisms driving the observed correlation between Delta outflow and sturgeon year class strength will be addressed through targeted research and monitoring conducted in the years leading to the initiation of north Delta facilities operations. These targeted investigations are expected to identify the primary mechanisms that drive sturgeon year-class strength, and the final determination of the overall effects of Alternative 6A relative to NAA. However, the effects are considered less than significant relative to existing conditions.

Alternative 6A would affect spawning and egg incubation habitat for lamprey species as a result of increased water temperatures on the Feather River and redd dewatering in the Sacramento and American rivers. Flow reductions on several waterways, including the Sacramento, Trinity, and American rivers, when compared to Existing Conditions, would affect lamprey spawning, rearing and migration habitat. However, these effects are primarily the result of climate change, sea level rise, and future water demand, and not attributable to the alternative. Thus, the overall effects on lamprey would not be significant or adverse.

As evidenced by this summary, changes in flow under Alternative 6A are adverse to some fish species. Alternative 6A also includes the same conservation measures as Alternative 1A. When the flow and habitat restoration measures are considered together, many of the effects of Alternative 6A measures are beneficial or not adverse and/or less than significant. However, several effects resulting from changes in flows upstream of the Delta remain adverse and/or significant and unavoidable for most species. While adaptive management mitigation measures would be implemented to reduce the severity of effects, the results could still be adverse and/or significant. Summary Table 11-6A-SUM1 presents the results of the flow related effects on fish.

Table 11-6A-SUM1. Results of Flow-Related Effects on Fish

Species	Entrainment	Spawning	Rearing	Migration
Delta smelt	B/B	NA/LTS	ND/LTS	ND/LTS
Longfin smelt	B/B	ND/B (combined)		
Winter-Run Chinook salmon	B/B	NA/LTS	NA/LTS	A/SU
Spring-Run Chinook salmon	B/B	NA/LTS	NA/LTS	A/SU
Fall-Run/Late Fall-Run Chinook salmon	B/B	NA/LTS	NA/LTS	A/SU
Steelhead	B/LTS	NA/LTS	NA/LTS	A/SU
Sacramento splittail	NA/LTS	NA/LTS	NA/LTS	NA/LTS
Green sturgeon	B/LTS	NA/LTS	NA/LTS	ND/LTS
White sturgeon	B/LTS	NA/LTS	NA/LTS	ND/LTS
Pacific lamprey	NA/LTS	NA/LTS	NA/LTS	NA/LTS
River lamprey	NA/LTS	NA/LTS	NA/LTS	NA/LTS

Level of significance:

NEPA Conclusion	*CEQA Conclusion*
A = Adverse.	SU = Significant and Unavoidable.
NA = Not Adverse.	LTS = Less than Significant.
B = Beneficial.	B = Beneficial.
ND = Not Determined.	S = Significant.

Restoration Measures (CM2, CM4–CM7, and CM10)

With respect to restoration measures, Alternative 6A is the same as Alternative 1A. Consequently, all the effects associated with restoration measures under Alternative 6A are the same as those described above under the Alternative 1A summary.

Other Conservation Measures (CM12–CM19 and CM21)

With respect to other conservation measures, Alternative 6A is the same as Alternative 1A. Consequently, all the effects associated with other conservation measures under Alternative 6A are the same as those described above under the Alternative 1A summary.

Comparison of Alternative 6A to Alternative 4 (Proposed Project)

Alternative 6A would convey up to 15,000 cfs of water from the north Delta to the south Delta through pipelines/tunnels via five screened intakes on the east bank of the Sacramento River between Clarksburg and Walnut Grove (i.e., Intakes 1 through 5). While Alternative 4 would also consist of constructing similar intake and conveyance structures, in this same area of the river, it would include only three intakes, with a conveyance capacity of up to 9,000 cfs. Alternative 6A would also have a different operations scenario (Scenario D), with an isolated conveyance process, compared to Alternative 4 (Scenario H) and dual conveyance operations.

Construction and Maintenance of CM1

The potential for construction and maintenance activities to affect the covered fish species would typically be proportional to the number of north Delta intakes constructed, and the total area of habitat affected. As a result, Alternative 6A would have a greater potential for effects than

Alternative 4 because it includes the construction of two additional intakes (five), along with the associated increase in streambed dredging. The potential effects of Alternative 6A would be similar to the effects described above for Alternative 1A, (see Table 11-1A-SUM1).

As discussed above, in-water and nearshore construction activities have the potential to cause adverse effects on covered species, although these adverse effects would be effectively avoided and minimized by implementing environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*). These include pile driving minimization measures AQUA-1a and AQUA-1b, as well as isolating much of the in-water work inside cofferdams, constructing in areas that have limited use by the covered species, adhering to the approved in-water work windows, and activity-specific timing restrictions. While individual fish may be affected by construction activities, the effects would not limit overall population productivity.

In summary, construction and maintenance activities would result in limited temporary and permanent effects on the covered fish species and their habitat. While these effects would vary by species and species life stages, the implementation of environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*), would reduce most of these construction effects to be not adverse and less than significant. The implementation of habitat restoration activities, particularly CM6 *Channel Margin Enhancement*, would offset effects of habitat loss or alteration at the intake sites.

Water Operations of CM1

Water operations under Alternative 6A differ from Alternative 4 in several ways. Alternative 6 includes five intakes in the north Delta to convey up to 15,000 cfs, while Alternative 4 utilizes three intakes, and can only convey up to 9,000 cfs. As discussed in Chapter 5, *Water Supply*, average annual exports under Alternative 6 are anticipated to be 3,758 TAF, which is substantially less than anticipated exports under all four operational scenarios for Alternative 4 (4,414 to 5,255 TAF). Average annual exports under Alternative 6 would also be substantially less than Existing Conditions (5,144 TAF), as well as NAA (4,441 TAF).

Changes in anticipated long-term average annual Delta outflow under Alternative 4 also vary between the operational scenarios (H1–H4). The average annual outflows would be greater for Alternative 6A than all the Alternative 4 operational scenarios (between 639 and 1,498 TAF greater). Alternative 6A would result in greater annual average outflow (about 1,383 TAF) than Existing Conditions, and about 634 TAF more than NAA.

There are various benefits to entrainment, rearing, and migration conditions for some species under both alternatives. While Alternative 6A results in beneficial effects salmonid entrainment, Alternative 4 results would typically not be adverse or less than significant, although beneficial effects would occur for some of these same species.

Restoration Measures (CM2, CM4–CM7, and CM10)

With respect to restoration measures, Alternative 6A would be the same as Alternative 4. Consequently, the effects or these measures would also be the same.

Other Conservation Measures (CM12–CM19 and CM21)

With respect to other conservation measures, Alternative 6A would be the same as Alternative 4. Consequently, the effects associated with these other conservation measures would also be the same for both alternatives.

11.0.2.11 Alternative 6B—Summary of Effects

Overview

Alternative 6B includes the same five intakes on the Sacramento River, and the same culvert and tunnel siphons, as Alternatives 1A and 1B. Alternative 6B also has an east-side alignment surface canal conveyance like the one included in Alternatives 1B and 2B. Alternative 6B differs from Alternative 1B because it does not include the south Delta intakes. However, because no construction impacts on the aquatic environment are associated with the south Delta intakes, construction impacts would be the same as those under Alternative 1B and Alternative 2B. In addition, only one barge landing would be constructed under Alternative 6B compared to six under Alternative 1A.

Water supply and conveyance operations would follow the guidelines described as Scenario D. Alternative 6B has the same diversion and conveyance operations as Alternative 6A; consequently, the analysis under Alternative 6A is applicable to Alternative 6B.

CM2, CM4–CM7, CM10, CM12–CM19, and CM21 would be implemented under this alternative, and these CMs would be identical to those under Alternatives 6A and 1A.

Construction and Maintenance of CM1

As indicated above for Alternative 1A, the potential for construction and maintenance activities to affect the covered fish species would typically be proportional to the number of north Delta intakes constructed, and the total area of habitat affected. Alternative 6B includes the same intakes as Alternative 1A. Therefore, the total area affected by intake construction would be the same, at about 28.7 acres (see Table 11-1A-SUM1). Unlike Alternative 1A, Alternative 6B includes an east side conveyance canal, instead of a tunnel and only one barge landing.

At the Alternative 6B intakes, between 1.2 and 6.9 acres of river area would be isolated behind cofferdams, and temporarily or permanently lost. During the in-water construction period, a total of up to about 27.3 acres of in-water habitat would be affected by dredging activities, this loss or alteration of low-quality spawning, rearing, and migration habitat for covered fish species would be the same as Alternative 1A (see Table 11-1A-SUM1). Similarly, the footprint of the intake and transition wall structures would result in permanent loss of about 11,900 feet of primarily steep-banked and riprapped shoreline habitat, also the same as Alternative 1A. The barge landing would include in-water and over-water structures, occupying approximately 15,000 square feet of shoreline habitat.

As discussed in detail for Alternative 1A, in-water and nearshore construction activities have the potential to cause adverse effects on covered species, although these adverse effects would be effectively avoided and minimized by implementing environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*). These include pile driving minimization measures AQUA-1a and AQUA-1b, as well as isolating much of the in-water work inside cofferdams, constructing in areas that have limited use by the covered species, adhering to the approved in-water work windows, and activity-specific timing restrictions. While individual fish may be affected by construction activities, the effects would not limit overall population productivity.

In summary, construction and maintenance activities would result in limited temporary and permanent effects on the covered fish species or their habitat. While these effects would vary by species and species life stages, the implementation of environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*), would reduce most of these construction effects to be not adverse and less than significant. The implementation of habitat restoration activities, particularly CM6 *Channel Margin Enhancement*, would offset effects of habitat loss or alteration at the intake sites.

Water Operations of CM1

With respect to water operations of CM1, Alternative 6B is the same as Alternative 6A. Consequently, all the effects associated with water operations of CM1 under Alternative 6B are the same as those described above under the Alternative 6A summary.

Restoration Measures (CM2, CM4–CM7, and CM10)

With respect to restoration measures, Alternative 6B is the same as Alternatives 6A and 1A. Consequently, all the effects associated with restoration measures under Alternative 6B are the same as those described above under the Alternative 1A summary.

Other Conservation Measures (CM12–CM19 and CM21)

With respect to other conservation measures, Alternative 6B is the same as Alternatives 6A and 1A. Consequently, all the effects associated with other conservation measures under Alternative 6B are the same as those described above under the Alternative 1A summary.

Comparison of Alternative 6B to Alternative 4 (Proposed Project)

Alternative 6B would convey up to 15,000 cfs of water from the north Delta to the south Delta through a surface canal, from five screened intakes on the east bank of the Sacramento River between Clarksburg and Walnut Grove (i.e., Intakes 1 through 5). While Alternative 4 would also consist of constructing similar intake and conveyance structures, in this area of the river, it would include only three intakes, with a conveyance capacity of up to 9,000 cfs. Alternative 6B would also have a different operations scenario (Scenario D), with an isolated conveyance process, compared to Alternative 4 (Scenario H) and dual conveyance operations. As described above, Scenario H incorporates a decision tree process that results in four potential operational sub-scenarios, depending on the outcome of the decision tree process for spring outflow and Fall X2 operations.

Construction and Maintenance of CM1

The potential for construction and maintenance activities to affect the covered fish species would typically be proportional to the number of north Delta intakes constructed, and the total area of habitat affected. As a result, Alternative 6B would have a greater potential for effects than Alternative 4 because it includes the construction of two additional intakes (five total), along with the associated increase in streambed dredging. The potential effects of Alternative 6B would be similar to the effects described above for Alternatives 1A and 1B, (see Table 11-1A-SUM1).

As discussed above, in-water and nearshore construction activities have the potential to cause adverse effects on covered species, although these adverse effects would be effectively avoided and minimized by implementing environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*). These include pile driving minimization measures AQUA-1a and AQUA-1b, as well as isolating much of the in-water work inside cofferdams, constructing in areas that have limited use by the covered species, adhering to the approved in-water work windows, and activity-specific timing restrictions. While individual fish may be affected by construction activities, the effects would not limit overall population productivity.

In summary, construction and maintenance activities would result in limited temporary and permanent effects on the covered fish species and their habitat. While these effects would vary by species and species life stages, the implementation of environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*), would reduce most of these construction effects to be not adverse and less than significant. The implementation of habitat restoration activities, particularly CM6 *Channel Margin Enhancement*, would offset effects of habitat loss or alteration at the intake sites.

Water Operations of CM1

With respect to water operations, Alternative 6B would be the same as Alternative 6A. Please refer to the comparison of Alternative 6A to Alternative 4.

Restoration Measures (CM2, CM4–CM7, and CM10)

With respect to restoration measures, Alternative 6B would be the same as Alternative 4. Consequently, the effects or these measures would also be the same.

Other Conservation Measures (CM12–CM19 and CM21)

With respect to other conservation measures, Alternative 6B would be the same as Alternative 4. Consequently, the effects associated with these other conservation measures would also be the same for both alternatives.

11.0.2.12 Alternative 6C—Summary of Effects

Overview

Construction impacts from Alternative 6C would be the same as those discussed for Alternative 1C. Like Alternative 1C, Alternative 6C would convey water from five fish-screened intakes in the Sacramento River between Clarksburg and Walnut Grove in the north Delta through a tunnel and two large canal segments to a new Byron Tract Forebay adjacent to CCF in the south Delta. However, like Alternatives 6A and 6B, Alternative 6C would be an isolated conveyance, no longer involving operation of the existing SWP and CVP south Delta export facilities for CCF and Jones Pumping Plant. Other than the isolated conveyance and the culvert siphons, and number of barge landings, the physical and structural components would be similar to those under Alternative 1C.

Water supply and conveyance operations would follow the guidelines described as Scenario D. Alternative 6C has the same diversion and conveyance operations as Alternative 6A; consequently, the analysis under Alternative 6A is applicable to Alternative 6C.

CM2, CM4–CM7, CM10, CM12–CM19, and CM21 would be implemented under this alternative, and these CMs would be identical to those under Alternatives 6A and 1A.

Construction and Maintenance of CM1

As indicated above for Alternative 1A, the potential for construction and maintenance activities to affect the covered fish species would typically be proportional to the number of north Delta intakes constructed, and the total area of habitat affected. Alternative 6C includes the same number of intakes (five) and the same intake locations as Alternative 1C and 2C. Therefore, the total area affected by intake construction would be similar to these other alternatives. These alternatives would have similar overall effects as Alternative 1A, which also has the same number of intakes, although the intakes are on the opposite (west) side of the river (see Table 11-1A-SUM1). Unlike Alternative 1A, Alternative 6C includes a west side conveyance canal, and two barge landings, although most of the in-water construction activities would be about the same.

At each Alternative 6C intake, between 1.4 and 7.8 acres of river area would be isolated behind cofferdams, and temporarily or permanently lost, for an estimated maximum total of 32.7 acres. This is about 14% greater than Alternative 1A. During the in-water construction period, a total of up to about 20.3 acres of in-water habitat would be affected by dredging activities, this loss or alteration of low-quality spawning, rearing, and migration habitat for covered fish species would be about 25% less than for Alternative 1A (see Table 11-1A-SUM1). Likewise, the footprint of the intake and transition wall structures would result in permanent loss of about 10,100 feet of primarily steep-banked and riprapped shoreline habitat, or about 15% less than for Alternative 1A. The barge landings would include in-water and over-water structures, occupying approximately 15,000 square feet of shoreline habitat, although this would be 67% lower than for Alternative 1A.

As discussed in detail for Alternative 1A, in-water and nearshore construction activities have the potential to cause adverse effects on covered species, although these adverse effects would be effectively avoided and minimized by implementing environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*). These include pile driving minimization measures AQUA-1a and AQUA-1b, as well as isolating much of the in-water work inside cofferdams, constructing in areas that have limited use by the covered species, adhering to the approved in-water work windows, and activity-specific timing restrictions. While individual fish may be affected by construction activities, the effects would not limit overall population productivity.

In summary, construction and maintenance activities would result in limited temporary and permanent effects on the covered fish species or their habitat. While these effects would vary by species and species life stages, the implementation of environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*), would reduce most of these construction effects to be not adverse and less than significant. The implementation of habitat restoration activities, particularly CM6 *Channel Margin Enhancement*, would offset effects of habitat loss or alteration at the intake sites.

Water Operations of CM1

With respect to water operations of CM1, Alternative 6C is the same as Alternative 6A. Consequently, all the effects associated with water operations of CM1 under Alternative 6C are the same as those described above under the Alternative 6A summary.

Restoration Measures (CM2, CM4–CM7, and CM10)

With respect to restoration measures, Alternative 6C is the same as Alternatives 6A and 1A. Consequently, all the effects associated with restoration measures under Alternative 6C are the same as those described above under the Alternative 1A summary.

Other Conservation Measures (CM12–CM19 and CM21)

With respect to other conservation measures, Alternative 6C is the same as Alternatives 6A and 1A. Consequently, all the effects associated with other conservation measures under Alternative 6C are the same as those described above under the Alternative 1A summary.

Comparison of Alternative 6C to Alternative 4 (Proposed Project)

Alternative 6C would convey up to 15,000 cfs of water from the north Delta to the south Delta through a surface canal on the west side of the Sacramento River, from five screened intakes constructed between Clarksburg and Walnut Grove (i.e., Intakes 1 through 5). While Alternative 4 would construct similar intake facilities in this portion of the river, it would include only three intakes (with up to 9,000 cfs combined capacity), and the intakes would be on the east side of the river. While Alternative 4 would tunnel under a number of waterways along the conveyance route, the surface canal for Alternative 6C would use culvert siphons to pass under nine waterways, each requiring in-water construction. Alternative 2C would also have two barge landings and 16 bridge crossings compared to six barge landings and no bridge crossings for Alternative 4.

In addition to these construction differences, Alternative 6C includes a different operations scenario (Scenario D) than Alternative 4 (Scenario H). Scenario H incorporates a decision tree process that results in four potential operational sub-scenarios, depending on the outcome of the decision tree process for spring outflow and Fall X2 operations.

Construction and Maintenance of CM1

The potential for construction and maintenance activities to affect the covered fish species would typically be proportional to the number of north Delta intakes constructed, and the total area of habitat affected. As a result, Alternative 6C would have substantially greater potential for effects than Alternative 4, because it includes the construction of two additional intakes (five total). The additional intakes would also require dredging to re-contour the adjacent streambed. These effects would be the similar to those described above for Alternative 1A and 1C (see Table 11-1A-SUM1).

As discussed above, in-water and nearshore construction activities have the potential to cause adverse effects on covered species, although these adverse effects would be effectively avoided and minimized by implementing environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*). These include pile driving minimization measures AQUA-1a and AQUA-1b, as well as isolating much of the in-water work inside cofferdams, constructing in areas that have limited use by the covered species, adhering to the approved in-water work windows, and activity-specific timing restrictions. While individual fish may be affected by construction activities, the effects would not limit overall population productivity.

In summary, construction and maintenance activities would result in limited temporary and permanent effects on the covered fish species and their habitat. While these effects would vary by species and species life stages, the implementation of environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*), would reduce most of these construction effects to be not adverse and less than significant. The implementation of habitat restoration activities, particularly CM6 *Channel Margin Enhancement*, would offset effects of habitat loss or alteration at the intake sites.

Water Operations of CM1

With respect to water operations, Alternative 6C would be the same as Alternative 6A. Please refer to the comparison of Alternative 6A to Alternative 4.

Restoration Measures (CM2, CM4–CM7, and CM10)

With respect to restoration measures, Alternative 6C would be the same as Alternative 4. Consequently, the effects or these measures would also be the same.

Other Conservation Measures (CM12–CM19 and CM21)

With respect to other conservation measures, Alternative 6C would be the same as Alternative 4. Consequently, the effects associated with these other conservation measures would also be the same for both alternatives.

11.0.2.13 Alternative 7—Summary of Effects

Overview

Alternative 7 is the same as Alternative 1A except that it involves Intakes 2, 3, and 5 instead of Intakes 1, 2, 3, 4, and 5 and includes a different operational scenario. While Alternative 1A would divert up to 15,000 cfs and uses Operational Scenario A, Alternative 7 would divert up to 9,000 cfs in the north Delta and uses Operational Scenario E. Alternative 7 has Enhanced Aquatic Conservation which would enhance 20,000 acres of floodplain habitat versus 10,000 acres for Alternative 1A. A total of 40 linear miles of channel margin habitat would be enhanced under Alternative 7 instead of 20 linear miles for Alternative 1A. Alternative 7 has the same six barge facilities as Alternative 1A.

CM2, CM4–CM7, CM10, CM12–CM19, and CM21 would be implemented under this alternative, and these CMs would be identical to those under Alternative 1A.

Construction and Maintenance of CM1

Alternative 7 includes the same construction and maintenance elements as described above for Alternative 1A, except that it involves only three intakes (Intakes 2, 3, and 5) instead of five intakes (Intakes 1, 2, 3, 4, and 5) for Alternative 1A (see Table 11-1A-SUM1). Thus, the amount of permanently displaced shoreline habitat (7,450 linear feet), from the intakes and transition wall structures, would be about 37% less than for Alternative 1A (11,900 feet). The overall footprint of the three intakes would be about 56% smaller (5.1 acres) than for Alternative 1A (11.7 acres), and the amount of dredging and channel shaping would be about 38% less for Alternative 7 (17 acres) than for Alternative 1A (27.3 acres). Despite these differences in construction area, there would be no substantial difference in effects at the barge landing sites, as Alternative 7 includes the same six barge facilities as Alternative 1A.

In addition to the smaller construction footprint, and fewer potential effects on the covered fish species, Alternative 7 would enhance 100% more floodplain habitat (20,000 acres) and channel margin habitat (40 linear miles) than Alternative 1A (10,000 acres and 20 linear miles, respectively).

The smaller construction area would result in a substantially lower potential for effects on the covered fish species, due to proportionally less pile driving, dredging, and overall in-water construction activities. The fewer intakes would also result in a substantial reduction in the potential to trap or strand fish within the cofferdams, and reduce the risks associated with rescuing these fish. Despite the substantial reduction in pile driving activity, the pile driving effects could still be adverse, although the implementation of Mitigation Measures AQUA-1a and AQUA-1b would effectively avoid and minimize adverse effects from impact pile driving.

The reduced construction activities would also have less potential for water quality degradation from increased turbidity, inadvertent spills of hazardous materials, and disruption of contaminated sediments. In addition, these potential effects would be effectively avoided and minimized by isolating much of the in-water work inside cofferdams, constructing in areas that have limited use by the covered species, adhering to the approved in-water work windows, activity-specific timing restrictions, and by implementing environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*). These environmental commitments would be expected to protect covered fish species from adverse water quality effects resulting from project construction. These same commitments would also offset potential effects of periodic maintenance activities, which would also be proportionally reduced compared to Alternative 1A.

The fewer in-water structures constructed under Alternative 7, compared to Alternative 1A, would likely result in proportionally less potential predator habitat, although the overall effect on predation rates would be negligible.

As the construction and maintenance activities would be similar to those discussed for Alternative 1A, the types of effects on the covered species and non-covered species of primary management concern would also be similar, although the magnitude of effects would be proportionally less. In addition, the increased habitat enhancement provided by Alternative 7 would result in greater benefits to the covered species than Alternative 1A. Therefore, the construction and maintenance activities associated with Alternative 7 would not be adverse to the covered species, and the effects would be less than significant.

Water Operations of CM1

The methods and analysis of Alternative 7 are the same as those previously described for Alternative 1A. However, Alternative 7 includes three intakes rather than the five utilized in Alternative 1A, and Alternative 7 uses water operations scenario E. Since the size of the conveyance infrastructure and the water operations scenario differs, the effects are different.

Changes in Exports and Outflow

As discussed in Chapter 5, *Water Supply*, over the long term, average annual Delta exports under Alternative 7 are anticipated to increase by 1,389 TAF relative to Existing Conditions, and by 686 TAF relative to the No Action Alternative. It is important to note that some outflow changes under Alternative 7 are greater relative to Existing Conditions because Existing Conditions does not includes operations to meet Fall X2, whereas NAA and Alternative 7 do include Fall X2.

Over the long-term, approximately 62% of the exported water will be from the new north Delta intakes, and average monthly diversions at the south Delta intakes would correspondingly decrease.

This is in part because of restrictions on diversions from south Delta (no diversions at the south Delta intakes in April, May, October, and November). These changes would increase the proportion of San Joaquin River water flowing throughout the South, West, and Interior Delta, and a corresponding decrease in the proportion of Sacramento River water.

As a result of changes in points of diversion and the quantity and timing of diversions (more water diverted in April and May and less water diverted September through January), there would be beneficial, not adverse/less than significant, and adverse/significant and unavoidable effects/impacts on fish under Alternative 7. Following is a summary of these effects as they relate to the key factors of entrainment and flow, which in turn affects fish survival and spawning, rearing, and migration habitat conditions.

Entrainment

Similar to Alternative 1A, overall entrainment of numerous species under Alternative 7 would be less than or similar to the levels experienced in the recent years. This is because the north Delta diversion operations would reduce reliance on south Delta export facilities (greater entrainment rates are expected to occur at south Delta facilities), along with additional minor benefits from decommissioning of agricultural diversions in restoration areas and implementation of an alternative intake for the North Bay Aqueduct. Additionally, the reduced exports under Alternative 7 as compared to 1A provide further reductions in entrainment, resulting in beneficial effects for delta smelt, longfin smelt, salmonids, and sturgeon.

Reduced entrainment of juvenile salmonids would occur in the majority of years under all water year types relative to current conditions, whereas Alternative 1A reductions were only under the wetter conditions.

Finally, Alternative 7 is expected to slightly reduce Pacific and river lamprey entrainment due to reductions in south Delta exports and decommissioning agricultural diversions to an extent similar to Alternative 1A.

Since the proposed north Delta intakes under Alternative 7 are the same design as those proposed under Alternative 1A, the potential to affect some fish species through contact with the screens and/or increased predation around those facilities still exists but to a lesser extent because of the fewer number of intakes (three as compared to five). Regardless, these effects are considered to be not adverse.

In summary, entrainment is expected to remain at or below the levels currently experienced by fish in the Delta. There are very few instances where there would be increases, but these are substantially offset by decreases during other periods. Effects are at a minimum not adverse and less than significant, with effects being beneficial for many species.

Flows

While San Joaquin River flows are not expected to be affected by Alternative 7, flow changes are expected in the Sacramento River and its tributaries, as well as within the Sacramento-San Joaquin Delta. Changes in flow will result from changes in releases from upstream reservoirs, diversions from the south Delta, and reductions in flows downstream of the proposed north Delta intakes.

The area of fall abiotic habitat for juvenile delta smelt in the open-water areas of the Suisun Bay, Suisun Marsh, and West Delta subregions would be larger under Alternative 7 than under NAA conditions. Alternative 7 would further benefit delta smelt by habitat restoration, which has the potential to increase spawning and rearing habitat and supplement food production and export to rearing areas. Alternative 7 is not expected to substantially change migration conditions for delta smelt.

Based on Kimmerer et al. (2009), reduced outflows in January through June have the potential to reduce longfin smelt abundance. Average relative longfin smelt abundance would be 20 to 25% greater under Alternative 7 compared to NAA. Rearing conditions for larval and juvenile longfin smelt can also be analyzed by assessing Delta outflows. On average, Delta outflow would be similar under Alternative 7 compared to NAA from January through May, and increased by 12% in June.

With regard to salmonids, the effects would range from adverse to beneficial, although most would be less than significant or not adverse (Table 11-7-SUM1). For example, entrainment effects would be beneficial for spring- and fall-/late fall-run Chinook salmon, while flow reductions on almost all waterways analyzed (Sacramento, Feather, American, and Stanislaus rivers) would adversely affect meaningful portions of the fall-run population for rearing. While the flow reductions would also adversely affect spawning conditions, these effects would be primarily due to climate change, sea level rise, and future water demand, as opposed to the direct effects of the alternative. In addition, the effects of some impact mechanisms cannot be determined with existing information, and will require additional modeling. These mechanism include effects on migration conditions for the four Chinook salmon species and steelhead, as well as spawning conditions for winter-run and spring run Chinook salmon. Additional modeling results will be reviewed to confirm potential adverse or significant effects.

Generally consistent with Alternative 1A, improved flow conditions over the Fremont Weir and in the Yolo Bypass would some benefits to Sacramento splittail, primarily with regard to improved spawning and migration conditions. However, the overall effects would be not adverse.

Alternative 7 would result in similar effects for green and white sturgeon as those described for Alternative 1A. Alternative 7 would reduce flows and increase water temperatures, resulting in increased egg mortality and decreased rearing conditions for both species. However, these impacts would be less than significant or not adverse. Alternative 7 would result in adverse effects on migration conditions for green sturgeon, due to reduced flows in the Sacramento and Feather Rivers during adult, larval, and juvenile migration periods. Although the effects on green sturgeon migration habitat are considered unavoidable, proposed adaptive management mitigation measures have the potential to reduce the severity of the impacts though not necessarily to a less than significant level. Effects on white sturgeon migration conditions would be less than significant, relative to Existing Conditions, but targeted investigations and monitoring activities would be conducted to identify the final determination of the overall effects of Alternative 7 relative to NAA.

Alternative 7 would not have substantial effects on spawning and egg incubation habitat for lamprey species. Flows and temperatures under Alternative 7 would generally be similar to, or better than, those under NAA during lamprey spawning and incubation periods. Flow reductions on several waterways, including the Sacramento, Trinity, and American rivers, when compared to Existing Conditions, would have negative effects on lamprey rearing conditions. However, these effects are attributable to climate change, sea level rise, and future water demand, as opposed to direct effects of the alternative.

As evidenced by this summary, some changes in flow under Alternative 7 are adverse to fish species. Alternative 7 also includes the same conservation measures as Alternative 1A, with additional amounts of habitat restoration which provide substantial habitat improvements for fish. When the flow and habitat restoration measures are considered together, many of the effects of Alternative 7 measures are beneficial or not adverse and/or less than significant. However, several effects resulting from changes in flows upstream of the Delta remain adverse and/or significant and unavoidable. Summary Table 11-7-SUM1 presents the results of the flow related effects on fish.

Table 11-7-SUM1. Results of Flow-Related Effects on Fish

Species	Entrainment	Spawning	Rearing	Migration
Delta smelt	B/B	NA/LTS	ND/LTS	ND/LTS
Longfin smelt	B/B	ND/LTS (combined)		
Winter-Run Chinook salmon	NA/LTS	ND/LTS	NA/LTS	ND/LTS
Spring-Run Chinook salmon	NA/B	ND/LTS	NA/LTS	ND/LTS
Fall-Run/Late Fall-Run Chinook salmon	NA/B	NA/LTS	A/SU	ND/LTS
Steelhead	NA/LTS	NA/LTS	NA/LTS	ND/LTS
Sacramento splittail	NA/LTS	NA/LTS	NA/LTS	NA/LTS
Green sturgeon	NA/LTS	NA/LTS	NA/LTS	A/SU
White sturgeon	NA/LTS	NA/LTS	NA/LTS	ND/LTS
Pacific lamprey	NA/LTS	NA/LTS	NA/LTS	NA/LTS
River lamprey	NA/LTS	NA/LTS	NA/LTS	NA/LTS

Level of significance:

NEPA Conclusion	*CEQA Conclusion*
A = Adverse.	SU = Significant and Unavoidable.
NA = Not Adverse.	LTS = Less than Significant.
B = Beneficial.	B = Beneficial.
ND = Not Determined.	S = Significant.

Restoration Measures (CM2, CM4–CM7, and CM10)

With respect to restoration measures, Alternative 7 is the same as Alternative 1A except that it includes twice the restored habitat for CM5 *Seasonally Inundated Floodplain* and CM6 *Channel Margin Enhancement*. That is, CM5 *Seasonally Inundated Floodplain* has 20,000 acres under Alternative 7 rather than 10,000 acres under Alternative 1A and CM6 *Channel Margin Enhancement* has 40 miles of channel enhancement under Alternative 7 rather than 20 miles of channel enhancement under Alternative 1A. Consequently, all of the effects associated with Alternative 7 are the same as Alternative 1A except for those associated with additional habitat creation or the additional habitat itself, as described below. For a summary discussion of the effects of other restoration measures see the complete analysis under Alternative 1A.

Effects of Construction of Restoration Measures

The types of effects related to construction of restoration measures for Alternative 7 would be the same as those described for Alternative 1A. The area of potential effects of restoration construction activities under Alternative 7 would be greater than that described for Alternative 1A due to the increased floodplain and channel margin habitat enhancement. However, the discussion under

Alternative 1A still applies because the same in-water construction window, lack of impact pile driving, and implementation of Appendix 3B, *Environmental Commitments* would still occur. These measures would avoid or minimize any adverse or significant effects. As a result, the effects of construction of restoration measures are not adverse and are less than significant for covered and non-covered fish species.

Contaminants Associated with Restoration Measures

The types of effects related to contaminants from construction of restoration measures for Alternative 7 would be the same as those summarized for Alternative 1A, although the area of potential effects would be greater due to the increased floodplain and channel margin habitat enhancement. However, the discussion under Alternative 1A still applies and the effects would be the same. Contaminants associated with restoration measures would not be adverse and are less than significant for covered and non-covered fish species.

Restored Habitat Conditions

The effects of restored habitat conditions for CM2 *Yolo Bypass Fisheries Enhancement*, CM4 *Tidal Natural Community Restoration*, and CM7 *Riparian Natural Community Restoration* would be the same as summarized under Alternative 1A. The types of effects of restored habitat for CM5 *Seasonally Inundated Floodplain Restoration* and CM6 *Channel Margin Enhancement* would also be the same as summarized for Alternative 1A except that double the amount of habitat would be created. For CM5 *Seasonally Inundated Floodplain*, this doubling of habitat would provide proportionally more benefit than that described under Alternative 1A. Consequently, increased habitat would be most beneficial for Chinook salmon, steelhead, Sacramento splittail, green sturgeon, and white sturgeon which would use the new habitat. All covered and non-covered species would benefit from the increased food production either within, or exported from, the new habitat. As described in the summary for Alternative 1A, for CM7 *Riparian Natural Community Restoration* the restored habitat would be most beneficial for Chinook salmon, Sacramento splittail, green sturgeon, and white sturgeon. Steelhead, Pacific lamprey, and river lamprey would receive minor benefit. All covered and non-covered fish species would receive benefits from increased food production associated with CM5 and CM6. The overall effects would be beneficial for all covered and non-covered fish species.

Other Conservation Measures (CM12–CM19 and CM21)

With respect to other conservation measures, Alternative 7 is the same as Alternative 1A as described above under Other Conservation Measures (CM12–CM19 and CM21). Consequently, all of the effects associated with Alternative 7 are the same as Alternative 1A except for those associated with additional habitat creation or the additional habitat itself. Therefore, the only other conservation measure specifically addressed for Alternative 7 is CM12 *Methylmercury Management*. The effects associated with the additional habitat creation and the additional habitat are summarized below. For a summary discussion of the effects of other conservation measures see the complete analysis under Alternative 1A.

Methylmercury Management (CM12)

The effects of CM12 *Methylmercury Management* would be the same as described under Alternative 1A except that they would be applied over a larger area. Consequently, these effects would not be adverse and are less than significant.

Comparison of Alternative 7 to Alternative 4 (Proposed Project)

The substantial increase in restoration activities (20 additional miles of channel margin habitat and 10,000 additional acres of seasonally inundated floodplain) are the primary differences between Alternative 7 and Alternative 4. The other difference is the operating scenario, Scenario E for Alternative 7, and Scenario H for Alternative 4. Otherwise, the number and location of the intakes would be the same, as would be the conveyance facilities and the diversion volume (up to 9,000 cfs of water). Alternative 4 also incorporates a decision tree process into Scenario H, that results in four potential operational sub-scenarios, depending on the outcome of the decision tree process for spring outflow and Fall X2 operations.

Construction and Maintenance of CM1

Due to the overall similarities in the facilities constructed, the potential for construction and maintenance activities to affect the covered fish species would be the same for Alternative 7 as for Alternative 4 (see Table 11-1A-SUM1).

Water Operations of CM1

Water operations under Alternative 7 differ from Alternative 4, although both include the same three intakes in the north Delta to convey up to 9,000 cfs. As discussed in Chapter 5, *Water Supply*, average annual exports under Alternative 7 are anticipated to be 3,754 TAF, which is substantially less than anticipated exports under all four operational scenarios for Alternative 4 (4,414 to 5,255 TAF). Average annual exports under Alternative 7 would also be substantially less than Existing Conditions (5,144 TAF), as well as NAA (4,441 TAF).

Changes in anticipated long-term average annual Delta outflow under Alternative 4 also vary between the operational scenarios (H1–H4). The average annual outflows would be between 688 and 1,547 TAF greater for Alternative 7 than all the Alternative 4 operational scenarios. Alternative 7 would result in greater annual average outflow (about 1,432 TAF) than Existing Conditions, and about 683 TAF more than NAA.

There are various benefits to entrainment and spawning conditions for some species under both alternatives, with Alternative 7 providing beneficial entrainment effects for four covered fish species, including the same two species (longfin smelt and spring-run Chinook salmon) benefiting from Alternative 4 (Table 11-7-SUM1). Both alternatives also provide beneficial effects on delta smelt rearing and Sacramento splittail migration.

In contrast, Alternative 7 would results in adverse or significant and unavoidable effects on migration conditions for green sturgeon, and rearing conditions for fall-, and late fall-run Chinook salmon. However, potential effects on spawning, egg incubation, and migration conditions for winter-run and spring-run Chinook salmon, as well as migration conditions for fall-/late fall-run Chinook salmon, steelhead and white sturgeon, have not yet been determined, due to existing uncertainties.

Restoration Measures (CM2, CM4–CM7, and CM10)

With respect to restoration measures, Alternative 7 would be the same as Alternative 4. Consequently, the effects or these measures would also be the same.

Other Conservation Measures (CM12–CM19 and CM21)

With respect to other conservation measures, Alternative 7 would be the same as Alternative 4. Consequently, the effects associated with these other conservation measures would also be the same for both alternatives.

11.0.2.14 Alternative 8—Summary of Effects

Overview

Alternative 8 is similar to Alternative 1A except that it involves Intakes 2, 3, and 5 instead of Intakes 1, 2, 3, 4, and 5 and includes a different operational scenario. While Alternative 1A would divert up to 15,000 cfs and uses Operational Scenario A, Alternative 6 would divert up to 9,000 cfs from the north Delta and would use Operational Scenario F. Operational Scenario F would provide up to 1.5 MAF in increased Delta outflow and would include cold water pool management criteria for specific upstream reservoirs. Additionally, Operational Scenario F includes the same rules as Operational Scenario E (including eliminating south Delta exports in April and May). Alternative 8 has the same six barge facilities as Alternative 1A.

CM2, CM4–CM7, CM10, CM12–CM19, and CM21 would be implemented under this alternative, and these CMs would be identical to those under Alternative 1A.

Construction and Maintenance of CM1

As indicated above for Alternative 1A, the potential for construction and maintenance activities to affect the covered fish species would typically be proportional to the number of north Delta intakes constructed, and the total area of habitat affected. Alternative 8 includes the same three intakes as Alternative 7. Therefore, the total area affected by intake construction would be the same as those described above for Alternative 7. Alternative 8 would also have similar, although less, effects from intake construction and maintenance activities compared to Alternative 1A (see Table 11-1A-SUM1). As with Alternative 1A however, Alternative 8 includes a conveyance tunnel and six barge landings, so the effects of constructing these facilities would be about the same as those discussed above for Alternative 1A.

At each Alternative 8 intake, between 1.3 and 6.9 acres of river area would be isolated behind cofferdams, and temporarily or permanently lost, for a maximum total estimate of 18.1 acres. Although these areas vary by intake, the overall effects would be about 37% less than for Alternative 1A (28.7 acres). During the in-water construction period, a total of up to about 17 acres of in-water habitat would be affected by dredging activities, this loss or alteration of low-quality spawning, rearing, and migration habitat for covered fish species would also be about 37% less than for Alternative 1A (see Table 11-1A-SUM1). Likewise, the footprint of the intake and transition wall structures would result in permanent loss of about 7,450 feet of primarily steep-banked and riprapped shoreline habitat, or about 37% less than for Alternative 1A. The barge landings would include in-water and over-water structures, occupying approximately 15,000 square feet of shoreline habitat each, and the total would be similar to Alternative 1A.

As discussed in detail for Alternative 1A, in-water and nearshore construction activities have the potential to cause adverse effects on covered species, although these adverse effects would be effectively avoided and minimized by implementing environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*). These include pile driving minimization measures

AQUA-1a and AQUA-1b, as well as isolating much of the in-water work inside cofferdams, constructing in areas that have limited use by the covered species, adhering to the approved in-water work windows, and activity-specific timing restrictions. While individual fish may be affected by construction activities, the effects would not limit overall population productivity.

In summary, construction and maintenance activities would result in limited temporary and permanent effects on the covered fish species or their habitat. While these effects would vary by species and species life stages, the implementation of environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*), would reduce most of these construction effects to be not adverse and less than significant. The implementation of habitat restoration activities, particularly CM6 *Channel Margin Enhancement*, would offset effects of habitat loss or alteration at the intake sites.

Water Operations of CM1

The methods and analysis of Alternative 8 are the same as those previously described for Alternative 1A. However, Alternative 8 includes three intakes rather than the five utilized in Alternative 1A, and Alternative 8 uses water Operational Scenario F (which includes the same rules as Alternative 7; Operational Scenario E). Since the size of the conveyance infrastructure and the water operations scenario differs, the effects are different.

Changes in Exports and Outflow

As discussed in Chapter 5, *Water Supply*, over the long term, average annual Delta exports under Alternative 8 are anticipated to decrease by 2,046 TAF relative to Existing Conditions, and by 1,342 TAF relative to the No Action Alternative. Over the long-term, approximately 70% of the exported water will be from the new north Delta intakes, and average monthly diversions at the south Delta intakes would correspondingly decrease. This is in part because of restrictions on diversions from south Delta (no diversions at the south Delta intakes in April and May). These changes would increase the proportion of San Joaquin River water flowing throughout the south, west, and interior Delta, and a corresponding decrease in the proportion of Sacramento River water.

Under Alternative 8, long-term average annual Delta outflow is anticipated to increase 2,195 TAF relative to Existing Conditions and by 1,445 TAF relative to the NAA.

As a result of changes in points of diversion and the quantity and timing of diversions (more water diverted from mid-February through May and less water diverted June through January), there would be beneficial, not adverse/less than significant, and adverse/significant and unavoidable effects/impacts on fish under Alternative 8. Following is a summary of these effects as they relate to the key factors of entrainment and flow, which in turn affects fish survival and spawning, rearing, and migration habitat conditions.

Entrainment

Under Alternative 8 several more species would experience benefits with respect to entrainment than under Alternative 1A. This is because the Alternative 8 operations would have less reliance on south Delta export facilities (greater entrainment rates are expected to occur at south Delta facilities), including no diversion from the south Delta intakes in April and May, along with additional minor benefits from decommissioning of agricultural diversions in restoration areas and implementation of an alternative intake for the North Bay Aqueduct. Additionally, the reduced exports under Alternative 8 as compared to 1A provide further reductions in entrainment, resulting in beneficial effects for several species.

Beneficial effects with respect to entrainment would be experienced by delta smelt, winter-run Chinook salmon, spring-run Chinook salmon, fall-run/late-fall run Chinook salmon, steelhead, green sturgeon, and white sturgeon, relative to Existing Conditions. Although entrainment effects on delta and longfin smelt would be beneficial, relative to NAA, for the other species the effects would not be adverse.

Since the proposed north Delta intakes under Alternative 8 are the same design as those proposed under Alternative 1A, the potential to affect some fish species through contact with the screens and/or increased predation around those facilities still exists but to a lesser extent because of the fewer number of intakes (three as compared to five). Regardless, these effects are considered to be not adverse.

In summary, entrainment is expected to remain at or below the levels currently experienced by fish in the Delta. There are very few instances where there would be increases, and these are substantially offset by decreases during other periods. Effects are at a minimum not adverse and less than significant, with effects being beneficial for many species, particularly relative to Existing Conditions.

Flows

While San Joaquin River flows are not expected to be affected by Alternative 8, flow changes are expected in the Sacramento River and its tributaries, as well as within the Sacramento-San Joaquin Delta. Changes in flow will result from changes in releases from upstream reservoirs, reduced diversions from the south Delta, and reduced flows downstream of the proposed north Delta intakes.

The abiotic habitat index under Alternative 8 across all water years would be similar (<5% change) to NAA without restoration. Alternative 8 also has the potential to benefit delta smelt by habitat restoration, particularly in the Suisun Marsh, West Delta, and Cache Slough ROAs through increased spawning and rearing habitat and supplement food production and export. With habitat restoration, Alternative 8 flows may result in a 30% increase in the average abiotic habitat index compared to the NAA. These overall effects would be due to the inundation of new areas of the Delta resulting from habitat restoration effects; it is assumed that 100% of the newly restored habitat would be utilized by delta smelt. Alternative 8 is not expected to substantially change migration conditions for delta smelt.

Increased spring outflows under Alternative 8 would contribute to increases in longfin smelt abundance from increased larval transport flows and spring habitat quantity and quality for larval and early juvenile longfin smelt in the Suisun Marsh and west Delta subregions. Predicted average relative longfin smelt abundance would be increased by up to 57% under Alternative 8 compared to NAA conditions, with particular increases in below normal, dry, and critical water year types. Rearing conditions for larval and juvenile longfin smelt can also be analyzed by assessing Delta outflows. On average, January–March Delta outflows would be similar to NAA conditions, while outflows would be increased under Alternative 8 from April–June by 10–14%.

With regard to salmonids, several issues were identified as described below with many of them resulting in adverse and/or significant effects (i.e., compared to NAA and Existing Conditions, respectively). For example, Sacramento River attraction flows for migrating adult salmonids would be lower from operations of the north Delta diversions under Alternative 8, but not necessarily to an adverse level. Winter-run Chinook salmon would be adversely affected by reduced spawning and egg incubation habitat (higher egg mortality), reduced extent and quality of fry and juvenile rearing habitat, and reduced migration conditions as a result of reduced flows. These same flow reductions would reduce rearing and migration habitat to an adverse level for spring-run salmonids. Similarly, the effects on migration habitat for fall-run/late-fall run Chinook salmon would be adverse. Although the adverse effects would be unavoidable, proposed adaptive management mitigation measures would reduce the severity of the impacts, although not necessarily to a less than significant or not adverse level.

Steelhead would be adversely affected for two parameters under Alternative 8. While there are benefits to a decrease in the occurrence of unsuitable water temperatures for rearing in the Feather River and higher flows on several waterways during some months, the flow reductions during key periods (March and April, dry years in particular) would have an adverse effect on juvenile steelhead rearing and steelhead migration conditions. While there is no feasible mitigation available, proposed monitoring and modeling mitigation has the potential to reduce the severity of impact though not necessarily to a less than significant level.

Generally consistent with Alternative 1A, improved flow conditions over the Fremont Weir and in the Yolo Bypass provide substantial benefits to Sacramento splittail, primarily with regard to spawning and migration. Overall effects on Sacramento splittail would not be adverse.

Alternative 8 would result in similar effects for green and white sturgeon as those described for Alternative 1A. Alternative 8 would reduce flows and increase water temperatures, resulting in increased egg mortality and reduced rearing, although these effects would not be adverse and less than significant. However, reductions Sacramento and Feather River flows during multiple months would adversely affect the migratory abilities of all three life stages by slowing or inhibiting downstream migration of larvae and reducing the ability to sense upstream migration cues and pass impediments by adults. Proposed adaptive management mitigation measures would have the potential to reduce the severity of impact, although not necessarily to a not adverse level.

Similar to sturgeon, Alternative 8 would affect spawning and egg incubation habitat for lamprey species as a result of increased water temperatures on the Feather River and redd dewatering in the Sacramento and American rivers. Flow reductions on several waterways, including the Sacramento, Trinity, and American rivers would have an adverse effect on river lamprey rearing and migration habitat. Proposed adaptive management mitigation measures would have the potential to reduce the severity of impact, although not necessarily to a not adverse or less than significant level.

As evidenced by this summary, some changes in flow under Alternative 8 are adverse to fish species. Alternative 8 also includes the same conservation measures as Alternative 1A, with additional amounts of habitat restoration which provide substantial habitat improvements for fish. When the flow and habitat restoration measures are considered together, many of the effects of Alternative 8 measures are beneficial or not adverse and/or less than significant. However, several effects resulting from changes in flows upstream of the Delta remain adverse and/or significant and unavoidable. While proposed adaptive management mitigation measures would have the potential to reduce the severity of impacts, although not necessarily to a not adverse level. Summary Table 11-8-SUM1 presents the results of the flow related effects on fish.

Table 11-8-SUM1. Results of Flow-Related Effects on Fish

Species	Entrainment	Spawning	Rearing	Migration
Delta smelt	B/B	NA/LTS	ND/LTS	ND/LTS
Longfin smelt	B/LTS	ND/LTS (combined)		
Winter-Run Chinook salmon	NA/B	A/SU	A/SU	A/SU
Spring-Run Chinook salmon	NA/B	NA/LTS	A/SU	A/SU
Fall-Run/Late Fall-Run Chinook salmon	NA/B	NA/LTS	NA/LTS	A/SU
Steelhead	NA/B	NA/LTS	A/SU	A/SU
Sacramento splittail	NA/LTS	NA/LTS	NA/LTS	NA/LTS
Green sturgeon	NA/B	NA/LTS	NA/LTS	A/SU
White sturgeon	NA/B	NA/LTS	NA/LTS	A/SU
Pacific lamprey	NA/LTS	A/SU	A/SU	NA/LTS
River lamprey	NA/LTS	A/SU	A/SU	A/SU

Level of significance:

NEPA Conclusion	*CEQA Conclusion*
A = Adverse.	SU = Significant and Unavoidable.
NA = Not Adverse.	LTS = Less than Significant.
B = Beneficial.	B = Beneficial.
ND = Not Determined.	S = Significant.

Restoration Measures (CM2, CM4–CM7, and CM10)

With respect to restoration measures, Alternative 8 is the same as Alternative 1A. Consequently, all the effects associated with restoration measures under Alternative 8 are the same as those described above under the Alternative 1A summary.

Other Conservation Measures (CM12–CM19 and CM21)

With respect to other conservation measures, Alternative 8 is the same as Alternative 1A. Consequently, all the effects associated with other conservation measures under Alternative 8 are the same as those described above under the Alternative 1A summary.

Comparison of Alternative 8 to Alternative 4 (Proposed Project)

The operating scenario is the primary difference between Alternative 8 (Scenario F) and Alternative 4 (Scenario H). Scenario H incorporates a decision tree process that results in four potential operational sub-scenarios, depending on the outcome of the decision tree process for spring outflow and Fall X2 operations. Other than that, the number and location of the intakes would be the same, as would be the conveyance facilities and the diversion volume (up to 9,000 cfs of water).

Construction and Maintenance of CM1

Due to the overall similarities in the facilities constructed, and the expected maintenance activities, the potential for construction and maintenance activities to affect the covered fish species would be the same for Alternative 8 as for Alternative 4 (see Table 11-1A-SUM1).

As discussed above, in-water and nearshore construction activities have the potential to cause adverse effects on covered species, although these adverse effects would be effectively avoided and minimized by implementing environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*). These include pile driving minimization measures AQUA-1a and AQUA-1b, as well as isolating much of the in-water work inside cofferdams, constructing in areas that have limited use by the covered species, adhering to the approved in-water work windows, and activity-specific timing restrictions. While individual fish may be affected by construction activities, the effects would not limit overall population productivity.

In summary, construction and maintenance activities would result in limited temporary and permanent effects on the covered fish species and their habitat. While these effects would vary by species and species life stages, the implementation of environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*), would reduce most of these construction effects to be not adverse and less than significant. The implementation of habitat restoration activities, particularly CM6 *Channel Margin Enhancement*, would offset effects of habitat loss or alteration at the intake sites.

Water Operations of CM1

Water operations under Alternative 8 differ from Alternative 4 in a few ways. They are similar in that both Alternative 8 and Alternative 4 include three intakes in the north Delta to convey up to 9,000 cfs. However, As discussed in Chapter 5, *Water Supply*, average annual exports under Alternative 8 are anticipated to be 3,098 TAF, while Alternative 4 has anticipated exports ranging from 4,414 (under H4) to 5,255 (under H1). Changes in anticipated long-term average annual Delta outflow under Alternative 4 also vary between the operational scenarios (H1–H4). The average annual Delta outflows would be less for the Alternative 4 operational scenarios than Alternative 8 (between 1,450 and 2,309 TAF less). Alternative 8 would also result in greater annual average Delta outflow than Existing Conditions (about 2,194 TAF) and the NAA (about 1,445 TAF).

There are various benefits to entrainment and rearing for some species under both alternatives, but Alternative 8 has substantially more beneficial effects to entrainment than Alternative 4. The substantive difference is that Alternative 8 results in adverse effects/significant and unavoidable impacts on several species for spawning (winter-run Chinook salmon and the lamprey species), rearing (winter-run and spring-run salmon, steelhead, and the lamprey species), and migration (all the covered fish species except delta smelt, Sacramento splittail and Pacific lamprey), whereas Alternative 4 doesn't result in any adverse effects/significant and unavoidable impacts.

Restoration Measures (CM2, CM4–CM7, and CM10)

With respect to restoration measures, Alternative 8 would be the same as Alternative 4. Consequently, the effects or these measures would also be the same.

Other Conservation Measures (CM12–CM19 and CM21)

With respect to other conservation measures, Alternative 8 would be the same as Alternative 4. Consequently, the effects associated with these other conservation measures would also be the same for both alternatives.

11.0.2.15 Alternative 9—Summary of Effects

Overview

Alternative 9 is similar to Alternative 1A in that 15,000 cfs would be diverted to the south Delta. However, under Alternative 9 there would be four basic corridors. Two corridors would convey Sacramento River water through the Delta via existing channels rather than through canals or tunnels. Rather than five intakes as in Alternative 1A, fish-screened intakes would be constructed at the DCC and at Georgiana Slough to convey the water into these corridors. Two other channels would be used as fish movement corridors providing for fish migration from the San Joaquin River and the Mokelumne River. Alternative 9 also includes Operational Scenario G rather than Operational Scenario A, as in Alternative 1A. Scenario G would not contain any bypass rules; rather the flow into the two water diversion channels would be controlled by tidal hydraulics and the DCC gate closure rules. Alternative 9 would include 12 additional operable gates on various waterways within the interior Delta and five barge facilities. All but one of the barge sites would be in different locations from the six barge facilities under Alternative 1A.

CM2, CM4–CM7, CM10, CM12–CM19, and CM21 would be implemented under this alternative, and these CMs would be identical to those under Alternative 1A.

Construction and Maintenance of CM1

Unlike the other alternatives, Alternative 9 does not include the construction of new north Delta intake facilities. Instead, the DCC gates would be modified to include fish screens, and possibly a new gate, and a Georgiana Slough screened diversion would be constructed. In-water construction would also affect environmental conditions at several other locations in the Delta: where 12 additional operable gates and five barge landings would be constructed; where several waterways would be dredged to increase channel capacity in order to convey required flows; where levees would be constructed or modified; and where canals, bridges, and pump stations would be constructed.

Although the in-water facilities under Alternative 9 differ from those for the other alternatives, the construction and maintenance activities would remain similar. In-water cofferdams would be constructed to isolate the work areas, potentially requiring impact pile driving, and shoreline armoring and dredging activities would also occur. However, the work would be spread over a larger area, affecting a variety of different habitats than the typical steep and armored Sacramento River shoreline.

In addition to the different habitats potentially affected, the multiple work sites under Alternative 9 would increase the overall potential for effects, particularly due to the larger in-water footprint. The in-water footprint of the operable gates (about 15.4 total acres) would be about 32% greater than the permanent footprint of the Alternative 1A intakes (11.7 acres) (see Table 11-1A-SUM1). This is expected to result in greater in-water construction activities and a greater chance for effects from pile driving, trapping fish within the cofferdam structures, and overall habitat disturbances. There would also be about 108% more dredged area under Alternative 9 (59.6 acres) than under Alternative 1A (27.3 acres), substantially increasing the potential for direct and indirect fish losses and habitat alterations. The potential effects on water quality would also be increased. However, the area affected by the five barge landing structures (15,000 square feet each) would be less than the six landings for Alternative 1A.

As discussed in detail for Alternative 1A, in-water and nearshore construction activities have the potential to cause adverse effects on covered species, although these adverse effects would be avoided or minimized by implementing environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*). These include pile driving minimization measures AQUA-1a and AQUA-1b, as well as isolating much of the in-water work inside cofferdams, constructing in areas that have limited use by the covered species, adhering to the approved in-water work windows, and activity-specific timing restrictions. While individual fish may be affected by construction activities, the effects would not limit overall population productivity.

In summary, construction and maintenance activities would result in limited temporary and permanent effects on the covered fish species or their habitat. While these effects would vary by species and species life stages, the implementation of environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*), would reduce most of these construction effects to be not adverse and less than significant. The implementation of habitat restoration activities, particularly CM6 *Channel Margin Enhancement*, would offset effects of habitat loss or alteration at the intake sites.

Water Operations of CM1

The methods and analysis of Alternative 9 are the same as those previously described for Alternative 1A. However, Alternative 9 does not include intakes as described for Alternative 1A; rather it utilizes intakes that would provide water through existing Delta channels (i.e., Through Delta/Separate Corridors). Alternative 9 uses water Operational Scenario G. Since the type of the conveyance infrastructure and the water operations scenario differs, the effects are different.

Changes in Exports and Outflow

As discussed in Chapter 5, *Water Supply*, over the long term, average annual Delta exports under Alternative 9 are anticipated to decrease by 767 TAF relative to Existing Conditions, and by 63 TAF relative to the No Action Alternative. Additionally, 100% of the exported water will be from the south Delta.

Under Alternative 9, long-term average annual Delta outflow is anticipated to increase 807 TAF relative to Existing Conditions and by 57 TAF relative to the NAA. It is important to note that some outflow changes under Alternative 9 are greater relative to Existing Conditions because Existing Conditions does not includes operations to meet Fall X2, whereas NAA and Alternative 9 do include Fall X2.

As a result of changes in points of diversion and the quantity and timing of diversions (more water diverted in August through mid-January as well as April and May, and less water diverted mid-January through March), there would be beneficial, not adverse/less than significant, and adverse/significant and unavoidable effects/impacts on fish under Alternative 9. Following is a summary of these effects as they relate to the key factors of entrainment and flow, which in turn affects fish survival and spawning, rearing, and migration habitat conditions.

Entrainment

Under Alternative 9, overall entrainment of numerous species would be less than levels experienced in recent years. This would occur because of changes in flow in the Old River and Middle River due to screened intakes and operable barriers that would isolate the Old River fish corridor and associated channels from the pumping effects of the south Delta facilities. The Old River is a major pathway for delta smelt entrainment and it would no longer convey water to the south Delta facilities. In addition, proposed intakes at DCC and Georgiana Slough would be screened to minimize fish entrainment for the north Delta into the main conveyance channel for Alternative 9 via Middle River. Consequently, delta smelt from the north and central Delta would experience much less pumping effects and substantially reduced south Delta entrainment, and the effects would be beneficial. The other fish migration corridors would also isolate many fish, such as migrating juvenile salmonids, from the south Delta facilities thereby substantially reducing entrainment.

There would be additional minor benefits from decommissioning of agricultural diversions in restoration areas and implementation of an alternative intake for the North Bay Aqueduct, these effects on the covered fish species are not adverse.

The proposed DCC and Georgiana Slough intakes under Alternative 9 would result in some increased predation, but the effects are considered to be not adverse.

In summary, entrainment is expected to remain at or below the levels currently experienced by fish in the Delta. There are very few instances where there would be increases, but these are more than offset by decreases during other periods. Effects are at a minimum not adverse and less than significant, and likely beneficial for many species.

Flows

Some improved flows are expected in the lowermost San Joaquin River under Alternative 9 because of the isolated fish corridors. Operational flow changes are expected in the Sacramento River and its tributaries, as well as within the Sacramento-San Joaquin Delta. Changes in flow will result from changes in releases from upstream reservoirs.

The area of fall abiotic habitat for juvenile delta smelt in the open-water areas of the Suisun Bay, Suisun Marsh, and west Delta subregions would be similar under Alternative 9 to that under NAA conditions, without considering potential benefits of habitat restoration. Substantial increases in abiotic habitat index would occur with habitat restoration, assuming 100% habitat occupancy. In contrast to Alternative 1A, this habitat area would increase even more relative to Existing Conditions without the Fall X2 flows.

Unlike the other alternatives, Alternative 9 has the potential to affect migration conditions for delta smelt and other covered fish species. Alternative 9 includes 16 physical barriers that would limit movement of delta smelt in the interior Delta. However, limiting some migration pathways might reduce the risk of entrainment at the south Delta facilities.

Flows at Rio Vista under Alternative 9 would be similar (<10% difference) to Existing Conditions during the longfin smelt spawning period. Decreased spring outflows under Alternative 9 have the potential to contribute to decreases (by up to about 37%) in longfin smelt abundance from reduced larval transport flows and spring habitat quantity and quality for larval and early juvenile longfin smelt in the Suisun Marsh and west Delta subregions. Predicted average relative longfin smelt abundance under Alternative 9 would be increased 6–8% relative to NAA. In wet water years, relative abundance would be increased 12–15% compared to NAA. Longfin smelt may also benefit from habitat restoration actions, intended to provide additional food production and export to longfin smelt rearing areas. This potential benefit is not reflected in the X2-longfin smelt abundance regression.

While Sacramento River attraction flows for migrating adult salmonids would be lower from operations of the north Delta diversions under Alternative 9, it would not be to an adverse level. However, winter-run, spring-run, and fall-run/late-fall run Chinook salmon would be affected by reduced spawning and egg incubation habitat (higher egg mortality), reduced extent and quality of fry and juvenile rearing habitat and reduced migration habitat as a result of reduced flows when compared to Existing Conditions. These effects would not result in a significant impact because the differences are primarily the result of climate change, sea level rise and future water demand and not attributable to the alternative.

Similar to Chinook salmon, steelhead would be affected for spawning, rearing, and migration habitat due to flow reductions and temperatures in upstream tributaries. As with Chinook salmon, these effects would not result in a significant impact because the differences are primarily the result of climate change, sea level rise and future water demand, and not attributable to the alternative.

Generally consistent with Alternative 1A, improved flow conditions over the Fremont Weir and in the Yolo Bypass provide substantial benefits to Sacramento splittail, primarily with regard to spawning and migration. Overall effects on Sacramento splittail would not be adverse.

With regard to sturgeon, Alternative 9 would reduce flows and increase water temperatures, resulting in increased egg mortality and reduced rearing habitat, although not to an adverse level. While the effects on migration conditions resulting from flow changes could be adverse relative to NAA, based on the observed positive correlation between year class strength and flow, the mechanism responsible for this correlation is uncertain. However, targeted investigations are expected to identify the primary mechanisms that drive sturgeon year-class strength, and the final determination of the overall effects of Alternative 9 relative to NAA. Alternative 9 would not result in significant impacts to sturgeon relative to Existing Conditions, because the differences are primarily the result of climate change, sea level rise and future water demand and not attributable to the alternative.

Similar to sturgeon, Alternative 9 would affect spawning and egg incubation habitat for lamprey species as a result of increased water temperatures on the Feather River and redd dewatering in the Sacramento and American rivers. Flow reductions on several waterways, including the Sacramento, Trinity, and American rivers, when compared to Existing Conditions, would have an effect on lamprey rearing and migration habitat. As described previously for other species, these effects would not result in a significant impact because the differences are primarily the result of climate change, sea level rise and future water demand and not attributable to the alternative.

As evidenced by this summary, some changes in flow under Alternative 9 are adverse to fish species. Alternative 9 also includes the same conservation measures as Alternative 1A. When the flow and habitat restoration measures are considered together, several of the effects of Alternative 9 are beneficial, while most are not adverse and/or less than significant. However, the effects resulting from changes in flows upstream of the Delta remain uncertain to sturgeon migration conditions. Summary Table 11-9-SUM1 presents the results of the flow related effects on fish.

Table 11-9-SUM1. Results of Flow-Related Effects on Fish

Species	Entrainment	Spawning	Rearing	Migration
Delta smelt	B/B	NA/LTS	ND/LTS	ND/LTS
Longfin smelt	B/B	ND/LTS (combined)		
Winter-Run Chinook salmon	B/B	NA/LTS	NA/LTS	NA/LTS
Spring-Run Chinook salmon	B/B	NA/LTS	NA/LTS	NA/LTS
Fall-Run/Late Fall-Run Chinook salmon	B/B	NA/LTS	NA/LTS	NA/LTS
Steelhead	B/B	NA/LTS	NA/LTS	NA/LTS
Sacramento splittail	B/B	NA/LTS	NA/LTS	NA/LTS
Green sturgeon	B/B	NA/LTS	NA/LTS	ND/LTS
White sturgeon	B/B	NA/LTS	NA/LTS	ND/LTS
Pacific lamprey	B/B	NA/LTS	NA/LTS	NA/LTS
River lamprey	B/B	NA/LTS	NA/LTS	NA/LTS

Level of significance:

NEPA Conclusion	*CEQA Conclusion*
A = Adverse.	SU = Significant and Unavoidable.
NA = Not Adverse.	LTS = Less than Significant.
B = Beneficial.	B = Beneficial.
ND = Not Determined.	S = Significant.

Restoration Measures (CM2, CM4–CM7, and CM10)

With respect to restoration measures, Alternative 9 is the same as Alternative 1A. Consequently, all the effects associated with restoration measures under Alternative 9 are the same as those described above under the Alternative 1A summary.

Other Conservation Measures (CM12–CM19 and CM21)

With respect to other conservation measures, Alternative 9 is the same as Alternative 1A. Consequently, all the effects associated with other conservation measures under Alternative 9 are the same as those described above under the Alternative 1A summary.

Comparison of Alternative 9 to Alternative 4 (Proposed Project)

The comparison of Alternative 9 with Alternative 4, would be similar to the comparison with Alternative 1A, described above. However, different habitats would be affected, due to the multiple and diverse work sites under Alternative 9 (see Table 11-1A-SUM1). This is expected to result in greater in-water construction activities, and a greater chance for effects from pile driving, trapping fish within the cofferdam structures, and overall habitat disturbances. Thereby substantially increasing the potential for direct and indirect fish losses and habitat alterations. The potential effects on water quality would also be increased, compared to Alternative 4.

Alternative 9 would follow Operational Scenario G, while Alternative 4 would follow Operational Scenario H, resulting in different patterns of water withdrawals from the north Delta, and potentially different effects on water quality and aquatic habitat conditions in the Plan Area. As fully described in Chapter 3, *Description of Alternatives,* Alternative 4 operations incorporate a decision tree process that results in four potential operational sub-scenarios, depending on the outcome of the decision tree process for spring outflow and Fall X2 operations.

Construction and Maintenance of CM1

The potential for construction and maintenance activities to affect the covered fish species would be similar for Alternative 9 as for Alternative 4 (see Table 11-1A-SUM1). However, the magnitude of effect would be greater for Alternative 9. There would be about 233% more dredged area under Alternative 9 (59.6 acres) than under Alternative 4 (17.1 acres), as well as a 94% increase (15.2 acres) in temporary habitat disturbances, and a 25% increase (3.1 acres) in the footprint of permanent structures, compared to Alternative 4. The area affected by the five barge landing structures (15,000 square feet each) would also be slightly less than the six landings for Alternative 4.

As discussed above, in-water and nearshore construction activities have the potential to cause adverse effects on covered species, although these adverse effects would be effectively avoided and minimized by implementing environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*). These include pile driving minimization measures AQUA-1a and AQUA-1b, as well as isolating much of the in-water work inside cofferdams, constructing in areas that have limited use by the covered species, adhering to the approved in-water work windows, and activity-specific timing restrictions. While individual fish may be affected by construction activities, the effects would not limit overall population productivity.

In summary, construction and maintenance activities would result in limited temporary and permanent effects on the covered fish species and their habitat. While these effects would vary by species and species life stages, the implementation of environmental commitments and BMPs (see Appendix 3B, *Environmental Commitments*), would reduce most of these construction effects to be not adverse and less than significant. The implementation of habitat restoration activities, particularly CM6 *Channel Margin Enhancement*, would offset effects of habitat loss or alteration at the intake sites.

Water Operations of CM1

Water operations under Alternative 9 differ from Alternative 4 in several ways. Alternative 9 includes two fish screened barriers leading into existing waterway corridors. The two corridors would be modified to convey up to 15,000 cfs, while Alternative 4 utilizes three screened intakes, and can only convey up to 9,000 cfs. As discussed in Chapter 5, *Water Supply*, average annual exports under Alternative 9 are anticipated to be 4,377 TAF, while Alternative 4 has anticipated exports ranging from 4,414 (under H4) to 5,255 (under H1). Changes in anticipated long-term average annual Delta outflow under Alternative 4 also vary between the operational scenarios (H1–H4). Average annual Delta outflows would be less for the Alternative 4 operational scenarios than Alternative 9 (between 62 and 921 TAF less). Alternative 9 would also result in greater annual average Delta outflow than Existing Conditions (about 806 TAF more) and NAA (about 57 TAF more).

There are various benefits to entrainment and rearing for some species under both alternatives, but Alternative 9 has more beneficial effects to entrainment than Alternative 4. Uncertainties regarding the effects of both alternatives on sturgeon migration conditions, would be addressed through targeted investigations to identify the primary mechanisms that affect sturgeon year-class strength, and the final determination of the overall effects of the alternatives relative to NAA.

Restoration Measures (CM2, CM4–CM7, and CM10)

With respect to restoration measures, Alternative 9 would be the same as Alternative 4. Consequently, the effects or these measures would also be the same.

Other Conservation Measures (CM12–CM19 and CM21)

With respect to other conservation measures, Alternative 9 would be the same as Alternative 4. Consequently, the effects associated with these other conservation measures would also be the same for both alternatives.

11.1 Environmental Setting/Affected Environment

This section provides a general description of the area of potential environmental effects relative to fish and aquatic resources. As described in Chapter 1, *Introduction*, the area that may be affected by BDCP alternatives—the *project area*—is divided into three separate regions, as described below.

This *Environmental Setting/Affected Environment* discussion for aquatic resources is organized into the following components.

- Section 11.1.1, *Areas of Potential Environmental Effects*
- Section 11.1.2, *Natural Communities*
- Section 11.1.3, *Species Evaluated in the EIR/EIS*
- Section 11.1.4, *Ecological Processes and Functions*
- Section 11.1.5, *Stressors*

11.1.1 Areas of Potential Environmental Effects

This section describes the geographic areas where potential effects may be expected to occur with implementation of the BDCP alternatives (see Chapter 1, *Introduction*). Generally, the geographic areas influenced by implementation of BDCP alternatives are described and evaluated as listed below.

- Plan Area
- Upstream of the Delta
- SWP/CVP Export Service Areas
- San Pablo and San Francisco Bays

11.1.1.1 Plan Area

As described in Chapter 1, *Introduction*, the Plan Area, the area covered by the BDCP, comprises the statutory Delta (as defined in Water Code Section 12220); Suisun Bay; and the Restoration Opportunity Areas (ROAs), including those in Yolo Bypass and Suisun Marsh (see Figure 1-9). Because of its unique physical, ecological, and hydrologic characteristics, Yolo Bypass is discussed separately, following *The Delta and Suisun Bay*. A full description of surface water in these areas is provided in Chapter 6, *Surface Water*.

The Delta and Suisun Bay

The Delta can be divided into four regions: the north Delta, central Delta, south Delta, and west Delta. The north Delta is dominated by the waters of the Sacramento River, which are of relatively low salinity, whereas the relatively higher salinity waters of the San Joaquin River dominate the south Delta (refer to Chapter 8, *Water Quality*, for a discussion of water quality in the Sacramento River, the San Joaquin River and the Delta). The central Delta includes many channels where waters from the Sacramento and San Joaquin Rivers and their tributaries converge. The west Delta also includes many channels and sloughs influenced by tidal movement, tributary inflow, local irrigation operations, and SWP and CVP operations.

Suisun Bay is a shallow embayment between Chipps Island at the western boundary of the Delta and the Benicia-Martinez Bridge at the eastern end of Carquinez Strait. Adjacent to Suisun Bay is Suisun Marsh, the largest brackish marsh in the United States. The narrow, 12-mile-long Carquinez Strait joins Suisun Bay with San Pablo Bay. Suisun Bay is a large area of open water that is transitional between the freshwaters of the Delta and the saltwaters of San Francisco Bay; it is a shallow region of wind-stirred, brackish water, lined with tidal marshes (Moyle 2008). The largest of these marshes—nearly as large as Suisun Bay itself—is Suisun Marsh, a 30,000+ hectare (approximately 74,130-acre) marsh that is largely managed as freshwater wetlands to support waterfowl hunting (Moyle 2008). Suisun Marsh maintains its freshwater character because of inflow from the Sacramento River via Montezuma Slough (Moyle 2008). Large tidal gates on the upper end of Montezuma Slough control salinity in the marsh by allowing freshwater to flow in but preventing the tides from pushing it back out again (Moyle 2008). More than 360 kilometers (km) (approximately 225 miles) of levees separate marsh islands from the tidal channels, in which water is still seasonally brackish (Moyle 2008). The channels are highly productive of fish, which are a mixture of freshwater and marine species (Moyle 2008).

Seasonal and annual variability in hydrologic conditions, including the magnitude of flows into the Delta from the Sacramento and San Joaquin Rivers and other tributaries, and the outflow from the Delta into San Francisco Bay, affect habitat quality, availability, and abundance for a number of fish and invertebrate species in the Delta. For a detailed description of Delta hydrodynamics and conditions affecting Delta hydrodynamics (e.g., operations and natural hydrologic conditions), see Chapter 5, *Water Supply* and Chapter 6, *Surface Water*. For a detailed discussion on water quality objectives that influence SWP and CVP operations, see Chapter 8, *Water Quality*.

Yolo Bypass

The Yolo Bypass is a leveed, 59,000-acre floodplain on the west side of the lower Sacramento River that carries floodwaters from several northern California waterways to the Delta (Yolo Bypass Working Group 2001). Yolo Bypass (and its upstream counterpart, Sutter Bypass), convey flood flows of the Sacramento River and smaller tributaries around and away from cities such as Sacramento (Sommer et al. 2008). The Yolo Bypass is partially inundated with Sacramento River flows during parts of winter and spring, in about 70% of years (Sommer et al. 2008). The primary input to the Yolo Bypass is through Fremont Weir in the north, which conveys floodwaters from the Sacramento and Feather Rivers (Sommer et al. 2003). At peak flows, up to 24,000 hectares (approximately 59,300 acres) of the Yolo Bypass are inundated (Sommer et al. 2008). Typical dimensions are from 2 to 10 km (approximately from 1.2 to 6 miles) wide, with a mean depth of 2 meters (approximately 6.5 feet) or less (Sommer et al. 2008). The floodwaters flowing through the Yolo Bypass re-enter the Sacramento River via Cache Slough (Moyle 2008). The principal permanent water channel in the Yolo Bypass is the Toe Drain, which runs along the levee on the eastern side (Moyle 2008).

Important ecological processes within the overall Yolo Basin include streamflow and inundation, stream erosion, and natural sediment supply. Important aquatic habitats in the Yolo Basin include stream and slough channels and seasonally inundated floodplains, for fish migration and holding, spawning, and nursery habitats (CALFED Bay-Delta Program 2000a). Important aquatic habitat in the Cache Slough complex include freshwater tidal marsh and herbaceous wetlands.

The Yolo Bypass provides diverse habitats for a wide variety of fish, wildlife, and plant communities, primarily native resident (nonmigratory) fish (Table 11-1), riparian communities, seasonally and permanently flooded wetlands, wildlife, and waterfowl (CALFED Bay-Delta Program 2000a). Sommer et al. (1997) demonstrated that the Yolo Bypass is one of the single most important habitats for Sacramento splittail (see Section 11.1.3.1, *Covered Fish Species*, for a discussion of Sacramento splittail). Introduced fish species frequently dominate the fauna in the Delta on a year-round basis (Bennett and Moyle 1996). However, unlike the other Delta habitats, the floodplain in the Yolo Bypass is seasonally dewatered during late spring through autumn, which prevents exotic species from establishing year-round dominance except in perennial water sources (Sommer et al. 2003).

Table 11-1. Native and Introduced Fish Species Observed in the Yolo Bypass from 1997 to 2010

Native Fish Species	Introduced Fish Species	
Chinook salmon	American shad	Redear sunfish
Steelhead/rainbow trout	Threadfin shad	Green sunfish
Pacific lamprey	Common carp	Warmouth
River lamprey	Goldfish	Black crappie
Hitch	Fathead minnow	White crappie
Sacramento blackfish	Golden shiner	Bigscale logperch
Sacramento pikeminnow	Red shiner	Largemouth bass
Sacramento sucker	Channel catfish	Smallmouth bass
Sacramento splittail	White catfish	Spotted bass
Prickly sculpin	Black bullhead	Striped bass
Pacific staghorn sculpin	Brown bullhead	Shimofuri goby
Threespine stickleback	Wakasagi	Yellowfin goby
Sacramento tule perch	Inland silverside	Pumpkinseed
Delta smelt	Western mosquitofish	
White sturgeon	Bluegill	
Longfin Smelt	Brown trout	
Hardhead	Yellow bullhead	

Source: Unpublished DWR Yolo Bypass Monitoring Data.

The portion of the Yolo Bypass north of the Yolo Causeway on Interstate 80 is an important migratory route during wet years for downstream migrant Chinook salmon, steelhead, and other native and anadromous fishes originating from upstream areas. When flooded, the Yolo Bypass provides valuable spawning habitat for native resident fish (CALFED Bay-Delta Program 2000a). For example, during flood pulses, the Yolo Bypass floodplain provides juvenile anadromous salmonids an alternative migration corridor to the lower Sacramento River (Sommer et al. 2003). The results of Sommer et al. (2001) indicated that this seasonal floodplain habitat provides better rearing conditions than the adjacent Sacramento River channel for two reasons: (1) increased area of suitable habitat (e.g., extensive shoals and increased habitat complexity); and (2) increased food resources. Sommer et al. (2001) found that improved rearing conditions allowed juvenile salmon to grow substantially faster in the Yolo Bypass floodplain than in the adjacent Sacramento River, primarily because of a higher abundance of invertebrate prey in the floodplain.

In addition to providing key habitat for native and nonnative fish, seasonal inundation of the Yolo Bypass may benefit organisms downstream in the brackish portion of the San Francisco Estuary through transfer of phytoplankton and detritus (Sommer et al. 2003). Modeling studies by Jassby and Cloern (2000) suggest that phytoplankton produced in the Yolo Bypass may be an important source of organic carbon to the San Francisco Estuary, at least during flood events. The Yolo Bypass also is probably a major pathway for detrital material to reach the phytoplankton-deficient San Francisco Estuary (Sommer et al. 2003). Schemel et al. (1996 as cited in Sommer et al. 2003) found that the Yolo Bypass is the major pathway for organic matter to the San Francisco Estuary during wet years.

The loss and degradation of historical habitat, due to land use changes, is a major ecological stressor on fish and wildlife species throughout the Delta. These changes have resulted in the conversion of large areas of tidal and intertidal habitat to agricultural, industrial, and urban uses, resulting in dramatic reductions in the habitat available for associated fish and wildlife species (The Bay Institute 1998; CALFED Bay-Delta Program 2000). Today, these areas of former tidal marshes consist primarily of channelized waterways surrounding highly productive row-cropped agricultural islands that are protected from flooding by over 1,300 miles (2,093 kilometers) of levees. Dewatering of the marshes and plowing the peat soils for farming have led to peat oxidation losses, soil compaction, and erosion of the islands, resulting in surface subsidence. The result is that the interiors of many Delta islands have substantially subsided and are now depressions well below the level of the surrounding water, protected only by a ring of levees. Channelization, levee-building, removal of vegetation to stabilize levees, and upstream flood management have also reduced the extent of this community and altered its ecological function through changes to flooding frequency, inundation duration, and quantity of alluvial material deposition.

Other notable general stressors to ecological functions, processes, habitats, and species in the Yolo Basin include: (1) water diversions and historical gravel mining in the tributaries; (2) insufficient available flow to maintain a continuous riparian corridor; (3) mercury contamination from natural and previously mined sources that is taken up through the aquatic food chain; and (4) poor-quality agricultural tailwater entering the Yolo Bypass canals and sloughs (CALFED Bay-Delta Program 2000a).

The Yolo Bypass and Fremont Weir are a source of migratory delay and loss of adult Chinook salmon, steelhead, and sturgeon (National Marine Fisheries Service 2009a). The existing fish passage structure at Fremont Weir is inadequate to allow normal fish passage at most flows due to the Army Corps of Engineers' Sacramento River Flood Control Project (National Marine Fisheries Service 2009a). Therefore, adult salmonids and sturgeon migrating upstream through the Yolo Bypass are unable to reach upstream spawning habitat in the Sacramento River and its tributaries when there is no flow through Fremont Weir (Harrell and Sommer 2003). Other structures within the Yolo Bypass, such as the Toe Drain, Lisbon Weir, and irrigation dams in the northern end of the Tule Canal, also can impede migration of adult anadromous fish (National Marine Fisheries Service 2009a). Additionally, stranding of juvenile salmonids and sturgeon has been reported in the Yolo Bypass in scoured areas behind the weir and in other areas (National Marine Fisheries Service 2009a). However, the 2009 National Marine Fisheries Service (NMFS) Biological Opinion (2009 NMFS BiOp) on the Continued Long-term Operation of the CVP and SWP (National Marine Fisheries Service 2009a) required that the U.S. Bureau of Reclamation (Reclamation) and/or the California Department of Water Resources (DWR) submit a plan to NMFS to provide for high-quality, reliable migratory passage for Sacramento River Basin adult and juvenile anadromous fish through the Yolo Bypass.

The 2009 NMFS BiOp (National Marine Fisheries Service 2009a) also required that Reclamation and DWR submit to NMFS a plan to evaluate options to: (1) restore juvenile rearing areas in the lower Sacramento River Basin that provide seasonal inundation at appropriate intervals; (2) increase inundation of suitable acreage within the Yolo Bypass; and (3) modify operations of the Sacramento Weir or Fremont Weir to increase juvenile rearing habitat. Reclamation and the DWR submitted the Yolo Bypass Salmonid Habitat Restoration and Fish Passage Implementation Plan in September, 2012. The plan addresses increasing seasonal inundation and improving fish passage in the Yolo Bypass. Several alternatives are discussed for achieving both of these goals, including performance measures to assess the success of the plan.

The southern outlet of the Yolo Bypass is Liberty Island, which is an inundated island encompassing 5,209 acres (CALFED Bay-Delta Program 2005). Liberty Island has been flooded since 1998 when its levees were breached during high flows through the Yolo Bypass (CALFED Bay-Delta Program 2005). Between 1998 and 2005, Liberty Island has transformed from a large organic tomato farm to over 800 acres of freshwater tidal marsh and emerging marsh, 55 acres of herbaceous wetlands, and almost 20 acres of riparian habitat (CALFED Bay-Delta Program 2005). While nonnative fish have dominated sampling efforts at Liberty Island, native fish species observed include Chinook salmon, Sacramento splittail, longfin smelt, delta smelt, Sacramento tule perch, Sacramento pikeminnow, and starry flounder (CALFED Bay-Delta Program 2005).

The Cache Slough Complex, which includes Liberty Island, Little Holland Tract, Hastings Tract, and Prospect Island, has become an important focus for restoration activities in the north Delta to increase and improve the overall habitat for delta smelt (California Department of Fish and Game 2008b). This area has high restoration potential as tidal freshwater marsh and slough habitat because: (1) island subsidence is low compared to other parts of the Delta; (2) it maintains much of its original drainage pattern; (3) it is a major spawning and rearing region for delta smelt; (4) it has strong tidal currents that move water from the Sacramento River in and out of its channels; (5) it drains the lower end of the Yolo Bypass; and (6) it contains Liberty Island (which has already been flooded and provides high-quality habitat and ecological functions) (Moyle 2008). The region can be converted relatively easily into favorable tidal habitat for native fish (Moyle 2008). This area is expected to provide favorable areas for spawning and rearing, being unsuitable for egg and larval predators (Moyle 2008).

11.1.1.2 Upstream of the Delta

As discussed in Chapter 3, *Description of Alternatives*, the areas upstream of the Plan Area that could potentially be affected by the BDCP alternatives include those areas in the SWP and CVP system that may be affected by alterations in SWP and CVP operations, including the reservoirs, rivers, and other components of the SWP and CVP. These components include the following instream, reservoir, and riparian areas.

- Claire Engle Lake, Lewiston Lake, and the Trinity River
- Shasta Lake and the upper and lower Sacramento River
- Whiskeytown Reservoir and Clear Creek
- Oroville Reservoir, Thermalito Afterbay, and the lower Feather River
- Folsom Reservoir, Lake Natoma and the lower American River
- New Melones Reservoir and the Stanislaus River

- Millerton Reservoir and the San Joaquin River

The timing, duration, and magnitude of water exports affect hydrodynamic conditions that may be critical to species present in the river reaches and reservoirs upstream of the Delta. Flows within the rivers and tributaries are altered by SWP and CVP facilities and operations, and are important to the movement and migration behaviors, straying potential, habitat availability and suitability, and stranding potential of numerous aquatic species. Operational changes to flow timing, duration, and magnitude directly affect anadromous species adult immigration, spawning, egg incubation, rearing, and outmigration, as well as resident non-migratory species habitat availability for all life stages.

Water management and conveyance, hydrology, and water quality in these upstream rivers and reservoirs are discussed in Chapter 5, *Water Supply*; Chapter 6, *Surface Water*; and Chapter 8, *Water Quality*, respectively. Therefore, the following sections focus primarily on aquatic resources and provide a summary of the key stressors within each geographic area, as appropriate.

Claire Engle and Lewiston Lakes

The Trinity River Division consists of Trinity Dam and Claire Engle Lake, Trinity Powerplant, Lewiston Dam and Lake, Lewiston Powerplant, Clear Creek Tunnel, Judge Francis Carr Powerhouse, Whiskeytown Dam and Lake, Spring Creek Tunnel and Powerplant, Spring Creek Debris Dam and Reservoir, and related pumping and distribution facilities, which are used to divert water from the Trinity River Basin into the Sacramento River Basin.

Claire Engle Lake is considered relatively unproductive, with low-standing crops of zooplankton (U.S. Fish and Wildlife Service et al. 2000). The fisheries in Claire Engle Lake include both coldwater and warmwater species. Claire Engle Lake supports a trophy smallmouth bass fishery and provides substantial sportfishing for largemouth bass, rainbow and brown trout, and Kokanee salmon. Other fish species in Claire Engle Lake include Pacific lamprey, speckled dace, Klamath smallscale sucker, Coast Range sculpin, green sunfish, and brown bullhead (U.S. Fish and Wildlife Service et al. 2000). Lewiston Lake primarily supports a trout fishery (rainbow, brown, and brook trout) but also supports Pacific lamprey, Kokanee salmon, speckled dace, Klamath smallscale sucker, Coast Range sculpin, and smallmouth bass (U.S. Fish and Wildlife Service et al. 2000).

Trinity River

Trinity River flows out of Trinity and Lewiston Reservoirs. Native anadromous fish species in the mainstem Trinity River and its tributaries are spring- and fall-run Chinook salmon, coho salmon, steelhead (Trinity River Restoration Program 2009a), and potentially coastal cutthroat trout in the lower Klamath River (U.S. Fish and Wildlife Service et al. 2000). Native non-salmonid anadromous species that inhabit the Trinity River Basin include green sturgeon, white sturgeon, Pacific lamprey, and eulachon (U.S. Fish and Wildlife Service et al. 2000; Trinity River Restoration Program 2009).

The Trinity River Basin also contains various resident native and nonnative fish species, including rainbow trout, and non-game fish such as speckled dace, Klamath smallscale sucker, threespine stickleback, Coast Range sculpin, and marbled sculpin (U.S. Fish and Wildlife Service et al. 2000; Trinity River Restoration Program 2009). Nonnative fish species found in the Trinity and Klamath River Basins include American shad, brown bullhead, green sunfish, brown trout, and brook trout (U.S. Fish and Wildlife Service et al. 2000; Trinity River Restoration Program 2009). Fishing for Chinook salmon, steelhead, and rainbow and brown trout is a major recreational activity on the Trinity River throughout the year (Trinity River Restoration Program 2009).

Special-status (listed or of designated concern under the federal Endangered Species Act [ESA] or California Endangered Species Act [CESA]) and recreationally and/or commercially important fish species potentially occurring in the Trinity River are identified below.

- Southern Oregon/Northern California coastal coho salmon
- Upper Klamath/Trinity River Chinook salmon
- Klamath Mountains Province steelhead
- Green sturgeon
- White sturgeon
- Pacific lamprey
- River lamprey
- Eulachon
- American shad

Construction and operation of the Trinity River Dam, combined with watershed erosion, large-scale gold dredging, and other anthropogenic disturbances, have resulted in the following changes in habitat conditions in the Trinity River (Trinity River Restoration Program 2009).

- Obstruction to river reaches upstream of Trinity River Dam (Lewiston Dam)
- Changes to the quantity and timing of flows
- Changes in channel geomorphology
- Changes in substrate composition by the addition of fine sediments and restriction of gravel recruitment
- Changes in water temperature

Harvest and Hatchery Management

The Trinity River Salmon and Steelhead Hatchery is operated by the California Department of Fish and Wildlife (CDFW) and funded by Reclamation to mitigate for the loss of salmonid production upstream of Lewiston Dam resulting from the Trinity River Dam (Trinity River Restoration Program 2009). The hatchery produces 1.4 million spring-run Chinook salmon, 2.9 million fall-run Chinook salmon, 500,000 coho salmon, and 800,000 steelhead annually (National Marine Fisheries Service 2009a).

Shasta Lake

Aquatic habitat in Shasta Lake is related to seasonal stratification. The lake is stratified from April through November, supporting a “two-story” fishery. During stratification, the warm upper layer (epilimnion) (approximately 68°F) supports warmwater game fish and the lower layers (metalimnion and hypolimnion) support the coldwater fishery. Coldwater species include rainbow trout, brown trout, landlocked white sturgeon, landlocked coho salmon (Bureau of Reclamation et al. 2003), and Chinook salmon (Bureau of Reclamation 2013). Warmwater species include smallmouth bass, largemouth bass, spotted bass, black crappie, bluegill, green sunfish, channel catfish, white catfish, and brown bullhead (Bureau of Reclamation et al. 2003). Nongame species in

Shasta Lake include hardhead, golden shiner, threadfin shad, common carp, Sacramento sucker, and Sacramento pikeminnow (Bureau of Reclamation et al. 2003).

The operation of Shasta and Sacramento River diversions can cause water surface elevations to fluctuate approximately 55 feet annually (Bureau of Reclamation et al. 2003). Reservoir surface elevation fluctuations can disturb littoral (shallow, nearshore) habitats, including spawning and rearing habitat for warmwater game fish (Bureau of Reclamation et al. 2003). Operations also influence the coldwater pool that can influence coldwater fishery habitat.

Upper Sacramento River (Keswick Dam to Red Bluff Diversion Dam)

Since the construction of Shasta Dam, the Sacramento River upstream of Red Bluff Diversion Dam (RBDD) is a perennial coldwater stream. The reach supports all four races of Chinook salmon, steelhead, and green sturgeon, as well as a popular wild trout fishery (National Marine Fisheries Service 2009a). Adult hardhead and Sacramento sucker are known to seasonally pass through the ladders at RBDD (Tehama-Colusa Canal Authority 2008). Additional fish species that may occur in this reach include Sacramento splittail, white sturgeon, rainbow trout, brown trout, largemouth bass, and smallmouth bass (see Table 11-1)(Tehama-Colusa Canal Authority 2008).

A major tailwater trout population supports a thriving recreational fishery due to the coldwater releases provided for winter-run Chinook salmon (National Marine Fisheries Service 2009a). There is potential that heavy angling pressure could affect salmonids in the area (National Marine Fisheries Service 2009a). Boating and other water-related activities can affect water quality and harass fish species, particularly during spawning (National Marine Fisheries Service 2009a). In addition, the U.S. Army Corps of Engineers (USACE) permitting activities that authorize dredging and other construction-related activities in the Sacramento River have modified aquatic habitat, including increasing sedimentation, simplifying streambank and riparian habitat, reducing connectivity to floodplain habitat, and modifying hydrology (National Marine Fisheries Service 2009a).

Harvest and Hatchery Management

A resident rainbow trout population supports a very popular wild trout fishery in the upper Sacramento River (National Marine Fisheries Service 2009a). Because steelhead and resident rainbow trout are the same species, there is concern that the steelhead genome could be affected by breeding with resident trout. Additionally, it is possible that fishing for resident trout could affect Chinook salmon and steelhead. Seasonal closures to protect listed salmonids can reduce fishing opportunities for wild trout. Rotary screw trap data at RBDD indicate that most juvenile steelhead observed there are resident forms, based on timing and size. Zimmerman et al. (2008) found that the vast majority of steelhead collected from the Sacramento River exhibited a resident rainbow trout life history strategy.

The Livingston Stone National Fish Hatchery on the upper Sacramento River has been producing and releasing juvenile winter-run Chinook salmon since 1998, and is managed as a conservation hatchery. This conservation program has apparently resulted in a net increase in the numbers of returning adult winter-run Chinook salmon (Brown and Nichols 2003).

The Coleman National Fish Hatchery was established in 1942 to mitigate the loss of natural salmon from historical spawning areas. Long-term production goals for the hatchery are as follows: 12,000,000 fall-run Chinook salmon, 1,000,000 late fall-run Chinook salmon, 250,000 winter-run

Chinook salmon, and 600,000 steelhead annually (U.S. Fish and Wildlife Service 2008). In 1998, the winter-run propagation program was relocated from Coleman National Fish Hatchery to the Livingston Stone National Fish Hatchery on the Sacramento River. Winter-run Chinook salmon still have access to Battle Creek above the Coleman National Fish Hatchery weir from a fish ladder that is open during the peak of the winter-run Chinook salmon migration period (Ward and Kier 1999). However, if a winter-run Chinook salmon population exists in Battle Creek, its population size is unknown, likely very small, and is potentially mainly or entirely composed of strays from the mainstem Sacramento River.

Lower Sacramento River (Red Bluff Diversion Dam to Confluence with Lower American River)

The following descriptions of the lower Sacramento River reaches and references therein are taken directly from Volume II of the *Ecosystem Restoration Program Plan* (CALFED Bay-Delta Program 2000a):

> South of Red Bluff, the river meanders over a broad alluvial floodplain confined by older, more consolidated geologic formations (i.e., more cohesive deposits resistant to bank erosion). The extent of river floodplain and active channel meander belt from Red Bluff to Chico Landing has remained relatively unchanged and includes a significant amount of riparian forest and wildlife. The Chico Landing to Colusa reach includes the mouth of Stony Creek and no other major tributaries. In this reach, most of the high flow during storm runoff events leaves the river along the east bank and enters the expansive floodplain of Butte Basin. Much of the river downstream of Chico Landing has been subject to flood control with an extensive system of setback levees, basin and bypass outflows, and streambank protective measures, such as riprap. However, considerable riparian forest remains within the levees along the active channel (CALFED Bay-Delta Program 2000a).
>
> The Colusa to Verona reach includes the mouth of Butte Creek at the Butte Slough outfall gate, but no significant tributary inflow until the Colusa Basin drain enters the river near Knights Landing. In past years outflow at the Colusa Basin Drain has contributed to attraction of adult Chinook salmon from their normal migratory pathway of the Sacramento River. Fish that stray into the Colusa Basin Drain are subject to stranding and loss from the spawning population (CALFED Bay-Delta Program 2000a).
>
> High flows leave the river by way of the Colusa and Tisdale weirs. Farther downstream, most flow from the Sutter Bypass/Butte Slough and Sacramento River leaves the river again, flowing down the Yolo Bypass to the Delta at Rio Vista. Most of the levees in this reach have little riparian forest or remaining shaded riverine aquatic habitat. This reach is the most important spawning area for striped bass (CALFED Bay-Delta Program 2000a).

In addition to the fish species utilizing the Sacramento River upstream of RBDD, fish species of recreational importance utilizing the Sacramento River downstream of RBDD include striped bass and American shad (Tehama-Colusa Canal Authority 2008). Striped bass are not recognized as spawning or rearing in the Sacramento River upstream of RBDD, and American shad were reportedly unable to migrate upstream of RBDD when the gates are down (Tehama-Colusa Canal Authority 2008); current operations include year round gate openings.

Harvest and Hatchery Management

There is no hatchery stocking program in this reach of the Sacramento River. However, hatcheries located elsewhere in the Central Valley (e.g., Feather River and Battle Creek) can potentially influence wild anadromous salmonid spawning in the Sacramento River. Additional discussion of Sacramento River hatchery influences is provided in the discussion of the reach of the Sacramento River from Keswick to Red Bluff (above). Due to current harvest regulations, harvest associated with

Chinook salmon, steelhead, and sturgeon sportfisheries does not appear to be a threat to listed fish. However, Chinook salmon harvest regulations are being adaptively managed on a year-to-year basis because there is a concern for overharvest. In addition, illegal harvest (poaching) is a generally unquantified concern for all of these species.

Whiskeytown Reservoir

The fisheries in Whiskeytown Reservoir include both coldwater and warmwater species. Native fish species known to occur in Whiskeytown Reservoir include Sacramento sucker, California roach, hardhead, Sacramento pikeminnow, Pacific lamprey, rainbow trout, Chinook salmon, and riffle sculpin (U.S. Fish and Wildlife Service et al. 2000). Nonnative fish that occur in Whiskeytown Reservoir include green sunfish, bluegill, smallmouth bass, spotted bass, largemouth bass, black crappie, Kokanee salmon, brown trout, brook trout, brown bullhead, and channel catfish (U.S. Fish and Wildlife Service et al. 2000).

Clear Creek

Whiskeytown Dam is a complete barrier to fish passage and is the uppermost boundary of habitat available to anadromous fish. Special-status (listed or of designated concern under the ESA or CESA) and recreationally and/or commercially important fish species potentially occurring in lower Clear Creek are identified below (California Department of Water Resources 1986).

- Central Valley spring-run Chinook salmon
- Central Valley fall-/late fall-run Chinook salmon
- Central Valley steelhead
- Pacific lamprey
- Sacramento-San Joaquin roach
- Hardhead

Harvest and Hatchery Management

There are no hatcheries located on Clear Creek, although strays for other hatcheries (i.e., Feather River Hatchery) return to Clear Creek and have the potential to impact wild spring-run Chinook salmon. However, to re-establish spring-run Chinook salmon in Clear Creek, approximately 200,000 juveniles from the Feather River Hatchery were planted in Clear Creek annually in 1991, 1992, and 1993 (Newton and Brown 2004).

Lake Oroville and Thermalito Afterbay

The following information on Lake Oroville and associated facilities is taken from the Environmental Water Account Draft EIS/EIR (Bureau of Reclamation et al. 2003) and Oroville Facilities Federal Energy Regulatory Commission Relicensing Project 2100 Draft EIR (California Department of Water Resources 2007) and references therein.

Like many other California foothill reservoirs, Lake Oroville is steep sided, with large surface fluctuations and a low surface-to-volume ratio. Lake Oroville thermally stratifies in spring, destratifies in fall, and remains destratified throughout winter. Due to the stratification, Lake Oroville contains a two-story fishery, supporting both coldwater and warmwater fisheries that are thermally segregated for most of the year. Coldwater fish use the deeper, cooler, well-oxygenated hypolimnion, whereas warmwater fish are found in the warmer, shallower, epilimnetic, and littoral zones. After the lake destratifies in fall, the two fishery components mix in their habitat utilization.

Lake Oroville's coldwater fishery is composed of coho salmon, brown trout, rainbow trout, and lake trout (California Department of Water Resources 2001).

The Lake Oroville warmwater fishery is a regionally important self-sustaining fishery. The black bass fishery is the largest warmwater fishery in terms of angler effort and economic impact on the area. Spotted bass are the most abundant bass species in Lake Oroville, followed by largemouth, redeye, and smallmouth bass, respectively. Catfish are the next most popular warmwater fish at Lake Oroville, with both channel and white catfish present in the lake. White and black crappie are also found in Lake Oroville, although populations fluctuate widely from year to year. Bluegill and green sunfish are the two primary sunfish species in Lake Oroville; redear sunfish and warmouth are also present. Although common carp are considered by many to be a nuisance species, they are abundant in Lake Oroville. The primary forage fish in Lake Oroville are wakasagi and threadfin shad. Threadfin shad were intentionally introduced in 1967 to provide forage for gamefish, whereas the wakasagi migrated down from an upstream reservoir in the mid-1970s (California Department of Water Resources 2001).

The Thermalito Forebay is a cold, shallow, open reservoir with minor fluctuations in surface elevations and a high surface-to-volume ratio. It remains cold throughout the year because it is supplied with cold water from Lake Oroville, although pump-back operations from the Thermalito Afterbay warm the forebay somewhat during certain times of the year. CDFW manages the forebay as a put-and-take trout fishery, where catchable (approximately 1/2 pound) trout are stocked biweekly. Rainbow and brook trout are the primary fish planted, although surplus Chinook salmon yearlings reared in the Feather River Fish Hatchery were stocked in the forebay in February 2000. Warmwater fish species found in Lake Oroville are believed to exist in the forebay in low numbers (California Department of Water Resources 2001).

The diverse temperature structure of the Thermalito Afterbay has provided suitable habitat for both coldwater and warmwater fish. A popular largemouth bass fishery currently exists, large trout are sometimes caught near the inlet, and an experimental steelhead fishery occurs in the afterbay. Only limited salmonid stocking occurs at the afterbay, so these fish most likely passed through the Thermalito Pumping-Generating Plant from the forebay. Although limited fish sampling has been conducted at the afterbay, smallmouth bass, rainbow trout, brown trout, redear sunfish, bluegill, black crappie, channel catfish, and common carp have all been observed. Most of the Lake Oroville sportfish probably occur in the afterbay to some degree (California Department of Water Resources 2001).

Feather River (Oroville Reservoir to Confluence with Sacramento River)

The Feather River is considered to be a major tributary to the Sacramento River, providing approximately 25% of the flow (as measured at Oroville Dam) in the Sacramento River (California Department of Water Resources 2007). The lower Feather River commences at Fish Barrier Dam, downstream of Oroville Dam. The lower Feather River consists of two distinct channels with distinct flow regimes: (1) the Low Flow Channel, which extends 8 miles from Fish Barrier Dam (RM 67) to the Thermalito Afterbay Outlet (RM 59); and (2) the High Flow Channel, which extends from the Thermalito Afterbay Outlet to the confluence with the Sacramento River.

Special-status (listed or of designated concern under the ESA or CESA) and recreationally and/or commercially important fish species potentially occurring in the lower Feather River are identified below.

- Central Valley spring-run Chinook salmon
- Central Valley fall-/late fall-run Chinook salmon
- Central Valley steelhead
- Hardhead
- River lamprey
- Pacific lamprey
- Sacramento splittail
- Sacramento-San Joaquin roach
- Green sturgeon
- White sturgeon
- Striped bass
- American shad

The most important sportfish species in the lower Feather River is fall-run Chinook salmon, although striped bass and American shad are also common targets for anglers (Bureau of Reclamation et al. 2003). Anglers target both warmwater and coldwater species by fishing from the shore, using boats, or hiring a fishing guide service (California Department of Water Resources 2004a).

Harvest and Hatchery Management

The Feather River Fish Hatchery was constructed by DWR in 1967 to compensate for salmonid spawning habitat lost as a result of construction of Oroville Dam. The hatchery is one of five major Central Valley hatcheries producing and releasing fall-run and spring-run Chinook salmon, and steelhead (California Department of Water Resources 2007).

Folsom Reservoir and Lake Natoma

Strong thermal stratification occurs within Folsom Reservoir annually between April and November. In terms of aquatic habitat, the upper, warmwater layer (epilimnion) of Folsom Reservoir provides habitat for warmwater fishes, whereas the reservoir's lower layers (metalimnion and hypolimnion) form a coldwater pool that provides habitat for coldwater fish species throughout summer and fall. Hence, Folsom Reservoir supports a two-story fishery during the stratified portion of the year (April through November).

Native species that occur in the reservoir include hardhead and Sacramento pikeminnow. However, introduced largemouth bass, smallmouth bass, spotted bass, bluegill, crappie, and catfish constitute the primary warmwater sportfisheries of Folsom Lake. The lake's coldwater sportfish species include rainbow and brown trout, Kokanee salmon, and Chinook salmon, all of which are currently or have been stocked by CDFW (Bureau of Reclamation et al. 2003). Lake Natoma supports many of the same fish species found in Folsom Lake (i.e., rainbow trout, bass, sunfish, and catfish) (Bureau of Reclamation 2003).

Folsom Reservoir is usually subject to substantial reductions in surface elevation from late spring and summer until inflows increase during the winter rainy season and during the spring runoff period (Bureau of Reclamation 2003). Fluctuations in water surface elevation that occur during nesting periods can result in nest abandonment and adversely affect both spawning and juvenile survival of some resident warmwater fish species (Bureau of Reclamation 2003).

Water surface elevations in Lake Natoma typically fluctuate up to 3 feet on a daily and weekly basis (Bureau of Reclamation 2003). Lake Natoma's daily water surface elevation fluctuations, in addition to limited primary and secondary production, are believed to reduce the size and annual production of many of its fish populations, relative to Folsom Lake (Bureau of Reclamation 2003).

Lower American River (Nimbus Dam to Confluence with Sacramento River)

Use of the American River by anadromous fish is limited to the 23 miles of river below Nimbus Dam (the lower American River) (Bureau of Reclamation et al. 2003). At least 43 species of fish have been reported to occur in the lower American River system, including numerous resident native and introduced species, and several anadromous species. Special-status (listed or of designated concern under the ESA or CESA), and recreationally and/or commercially important fish species in the lower American River are identified below.

- Central Valley spring-run Chinook salmon
- Central Valley fall-/late fall-run Chinook salmon
- Central Valley steelhead
- Hardhead
- Pacific lamprey
- Sacramento splittail
- Sacramento-San Joaquin roach
- White sturgeon
- Striped bass
- American shad

The lower American River is one of the few urban rivers in California that supports relatively large runs of anadromous salmonids, which results in the river receiving high angling pressure during many years. Additionally, anglers target striped bass and American shad seasonally (Sacramento County 2008). Resident rainbow trout are present in the upper segment of the river; and a warmwater population of largemouth bass, various sunfish, and catfish comprise the remainder of the fishery (Sacramento County 2008). Fishing in the lower American River is permitted year-round, except during fall and early winter when the river is closed to protect spawning Chinook salmon as regulated by CDFW (Sacramento County 2008).

Harvest and Hatchery Management

CDFW operates the Nimbus Salmon and Steelhead Hatchery and the American River Trout Hatchery, located immediately downstream from Nimbus Dam. The Nimbus Salmon and Steelhead Hatchery produces anadromous fall-run Chinook salmon and steelhead. Steelhead produced in the facility are genetically similar to Eel River steelhead and are not part of the Central Valley distinct populations segment (DPS) nor protected under the ESA (California Hatchery Review Project 2012). Juvenile fall-run Chinook salmon produced by the Nimbus Hatchery are released directly into the American River and into San Pablo Bay to improve their survival rates and contribution to the fishery, as well as to reduce the effects of competition between hatchery and wild fish (California Department of Fish and Game and National Marine Fisheries Service 2001).

New Melones Lake

The sportfishery in New Melones Lake is focused on rainbow and brown trout, largemouth bass, sunfishes such as black crappie and bluegill, and three species of catfish (Bureau of Reclamation 2010) minnows, suckers, Kokanee salmon, and common carp also are present in the lake (Bureau of Reclamation 2010). Rainbow and brown trout and large channel catfish are generally restricted to colder, deeper water during summer, when New Melones Reservoir has two distinct thermal layers of water, although large brown trout and channel catfish are found in shallow water near steep banks at night when they ascend to feed (Bureau of Reclamation 2010).

Stanislaus River

Historically, spring-run Chinook salmon were believed to be the primary salmon run in the Stanislaus River, but the fall-run Chinook salmon population became dominant following construction of Goodwin Dam. Goodwin Dam blocked upstream migration between 1913 and 1929 and currently blocks upstream migration (Yoshiyama et al. 1996; National Marine Fisheries Service 2009a). Central Valley steelhead were thought to be extirpated from the San Joaquin River system (National Marine Fisheries Service 2009a). However, monitoring has detected small self-sustaining (i.e., non-hatchery origin) populations of steelhead in the Stanislaus River and other streams previously thought to be devoid of steelhead (Stanislaus River Fish Group 2003; McEwan 2001). Other anadromous fish species that occur in the lower Stanislaus River include striped bass, American shad, Pacific lamprey, and river lamprey (Stanislaus River Fish Group 2003). Striped bass and American shad were introduced into the Sacramento-San Joaquin River Basin in the late 1880s (Stanislaus River Fish Group 2003).

Special-status (listed or of designated concern under the ESA or CESA) and recreationally and/or commercially important fish species potentially occurring in the Stanislaus River are identified below (Stanislaus River Fish Group 2003).

- Central Valley fall-/late fall-run Chinook salmon
- Central Valley steelhead
- Hardhead
- River lamprey
- Pacific lamprey
- Sacramento-San Joaquin roach

- Green sturgeon
- White sturgeon
- Striped bass
- American shad

Juvenile salmonid monitoring has been conducted at Oakdale and/or Caswell on the Stanislaus River since 1995; monitoring has been used to estimate abundance of outmigrating fall-run juvenile Chinook salmon and Central Valley steelhead, and rainbow trout to the San Joaquin River (National Marine Fisheries Service 2009a). Steelhead smolts also have been occasionally observed at Caswell State Park and Oakdale (U.S. Fish and Wildlife Service 2000a). A study by Zimmerman et al. (2008) documented the presence of steelhead in the Stanislaus River.

The Stanislaus River historically had 113 miles of anadromous fish habitat (National Marine Fisheries Service 2009a); currently, only the lower 58 river miles are accessible to anadromous fish, with access terminating at Goodwin Dam (KDH Environmental Services 2008).

The presence of Old Melones Dam within New Melones Reservoir causes the release of warm surface water from New Melones Reservoir whenever storage levels fall below approximately 1 million acre-feet (Stanislaus River Fish Group. 2003). In addition, Tulloch Reservoir can be warmer than 56°F through the end of October, although coldwater releases are made from New Melones Dam (California Department of Fish and Game 1998).

Harvest and Hatchery Management

A genetic analysis of steelhead smolts captured in rotary screw traps on the Stanislaus River indicates that they are closely related to the upper Sacramento River steelhead, but not steelhead from the Mokelumne River Hatchery or Nimbus Hatchery on the American River (McEwan 2001); they appear to be a population of naturally produced fish (Stanislaus River Fish Group. 2003). No hatchery-reared steelhead are released in the San Joaquin River Basin (Stanislaus River Fish Group. 2003).

Millerton Lake

Millerton Lake is a popular recreational fishing lake, supporting striped bass and black bass. The fish assemblages in Millerton Lake have changed from the original native community composition to an introduced warmwater lake community. Introduced fish species in the reservoir include hatchery-raised rainbow trout, brown trout, Kokanee salmon, striped bass, American shad, largemouth bass, smallmouth bass, spotted bass, green sunfish, bluegill, redear sunfish, crappie, golden shiner, white sturgeon, brown bullhead, white catfish, channel catfish, common carp, mosquitofish, and inland silverside (Ecological Analysts 1980; Moyle 2002; Shaffer 2002).

Millerton Lake is one of the few inland lakes with a self-sustaining American shad population and a relatively successful striped bass population (Ecological Analysts 1980; Shaffer 2002). However, unstable population trends of striped bass and centrarchids indicate that the lake is not able to support a self-sustaining striped bass population (Bureau of Reclamation and California Department of Parks and Recreation 2008). Millerton Lake does not provide suitable spawning and egg-laying habitat for many fish species, including striped bass, largemouth and smallmouth bass, trout, and centrarchids (Bureau of Reclamation and California Department of Parks and Recreation 2008). The lack of a littoral zone in the reservoir precludes most egg laying in that area (Bureau of Reclamation and California Department of Parks and Recreation 2008).

San Joaquin River

Friant Dam presents an upstream migration barrier to anadromous salmonids. All spawning of anadromous fish in the San Joaquin River Basin occurs in the tributaries to the San Joaquin River. As reported by Reclamation et al. (2003), the portion of the San Joaquin River from Mossdale/Vernalis to the mouth of the Merced River is the most significant for anadromous fish that use the San Joaquin River for migration. This 43-mile reach includes the confluences of the Merced, Tuolumne, and Stanislaus Rivers. Fall-run Chinook salmon, Central Valley steelhead, striped bass, American shad, and white sturgeon are the anadromous fish species present in the San Joaquin River from the Merced River confluence to Mossdale (Bureau of Reclamation et al. 2003). Shad and striped bass migrate from the Pacific Ocean via the Delta into the San Joaquin River to spawn in the spring (Bureau of Reclamation et al. 2003). Sacramento splittail, pikeminnow, and other native species are also found in the San Joaquin River (Bureau of Reclamation et al. 2003). However, this portion of the San Joaquin River is dominated by introduced species such as largemouth bass, silversides, green sunfish, and brown bullhead. Introduced species dominate in terms of numbers and biomass (Bureau of Reclamation et al. 2003).

Special-status (listed or of designated concern under the ESA or CESA) and recreationally and/or commercially important fish species potentially occurring in the San Joaquin River (below the Merced River confluence) are identified below.

- Central Valley fall-/late fall-run Chinook salmon
- Central Valley steelhead
- Hardhead
- Pacific lamprey
- Sacramento splittail
- Sacramento-San Joaquin roach
- Green sturgeon
- White sturgeon
- Striped bass
- American shad

The San Joaquin River Restoration Program (SJRRP), which addresses the area of the San Joaquin River extending from Friant Dam downstream to the confluence of the Merced River, has established goals related to fisheries restoration and water management in the San Joaquin River (San Joaquin River Restoration Program 2009). The SJRRP's preliminary fish population objectives relate to fall- and spring-run Chinook salmon (San Joaquin River Restoration Program 2009). Habitat objectives for the restoration area along the San Joaquin River were also developed to address physical habitat, stream flow, water temperature, and water quality impairments (see San Joaquin River Restoration Program 2009). In addition, CDFW is in the planning stages to implement a conservation hatchery below Friant Dam to produce spring-run Chinook salmon.

11.1.1.3 SWP/CVP Export Service Areas

As described in Chapter 1, *Introduction*, the Export Service Areas include the areas where water supply deliveries may be affected by the BDCP alternatives. SWP and CVP facilities influence habitat conditions downstream of the Plan Area. Facilities in the Export Service Areas deliver Delta exports to SWP and CVP contractors. Details regarding these facilities and operations are provided in Chapter 5, *Water Supply*. The relationship between these facilities and the fisheries resources they support are provided below.

Water exportation and facilities operations in the Export Service Areas result in both direct and indirect effects on aquatic species. Surface water elevation potentially affects survival and reproductive success of warmwater and coldwater species that occupy reservoirs in the Export Service Areas. Operational changes to water elevations may affect fisheries during critical spawning periods, overall reservoir levels, and the availability of shallow nearshore rearing habitat. Seasonal changes in reservoir water surface elevation may affect multiple life stages by altering the availability of littoral habitat and increasing the risk to stranding and nest dewatering. Additionally, facility operations within the Export Service Areas potentially alter water quality conditions such as temperature and dissolved oxygen (DO) concentrations which are important to certain aquatic species.

Many of the reservoirs in the Export Service Areas provide aquatic habitat and are stocked with fish, including trout, striped bass, centrarchids, and catfish (Table 11-2).

Table 11-2. SWP/CVP Export Service Area Delivery Reservoirs

Reservoirs	Coldwater Fishery	Warmwater Fishery	Central Valley Project	State Water Project
Anderson Reservoir		X		
Diamond Valley Lake	X	X		X
San Luis Reservoir and O'Neil Forebay	X	X	X	X
Castaic Lake/Lagoon	X	X		X
Lake Perris	X	X		X
Lake Mathews[a]				X

Sources: California Department of Fish and Game 2010a; California Department of Fish and Wildlife 2013a; Reclamation and California Department of Parks and Recreation 2005; Castaic Lake State Recreation Area 2010.

[a] Lake Mathews is not open to the public for recreational purposes (Metropolitan Water District Administrative Code § 4208).

11.1.1.4 San Pablo and San Francisco Bays

Hydrologically, the Bay may be divided into two broad subdivisions with differing ecological characteristics: a southern reach consisting of South Bay; and a northern reach composed of Central, San Pablo, and Suisun Bays (The Bay Institute 1998; CALFED Bay-Delta Program 2000a). The southern reach receives little freshwater discharge, leading to high salinity and poor circulation (high residence time). It also has more extreme tides. The northern reach, which directly receives Delta outflow, is characterized by less extreme tides and a pronounced horizontal salinity gradient, ranging from near full marine conditions in Central Bay to near freshwater conditions in Suisun Bay.

Central Bay and Suisun Bay contain large islands, features not present in San Pablo Bay and South Bay (The Bay Institute 1998; CALFED Bay-Delta Program 2000a).

Northern Reach – Central San Francisco and San Pablo Bays

Ecological factors having the greatest influence on the northern reach and marsh fish and wildlife include freshwater inflow from rivers, wetlands, riparian vegetation, and aquatic habitat diversity. Habitats in the northern reach are tidal perennial aquatic habitat, tidal saline emergent wetland, seasonal wetland, perennial grassland, agricultural land, and riparian habitat. These habitats support a variety of native marine, estuarine, freshwater, and anadromous fish (CALFED Bay-Delta Program 2000a). San Francisco Bay is designated as a coastal estuary Habitat Area of Particular Concern (HAPC) and eelgrass (*Zostera marina*) is designated as seagrass HAPC for Pacific groundfish species. Fish species that currently depend on tidal marshes and adjoining sloughs, mudflats, and embayments include delta smelt, longfin smelt, Chinook salmon, green sturgeon, white sturgeon, pacific herring, starry flounder, Sacramento splittail, and striped bass (The Bay Institute 1998; CALFED Bay-Delta Program 2000a; Baxter et al. 2008). Other fish commonly found in Central Bay include northern anchovy, halibut, American shad, bay goby, white croaker, Pacific staghorn sculpin, and marine surfperches. English sole, shiner surfperch, jacksmelt, topsmelt, diamond turbot, and speckled sand dab are common in shallow waters around Central Bay. The leopard shark, sevengill shark, and the brown smoothhound are abundant in the intertidal mudflats of the Central Bay. The sand substrate and rock outcrops in the Central Bay support recreational fish such as the halibut, striped bass, rockfish, and lingcod. Stressors include water management and conveyance, water quality, legal and illegal harvest, food availability wave and wake erosion, and introduced nonnative plant and animal species (CALFED Bay-Delta Program 2000a, Baxter et al. 2008).

Southern Reach – South San Francisco Bay

The southern reach receives far less freshwater runoff and does not generally exhibit the type of estuarine circulation that occurs in the northern reach (The Bay Institute 1998). Salinity is characteristically high, often similar to nearshore ocean levels, but is generally homogeneous. The reach is characterized by a much higher residence time of water, and on average is flushed at about one-fourth the rate of the northern reach (The Bay Institute 1998).

The South Bay supports a primarily marine fish assemblage owing to its saline water environment. Fish species include planktivorous topsmelt, jacksmelt, bay pipefish, brown rockfish, surfperches, surf smelt, longfin smelt, diamond turbot, arrow goby, and staghorn sculpin (The Bay Institute 1998). Anadromous salmonids produced in tributaries to the South Bay include steelhead and Chinook salmon.

11.1.2 Natural Communities

11.1.2.1 Covered Aquatic Natural Communities

The following discussion on aquatic natural communities is based on Chapter 2 of the BDCP and the Ecosystem Restoration Program Plan (ERPP) (CALFED Bay-Delta Program 2000a). The BDCP's descriptions address habitats in the Plan Area (natural communities covered by the plan) and are based on broad community descriptions that were developed for the CALFED Bay-Delta Program (CALFED) Multi-Species Conservation Strategy (MSCS) by the CALFED agencies. The description of habitat types outside the Plan Area is from the ERPP, which addresses the entire area potentially affected by the BDCP alternatives.

This discussion includes habitats used by both aquatic and terrestrial resources. However, habitats and natural communities that could potentially be affected by BDCP activities that are used exclusively by terrestrial species (e.g., grassland and inland dune scrub) are described in Chapter 12, *Terrestrial Biological Resources*. Although there is some overlap in the discussion here and in Chapter 12, this section describes the habitats as they pertain to aquatic resources.

Tidal Perennial Aquatic

The tidal perennial aquatic natural community occurs within the Delta and Greater San Francisco Bay ecological zones. It includes deep water aquatic (greater than 10 feet deep from mean lower low tide [the lowest of the low tides in a day]), shallow aquatic (less than or equal to 10 feet deep from mean lower low tide), and unvegetated intertidal (i.e., tideflats) zones of estuarine bays, river channels, and sloughs (CALFED Bay-Delta Program 2000a). Under current operations, the tidal perennial aquatic community in the Delta is mainly freshwater, with brackish and saline conditions occurring in the western Delta during high tides and low flows.

Zooplankton are the primary consumers of phytoplankton in the tidal perennial aquatic community food web and are important prey for fish and macroinvertebrates. Zooplankton species composition is strongly influenced by salinity in the tidal perennial aquatic community. In the estuarine and brackish portions of the Delta, calanoid copepods, cyclopod copepods, and mysid shrimp are the primary zooplankton species. In freshwater regions, cladocerans and calanoid copepods are the dominant zooplankton present (California Department of Water Resources 2013).

The majority of fish species in the Delta use the tidal perennial aquatic community. This community is used by fish for foraging, spawning, egg incubation and larval development, juvenile nursery areas, and migratory corridors. Most Delta resident fish species spend their entire lives in the tidal perennial aquatic community. Other fishes in the Delta may spend certain seasons or part of their lives in different areas of the community, based on physical factors such as salinity, turbidity, DO, flow rates, and water temperature.

The tidal perennial aquatic community provides habitat for all of the aquatic Delta food web. Use of the tidal perennial aquatic community by individual species is often determined by multiple physical factors (e.g., flow, salinity, wind, tide, and temperature), many of which vary at multiple temporal scales (California Department of Water Resources 2013). Phytoplankton and zooplankton spend their entire lives in the water medium. Many fish spend their entire lives in the tidal perennial aquatic community and use it for foraging, spawning, rearing, resting, and migration. Resident and migratory fish use tidal perennial aquatic habitat for spawning, rearing, foraging, and escape cover. Striped bass, delta smelt, Sacramento splittail, and many resident Bay-Delta fish use this habitat for rearing and as adults (CALFED Bay-Delta Program 2000a). Young steelhead and Chinook salmon forage in these productive waters as fry and juveniles to put on weight before entering the ocean. Changes in physical attributes of the water column, such as flow, salinity and water temperature, provide environmental cues for some species to trigger the timing of biological events, such as migration and spawning. Chapter 12, *Terrestrial Biological Resources*, provides further discussion on the ecosystem functions occurring in the tidal perennial aquatic community.

Within the water column of the nontidal freshwater permanent emergent community, there are gradients of light, oxygen and other chemicals, pH, and temperature that combine in various ways and result in a range of microhabitat types (California Department of Water Resources 2013). The tidal perennial aquatic community provides an important ecological connection between open water areas and shallow water, emergent wetlands, and riparian habitats. Much of the productivity, organic matter, and inorganic sediment from upstream waterways and marshes eventually move into this community. In the Delta, saline coastal oceanic water is mixed and diluted by flowing freshwater of rivers (California Department of Water Resources 2013). This mix of fresh and oceanic water forms a salinity gradient that varies in area and location with daily and seasonal variations in freshwater inflow and tidal action. This gradient can affect the location of species that depend on salinity, such as estuarine vegetation, and delta smelt and longfin smelt. The location of this gradient varies on multiple time scales—daily tides, monthly lunar cycle, intra-annual (seasonal) river flow patterns, interannual river flow variation from interannual rainfall variation, and long-term global climate change (see below) (Kimmerer 2004).

The tidal perennial aquatic community has been heavily influenced by introductions of a number of nonnative species on nearly every trophic level. These nonnative species have caused substantial adverse effects on the physical habitat and the food web, ultimately affecting the growth and survival of the species covered under the BDCP. In addition to physical habitat changes, introduced nonnative predatory fish have a direct impact on survival of native fish species. There has been a decline in habitat quality resulting in reduction of quantity and quality of prey due to the introduction of invasive species such as the overbite clam (*C. amurensis*) and cyclopoid copepod (*Limnoithona tetraspina*) (Baxter et. al. 2008). The estimated juvenile Chinook salmon mortality at the Clifton Court Forebay suggests that striped bass and other predatory fish, primarily nonnative, pose a threat to juvenile Chinook salmon moving downstream, especially where the stream channel has been altered from natural conditions (California Department of Water Resources 1995d). Predators such as striped bass, largemouth bass, and catfish also prey on delta smelt and splittail (U.S. Fish and Wildlife Service 1996). However, the extent that these predators may affect delta smelt and splittail populations is unknown. Brazilian waterweed *Egeria*, an invasive plant, provides excellent habitat for nonnative ambush predators such as bass (California Department of Water Resources 2013). Chapter 12, *Terrestrial Biological Resources*, provides further detailed discussion on nonnative species, including aquatic weeds, occurring in the tidal perennial aquatic community.

Tidal Mudflat

Tidal mudflats are typically the unvegetated sediments in the intertidal zone between the mean high tide and the mean lower low water. They are generally associated with tidal freshwater or brackish emergent wetlands at their upper edge and the tidal perennial aquatic community at their lower edge.

When the tidal mudflat community is flooded, it serves as shallow open water habitat for pelagic fish species (including Sacramento splittail, salmonids) and benthic fish species (including sturgeon). This habitat can provide refugia from predators and foraging opportunities for fishes. During low tides, smaller benthic species, such as gobies, flatfish, and sculpin, inhabit the tidal mudflats if depressions in mud provide pooled water.

Tidal Brackish Emergent Wetland

Tidal brackish emergent wetland is a transitional community between tidal perennial aquatic and terrestrial upland communities. Tidal brackish emergent wetland occurs in the San Francisco Bay saltwater/Delta freshwater mixing zone that extends from near Collinsville westward to the

Carquinez Strait. Tidal brackish emergent wetland is present on the south side of Suisun Bay and on islands in mid-channel, but most of its extent is present in Suisun Marsh (California Department of Water Resources 2013).

A productive habitat, the tidal brackish emergent wetland community provides high-quality fry and juvenile rearing habitat, such as for Sacramento splittail, salmonids, delta smelt, longfin smelt, and sturgeon. In addition, organic material is exported from the marsh to provide food to nearby fish species (Moyle 2002).

Tidal Freshwater Emergent Wetland

Tidal freshwater emergent wetland habitat is typically a transitional zone between tidal perennial aquatic and valley/foothill riparian habitats. The tidal freshwater emergent wetland community often occurs at the shallow, slow-moving, or stagnant edges of freshwater waterways or ponds in the intertidal zone and is subject to frequent, long-duration flooding (SAIC 2009). Chapter 12, *Terrestrial Biological Resources*, provides further description of tidal freshwater emergent wetland habitat communities.

A productive habitat, tidal freshwater emergent wetland provides food and cover for numerous terrestrial and aquatic species, including fishes. Many of the fish in the tidal perennial aquatic Natural Community also use Tidal Freshwater Emergent habitat when inundated (SAIC 2009). Younger stages (e.g., larvae, fry) of some species rear in shallower waters that support emergent vegetation. Further, many fish species use emergent vegetation as refuge from predation and high flows (California Department of Water Resources 2013).

Tidal freshwater emergent wetland communities provide habitat for a variety of fish and wildlife species; however, island reclamation throughout the Delta, channelization, and anthropogenic changes to flow patterns have altered the ecosystem function and habitat value of these wetlands in the watershed (The Bay Institute 1998). Chapter 12, *Terrestrial Biological Resources*, provides further description of ecosystem functions of tidal freshwater emergent wetland communities.

Tidal freshwater emergent wetland communities occur on virtually all exposures and slopes provided the surface is saturated or at least periodically flooded by tidal action. In the Plan Area, tidal freshwater emergent wetlands typically occur on the water-side of levees where the water is not too deep (The Bay Institute 1998). Where brackish conditions occur (e.g., the western edge of the Plan Area), tidal freshwater emergent wetlands merge into tidal brackish emergent and tidal saline emergent wetlands that support plants and invertebrates tolerant of brackish or saline conditions. Physical factors that affect the location of gradients between community types include elevation, salinity and water inundation patterns at multiple temporal scales (e.g., daily tidal, lunar, seasonal, interannual). Chapter 12, *Terrestrial Biological Resources*, provides further description of environmental gradients of tidal freshwater emergent wetland communities.

Valley/Foothill Riparian

Broadly defined, the valley/foothill riparian community is often a transition zone between aquatic and upland terrestrial habitat and is found in a wide range of geologic, edaphic, and other environmental conditions (e.g., variable light and nutrient availability) (California Department of Water Resources 2013). Chapter 12, *Terrestrial Biological Resources*, provides further description of valley/foothill riparian habitat communities.

Riparian habitats support the greatest diversity of wildlife species of any habitat in California, including many species of fish within channel edge habitats (CALFED Bay-Delta Program 2000a). Furthermore, more extensive and continuous riparian forest canopy on the banks of estuaries and rivers stabilize channels; help shape submerged aquatic habitat structure; benefit the aquatic environment by contributing shade, overhead canopy, and instream cover for fish; and reduce river water temperature (CALFED Bay-Delta Program 2000a). More extensive and continuous shoreline vegetation associated with woody debris (branches and root wads) and leaf and insect droppings in shallow aquatic habitats will increase the survival and health of juvenile salmonids, resident Delta native fishes, and introduced resident fishes (CALFED Bay-Delta Program 2000a).

Riparian ecosystems provide higher ecosystem services and wildlife habitat compared to other terrestrial ecosystems (California Department of Water Resources 2013). Riparian areas serve as the hydrologic connection between terrestrial uplands and aquatic ecosystems, receiving water from precipitation, overland runoff, groundwater discharge, and flow from the adjacent water body or alluvial aquifer (California Department of Water Resources 2013).

Although the fish species do not rely primarily on riparian habitat per se, because they are aquatic species, they are directly and indirectly supported by the habitat services and food sources provided by the highly productive riparian ecosystem (California Department of Water Resources 2013). Riparian communities provide habitat and food for species fundamental to the aquatic and terrestrial food web, from insects to top predators (California Department of Water Resources 2013). Riparian vegetation on floodplains can provide additional benefits to fish when the floodplain is inundated. For further information on ecosystem function of valley/foothill riparian habitat, refer to Chapter 12, *Terrestrial Biological Resources*.

Due to its location in the transition zone between aquatic and terrestrial ecosystems, the valley/foothill riparian community is characterized by biotic (e.g., species composition) and abiotic (e.g., hydrologic) gradients (California Department of Water Resources 2013). These gradients interact to form highly diverse and complex communities, both structurally and functionally. They also interact strongly with and influence the aquatic, emergent, and upland habitats along their edges. Chapter 12, *Terrestrial Biological Resources*, further describes environmental gradient related to valley/foothill riparian communities.

Nontidal Perennial Aquatic

Nontidal perennial aquatic natural communities in the Delta can range in size from small ponds in uplands to large lakes, such as North and South Stone Lakes (California Department of Water Resources 2013). The nontidal perennial aquatic natural community can be found in association with any terrestrial habitat and can transition into nontidal freshwater permanent emergent wetland and valley/foothill riparian. The littoral zone of the nontidal perennial aquatic community is defined as the portion of the water column penetrable by light and that occurs at the edges of lakes and throughout most ponds (California Department of Water Resources 2013). The limnetic zone extends below the littoral zone to the deepest part of the water body. Chapter 12, *Terrestrial Biological Resources*, provides further description of Nontidal Perennial Aquatic habitat.

A thin layer of floating duckweed often covers the surface of shallow nontidal perennial aquatic waters. Desmids, diatoms, protozoans, crustaceans, hydras, and snails live on the under-surface of the layer, whereas mosquitoes and other aquatic insect larvae may live in between the plants.

Zooplankton, such as rotifers, copepods, and cladocerans, live suspended in the water column and graze on phytoplankton and other organic matter (California Department of Water Resources 2013). Together with phytoplankton, these organisms compose the base of the nontidal perennial aquatic food web. A variety of aquatic insects (e.g., dipterans, coleopterans, chironomids, trichopterans, plecopterans, and ephemeropterans) and springtails use the nontidal perennial aquatic habitat for their larval stage (California Department of Water Resources 2013). Native fish that can be found in some nontidal perennial aquatic communities include the Sacramento perch, hitch, and Sacramento tule perch (California Department of Water Resources 2013). Nontidal perennial aquatic communities support many nonnative freshwater fish species, including sunfish, bass, common carp, inland silverside, fathead minnow, and western mosquitofish. These species prey on or compete with native fish both directly and indirectly for resources (California Department of Water Resources 2013).

Nontidal Freshwater Permanent Emergent Wetland

The nontidal freshwater permanent emergent wetland community is composed of permanently saturated wetlands, including meadows, dominated by emergent plant species that do not tolerate permanent saline or brackish conditions (CALFED Bay-Delta Program 2000a). Nontidal freshwater permanent emergent wetland communities in the Plan Area occur in small fragments along the edges of the nontidal perennial aquatic and valley/foothill riparian natural communities. Chapter 12, *Terrestrial Biological Resources*, provides further description of the nontidal freshwater permanent emergent wetland natural community.

The nontidal freshwater permanent emergent wetland community in the Plan Area supports many nonnative freshwater fish species, including centrarchids, common carp, inland silverside, fathead minnow, and western mosquitofish. These nonnative species prey on or compete with native fish and amphibian species both directly and indirectly for resources. Common invasive plants found in this habitat include Brazilian waterweed *Egeria*, Eurasian watermilfoil, and water hyacinth. These plants form thick mats that exclude native vegetation and associated wildlife (California Department of Water Resources 2013).

The nontidal freshwater permanent emergent wetland community generally forms the boundary around the nontidal perennial aquatic community. Its most significant ecosystem functions include providing a source of primary productivity and a habitat for native fish, amphibians, and reptiles. Its importance as a source of primary productivity can increase or decrease if the body of water is dominated by algal phytoplankton or aquatic plants, depending on whether the body of water is in a turbid- or clear-water state. The presence and abundance of primary consumers can affect the ecosystem because they provide a food source for other species, including invertebrate and fish species.

External gradients to terrestrial ecosystems exist at the boundary of this community because it provides the transition between open water habitat and riparian forest, grassland, or agricultural lands.

Managed Wetland

The managed wetland natural community consists of areas that are intentionally flooded and managed during specific seasonal periods to enhance habitat values for specific wildlife species (CALFED Bay-Delta Program 2000a). The managed wetland community includes some areas of the

CALFED ERPP "seasonal wetlands" habitat and fits into the "fresh emergent wetland" classification from the California Wildlife Habitat Relationships (California Department of Water Resources 2013).

Within the watershed, managed wetland is distributed largely in the northern, central, and western portions of the Delta, as well as in Suisun Marsh (California Department of Water Resources 2013). Substantial acreage of this type occurs in the Yolo Bypass, Stone Lakes Wildlife Refuge, Cosumnes River Preserve, and Suisun Marsh (California Department of Water Resources 2013).

Managed wetlands are managed specifically to promote use by waterfowl, specifically ducks (California Department of Water Resources 2013). During winter inundation, managed wetlands in the Yolo Bypass provide spawning and rearing habitat for Sacramento splittail and refuge habitat for other fish species (California Department of Water Resources 2013).

Cultivated Lands

Agricultural land uses and cover types in the watershed primarily include grain, field, truck, and hay crops; orchards and vineyards; and irrigated pastures. Chapter 12, *Terrestrial Biological Resources*, provides further discussion on agricultural land in the watershed.

When inundated, the Yolo Bypass provides habitat for at least 42 fish species, including delta smelt, Sacramento splittail, Chinook salmon, steelhead, and white sturgeon (California Department of Water Resources 2013). Evidence suggests that these species benefit from floodplain inundation because of increased food, lower water velocity, and warmer water.

11.1.2.2 Noncovered Aquatic Natural Communities

The following habitat types are found within the area potentially affected by the BDCP alternatives, including the Plan Area, but they are not covered natural communities under the BDCP.

Valley Riverine Aquatic

Valley riverine aquatic habitat includes the water column of flowing streams and rivers in low-gradient channel reaches below an elevation of approximately 300 feet that are not tidally influenced. This includes associated shaded riverine aquatic, pool, riffle, run, and unvegetated channel substrate (including seasonally exposed channel bed) habitat features, and sloughs, backwaters, overflow channels, and flood bypasses hydrologically connected to stream and river channels. Valley riverine aquatic habitat includes portions of the ERPP riparian and riverine aquatic habitat (CALFED Bay-Delta Program 2000b).

Anadromous and estuarine fish species, such as Chinook salmon, steelhead, Sacramento splittail, delta smelt, sturgeon, lamprey, Sacramento pikeminnow, and Sacramento perch use the valley riverine aquatic habitat (CALFED Bay-Delta Program 2000b).

Montane Riverine Aquatic

Montane riverine aquatic habitat includes the water column of flowing streams and rivers above an elevation of approximately 300 feet. This includes associated shaded riverine aquatic, pool, riffle, run, and unvegetated channel substrate (including seasonally exposed channel bed) habitat features, and sloughs, backwaters, and overflow channels hydrologically connected to stream and river channels. Montane riverine aquatic habitat includes portions of the ERPP riparian and riverine aquatic habitat (CALFED Bay-Delta Program 2000b).

Anadromous fish species such as Chinook salmon, sturgeon, lamprey, Sacramento pikeminnow, and steelhead use the montane riverine aquatic habitat (CALFED Bay-Delta Program 2000b).

Montane Riparian

Montane riparian habitat includes all successional stages of woody vegetation, such as willow, black cottonwood, white alder, birch, and dogwood, within the active floodplains of moderate-to-high-gradient reaches of streams and rivers generally above an elevation of 300 feet. Montane riparian habitat includes portions of the ERPP riparian and riverine aquatic habitat (CALFED Bay-Delta Program 2000b).

Saline Emergent

Saline emergent habitat includes the portions of San Francisco, San Pablo, and Suisun Bays and the Delta that support emergent wetland plant species that are tolerant of saline or brackish conditions within the intertidal zone or are located on lands that historically were subject to tidal exchange (i.e., diked wetlands). Saline emergent habitat includes all or portions of the ERPP saline emergent wetland tidal and Delta sloughs, and midchannel islands and shoals habitats (CALFED Bay-Delta Program 2000b).

Anadromous and estuarine fish species, such as Chinook salmon, steelhead, Sacramento splittail, delta smelt, and Sacramento perch use the saline emergent habitat (CALFED Bay-Delta Program 2000b).

Low Salinity Zone

Pelagic fish habitat is characterized by physical and chemical properties such as salinity, turbidity, and water temperature, and biological properties such as prey production. Thus, pelagic fish habitat suitability in the estuary is at least partially influenced by variation in freshwater flow (e.g., Delta outflow) (Jassby et al. 1995; Bennett and Moyle 1996; Kimmerer 2004).

Several fish species use a variety of behaviors to maintain themselves within open-water areas where water quality and food resources are favorable (Bennett et al. 2002). Delta smelt, longfin smelt, striped bass, and threadfin shad distribute themselves at different concentrations of salinity within the estuarine salinity gradient (Feyrer et al. 2007; Kimmerer 2002a), indicating that, at any point in time, salinity is a major factor affecting the geographic distributions of these species. The term "low-salinity zone" (LSZ) within the San Francisco Estuary was created and is defined as the area within the estuary where salinity is approximately 0.5 to 6 parts per thousand (ppt). X2 (i.e., roughly the center of the LSZ), is defined as salinity of around 2 ppt (Kimmerer 2002b). The term "X2" is used to define the distance from the Golden Gate Bridge upstream to where salinity near the bottom of the water column is approximately 2 ppt. Salinity between 2 and approximately 30 ppt is roughly linearly distributed between X2 and the mouth of the estuary (Monismith et al. 1996). X2 reflects the physical response of the San Francisco Estuary to changes in flow and provides a geographic frame of reference for estuarine conditions (Kimmerer 2002b). The estuary responds to freshwater flow, as characterized by the statistical relationship between X2 and flow (Kimmerer 2004). Because the position of X2 relies on a number of physical parameters, including river flows, water diversions and tides, its position shifts over many kilometers on a daily and seasonal cycle. Over the course of a year, the location of X2 can range from San Pablo Bay during high river flow periods to up into the Delta during low-flow periods (generally summer/fall).

Relationships between X2 and abundance of fish and aquatic species have been developed for many estuarine-dependent copepods, mysids, bay shrimp, and several fishes—including longfin smelt, Pacific herring, starry flounder, Sacramento splittail, American shad, and striped bass (Kimmerer 2002a). For example, Feyrer et al. (2007) reported that higher outflow that expands and moves delta smelt habitat downstream of the Delta is expected to improve conditions for delta smelt. Kimmerer (2002a) found that distributions of fish species including striped bass, Sacramento splittail, longfin smelt, delta smelt, and starry flounder, substantially overlapped with the LSZ.

According to California Department of Fish and Game (2010a), the available data and information indicate that (1) the abundance of many fish and aquatic species is related to water flow timing and quantity; (2) for many fish and aquatic species, more water flow translates into greater species production or abundance; (3) fish and aquatic species are adapted to use the water resources of the Delta during all seasons of the year, but for many species, important life history stages or processes consistently coincide with increased winter-spring flows; and (4) the source, quality, and timing of water flows through the estuary influences the production of Chinook salmon in both the San Joaquin River and Sacramento River Basins (California Department of Fish and Game 2010b).

The extent of the low salinity zone, which is determined by the location of the X2 isohaline, largely overlaps with the distribution of other essential physical resources and key biotic resources that are necessary to support delta smelt, but is not the only factor that defines the extent of habitat for delta smelt. The delta smelt fall abiotic habitat index developed by Feyrer et al. (2011) is based on the probability of presence of delta smelt given certain water clarity and salinity and does not account for other abiotic (e.g., water velocity, depth) and biotic (e.g., food density) factors that may interact with water clarity and salinity to influence the probability of occurrence. The three physical variables (temperature, salinity, and turbidity) combined could explain just a quarter of the variance in patterns of delta smelt presence and absence in the estuary. It is unclear what portion of that fractional explained variance is actually due to turbidity, rather than salinity. While temperature was not found to be a predictor of delta smelt presence in the fall, although it has been shown to be important during summer months (Nobriga et al. 2008).

The overall relationship between X2 and the delta smelt fall abiotic habitat index is the result of two linked statistical analyses, each of which include uncertainties that are compounded when the analyses are combined. In addition, while the position of X2 is correlated with the distribution of salinity and turbidity regimes (Feyrer et al. 2007), the relationship of that distribution and smelt abundance indices is not clear (National Research Council 2010). Nevertheless, this method has been previously applied to analyses for delta smelt habitat and therefore is included in this analysis of relative comparisons between action alternatives and baseline conditions.

11.1.3 Species Evaluated in the EIR/EIS

11.1.3.1 Covered Fish Species

The following endangered or threatened species are identified as covered species in the BDCP, and DWR is requesting incidental take of these species.

- Delta smelt (State endangered/Federally threatened)
- Longfin smelt (State threatened)

- Chinook salmon, Sacramento River winter-run evolutionarily significant unit (ESU) (State endangered/Federally endangered)
- Chinook salmon, Central Valley spring-run ESU(State threatened/Federally threatened)
- Chinook salmon, Central Valley fall-and late-fall run ESU(State species of concern/Federal species of concern)
- Steelhead, Central Valley DPS(Federally threatened)
- Sacramento splittail (State species of concern)
- Green sturgeon, southern DPS (State species of concern/Federally threatened)
- White sturgeon (State species of concern)
- Pacific lamprey (State species of concern)
- River lamprey (State species of concern)

All of the fish species above are listed as threatened or endangered under the ESA. threatened or endangered under CESA or California species of special concern identified by DFW. They are addressed in this document if they would be affected by the project.

In addition to the ESA listings, the Plan Area contains critical habitat designated under the ESA, and essential fish habitat (EFH) protected under the Magnuson-Stevens Fishery Conservation and Management Act, for the following species:

- Chinook salmon, Sacramento River winter-run ESU – critical habitat and EFH
- Chinook salmon, Central Valley spring-run ESU – critical habitat and EFH
- Chinook salmon, Central Valley fall-and late-fall run ESU – EFH
- Steelhead, Central Valley DPS – critical habitat
- Delta smelt – critical habitat
- Green sturgeon, southern DPS – critical habitat

The fish species accounts, geographic distribution, and life history timings of the covered species in the watershed are summarized in Appendix 11A.

11.1.3.2 Noncovered Species

Noncovered fish and aquatic species are species which are not listed as endangered or threatened under state and federal endangered species acts, have ecological, recreational, or commercial importance and are assessed in this document for impacts. The noncovered fish and aquatic species are listed below:

- Striped bass
- American shad
- Largemouth bass
- Sacramento–San Joaquin roach
- Hardhead (State species of concern)

- Sacramento perch
- Sacramento tule perch
- Threadfin shad
- California bay shrimp

The fish and aquatic species accounts of the non-covered species in the watershed are summarized in Appendix 11B. Sacramento perch are essentially extirpated from the Sacramento-San Joaquin system (Appendix 11B) and are not addressed further.

11.1.4 Ecological Processes and Functions

Because of the interconnectedness of hydrology throughout the system known as the San Francisco Bay-Delta watershed, an overview of activities throughout the watershed is essential to an understanding of current conditions in the Plan Area. Historical modification of ecosystem processes and functions in the Plan Area and throughout the watershed have influenced the current conditions of natural communities and special-status species. Since the Gold Rush, agricultural and residential development; land reclamation; flood control measures; water management and diversions; sediment movement and deposition associated with gold mining; contamination from gold mining and pesticide use; introduction of invasive nonnative vegetation, wildlife, and aquatic species; and other human influences have affected the ecosystem processes and functions. As a result of these influences, carbon and nutrient cycling in the ecosystem and the maintenance of biodiversity have been changed, affecting both terrestrial and aquatic ecosystems.

11.1.4.1 Hydrology

A full description of hydrology is provided in Chapter 5*, Water Supply* and Chapter 6, *Surface Water.* The following is provided as a brief overview of hydrologic conditions.

The volume and distribution of water in the watershed influence important ecological processes and functions. Streamflows within the watershed are extremely variable. Most of the unimpeded flow occurs from December through June. A large part of the total flow volume occurs during relatively short periods, caused either by rainfall or snowmelt. Construction and operation of dams on major rivers and streams has reduced peak winter and spring flows, and increased summer and fall flows. Dry-year flows can be higher in regulated streams than in unregulated streams because of release of carryover storage from reservoirs. Winter and spring peak flows, and summer and fall base flows are important to maintain ecological processes such as sediment transport, stream meandering, and riparian habitat regeneration. Native fish species evolved with these flow patterns, and spawning and migrating fish depend on the natural seasonal and interannual streamflow patterns. Native habitats and species in the watershed's ecosystem evolved in the context of a highly variable flow regime punctuated by extreme seasonal and interannual changes in flow (CALFED Bay-Delta Program 2000a).

The volume and distribution of water in the watershed influence important ecological processes and functions. The natural hydrograph in the watershed is extremely variable with most of the unimpeded flow occurring from December through June during relatively short periods, caused either by rainfall or snowmelt. Native fish species evolved with these flow patterns, and spawning and migrating fish depend on naturally variable seasonal and interannual streamflow patterns for maintenance of the habitat conditions needed to successfully complete their life cycles (CALFED

Bay-Delta Program 2000a). Construction and operation of dams on major rivers and streams has reduced peak winter and spring flows and increased summer and fall flows, altering the natural processes that sustain these habitats (e.g. sediment transport, stream meandering, and riparian regeneration) and creating more stable hydrologic conditions favored by non-native species. River-transported sediments are an essential component of the physical structure and nutrient base of the Bay-Delta ecosystem and its riverine and tidal arteries. The coarse sediment supply is highly variable between the streams and tidal sloughs of the Sacramento and San Joaquin Rivers and Bay-Delta ecosystems. Most sediment is transported and deposited during winter and spring runoff events. Typically, bars, shoals, and braided deltas form or expand as floodwaters decline and stabilize during the dry season. Due to the construction of reservoirs on the major rivers in the watershed, sediment transport to the lower rivers below the reservoirs has been reduced.

Stream meander is a dynamic natural process, and is also a term used to describe the shape of the river as a sinuous or bending wave form. Rivers with active stream channel meander zones generally support a greater diversity of aquatic and terrestrial habitats and biotic communities. Central Valley streams have been affected by physical modifications that diminish stream meandering and associated aquatic and riparian habitats. However, substantial reaches of several large rivers still support full or partial characteristics of a dynamic stream meander pattern. The best example in California is the Sacramento River between Red Bluff and Butte City. Other important examples include the San Joaquin River (from Mossdale to Merced River); the Merced, Tuolumne, Cosumnes, Feather, and Yuba Rivers; and Cottonwood, Stony, and Cache Creeks.

Floodplains and flood processes provide important seasonal habitat for fish and wildlife, and provide sediment and nutrients to both the flooded lands and aquatic habitats of the rivers and Bay-Delta. Today, mostly primary open water channels remain, lacking floodplains, are bordered by steep-sided riprapped levees often lacking in native vegetation. The Delta waterways generally contain freshwater, with brief incursions of slightly brackish water into the northern and western Delta. The major incursions of brackish water into the legal Delta have occurred in the fall (Feyrer et al. 2007; Cloern and Jassby 2012); they are very rare during spring. Delta hydrodynamics are determined by a combination of flow parameters including Delta inflow, Delta diversions, tidal flows, and facility operations (e.g., operation of the Delta Cross Channel [DCC] gates). Cross-Delta water flow to the south Delta pumping plants reduces residence time of water in the Delta and alters flow direction and magnitude (Arthur et al. 1996; Kimmerer and Nobriga 2008).

Plant contributions to the estuary food web consist mostly of benthic algae and phytoplankton produced in the estuary and its watershed. The watershed food web is subject to seasonal and annual trends in response to variation in hydrologic and other environmental factors. The proportion of the organic material that moves through the Delta and reaches Suisun Bay varies considerably from year to year and depends, in part, on prevailing flow conditions. At higher flows, much of the organic material brought in by the rivers will travel to Suisun Bay or farther downstream to San Pablo Bay or central San Francisco Bay. At low flows, a greater proportion remains in the Delta or is exported from the South Delta pumping plants(Jassby and Cloern 2000).

For detailed discussion of water flow and hydrodynamics refer to Chapter 6, *Surface Water*.

11.1.4.2 Carbon and Nutrient Cycling

Changes in carbon and nutrient cylcling in the Delta have occurred over the past decades. A decline in important fish species in the Delta was identified around 2000, and has been attributed to a wide array of factors related to agricultural, waste water treatment plant, and contaminant discharges along with changing flow patterns (Ballard et al 2009; Baxter et al 2010; Glibert 2010; and others). This decline is widely known as the pelagic organism decline (POD). Recognizing that the flow of energy through the Delta food web is complex and poorly understood, some researchers have identified a shift at the primary production level from diatom blooms to other, lower quality food sources (Glibert 2010, 2011; Dugdale et al, 2007; Wilkerson et al 2006). In particular, these researchers have reported that increased levels of ammonium could inhibit diatom growth, thus providing a lower quality, less preferred food chain to support fish. Unlike many degraded water bodies, the Delta has not recently experienced extended algal blooms or hypoxia. Researchers have noted a shift in algal composition in the increase in cyanobacterium *Microcystis aeruginosa,* increase in flagellates, and decreases in diatoms (Lehmann et al 2005, 2008; Lehmann 1996; Brown 2010).

The primary source of Delta organic carbon is upstream tributaries (Jassby and Cloern 2000). Secondary sources are phytoplankton and bacterial production and agricultural drainage in the Delta. Most of the agricultural drainage organic carbon comes from Delta peat soils (Jassby et al. 2003). Other sources include waste water treatment plant discharges and exports from tidal marsh areas and Yolo Bypass.

Although substantial wetland acreage remains in Suisun Marsh, much of the area is no longer tidally active because it is diked and isolated from tidal influences. Carbon and nutrient exchange with the surrounding waterways is therefore reduced in Suisun Marsh.

Most of the historic floodplain in the Delta has been converted to agricultural fields, including farmed wetlands (rice fields), or to wetlands managed for waterfowl habitat. Therefore, the tidal exchange of carbon and nutrients between wetlands and open water has been reduced. Periodic flooding of the Yolo Bypass still contributes to carbon and nutrient cycling, which provides important ecosystem functions (Sommer et al. 2001). Accidental and intentional levee breaches and floodplain flooding, such as the Liberty Island levee breach in the 1990s, has reconnected large tracts of historic floodplain with the Delta, thereby increasing the carbon and nutrient exchange levels in recent years.

11.1.4.3 Biodiversity

The conversion of original Delta habitat to diked and drained farm fields separated by wide open-water channels has substantially reduced the species diversity of the Delta. In Suisun Marsh, there is a predominance of diked, managed wetlands. The wetlands of Suisun Marsh still provide habitat for a diverse assemblage of waterfowl species (see Chapter 12, *Terrestrial Biological Resources*, for additional information on the biological resources in Suisun Marsh). However, there are biological trade-offs between water fowl and listed fish species, as the managed wetlands also result in water quality violations that have negative, sometimes fatal, effects on aquatic species.

The Yolo Bypass was historically a vast mosaic of natural vegetative communities, including large areas of seasonally flooded wetlands and riparian habitat (California Department of Fish and Game and Yolo Basin Foundation 2008). Because of seasonal and annual climatic variations, the habitats were highly dynamic. Hydrologic variability was reduced following construction of upstream dams on the Sacramento River, its tributaries, and Putah and Cache creeks. As was discussed for the Delta, the building of levees disconnected floodplains from the active stream channels, while agricultural land conversion reduced wetland and riparian habitat area (California Department of Fish and Game and Yolo Basin Foundation 2008). Overall, the biodiversity of species that could be supported by the Yolo Bypass was also reduced.

The current assemblages of fish in the watershed include a mixture of native and introduced species. Although there is limited knowledge of the ecology of native fishes in the past, the historical assemblages of fish upstream of and in the Delta were very different from the current assemblages (California Department of Water Resources 2013). For example, thicktail chub became extinct in the 1950s (California Department of Water Resources 2013). Also, the Sacramento perch, once abundant in sloughs off main channels, was extirpated from the Delta (Rutter 1908). Conversely, a large number of nonnative species of fish have been either intentionally (e.g., striped bass, channel catfish, American shad, threadfin shad, and largemouth bass) or unintentionally (e.g., goldfish) introduced into the system. Further, the abundance of many native fishes was much greater historically than currently. For example, Chinook salmon were once very abundant throughout the watershed, but today their abundance is relatively low. Similarly, other native anadromous fish populations, including sturgeon, and native resident fish populations, such as delta smelt and Sacramento splittail, have been substantially reduced in numbers and range. Populations of native invertebrates, such as the mysid shrimp, the amphipod, and cyclopoid copepods (Moyle 2002), have been replaced as dominant species by multiple nonnative species (Sommer 2007).

11.1.4.4 Aquatic Communities

Phytoplankton

Phytoplankton primary productivity in the Delta has experienced a long-term decline, and is currently low relative to other estuaries (Baxter et al. 2010; Cloern and Jassby 2008). As discussed in the previous section on nutrients, the phytoplankton assemblages have changed over the past decades (Glibert 2010, 2011; Dugdale et al, 2007; Wilkerson et al 2006). Changes in nutrient ratios (N:P) and ammonia from waste water treatment plant discharges have been identified as causes of the shift in phytoplankton assemblages. Once diatom-based, phytoplankton has shifted to smaller-celled organisms including cyanobacteria *Microcysitis aeruginosa* and flagellates, which have low nutritional value for Delta zooplankton, relative to nutritionally superior diatoms (Baxter et al. 2010).

In addition to the phytoplankton assemblage changes, overall reduction in chlorophyll-a in the water column has also been observed, and linked to changes in the ratio of nitrogen to phosphorous (Glibert 2010). Phytoplankton biomass (measured as chlorophyll-a) was high in the 1970’s, but decreased in the mid-1980’s. the decrease is attributed to both changes in the ratios of nitrogen, phosphorous and carbon, and the increase in the invasive clam (*Corbula amurensis*) which is a highly effective filterer of phytoplankton from the water column (Glibert 2011). The impact of Corbula is markedly high Susuin Bay, where the clam has flourished.

Zooplankton

Zooplankton assemblages changed in the 1980’s coincident with phytoplankton changes. Generally, the calanoid copepods and harpacticoid copepods have decreased, and the cyclopoid and invasive calanoid copepod species have increased (Glibert 2011). In the 1970’s, Calanoid copepods *Eurytemora affinis* and *Acartia Clausii* were dominant. Copepod species assemblages began to shift in the 1980’s. The calanoid copepod *Sinocalanus doerrii* first appeared, followed by the exotic *Pseudodiaptomis forbesi* and the invasive *Limnoithona tetraspina* (Glibert 2011). Increased abundance of the copepod *Pseudodiaptomis* coincided with the increase of the invasive clam *Corbula amurensis* in Suisun Bay in 1987. The abundance of cladocerans *Bosmina longirostris* and *Daphnia* sp. also increased significantly in the late 1980's through the 1990's (Glibert 2011).

11.1.5 Stressors

Stressors are actions, environmental characteristics or organisms that may negatively affect fish and aquatic resources, ecological processes, and habitats. An overview of stressors to fish and aquatic resources is first presented by geographic area (i.e., upstream of the Plan Area, the Plan Area, and downstream of the Plan Area). More detailed discussions regarding species-, run-, and life stage-specific stressors are provided in Appendix 11A.

Numerous documents were reviewed to identify stressors affecting fish and aquatic resources in the watershed. These documents include the draft BDCP Habitat Conservation Plan (HCP)/Natural Community Conservation Plan (NCCP), the Delta Regional Ecosystem Restoration Implementation Plan (DRERIP) Conceptual Models, the MSCS, the 2009 NMFS BiOp (National Marine Fisheries Service 2009a), the U.S. Fish and Wildlife Service (USFWS) BiOp (U.S. Fish and Wildlife Service 2008), NMFS and USFWS species recovery plans, primary literature, agency technical memoranda, and others. Common to many of these documents was the identification of major categories of stressors that negatively affect fish and aquatic species, ecological processes, and habitats within the watershed, including (1) water development and conveyance; (2) water quality, contaminants, and toxicity; (3) nonnative aquatic resources; (4) harvest and hatchery management; and (5) recreational and commercial activities.

11.1.5.1 Water Development and Conveyance

Current hydrodynamic conditions within the Delta act as ecosystem stressors by affecting species movement among habitats, limiting habitat availability and suitability, creating conditions favoring nonnative invasive species, and limiting food production. SWP and CVP exports have direct and indirect effects on fishes in the Delta. Specifically, exports entrain fish, alter hydrodynamics, and affect food webs. A full description of the export facilities is included in Chapter 5, *Water Supply.* A brief overview of the facilities is described below for reference.

The amount and timing of water exports from the Delta affects the level of entrainment. These hydrodynamic conditions affect water quantity and quality due to higher water velocities and reduced residence time, which alter various habitat types that are dependent upon natural flow patterns. In addition, the rate and location that water is diverted from the Delta affects the residence time of water in Delta channels that, in turn, affects primary and secondary production (California Department of Fish and Game 2008b).

Water Diversions

The SWP and CVP export facilities in the south Delta are the largest water diversions in the estuary. Additionally, a power plant in Pittsburg diverts water for its operations, and several diversions supply water to Contra Costa Water District, as well as to cities on the periphery of the Delta (California Department of Fish and Game 2008b). A detailed description of the SWP and CVP facilities is provided in Chapter 5, *Water Supply.*

The SWP and CVP use the Sacramento River and channels in the Delta to transport water from upstream tributaries and reservoirs to the SWP Harvey O. Banks Pumping Plant (Banks Pumping

Plant) and the CVP C. W. Jones Pumping Plant (Jones Pumping Plant) in the south Delta, as described in Chapter 5, Water Supply. Both pumping plants have associated fish collection facilities that are described below.

CVP and SWP Entrainment and Salvage Operations

Entrainment of Delta fish in water diversions has been an important focus for scientific investigation in the Delta and a key consideration for management of water operations and fish conservation. The south Delta SWP and CVP facilities are the largest water diversions in the Delta, and have been the subject of most scientific investigation and management actions relating to entrainment. In the past, these facilities have entrained large numbers of Delta fish species. Before fish reach the CVP and SWP facilities, there are other ways mortality occurs. Pre-screen mortality can occur in Old River when emigrating smolts from the San Joaquin River become diverted and drawn into the south Delta export facilities (Larry Walker Associates 2010). For example, between 1979 and 1993 up to 435,000 juvenile Chinook salmon and 56,000 delta smelt were salvaged annually at the SWP south Delta fish facility (Brown et al. 1996). The actual entrainment losses were likely an order of magnitude greater than measured salvage, due to predation in Clifton Court Forebay and the relatively low diversion efficiency of the louver fish exclusion system (the percentage of fish that are successfully directed to holding tanks and counted) (Brown et al. 1996; Castillo et al. 2012, Castillo et al. in review). Entrainment by agricultural diversions also occurs (Nobriga et al. 2004) but is not believed to be as substantial because of the small size of these intakes, although predation levels in the vicinity of the structures may be high (Vogel 2011).

In recent years, entrainment of pelagic species (e.g., delta smelt and longfin smelt) and other Delta fish from the south Delta facilities has been substantially reduced due to changes in export operations as well as declining abundance of some fish such as delta smelt (Kimmerer 2011).

Figure 11-1 compares total monthly and annual CVP and SWP salvage for several covered fish species (delta smelt, longfin smelt, Chinook salmon and splittail) from 1991 through 2010. Salvage is a variable proportion of entrainment, the actual proportion depending on louver efficiency, pre-screen loss levels, and many other factors, but is considered a reasonable index of total entrainment. Actual entrainment is always appreciably greater than salvage. Chinook salmon and delta smelt have a clear pattern of entrainment with peak salvage levels in 1999 and 2000 but a sharp decline in more recent years.

The monthly and annual salvage varies from year to year because of changes in pumping and changes in the density of fish (number of fish per unit volume of water) in the vicinity of the diversions. Splittail and longfin smelt have shown high levels of salvage in some years. For example, large numbers of larval and juvenile splittail are entrained at the south Delta facilities during wet years, when splittail abundance is high, compared to low entrainment levels in dry years. The increased entrainment during wet years is a result of increased availability of inundated floodplain habitat and greater recruitment of young splittail. Conversely, entrainment of longfin smelt can be higher in dry years because the distribution of longfin smelt shifts further upstream and closer to the south Delta facilities (Sommer et al. 2007). Salvage has a seasonal pattern as well, with salvage of all four species concentrated in March through May.

These graphs show that, as noted above, the number of fish salvaged at CVP and SWP in recent years is greatly reduced from previous levels. This presumably reflects reduced abundance of fish, various pumping restrictions, and the use of new management techniques for avoiding entrainment through the monitoring of turbidity events and management of OMR flows in the Central Delta. Nonetheless, entrainment remains a focus of regulatory concern because of its potential to affect fish populations. Thus, a key part of the EIR/EIS and BDCP Effects Analyses evaluates effects on entrainment.

Entrainment of fish does not necessarily mean they are killed. The fish salvage systems at the CVP Tracy Fish Facility and the SWP Skinner Fish Facility divert a portion of fish into a salvage system for collection and return to the Delta. These systems were designed primarily to salvage juvenile salmon and other fairly robust fish. Though delta smelt can survive the salvage process, they are more fragile and suffer greater mortality (Morinaka 2010). For the remainder of listed fish species, the proportion of fish killed by entrainment depends on factors such as predation and louver screening efficiency. Louver efficiency is 75% SWP and 47% at CVP (National Marine Fisheries Service 2009).

Because of the difficulty associated with estimating total population size of the Delta fish species, most analysts have estimated fish entrainment as a proportion of population indices assuming that this proportionality applies to the population as well. Kimmerer (2008) estimated the loss of larval and juveniles for the years 1995 to 2006 at between 0 and 26% of the larval and juvenile population and from 1 to 22% of the adult delta smelt population, giving a total population loss of 1–38% (Miller 2011). Miller (2011) reanalyzed and updated Kimmerer's analysis and concluded that a lower proportion of the delta smelt population (i.e., up to 15–30%) was lost to entrainment at the south Delta pumps than estimated by Kimmerer (2008). Kimmerer (2011) concurred with some points of Miller's reanalysis but also noted that the reduced proportions in recent years may reflect reduced abundance of delta smelt in the south Delta. While there is some uncertainty surrounding the proportion of the population that is lost to entrainment, both analyses indicate that appreciable proportions of the overall population of delta smelt may have been lost in some years.

The numbers and proportions of covered species such as delta smelt and listed Chinook salmon entrained in the south Delta pumps have been a consistent management concern, which has resulted in significant modification of regional water operations (U.S. Fish and Wildlife Service 2008; National Marine Fisheries Service 2009). Several recent analyses, have demonstrated some reason for concern related to entrainment loss of covered fish species.

- Mac Nally et al. (2010) found weak statistical evidence for a negative relationship between fall abundance of delta smelt and spring south Delta exports (i.e., larval/juvenile entrainment) or winter south Delta exports (i.e., adult entrainment).
- Thomson et al. (2010) found that winter exports had a high probability of inclusion in models explaining variation in delta smelt abundance but could not explain the step change in abundance during the Pelagic Organism Decline (POD) of the 2000s.
- Maunder and Deriso (2011) found some statistical support for a statistical model of factors affecting delta smelt that included estimates of adult entrainment, although as discussed in Appendix 5.G, *Fish Life Cycle Models* of the *BDCP Effects Analysis*, other competing models without adult entrainment included explain variations in delta smelt abundance more efficiently.
- Miller et al. (2012) found that survival of delta smelt from fall to summer was statistically negatively associated with total proportional entrainment of delta smelt (i.e., adults and larvae/juveniles from the next generation), although survival from fall to fall (i.e., the full life cycle) was not related to total entrainment.

- Newman and Brandes (2010) found that Chinook salmon smolts released in the interior Delta (Georgiana Slough) had relatively lower through-Delta survival than smolts released in the Sacramento River, and that the relative survival became lower as south Delta exports increased; a form of this relationship is included in the Delta Passage Model (Appendix 5.C, *Flows, Passage, Salinity, and Turbidity of the BDCP Effects Analysis*) and the Interactive Object-Oriented Simulation Model (IOS) winter-run Chinook salmon life cycle model (see Appendix 5.G, *Fish Life Cycle Models* of the *BDCP Effects Analysis*).
- The Oncorhynchus Bayesian Analysis (OBAN) salmon life cycle model (described in more detail in Appendix 5.G, *Fish Life Cycle Models* of the *BDCP Effects Analysis*) demonstrated a significant negative relationship between winter-run Chinook salmon through-Delta survival and south Delta exports.

Analyses and statistical models have also pointed to multiple stressors other than entrainment that could explain the recent population declines in delta smelt and other pelagic fish species (Baxter et al. 2010; Maunder and Deriso 2011).

The relative importance of entrainment and other attributes was evaluated by a group of regional scientists through a series of conceptual models published by the DRERIP[1]. The DRERIP models provide a conceptual view of the life history and habitat requirements of the species and a subjective ranking of stressors for the species. It is important to note that the DRERIP conceptual models generally were written prior to the 2008 and 2009 USFWS and NMFS BiOps (U.S. Fish and Wildlife Service 2008; National Marine Fisheries Service 2009a) and do not reflect the less negative flows in Old and Middle River or export reductions intended to reduce the effects of entrainment at the south Delta export facilities. The DRERIP model for delta smelt developed by Nobriga and Herbold (2009) ranked water exports (entrainment) and water transparency as the most important stressors on delta smelt at that time; food, competition and ecosystem effects also received high rankings. These rankings have not been updated to reflect the operational changes in pumping at the south Delta facilities. Williams (2010) discusses entrainment of juvenile Chinook salmon and steelhead at the pumps as being difficult to assess. While total numbers of salmonids are counted at salvage, it is unknown how many are lost to predation near the pumps or that bypass the collection facilities. Use of tagged hatchery fish to estimate survival versus naturally produced fish may also affect results because hatchery fish may suffer higher mortality rates than natural fish. There also may be an “indirect” mortality associated with modified circulation patterns or other conditions related to the pumps.

The DRERIP rankings as well as the quantitative analyses such as those of Kimmerer (2008, 2011) and Miller (2011), while reflecting different assumptions and approaches, converge on a conclusion that entrainment of large numbers of covered fish species has occurred in the past during periods of high water exports from the CVP and SWP facilities. The importance of entrainment to short- and long-term population dynamics of delta smelt is not yet clear. It is also noted that the number of fish entrained has declined in recent years, which could be a result of decreasing populations as well as improved water operations management. Because entrainment is a function of water exports, it will continue to receive close scrutiny and a focus of efforts to reduce impacts of water operations on fish.

[1] <http://www.dfg.ca.gov/ERP/conceptual_models.asp>.

In-Delta Agricultural Diversions

Approximately 2,200 water diversions are located in the Delta (Herren and Kawasaki 2001; U.S. Bureau of Reclamation 2008a; Bay Delta Conservation Plan 2008). Chapter 14, *Agricultural Resources*, describes agricultural diversion locations and operations in detail. The majority of the diversions divert water to agricultural fields between April and August, depending on the crop. The early part of this irrigation season coincides with the presence of juveniles of all nine covered fish species in the Delta (Bay Delta Conservation Plan 2008).

Entrainment by agricultural diversions is not frequently identified as a factor in the decline of Delta fisheries resources (e.g., delta smelt) (Bureau of Reclamation 2008a). However, Herren and Kawasaki (2001) report that over 95% of these small water diversions are not screened to reduce fish entrainment. These diversions are often located in small channels, potentially increasing the influence of the diversion on the channel relative to channel capacity. Hence, the potential for substantial entrainment of fish is high (Hallock and Van Woert 1959).

The shoreline location and timing of most agricultural diversions also may contribute to effects on Delta fisheries resources. Delta smelt spawning is thought to occur in shallow and shoreline waters from February through June, although spawning locations vary depending on hydrological conditions and temperature (Bennett 2005). Agricultural diversions are mostly active from late spring through fall when water is needed for spring and summer crops (Brown 1982), which overlaps with the spring spawning cycle of delta smelt and the subsequent appearance of yolk-sac larvae and larval delta smelt. These early life stages possess limited motility and are located in the shallow and shoreline waters in which they hatched (Bureau of Reclamation 2008a).

Because spawning and larval development are likely to occur in shallow shoreline locations and movement is limited, entrainment of these life stages by agricultural diversions may be more substantial (Bureau of Reclamation 2008a). To date, entrainment by agricultural in-Delta diversions has been evaluated in several studies. Cook and Buffaloe (1998 as cited in Nobriga et al. 2004) found that a large diversity of fish species can be entrained by small agricultural diversions in the Delta, especially YOY fish present from May through August. Limited studies conducted by Nobriga et al. (2004) indicate that self-cleaning screens have been at least 99% effective in reducing fish entrainment at non-project diversions, even for larval fishes less than 25 mm (about 1 inch). However, there is evidence that unscreened diversions entrain large numbers of nonnative species (Brown 1982; Nobriga et al. 2004). Therefore, screening diversions could be more beneficial to nonnative fish species than native fish species, potentially increasing competition with and predation by nonnatives on natives.

In-Delta Power Plant Diversions

Although the old Contra Costa County Power Plant at Antioch has recently closed, the Pittsburg Power Plant continues to operate using river water diversions for once-through cooling systems in the Delta. A detailed description of the in-Delta power plant locations and operations is provided in Chapter 20, *Public Services and Utilities*. Once-through cooled electrical generating plants in the Delta can impinge and entrain fish and aquatic organisms, including pelagic organisms and threatened and endangered species. These plants also could have other effects related to thermal discharges. Over time, these power plants have reduced their operations and currently only operate at the direction of the California Independent System Operator when additional power is needed to avoid power outages, primarily during the summer when Delta fisheries concerns are reduced.

Recently, the capacity utilization rates for these plants have been between 5 and 10% (State Water Resources Control Board et al. 2008).

The assessment and reduction of entrainment at the Contra Costa (intake no longer active) and Pittsburg Power Plants were identified as a measure to reduce impacts on pelagic organisms in the Delta (California Department of Water Resources and California Department of Fish and Game 2007). Mirant Delta LLC (Mirant) is currently working with CDFW to obtain an updated incidental take permit pursuant to CESA, a process that will require additional monitoring and evaluation of species entrainment and identification of avoidance and mitigation measures necessary to address the level of take. In addition, Mirant is participating in the BDCP in an effort to address the impacts of operations of their facilities. Establishment of updated requirements to ensure the protection of fish at power plant diversions has been identified as an element of the State Water Board's 2008 Strategic Workplan (State Water Resources Control Board et al. 2008).

In the 1950s, CDFW estimated that as many as 19 million small striped bass might pass through and be killed at the Contra Costa Power Plant each year between April and mid-August (Matica and Sommer 2005). In 1979, the total average annual entrainment of smelt species, Sacramento splittail, and salmon was estimated to be 86 million, 345,000, and 24,000, respectively. The total average annual impingement for smelt, Sacramento splittail, and salmon was estimated to be 178,000, 21,000, and 2,600, respectively (Matica and Sommer 2005). It is unclear whether these numbers are relevant to current entrainment trends, because populations of smelt are highly variable and power plant operations have been reduced such that the plants operate only to meet peak power needs (Matica and Sommer 2005).

A total of 331 fishes comprised of nine species and one taxon group were collected during entrainment sampling at the Contra Costa Power Plant Units 6 and 7 intakes from March 7, 2008, through July 8, 2008 (Mirant 2009). Six species and one taxon group comprised 99% of all fish collected at that intake. Prickly sculpin was the most abundant fish species (49%), followed by striped bass (16%), Pacific herring (13%), unidentified gobies (12%), threadfin shad (5%), delta smelt (4%), and longfin smelt (1%) (Mirant 2009). The old Contra Costa Power Plant was replaced by an new plant that uses water cools with water provided by the Antioch and Delta Diablo Sanitation District for cooling, thereby avoiding the entrainment of fish.

A total of 539 fish comprised of eight species and one taxon group were collected during entrainment sampling at the Pittsburg Power Plant from March 7, 2008, through July 8, 2008. Almost all of these fish (92.2%) were Pacific herring. Three other species and 1 taxon group comprised another 6.7% of fish collected: gobies (2.8%), prickly sculpin (2.6%), longfin smelt (0.7%), and delta smelt (0.6%) (Mirant 2009).

Refuges and Hunting Reserves

Refuges, wildlife preserves, and hunting reserves along the Sacramento River and in the Delta and Suisun Marsh (see Chapter 12, *Terrestrial Biological Resources*; Chapter 13, *Land Use*; and Chapter 15, *Recreation*) provide habitat for resident and migratory waterfowl, threatened and endangered species, and wetland-dependent aquatic biota. Water supplies for certain wildlife refuges in the Central Valley are administered through Central Valley Project Improvement Act (CVPIA) programs that acquire and convey water. Reclamation has obligations under the CVPIA to provide Incremental Level 4 refuge water supply, and water for some of these areas is acquired through water supply contracts with "willing sellers."

Suisun Marsh Facilities

Several facilities have been constructed by DWR and Reclamation to provide lower-salinity water to managed wetlands in the Suisun Marsh. The Suisun Marsh facilities, including the Roaring River Distribution System, Morrow Island Distribution System, and Goodyear Slough Outfall, were constructed in 1979 and 1980. The Suisun Marsh Salinity Control Gates were installed and became operational in 1988. Other facilities constructed under the Suisun Marsh Preservation Agreement include the Cygnus Drain and the Lower Joice Island Diversion. Refer to Chapter 5, *Water Supply*, for further descriptions of the facilities and their operations. Suisun Marsh facilities with the potential to entrain fish and aquatic resources are described below.

Roaring River Distribution System

The intake to the Roaring River Distribution System is screened to prevent entrainment of fish larger than approximately 25 mm (approximately 1 inch). DWR designed and installed the screens using CDFW criteria. Each screen is a stationary vertical screen, constructed of continuous-slot stainless steel wedge wire. All screens have 3/32-inch slot openings. After the listing of delta smelt, Roaring River Distribution System diversion rates have been controlled to maintain an average approach velocity below 0.2 ft./sec at the intake fish screen. Initially, the intake culverts were held at about 20% capacity to meet the velocity criterion at high tide (Bureau of Reclamation 2008a).

Morrow Island Distribution System

The Morrow Island Distribution System is used year-round, but most intensively from September through June. When managed wetlands are filling and circulating, water is tidally diverted from Goodyear Slough just south of Pierce Harbor through three 48-inch culverts. Drainage water from Morrow Island is discharged into Grizzly Bay by way of the C-Line Outfall (two 36-inch culverts) and into the mouth of Suisun Slough by way of the M-Line Outfall (three 48-inch culverts) rather than back into Goodyear Slough (Bureau of Reclamation 2008a).

The 1997 USFWS BiOp issued for dredging of the facility included a requirement for screening the diversion to protect delta smelt (Bureau of Reclamation 2008a). Due to the high cost of fish screens and the lack of certainty surrounding their effectiveness at the Morrow Island Distribution System, DWR and Reclamation proposed to investigate fish entrainment at the intake and to evaluate whether screening the diversion would provide substantial benefits to local populations of listed fish species. DWR staff monitored fish entrainment from September 2004 to June 2006 at the Morrow Island Distribution System in Suisun Marsh to evaluate entrainment losses at the facility. Monitoring took place over several months under various operational configurations to provide data on the site-specific impact of the diversion, with a focus on delta smelt and salmonids. Over 20 different species were identified during the sampling, yet only two fall-run-sized Chinook salmon (South Intake 2006) and no delta smelt from entrained water were caught (Bureau of Reclamation 2008a). Two species that associate with instream structures, threespine stickleback and prickly sculpin, comprised most of the entrained fish (Bureau of Reclamation 2008a).

Goodyear Slough Outfall

The Goodyear Slough Outfall was constructed to increase circulation and reduce salinity in Goodyear Slough by draining water from the southern end of the slough into Suisun Bay. The system also provides lower-salinity water to the wetland managers who flood their ponds with Goodyear Slough water. The system is open for free fish movement except very near the outfall when flap gates are closed during flood tides. Any fish moving from Goodyear Slough into the outfall would end up in Suisun Bay (Bureau of Reclamation 2008a).

Lower Joice Island Unit

The Lower Joice Island Unit consists of two 36-inch-diameter intake culverts on Montezuma Slough near Hunter Cut and two 36-inch-diameter culverts on Suisun Slough, also near Hunter Cut. The culverts were installed in 1991. The facilities include combination slide/flap gates on the slough side and flap gates on the landward side. In 1997, DWR contracted with the Suisun Resource Conservation District to construct a conical fish screen on the diversion on Montezuma Slough. Installation of the Lower Joice Island Fish Screen allows for year-round management of wetlands inside the island's perimeter levee (U.S. Fish and Wildlife Service 2000b).

Cygnus Unit

The Cygnus Unit is a 36-inch drain gate with flashboard riser that was installed in 1991 on a private parcel located west of Suisun Slough, and adjacent and south of Wells Slough. The property owner is responsible for operation and maintenance of the gate (California Department of Water Resources 2000).

11.1.5.2 Hydrograph and Hydrodynamic Alterations

This section describes the effects of hydrograph alterations in the Delta aquatic ecosystem resulting from water diversions, integrated SWP and CVP operations, and development in the watersheds upstream of the Delta. The various hydrodynamic influences affecting regions of the Delta may fluctuate (see Chapter 6, *Surface Water*). However, in general, the following conditions apply: (1) the west Delta is dominated by strong tidal inflows, which frequently result in reverse flows; (2) the north Delta is more influenced by inflows from the Sacramento and Mokelumne Rivers; (3) the south Delta is primarily affected by export pumping and inflows from the San Joaquin River; and (4) the central Delta is affected by a combination of these factors (refer to Chapter 6, *Surface Water*, for further discussion of Delta hydrodynamics). A detailed description of SWP and CVP operations and the effects of water development and conveyance on hydrodynamics is presented in Chapter 5, *Water Supply*.

Delta Inflow

Total Delta inflow includes the sum of Yolo Bypass, Sacramento River, Mokelumne River, Calaveras River, Cosumnes River, and San Joaquin River outflows (Bureau of Reclamation 2008a). The Sacramento River (including the Yolo Bypass) contributes about 77 to 85% of the freshwater inflows to the Delta, while the San Joaquin River contributes about 10 to 15%. The minor contribution of flows from the Mokelumne, Cosumnes, and Calaveras Rivers, which enter into the eastern side of the Delta, contribute most of the remainder of the Delta inflow. The highest Delta inflows occur from January through April due to floodflows (Bureau of Reclamation 2008a). Detailed discussion of SWP and CVP operations and natural hydrology effects on Delta inflow are described in Chapter 6, *Surface Water*.

Delta Outflow

Delta outflow is the primary driver of the salinity gradient in Suisun Bay. Delta outflow controls, in balance with upstream salinity intrusion from the Bay, the location of the LSZ (Kimmerer 2004;

Kimmerer et al. 2009; U.S. Fish and Wildlife Service 2008; National Marine Fisheries Service 2009a). Delta outflows also affect downstream transport of some species of larval fish and other aquatic organisms, as well as nutrients and food supplies into the lower reaches of the Delta and Suisun Bay. As previously discussed under *Pelagic Habitat Areas*, the abundance of many species inhabiting the Delta is related to water flow timing and quantity and salinity (California Department of Fish and Game 2010b).

Nearly 20% of the total mean Sacramento River outflow occurs between April and June under current SWP and CVP operations, compared to nearly 50% of the total mean outflow occurring between April and June during the later portion of the nineteenth century, before the two projects existed (The Bay Institute 1998; National Marine Fisheries Service 2009a). In all water-year types (wet, average, dry) the Sacramento River and its tributaries represent the largest flow into the Delta, followed by the San Joaquin River and then the eastside tributaries such as the Mokelumne and Cosumnes rivers. Delta outflow varies by water year type. For example, in the above normal 2000 water year more than 70% of water entering the Delta passed through the system as outflow (Governor's Delta Blue Ribbon Task Force 2008). In the dry 2001 and wet 1998 water year about 54% and 90%, respectively, of the water entering the Delta was outflow (Governor's Delta Blue Ribbon Task Force 2008).

Delta outflow targets have been developed to protect delta smelt and longfin smelt (U.S. Fish and Wildlife Service 2008; California Department of Fish and Game 2009). To improve delta smelt habitat, the 2008 USFWS Biological Opinion on the Coordinated Long-term Operation of the CVP and SWP (2008 USFWS BiOp sets forth targets for managing the location of X2 through increasing Delta outflow during fall when the preceding water year was wetter than normal (U.S. Fish and Wildlife Service 2008). Subject to adaptive management, USFWS (2008a) prescribes that sufficient Delta outflow be provided to maintain average location of X2 for September and October no greater (more eastward) than 74 km (about 46 miles) in the fall following wet years and 81 km (about 50 miles) in the fall following above-normal years. The monthly average X2 must be maintained at or seaward of these values for each individual month and not averaged over the 2-month period. In November, the inflow to SWP and CVP reservoirs in the Sacramento River Basin will be added to reservoir releases to provide an added increment of Delta inflow and to augment Delta outflow up to the fall target (U.S. Fish and Wildlife Service 2008). This action is to be implemented between September 1 and November 30 (U.S. Fish and Wildlife Service 2008). On-going litigation affected X2 implementation in 2011. In 2011, the District Court enjoined Reclamation and DWR from implementing Fall X2 at 74km but set the action at no more west than 79 km.

Old and Middle River Flows

Old and Middle Rivers are two major southern Delta channels that are pathways for export water moving toward the SWP and CVP pumps in the south Delta. In general, water is conveyed to Banks Pumping Plant and Jones Pumping Plant via the Old and Middle River channels, resulting in a net (over a tidal cycle or tidal cycles) flow toward the pumping plants (U.S. Fish and Wildlife Service 2008). When combined water export exceeds San Joaquin River inflows, the additional water is drawn from the Sacramento River through the DCC, Georgiana Slough, and Threemile Slough (U.S. Fish and Wildlife Service 2008). At high pumping rates, net San Joaquin River flow is toward Banks and Jones pumping plants (Arthur et al. 1996). Combined flow in the Old and Middle Rivers is measured as "OMR" flows, while flow in the San Joaquin River at Jersey Island is calculated as "Qwest." Flow toward the pumps is characterized as negative flow for both measurements. Further, OMR flow toward the pumps is increased seasonally by installation of the South Delta Temporary Barriers Project (TBP) (U.S. Fish and Wildlife Service 2008).

Decreasing net upstream flows may reduce the chances of migrating juvenile salmonids moving up lower Old River toward the SWP and CVP diversions. The same is true if the net flows are completely downstream. Old and Middle River flows that were negative, which were greater than -2,000 cfs ± 500 cfs, effectively prevented entrainment of delta smelt that were north of the sampling stations in Old and Middle Rivers (Bureau of Reclamation 2008a). A linear relationship between delta smelt salvage and flow exists at flows greater than -4,000 cfs (more seaward flow) (Bureau of Reclamation 2008a) (see delta smelt section under Section 11.1.3, *Fish Species Evaluated*). At flows less than -4,000 cfs (more landward flow) the salvage rate for delta smelt begins to take on an exponential characteristic. Based on particle tracking modeling, the Delta Smelt Working Group concluded that net river flows greater than -2,000 ± 500 cfs in Old and Middle Rivers reduced the zone of entrainment so that particles injected into the central Delta at Potato Slough would not be entrained toward the pumps (Kimmerer and Nobriga 2008*;* U.S. Bureau of Reclamation 2008a). NMFS (2009a) considered this information useful in analyzing the potential "zone of effects" for entraining emigrating juvenile and smolting salmonids. A similar pattern is observed in juvenile salmon and smolt salvage analyses conducted by DWR (National Marine Fisheries Service 2009a). Loss of older juveniles at the SWP and CVP fish collection facilities increases sharply at Old and Middle River flows of approximately -5,000 cfs and departs from the initial slope at flows below this. Using the proposed operational scenario in the Biological Assessment (Reclamation 2008) and given the data derived from Reclamation (2008), flows in Old and Middle Rivers are consistently greater than the -2,000 ± 500 cfs threshold for entrainment (i.e., more upstream flow) (National Marine Fisheries Service 2009a). Assuming that, in the normal (natural) flow patterns in the Delta, juvenile and smolting Chinook salmon and steelhead will use flow as a cue in their movements and will orient to the ambient flow conditions prevailing in the Delta waterways, then upstream flows will direct fish toward the pumps during current operations (National Marine Fisheries Service 2009a), when the Old and Middle Rivers flows are more negative than -2,000 cfs.

During wet, above-normal, and critically dry water-year types, the greatest level of negative net flows in Old and Middle Rivers are seen during the months of December, January, and July (National Marine Fisheries Service 2009a). The months of December and January coincide with the occurrence of juvenile winter-run and yearling spring-run Chinook salmon into the north Delta from the Sacramento River (National Marine Fisheries Service 2009a). NMFS (2009a) believes that these elevated levels of net negative flow present a risk to emigrating fish that have entered the central Delta through Georgiana Slough or, when the DCC gates are open, through the Mokelumne River system. In below-normal and dry water-year types, the Old and Middle River flows have high levels of net negative flow from December through March and again in June and July; this overlaps with a significant proportion of the salmonid emigration period through the Delta in the spring, particularly for winter-run Chinook salmon and Central Valley steelhead (National Marine Fisheries Service 2009a).

Old and Middle River Flow Targets

To protect pre-spawning adult delta smelt from entrainment during the initial high flows of the wet season (first flush), and to provide advantageous hydrodynamic conditions early in the migration period, the 2008 USFWS BiOp (U.S. Fish and Wildlife Service 2008) stipulates an average daily OMR flow of no more negative than -2,000 cfs for a total duration of 14 days, with a 5-day running average of no more negative than -2,500 cfs (within 25%) (i.e., Action 1). The cue for when this action is triggered depends on the date, as summarized below.

- ***December 1 to December 20*** – Based on an examination of turbidity data from Prisoner's Point, Holland Cut, and Victoria Canal; salvage data from the SWP and CVP; and other parameters important to the protection of delta smelt including, but not limited to, preceding conditions of X2, Fall Midwater Trawl, and river flows, the Smelt Working Group (SWG) may recommend a start date to USFWS (U.S. Fish and Wildlife Service 2008).
- ***After December 20*** – The action will begin if the 3-day average turbidity at Prisoner's Point, Holland Cut, and Victoria Canal exceeds 12 nephelometric turbidity units (NTUs). However, the SWG can recommend a delayed start or interruption based on other conditions, such as Delta inflow, that may affect vulnerability to entrainment (U.S. Fish and Wildlife Service 2008).

Subsequent to implementation of Action 1 (above), Action 2 is then implemented using an adaptive process to tailor protection to changing environmental conditions. As in Action 1, the intent of Action 2 is to protect pre-spawning adults from entrainment and, to the extent possible, from adverse hydrodynamic conditions (U.S. Fish and Wildlife Service 2008). Action 2 prescribes that the range of net daily OMR flows will be no more negative than -1,250 cfs to -5,000 cfs. Depending on extant conditions (and the general guidelines below), specific OMR flows within this range are recommended by the SWG from the onset of Action 2 through its termination. The OMR flow requirements do not apply whenever a three-day flow average is greater than or equal to 90,000 cfs in the Sacramento River at Rio Vista and 10,000 cfs in the San Joaquin River at Vernalis (U.S. Fish and Wildlife Service 2008). Once such flows have abated, the OMR flow requirements of Action 2 take effect (U.S. Fish and Wildlife Service 2008).

The window for triggering Action 1 and Action 2 concludes when either of the following conditions is met: (1) water temperature reaches 53.6°F (12°C) based on a three-station daily mean at Mossdale, Antioch, and Rio Vista; or (2) delta smelt spawning begins (presence of spent females in the Spring Kodiak Trawl spawning survey or observed in salvage at Banks or Jones pumping plant) (U.S. Fish and Wildlife Service 2008).

To minimize the number of larval delta smelt entrained at the facilities, once spawning is believed to have initiated (as determined by the two offramp conditions under Actions 1 and 2, above), net daily OMR flow will be no more negative than -1,250 cfs to -5,000 cfs based on a 14-day running average, with a simultaneous 5-day running average within 25% of the applicable requirement for OMR (U.S. Fish and Wildlife Service 2008). Offramp conditions for Action 3 include: (1) June 30; or (2) when water temperature reaches a daily average of 77ºF (25ºC) for three consecutive days at CCF (U.S. Fish and Wildlife Service 2008).

The 2009 NMFS BiOp also prescribes actions related to Old and Middle River flows and exports from January 1 through June 15 to protect anadromous salmonids, which limits negative flows to -2,500 cfs to -5,000 cfs in Old and Middle Rivers, depending on the presence of salmonids (National Marine Fisheries Service 2009a). Reverse flows are managed to reduce flows toward the pumps during periods of increased salmonid presence. The negative flow objective within the range will be determined based on a decision process, as described in National Marine Fisheries Service (2012a). On-going litigation modified implementation of these actions in 2012. In 2012, OMR flow conditions were set at -2,500 cfs for April 8–14, 2012 and -3,500 cfs April 15–30, 2012 (National Marine Fisheries Service 2012a).

11.1.5.3 Migration Barriers

Migration barriers or impediments may be caused by physical structures, inadequate attraction flows, adverse water quality conditions, delayed flooding of marshlands, or other factors. Barriers or impediments to movement of migrating fish species in the Delta may affect their physical condition (e.g., mechanical injury), physiological condition (e.g., spawning readiness and smolting), and/or survival (e.g., predation risk). In addition, barriers or impediments can result in straying of anadromous fish species (i.e., returning to non-natal streams).

Migration barriers and impediments to fish species within the Delta include the DCC, the Sacramento River Deep Water Ship Channel (SRDWSC), and the Stockton Deep Water Ship Channel (SDWSC). Additional passage barriers include structures located in Delta waterways, discussed below.

Delta Cross Channel Operations

The DCC diverts Sacramento River water into Snodgrass Slough and the Mokelumne River (when the DCC gates are open), where the water then flows through natural channels within the Central Delta until it reaches the SWP and CVP pumping plants, about 50 miles away (CALFED Bay-Delta Program 2001). A detailed discussion of DCC operations is provided in Chapter 5, *Water Supply*. As noted there, the DCC operation (open) improves water quality in the Central Delta by improving circulation patterns of good quality water from the Sacramento River and reducing salt water intrusion in the western Delta). The enhanced stability of the freshwater pool in the Delta has enabled nonnative species, such as centrarchids and catfish, as well as invasive plants, such as Brazilian waterweed *Egeria* and water hyacinth, to thrive (Brown and Michniuk 2007; National Marine Fisheries Service 2009a; Hestir 2010).

While the DCC improves water quality, the modification in water flows creates false attraction (attraction during adult immigration to non-natal rivers) to fish species such as Chinook salmon drawing these species into the lower San Joaquin River (National Marine Fisheries Service 2009a). Adult Chinook salmon that enter this area of the Delta are delayed in their upstream migration while they search for the distinctive olfactory (scent) migration cues of the Sacramento River in the lower San Joaquin River (National Marine Fisheries Service 2009a).

Fish such as juvenile salmonids that are in the central Delta generally have lower survival rates than fish that continue migrating downstream in the Sacramento River toward the west Delta. Recent studies appear to support the conclusion that closing the DCC gates will improve the survival of juvenile salmonids originating from the Sacramento River and migrating through the Delta (Bureau of Reclamation 2008a). Specifically, a recent particle tracking study (Kimmerer and Nobriga 2008) shows that DCC gate closure results in substantial increases in the proportion of Sacramento River water flowing into Georgiana Slough, Threemile Slough, and at the confluence of the Sacramento and San Joaquin Rivers, resulting in an overall similar proportion of flow diverted to the central Delta. This suggests that DCC gate closure may have less influence on the potential for central Delta fish mortality than previously thought (Bureau of Reclamation 2008a).

Studies for 2006–2007 by Perry and Skalski (2008 as cited in National Marine Fisheries Service 2009a) indicate that by closing the DCC gates when fish are present, total through-Delta survival of marked fish to Chipps Island increases by nearly 50% for fish moving downstream in the Sacramento River system. For 2007–2008 Perry and Skalski (2009) also found that fish survival in the interior Delta was lower than in the Sacramento River. However, closure of the DCC gates and the reduced flow did not result in a proportional reduction of salmon entry into the interior Delta. They found that a 30% reduction in DCC flow only resulted in a 15% entry reduction because more fish entered through the natural Georgiana Slough channel. The chance of fish entry into Georgiana Slough actually increased with the DCC gates closed, during that evaluation.

Perry et al. (2012) address migration routes and survival through the system in 2009-2010, which experienced higher flows than previous years in the study (see previous paragraph). They report lower survival rates for interior Delta migration compared to the Sacramento River migration route. The DCC gates were closed for all but one of their studied release groups.

The 2009 NMFS BiOp prescribes additional monitoring and alerts to trigger changes in DCC operations in order to reduce loss of emigrating salmonids and green sturgeon (National Marine Fisheries Service 2009a). Monitoring of salmonids and green sturgeon will be conducted in the Delta and upstream areas. Information collected from the monitoring programs will be used to make real-time decisions regarding DCC gate operation and export pumping (National Marine Fisheries Service 2009a).

The 2009 NMFS BiOp also prescribes modifications to DCC gate operations to reduce direct and indirect mortality of emigrating juvenile salmonids and green sturgeon (National Marine Fisheries Service 2009a). Between November 1 and June 15, DCC gate operations will be modified to reduce loss of emigrating salmonids and green sturgeon. The operating criteria provide for longer periods of gate closures during the emigration season to reduce direct and indirect mortality of yearling anadromous salmonids (National Marine Fisheries Service 2009a). From December 1 to January 31, the gates will remain closed, except as operations are allowed using the implementation procedures/modified Salmon Decision Tree, as described in NMFS (2009a).

Stockton Deep Water Ship Channel

The SDWSC has been identified as an impaired waterway because of low DO concentrations during late summer and early fall. The combination of low flows, high loads of oxygen-demanding substances (e.g., wastewater effluent), and channel geometry contribute to low DO levels (National Marine Fisheries Service 2009a). The State Water Resources Control Board (State Water Board) has established DO objectives of 6.0 milligrams per liter (mg/L) in the San Joaquin River between Turner Cut and Stockton from September 1 through November 30, and 5 mg/L during the remainder of the year, for the protection of aquatic life (Central Valley Regional Water Quality Control Board 2007). A detailed description of the SDWSC and low DO concentrations is provided in Chapter 6, *Surface Water*. The low DO area in the ship channel can act as a barrier, impediment, or source of mortality to upstream and downstream migrating San Joaquin River anadromous salmonids and other fish species.

Low DO levels are frequently observed in the portion of the SDWSC extending from Channel Point, downstream to Turner and Columbia Cuts (National Marine Fisheries Service 2009a). Over a 5-year period, starting in August 2000, a DO meter has recorded channel DO levels at Rough and Ready Island (Dock 20 of the West Complex). During this time period, there were 297 days in which the DO was below 5 mg/L in the San Joaquin River between Channel Point and Turner and Columbia Cuts during the September-through-May migratory period for salmonids (National Marine Fisheries Service 2009a). DWR's California Data Exchange Center data indicate that DO depressions occur during all migratory months, with substantial events occurring from November through March when Central Valley steelhead adults and smolts would be using this portion of the San Joaquin River as a migratory corridor (National Marine Fisheries Service 2009a).

Potential factors that contribute to these DO depressions are reduced river flows through the ship channel, released ammonia from the City of Stockton Regional Wastewater Control Facility, upstream contributions of organic materials (e.g., algal loads, nutrients, and agricultural discharges) and the increased volume of water in the dredged ship channel (National Marine Fisheries Service 2009a). During the winter and early spring emigration period, increased ammonia concentrations in the discharges from the City of Stockton Regional Wastewater Control Facility lower the DO in the adjacent SDWSC near the West Complex (National Marine Fisheries Service 2009a). In addition to the negative effects of the lowered DO on salmonid physiology, ammonia is in itself toxic to salmonids at low concentrations. Likewise, adult fish migrating upstream will encounter lowered DO in the SDWSC as they move upstream in fall and early winter due to low flows and excessive algal and nutrient loads coming downstream from the upper San Joaquin River watershed (National Marine Fisheries Service 2009a). Hallock et al. (1970) reported that levels of DO below 5 mg/L delay or block adult fall-run Chinook salmon upstream migration.

To address low DO levels in the SDWSC, DWR initiated the SDWSC Aeration Facility Program to assess DO aeration techniques. The program comprises a full-scale aeration system (California Department of Water Resources 2009a). The system has been sized to deliver approximately 10,000 pounds of oxygen per day into the SDWSC (California Department of Water Resources 2009a). The aeration system is anticipated to only be operated when SDWSC DO levels are below the Basin Plan (Central Valley Regional Water Quality Control Board 2007) DO water quality objectives (approximately 100 days per year). The program includes an ongoing assessment of DO levels in the SDWSC and vicinity (California Department of Water Resources 2009a).

Sacramento River Deep Water Ship Channel

A set of locks at the end of the SRDWSC, at the connection with the Sacramento River blocks the migration of all fish from the channel back to the Sacramento River (Bureau of Reclamation 2008a).

South Delta Temporary Barriers Project

The South Delta TBP consists of installation and removal of temporary rock barriers across several South Delta channels at the following locations: (1) Middle River near Victoria Canal; (2) Old River near Tracy; (3) Grant Line Canal near Tracy Boulevard Bridge; and (4) the head of Old River at the confluence of Old River and the San Joaquin River.

In various combinations, these barriers are intended to improve water levels and San Joaquin River salmon migration in the south Delta (U.S. Fish and Wildlife Service 2008). The barriers on Middle River, Old River near Tracy, and Grant Line Canal are flow control facilities designed to improve water levels for agricultural diversions and are in place during the growing season. During spring, the barrier at the head of Old River is intended to reduce the number of outmigrating salmon smolts entering Old River. During fall, this barrier is intended to improve flow and increase DO concentrations in the San Joaquin River near Stockton during the immigration period of adult fall-run Chinook salmon. As required under the 2008 USFWS BiOp, DWR will install the head of Old River barrier in the spring only if USFWS determines that delta smelt entrainment is not a concern (U.S. Fish and Wildlife Service 2008). The installation and operation of the South Delta TBP will continue until permanent gates are constructed (i.e., approximately 2012) (U.S. Fish and Wildlife Service 2008). As the permanent gates are being constructed, temporary barrier operations will continue as planned and permitted (U.S. Fish and Wildlife Service 2008).

NMFS (2009a) determined that the South Delta TBP would likely result in the following effects.

- Changes to flow patterns in the south Delta, increasing the potential for migration delays in conjunction with the barriers placement.
- Hydraulic conditions that will impede free passage of fish through the channels of the south Delta.
- Entrainment of a proportion of the fish that remain in the mainstem of the San Joaquin River into the channels leading southward under the influence of the SWP and CVP water diversion pumps.
- Increased risk of predation on juvenile salmonids and green sturgeon.
- Impacts on the functioning of the south Delta waterways as critical habitat for steelhead and green sturgeon by negatively impacting the value of the channels for migration and rearing (National Marine Fisheries Service 2009a).

South Delta Improvements Program

The objectives of the South Delta Improvements Program (SDIP) are to: (1) reduce the movement of outmigrating salmon from the San Joaquin River into Old River; (2) maintain adequate water levels and circulation in south Delta channels; and (3) increase water delivery and reliability to the SWP and CVP by increasing the diversion limit at CCF to 8,500 cfs (Bureau of Reclamation 2008a). A two-staged implementation approach is being followed for the SDIP.

- Stage 1 involves the construction and operation of gates at four locations in the South Delta channels and will address the first two objectives of the program. Proposed operation of the SDIP gates is described in detail in Chapter 5, *Water Supply*.
- Stage 2, if implemented, would address the objective of increasing the water delivery reliability of the SWP and CVP by increasing the diversion limit at CCF; however, this decision has been deferred indefinitely (Bureau of Reclamation 2008a; U.S. Fish and Wildlife Service 2008).

Stage 1 of the SDIP involves the placement of four permanent gates in the channels of the South Delta already affected by the temporary rock barriers installed under the South Delta TBP. NMFS expects that the operation of the permanent gates proposed for the SDIP will have many of the same effects as the South Delta TBP in regards to changes in the regional hydrodynamics and the increase in predation levels associated with the physical structures and near-field flow aspects of the barriers, as described below (National Marine Fisheries Service 2009a).

Stage 1 of the SDIP four gates TBP will require that any fish entering the South Delta will have to negotiate at least two gates to move through the system (National Marine Fisheries Service 2009a). The physical structures of the gates will create a point where predation pressure is increased and which migrating fish must negotiate to complete their downstream journey if they enter the South Delta channels (National Marine Fisheries Service 2009a). The barriers will also create predator habitat within the channels of the south Delta. The environmental stressors created by the implementation of the SDIP will add to the existing stressors present in the San Joaquin River Basin (National Marine Fisheries Service 2009a). NMFS (2009a) required that DWR halt implementation of the SDIP, and indicated that consultation for the SDIP cannot be reinitiated until after three years of fish predation studies at the temporary barrier are completed.

For further description of the potential effects on anadromous salmonids and green sturgeon from implementation of the SDIP, refer to NMFS (2009a). The final year of monitoring was to be completed in 2012, although the program is currently deterred indefinitely as a result of the POD in the Delta). Subsequent evaluation will determine the extent to which the program would be implemented.

Head of Old River Fish Control Gate

The original purpose of the Head of Old River Fish Control Gate was to benefit fall/late fall-run Chinook salmon by reducing the movement of salmon into the south Delta channels via the Old River. However, its effectiveness in preventing the salmon moving into the south Delta channels has not been verified.

Spring operation (closing) of the Head of Old River Fish Control Gate is regulated at the discretion of the fish and wildlife agencies and dependent on San Joaquin River flows. The gate can close as early as April 1 and continue through June 15, within the goal of protecting outmigrating salmon and steelhead. When the spring operation is completed, the gate would be operated in the fall to improve flow in the San Joaquin River (September and continues through December 7), thus helping to avoid historically present low DO conditions in the lower San Joaquin River near Stockton (Bureau of Reclamation 2008a). During this period, partial operation of the gate (partial closure to restrict flows from the San Joaquin River into Old River to approximately 500 cfs) may also be warranted to protect water quality in the south Delta channels. Generally, water quality in the south Delta channels is acceptable through June (Bureau of Reclamation 2008a). As discussed above, implementation of the SDIP, including the Head of Old River Fish Control Gate, may further increase stressors (e.g., passage impediments, predation) to fishes in the San Joaquin River and south Delta (National Marine Fisheries Service 2009a). A National Marine Fisheries Service Biological Opinion (National Marine Fisheries Service 2012) on the South Delta Temporary Barriers Program addresses the Head of Old River. It concluded that their installation and operation would not likely jeopardize the continued existence of the covered species or adversely modify or destroy designated critical habitats. The installation and operation of a rock barrier, rather than a gate, at Old River is proceeding.

Navigation and Flood Control

Flood control and navigation-related activities that alter aquatic habitat in the Delta include levees and levee maintenance, and channel maintenance and dredging. A detailed discussion of levees, levee maintenance, and channel maintenance and dredging in the Plan Area is presented in Chapter 6, *Surface Water*. Levee construction and maintenance, and channel maintenance and dredging activities have resulted in a loss of access by fish to seasonally inundated floodplain habitat, loss of riparian habitat, channel form changes, and water quality changes in the Plan Area.

Levees and Levee Maintenance

The development of the water conveyance system in the Delta has resulted in construction of more than 1,100 miles of armored levees to increase channel flood capacity elevations and flow capacity of the channels (Mount 1995). Creation of levees and the deep water shipping channels has reduced the natural tendency of the San Joaquin and Sacramento Rivers to create floodplains along their banks with seasonal inundations (Bureau of Reclamation 2008a). These annual inundations provided habitat for rearing and foraging juvenile native fish that evolved with this flooding process (National Marine Fisheries Service 2009a). The construction of levees disrupts the natural hydrologic processes, resulting in a multitude of habitat-related effects, including isolation of the natural floodplain behind the levee from the active channel and its fluctuating hydrology (National Marine Fisheries Service 2009a). Alterations in channel form and fluvial geomorphology reportedly have led to loss of shallow water habitats, channel deepening, reduced floodplain areas, aquatic habitat degradation, and alteration of lotic (in-water biological, chemical and physical interactions) conditions in the Delta and the North San Francisco Bay (North Bay) (CALFED Bay-Delta Program 1997), in addition to parts of upstream rivers (National Marine Fisheries Service 2009a).

Many of these levees use riprap to armor the bank from erosive forces. The effects of channelization and riprapping include the alteration of river hydraulics and cover along the bank as a result of changes in bank configuration and structural features (National Marine Fisheries Service 2009a). These changes affect the quantity and quality of nearshore habitat for juvenile fishes and have been well studied (National Marine Fisheries Service 2009a). Simple slopes protected with rock revetment generally create nearshore hydraulic conditions characterized by greater depths and faster, more homogeneous water velocities than occur along natural banks. Higher water velocities typically inhibit deposition and retention of sediment and woody debris. These changes generally reduce the range of habitat conditions typically found along natural shorelines, especially by eliminating the shallow, slow-velocity river margins used by juvenile fish as refuge and escape from fast currents, deep water, and predators (National Marine Fisheries Service 2009a). In addition, the armoring and revetment of stream banks tends to narrow rivers, reducing the amount of habitat per unit channel length (Sweeney et al. 2004).

In addition to direct effects of levees on aquatic habitat and fishes, riparian vegetation is eliminated in the riprapped portion of leveed banks, eliminating overhanging vegetation and future woody debris sources (Bureau of Reclamation 2008a). Large woody debris provides valuable habitat to fish such as salmonids (Bureau of Reclamation 2008a). Woody debris also has been removed from some rivers because it is perceived as a hazard to swimmers and boaters and impedes navigation (Bureau of Reclamation 2008a). The cumulative habitat loss from lack of woody debris recruitment, woody debris removal, and riprapping could be a factor in the decline of some Central Valley salmon populations (Bureau of Reclamation 2008a).

Most levees in the Delta were constructed from materials dredged from low-lying edges of islands, or adjacent channels. Emergency levee repairs have required importation of large amounts of riprap and other materials. Due to current concerns about the impacts of dredging on listed fish species and water quality, dredging for levee maintenance has slowed (Delta Protection Agency 2007). Active maintenance actions of reclamation districts have precluded the establishment of ecologically important riparian vegetation, introduction of valuable instream woody materials from these riparian corridors, and the productive intertidal mudflats characteristic of the undisturbed Delta habitat (National Marine Fisheries Service 2009). Other consequences of reduced riparian habitats include the loss of shaded riverine aquatic habitat, channel complexity, and food supplies (CALFED Bay-Delta Program 1997).

Channel Maintenance and Dredging

In support of commercial shipping in the Delta, dredging of the SDWSC and the SRDWSC will continue into the future (National Marine Fisheries Service 2009a). Dredging activities can result in physical, biological, and chemical changes to aquatic habitats in the Delta. In addition to the initial physically disruptive effects, the composition and abundance of the benthic community can become altered after dredging (U.S. Army Corps of Engineers 2004). Dredging also can result in a variety of water quality effects, such as increased turbidity, decreased DO, and resuspension of contaminated sediments (U.S. Army Corps of Engineers 2004). For example, DO concentrations in the water column can be substantially reduced during dredging if the suspended dredged material contains high concentrations of oxygen-demanding substances (e.g., hydrogen sulfide) (U.S. Army Corps of Engineers 2004). These effects have the potential to alter fish movement, distribution and survival, prey resources, and predation. Refer to U.S. Army Corps of Engineers (2004) for a detailed discussion of potential biological effects of dredging activities.

Water Quality, Contaminants, and Toxicity

Contaminants are organic and inorganic chemicals and biological pathogens that can cause adverse physiological response in humans, plants, fish, or wildlife (California Department of Fish and Game 2008b). A variety of contaminants entering Delta waterways are hypothesized to have direct effects on fish species and food web processes that adversely affect food abundance and availability. A detailed description of contaminants affecting Delta waterways, their potential effects on the physical environment, and the regulatory environment governing water quality is provided in Chapter 8, *Water Quality*.

Nutrient Input and Ammonia

In general, increased input of nutrients from agricultural runoff, wastewater treatment, and other sources can be an ecosystem stressor, and is often associated with low DO levels and other water quality stressors. In many aquatic systems, increased nutrient inputs result in algae blooms, which in turn result in low DO. However, algal blooms and anoxia are not common in the Delta system, and the change in nutrient cycling has been associated with a shifting in phytoplankton species assemblages, rather than increased primary productivity (Glibert 2011 and 2010).

The primary source of total ammonia in the Delta has historically been effluent discharged from WWTPs, and the primary contributing treatment facility is the Sacramento Regional WWTP (Jassby 2008). The facility also has been the largest source of total ammonia discharge to the Delta, making up 90% of the Sacramento River ammonia load (Jassby 2008). However, ammonia discharges from the Sacramento Regional facility have been decreasing, and will continue to decrease in compliance with regulatory requirements. The Stockton Regional Wastewater Control Facility historically had also been an important source of the ammonia load to the Delta via the San Joaquin River. This is no longer the case, as the Stockton facility has upgraded its treatment systems in recent years to include technology to remove ammonia and ammonium from effluent before discharge to the river (City of Stockton 2011).

Several researchers have linked inhibition of diatom productivity and increases in cyanobacteria and flagellates with increased ammonia in the Delta system (Baxter et al. 2010; Glibert 2010 and 2011). Glibert (2011) also cites the changes in nitrogen to phosphorous ratios with changes in species makeup.

Some studies have indicated ecosystem effects of ammonium at low concentrations below the AWQC levels. A recent study indicated that biota can be affected at concentrations as low as 0.38 mg/L of total ammonia nitrogen, based on a study of Delta copepods by Teh et al. (2011).

However, discharges of ammonium to the Delta from WWTPs have been, and continue to be, significantly reduced. The Sacramento Regional WWTP upgrades are expected to reduce ammonia/um loading into the Sacramento River. While this is not a result of BDCP, it is a related regional action that has the potential to affect the outcome of BDCP effects on covered fish species. In this case, reduced ammonia/um loading from Sacramento Regional WWTP would further reduce the potential for the BDCP to result in increased transport or accumulation in the Plan Area.

A detailed discussion of ammonia sources and the distribution of ammonia in the Delta is provided in Chapter 8, *Water Quality*.

Blue-Green Algae

Cyanobacteria (i.e., "blue-green algae") are common in estuarine waters and under certain conditions; however, large blooms of the toxic cyanobacterium have occurred in the central and western regions of the Delta since 1999 (Lehman et al. 2005), primarily during the summer and fall months (Lehman et al. 2005). The increase in cyanobacteria is part of the shift in the Delta food chain from diatom-based to less valuable food sources of smaller, cyanobacteria, flagellates and invasive copepods (Glibert 2010 and 2011; Baxter et al 2010).The large blooms that occur throughout the Delta are suspected of adversely affecting food web dynamics via reduced feeding and reproduction in aquatic invertebrates and may be a contributing factor to the POD in the Delta (Baxter et al. 2008). However, Lehman et al. (2005) and Lehman et al. (2008a) reported that the greatest threat of blue-green algae may be its negative impact on the quantity and quality of phytoplankton biomass (i.e., the basis of the Delta food web) through its inhibition of light transmission through the water column, rather than its direct or indirect toxic effects on aquatic organisms (Lehman et al. 2005). The presence of microcystins in the tissues of lower food web organisms (e.g., mesozooplankton, amphipods, worms, jellyfish, and clams) indicates that blooms of blue-green algae play a potentially substantial ecological role in Delta food web dynamics (Lehman et al. 2008a). Furthermore, microcystins may bioaccumulate, and may threatening the higher trophic levels of the food web (Lehman et al. 2005; Lehman et al. 2010).

Preliminary evidence indicates that the toxins produced by local blue-green algae blooms are not toxic to fish at current concentrations. However, blue-green algae could out-compete diatoms for light and nutrients, which are a rich food source for zooplankton in the Delta (Mueller-Solger et al. 2002). Water Temperature

Elevated water temperatures are a stressor on many aquatic species, which may be caused by lower flows, increased water surface area, warmwater inflow, lack of riparian shade, or other factors. Elevated water temperatures can generally affect fish and aquatic species by increasing respiration and metabolism, increasing growth rates, reducing resistance to diseases, decreasing reproductive fitness and success, reducing resistance to predation, and increasing mortality rates. Water temperature is closely correlated to air temperature in many cases, but may be heavily influenced by the related hydrologic conditions and/or lack of riparian shade. Maintenance of stream temperatures upstream of the Delta is important not only in terms of individual species' tolerances, but also because temperature drives metabolic and primary production rates and can influence mobilization rates of toxics and nutrients (e.g., development of toxic algal blooms from cyanobacteria) (California Department of Fish and Game 2008b). While riparian habitat may help to lower water temperatures in the tributaries to the Delta, water temperatures in the Delta and in Suisun Marsh channels are driven primarily by environmental factors (e.g., air temperature).

Delta hydrodynamic simulations reveal that tidal action and other factors may cause substantial mixing of water with variable salinity and temperature among regions of the Delta (Monsen et al. 2007). Although cooler water temperatures are usually the norm until after the spring runoff has ended, some portions of the Delta (i.e., south Delta and central Delta) can reach approximately 70°F by February during a dry year (National Marine Fisheries Service 2009a).

Preliminary DWR research in Suisun Marsh suggests potential for mature tidal marsh landscapes that flood on a biweekly time scale to contribute to significant temperature variation in the tidal sloughs that drain these marshes (Department of Water Resources 2009b). During late spring and summer, the water that drains from tidal marshes back into the surrounding sloughs overnight can be cooler than it was during the warm afternoon, due to the water sitting in very shallow pools on the marsh plain and being cooled by evaporation during nighttime (Department of Water Resources 2009b). However, this research has not been finalized.

Dissolved Oxygen

DO is the form of oxygen upon which most aquatic life depends (California Department of Fish and Game 2008b). DO concentrations are influenced by processes such as photosynthesis, atmospheric diffusion, biological oxygen demand, and aeration from wind/wave action.

Behavior of fish and aquatic organisms in response to DO levels can lead to short-term migrations (influenced by daily light cycles) or seasonal use patterns since DO levels are strongly affected by temperature (Hackney et al. 1976). When DO levels fall below the range of 5 to 9 mg/L, fish behaviors such as feeding, migration, and reproduction can be adversely affected (California Department of Fish and Game 2008b). DO levels approaching 2 mg/L yield hypoxic (reduced oxygen concentration) conditions, which serve as a delay to fish migration and can eradicate food web organisms (California Department of Fish and Game 2008b). A decrease in food web organisms decreases growth and fitness which lessens survival. Delays in migration affects spawning if fish cannot access appropriate spawning areas to deposit eggs. A decrease in fitness occurs either from females retaining eggs or minimal egg survival due to poor spawning habitat quality. Low DO levels can cause physiological stress and mortality to fish and other aquatic organisms, can delay both upstream and downstream migration of Chinook salmon, and may affect steelhead and white sturgeon similarly (National Marine Fisheries Service 2009a). Studies also have shown that hypoxia can cause endocrine (hormone) disruption in adult fish (Wu et al. 2003; Thomas et al. 2007). Endocrine disruption can potentially include alteration to reproduction, development, and other hormonally mediated processes.

A detailed discussion of DO in the SDWSC and other areas of the Delta is provided in Chapter 8, *Water Quality*.

Sediment and Turbidity

Sediment contamination can impact the ecological condition of the Delta. Numerous bottom-dwelling fish species, such as sturgeon and common carp, forage on invertebrates and detritus associated with sediments. These fish may be exposed to contaminants through direct ingestion of toxic materials in the sediments or indirectly by ingesting sediment-dwelling organisms that have accumulated toxic materials in their tissues (i.e., bioaccumulation). A detailed discussion of sediment accumulation of toxic compounds and turbidity is provided in Chapter 8, *Water Quality*.

Turbidity levels affect fish in different ways. Higher turbidity may be beneficial to delta smelt, and to other prey fish that use it to avoid predation. Turbidity also has the potential to negatively affect some fish species such as salmonids by temporarily disrupting normal behaviors that are essential to growth and survival such as feeding, sheltering, and migrating. For example, behavioral avoidance of turbid waters may be one of the most important effects of suspended sediments on salmonids (Birtwell et al. 1984; DeVore et al. 1980; Scannell 1988). Disruption of feeding behaviors increases the likelihood that individual fish would face increased competition for food and space, and experience reduced growth rates, or possibly weight loss. Elevated turbidity levels also may affect the sheltering abilities of some juvenile fishes and may increase their likelihood of survival by decreasing their susceptibility to predation. However, turbidity also has been reported to reduce predation risk to fish species such as migrating Chinook salmon in other estuaries (e.g., the Fraser River) (Nobriga 2008).

Mercury and Methylmercury

The chemistry of mercury in the environment is complex. Elemental mercury and mercury in the form of inorganic compounds have relatively low water solubility and tend to accumulate in soils and sediments. When mercury forms an organic complex called monomethylmercury (commonly referred to as methylmercury), it becomes more water soluble and the toxicity and bioavailability are greatly enhanced, making it a primary concern for ecosystem effects. Some habitats (e.g., high tidal marsh, seasonal wetlands, and floodplains) more readily facilitate the methylation of mercury, resulting in greater exposure to wildlife, whereas perennial aquatic habitats and low tidal areas have relatively lower methylation potential (Alpers et al. 2008; Ackerman and Eagles-Smith 2010; Wood et al. 2010).

The toxicity of methylmercury is amplified as it biomagnifies through the foodweb. Because methylmercury increases in concentration with each step up the food chain, the species at greatest risk to exposure are top predators including fish species such as bass and sturgeon (California Department of Fish and Game 2008b). Because of the widespread presence of toxic methylmercury in the Delta, much recent research has been completed on the cycling of methylmercury through the physical environment and biota of the area(Stephenson et al. 2007; Alpers et al. 2008; Ackerman and Eagles-Smith 2010; Wood et al. 2010).

A detailed discussion of mercury and methylmercury concentrations and distribution in the Delta is provided in Chapter 8, *Water Quality*.

Selenium and Other Metals

The main controllable sources of selenium in the Bay-Delta estuary are agricultural drainage (generated by irrigation of seleniferous soils in the western side of the San Joaquin basin) and discharges from North Bay refineries (in processing selenium-rich crude oil). Both the San Joaquin River and North Bay selenium loads have declined in the last 15 years in response to, first, a control program in the San Joaquin Grassland area, and, second, National Pollutant Discharge Elimination System (NPDES) permit requirements established for refineries in the late 1990s. The annual loads of selenium (mostly as selenate) entering the Bay-Delta estuary from the San Joaquin and Sacramento Rivers vary by water year (that is, by flow), but dissolved selenium loadings averaged 2,380 kilograms per year (kg/year) from the San Joaquin and 1,630 kg/year from the Sacramento in the 1990–2007 period. The Sacramento River selenium concentration, however, is essentially at background levels (.06 +/-.02 µg/L), without evidence of significant controllable sources (U.S. Environmental Protection Agency 2011a).

The San Joaquin watershed, and specifically the Grassland section of the watershed, historically has been identified as a source of selenium to the Delta. However, mitigation measures have been put into place to manage selenium discharges to meet regulatory requirements. According to the

Grassland Bypass Project Report 2006–2007, selenium loads already had been reduced by 75% in 2007 relative to 1996 levels (McGahan 2010:Chapter 2). Concentrations of selenium in Salt Slough reportedly met the monthly mean goal of 2 μg/L (U.S. Environmental Protection Agency 2011b). Selenium concentrations measured in the San Joaquin River were consistently below 5 μg/L (McGahan 2010:Chapter 2),). As selenium discharge from the Grassland Bypass Project continues to decrease as the 5 μg/L goal is approached, concentrations in the San Joaquin River also can be expected to decrease.

Under the Grassland Bypass Project, selenium discharges to Mud Slough (in the San Joaquin watershed) must be substantially reduced by December 31, 2019. Further, the Central Valley Regional Water Quality Control Board (2010b) recently approved an amendment to the basin plan in light of this project. The amendment requires that agricultural drainage be halted after December 31, 2019, unless water quality objectives are met in Mud Slough (north) and the San Joaquin River between Mud Slough (north) and the mouth of the Merced River. Also, if the State Water Resources Control Board (State Water Board) finds that timely and adequate mitigation is not being implemented, it can prohibit discharge any time before December 31, 2019. As a result, a substantial reduction in selenium inputs (unrelated to the BDCP) to the San Joaquin River by 2019 would be expected to result in lower selenium inputs to the Delta from the San Joaquin River.

Elevated selenium concentrations also have been identified in Suisun Bay. Although particulate concentrations of selenium (the most bioavailable) in this region are considered low, typically between 0.5 and 1.5 micrograms per gram (μg/g), the bivalve overbite clam (*Potamocorbula amurensis*) contains elevated levels of selenium that range from 5 to 20 μg/g (Stewart et al. 2004). Given the fact that *Potamocorbula* may occur in abundances of up to 50,000 per square meter, this area can be considered a sink for selenium because 95% of the biota in some areas are made up of this clam.

Selenium can occur in four oxidation stages as selenates (Se^{6+}), selenites (Se^{4+}), selenides (Se^{2-}), and elemental selenium. The oxidized state, selenates (Se^{6+}), is soluble and the predominant species in alkaline surface waters and oxidizing soil conditions. Selenates are readily reduced to selenites (Se^{4+}) and selenides (Se^{2-}), which are more bioavailable than selenate. Further reduction to elemental selenium can result in an insoluble precipitate, which is not bioavailable.

Although selenium is soluble in an oxidized state, the majority typically becomes reduced and partitions into the sediment/particulate phases in an aqueous system; these reduced sediment/particulate phases are the most bioavailable (Presser and Luoma 2010). Selenium in soils is taken up by plant roots and microbes and enters the food chain through uptake by lower organisms. A portion of the selenium also is recycled into sediments as biological detritus. Lemly and Smith (1987) indicate that up to 90% of the total selenium in an aquatic system may be in the upper few centimeters of sediment and overlying detritus (Lemly 1998).

Oxidized forms of selenium (selenates and selenites) may reduce further to precipitate as elemental selenium or complex with particulates. Selenate reduces to elemental selenium through dissimilatory reduction through reactions with bacteria. These reactions reduce selenium from surface waters, resulting in an increase in selenium concentrations in sediment over time. In wetlands in particular, the organic-rich stagnant waters create a chemically reducing environment in which dissolved selenate is able to convert to selenite or elemental selenium (Werner et al. 2008). The longer the residence time of surface waters, the higher the particulate concentration resulting in higher selenium concentrations in wetlands and shallows (Presser and Luoma 2006, 2010). Aquatic systems in shallow, slow-moving water with low flushing rates are thought to accumulate selenium most efficiently (Presser and Luoma 2006; Lemly 1998). However, the ratio of selenium in particulates (which is more bioavailable) to selenium in the water column is a complex relationship that can vary across different hydrologic regimes and seasons (Presser and Luoma 2010).

Because bioaccumulation can be an important component of selenium toxicity, water column selenium concentrations are not reliable indicators of risk to biota (Presser and Luoma 2010). Selenium enters the food chain at a low trophic level and, under certain conditions, is magnified up the food chain. Lower trophic organisms can bioaccumulate hundreds of times the waterborne concentration of selenium, especially where a food chain is based on sessile filter feeders. However, research has demonstrated that bioaccumulation is less important when the food chain is based on plankton rather than on sessile filter feeders, because plankton excrete most of the selenium they consume (Stewart et al. 2004). This is an important factor that mitigates bioaccumulation in some of the covered fish species, and is more fully discussed in later sections of this chapter.

Accumulation and distribution of selenium and other metals is described in detail in Chapter 8, *Water Quality*.

Agricultural Runoff

Chapter 14, *Agricultural Resources*, describes agricultural practices within the Delta in detail. In general, agricultural practices in the Delta could potentially affect fish and aquatic resources as a result of pesticide and herbicide inputs into Delta waterways. Agricultural drainage into the Delta can contain elevated levels of nutrients, suspended solids, organic carbon, salinity, selenium, and boron in addition to pesticides (City of Stockton 2005). Chapter 8, *Water Quality*, contains a detailed description of potential agricultural runoff contaminants in the Delta.

Herbicides and Pesticides

Herbicides and pesticides are of concern because of their potential toxicity to fish and other aquatic species in the Delta. In recent years, the types of pesticides used in agriculture have changed. Use of organophosphate chemicals found in pesticides such as diazinon and chlorpyrifos has decreased in favor of pyrethroid pesticides. Detailed discussion of agricultural herbicide and pesticide use in the Delta is provided in Chapter 14, *Agricultural Resources*.

Preliminary data suggest that both organophosphate and pyrethroid pesticides may have contributed to the higher incidence of toxic events in 2007, a dry year (Baxter et al. 2008). Pyrethroids are a group of synthetic chemicals currently used as insecticides in urban and agricultural areas. More than 1,000 synthetic pyrethroids have been developed (Agency for Toxic Substances and Disease Registry 2003), but only 25 are registered for use in California (Spurlock and Lee 2008). Pyrethroids are powerful neurotoxins, have immunosuppressive effects, and can inhibit essential enzymes such as ATPases (Werner and Orem 2008). Pyrethroids can cause acute toxicity at concentrations as low as 1 µg/L in fish (Werner and Orem 2008), and at lower levels between 2 and 5 ng/L (0.002 and 0.005 µg/L) in invertebrates. When various types of pyrethroid compounds are present together in an aqueous environment, the toxicity can be additive with increased toxic effects (Weston and Lydy 2010).

In addition to agricultural sources, recent studies have shown that WWTPs and urban runoff are important sources of pyrethroids to the Delta system. Pyrethroids have been detected at concentrations lethal to a native amphipod (*Hyalella azteca*) in urban runoff and effluent from the

Stockton, Vacaville, and Sacramento WWTPs (Weston and Lydy 2010). In addition, receiving waters (San Joaquin River, American River, and Sacramento River) had detections of pyrethroids at levels toxic (or potentially toxic) to Hyalella, particularly after rain events during low river flow conditions. Concentrations were higher in Vacaville creeks receiving effluent. Weston and Lydy (2010) reported few to no detections or toxicity to amphipods in Sacramento River water downstream of the Sacramento WWTP.

Organophosphate pesticides (organophosphates) are human-made chemicals that are used for pest control in both urban and agricultural environments. Sources of diazinon and chlorpyrifos in the Delta are predominantly agricultural as the sale of these compounds for most nonagricultural uses has been banned in recent years. In the Delta, diazinon is applied to crops during the dormant season (December–February) and irrigation or growing season (March–November) fairly equally (52% and 48%, respectively), while the majority of chlorpyrifos (97%) is applied to Delta crops during irrigation season (McClure et al. 2006).

Diazinon and chlorpyrifos have slightly different chemical properties that affect the way they behave in aquatic environments. Diazinon is fairly soluble and mobile and will bind only weakly to soil and sediment. Chlorpyrifos is less soluble than diazinon and less mobile because of its tendency to bind much more strongly to soil and sediment. Consequently, diazinon enters the Delta dissolved in runoff, while chlorpyrifos enters the Delta adsorbed to soil particles (McClure et al. 2006). Unlike organochlorine pesticides, organophosphates do not tend to bioaccumulate, as they are readily metabolized by most organisms. For example, diazinon in fish will be approximately 96% removed in just 7 days (McClure et al. 2006).

Endocrine Disrupting Compounds and Pharmaceutical and Personal Care Products

In recent years, there has been heightened scientific awareness and public debate over potential impacts that may result from exposure to endocrine-disrupting compounds (EDC), some of which are found in pharmaceuticals and personal care products and enter waterways via water treatment facilities. EDCs may block, mimic, stimulate, and/or inhibit the production of natural hormones, disrupting the endocrine system's natural functions. A detailed discussion of the effects of EDCs and pharmaceutical and personal care products on water quality in the Delta is provided in Chapter 8, *Water Quality*.

Diethylstibestrol (the drug DES) and certain pesticides (dioxin, polychlorinated biphenyls (PCBs), and DDT) are known endocrine disrupters in humans. In addition, plasticizers such as polybrominated diphenyl ethers (PBDEs) used as a fire retardant in furniture, televisions, and computers may bioaccumulate in fish and result in sublethal toxic effects. Studies conducted as part of the IEP's POD investigations showed some evidence of low frequency endocrine disruption in adult delta smelt males (Baxter et al. 2008).

Baxter et al. (2008) cite unpublished findings by Teh et al. reporting that 9 of 144 (6%) adult delta smelt males examined in 2005 had immature egg cells in their testes, an indication of low frequency endocrine disruption. Williamson and May (2002) examined 437 adult Chinook salmon from the Sacramento and San Joaquin Rivers and found that 16% of the 287 female specimens exhibited a Y-chromosome-specific marker, an indication that such fish were sex-reversed males (XY females). This study did not specifically correlate these incidences of possible sex-reversal to EDCs. In contrast, the Surface Water Ambient Monitoring Program exposed Rainbow Trout to 113 ambient water samples (de Vlaming et al. 2006), including 43 from Central Valley waterways that are tributary to the Delta, to determine exposure to estrogenic chemicals. The results of this study indicated that six samples (5% of the total) may have contained EDCs. The report noted that all six of these samples were at or near the threshold for the procedure, or may have contained false positives, and the majority of the samples tested were below EDC threshold concentrations for the analytical procedure. This led the authors to conclude that natural and synthetic estrogens do not appear to be a substantial contaminant in northern California water bodies.

Because natural hormones occur in extremely low concentrations in fish, it is thought that extremely low concentrations of exogenous endocrine disruptors could affect fish. However, the potency of exogenous EDCs is typically of a lower magnitude than endogenous endocrines (Pait and Nelson 2002). Endocrine disruption has been observed in fish exposed to wastewater effluents (Sumpter and Jobling 1995; Jobling et al. 1998; Chambers and Leiker 2006; Kidd et al. 2007). In Central Valley stream sampling, up to 38% of male fall-run Chinook salmon showed signs of endocrine disruption in the form of sex reversal (Williamson and May 2002). In 2005, a low level (6%) of adult delta smelt males showed evidence of endocrine disruption (Baxter et al. 2008). The identity and source of the EDCs causing these effects are not known.

Nonnative Species

The San Francisco Estuary has been described as the world's most invaded estuary, mostly due to the introduction of nonnative species via ballast water associated with the large volume of shipping from Asian ports (Cohen and Carlton 1998). As an active deepwater port with principal cargo destinations in Sacramento and Stockton, opportunities for ballast water introductions are high and frequent. Deliberate release of aquarium specimens, deliberate fisheries introductions, and bait bucket releases have also contributed to the number of nonnative species in the Bay-Delta (Kimmerer 2004). If local conditions are favorable, introduced species may establish successful reproducing populations; it appears that conditions in the Bay-Delta have historically been favorable for the establishment of a variety of species, particularly from south Asia. Introduced species that successfully establish often undergo a population boom, where the initial densities can be very high, followed by a bust that can reduce levels.

Extensive invasion of the Delta by nonnative species has been reported to have negatively affected ecosystem processes (California Department of Fish and Game 2008b). Changes in the Delta ecosystem caused by nonnative species have been reported to have reduced habitat suitability (e.g., turbidity effect, changes in habitat structure), and changed predator-prey and competitive relationships between native and nonnative species.

- ***Competition*** – *C*ompetition is a natural mortality factor that can have an unnatural effect on native fish populations when the competitors are introduced species. Elevated losses of native species may occur due to competition for nest sites, shelter, food, and other resources. Competition as a stressor is directly related to introduction of exotic species, and to water management activities or land use actions that may alter habitat conditions in favor of introduced competitors.
- ***Predation*** – Predation by nonnative fish species in some areas of the Delta is a stressor causing reduced survival of migrating and resident fish. The types and densities of predators, as well as the transit times of migrating individuals, influence predation potential on native species.

Nonnative Fish

Many of the Delta's fish are introduced species (Dill and Cordone 1997), particularly in freshwater to low-salinity habitats (Moyle 2002; Brown and Michniuk 2007), and less so in the marine environment (CALFED Bay-Delta Program 2008). Some of the most common nonnative fish in the Delta are members of the family centrarchidae, including largemouth bass, smallmouth bass, spotted bass, bluegill, warmouth, redear sunfish, green sunfish, white crappie, and black crappie (California Department of Fish and Game 2008b). The increase in nonnative submerged aquatic vegetation and the reduction of spring water velocities and summer salinity due to reservoir releases for diversions when these fish are spawning are hypothesized to have probably increased populations of these fish (Brown and Michniuk 2007). Centrarchids, in conjunction with submerged aquatic vegetation, can negatively affect native fish via predation, as well as competition (Nobriga and Feyrer 2007; Brown and Michniuk 2007).

Anecdotal information indicates that predatory fish, including nonnative species, congregate near the four regular release locations of SWP and CVP salvage facilities (California Department of Water Resources 2005). It is thought that these predators have learned to gather near the pipe exits when flushing pumps are activated, resulting in increased risk of predation to salvaged fish. Salvaged fish are released in high concentrations in a relatively small area and upon release tend to be disoriented and stressed and are sometimes injured, reportedly resulting in higher predation rates.

Nonnative Invertebrates

Overbite Clam and Asian Clam

Two species of nonnative bivalves, the Asian clam (*Corbicula fluminea*) and the overbite clam (referred to as either *Corbula amurensis* or *Potamorcorbula amurensis* depending on the individual paper), are two of the major consumers of phytoplankton in the Bay-Delta (Jassby et al. 2002).

Proliferation of the grazing clam, *C. amurensis*, is identified as a major contributor to this shift. Based on analysis of 27 years of benthic data, Peterson and Vayssieres (2010) documented the establishment of the overbite clam during the 1987–1994 drought under high salinity conditions that favored the clam. The population has persisted and extended its geographic range within the Delta (Kimmerer and Orsi 1996, Jassby et al. 2002). This increase in the population of overbite clam resulted in profound changes to the zooplankton community. Predation (i.e., filter feeding) of copepod nauplii by overbite clams has been documented and is implicated in the decline of several species. Within 1 year after the overbite clam invasion, the abundance of three common estuarine copepods declined by 53 to 91%. (Kimmerer et al. 1994). Changes in nutrient ratios related to increased ammonia have also been linked to the changes in zooplankton species assemblages (Glibert 2011 and 2012).

Prior to 1987, the mysid shrimp dominated the macrozooplankton community of the Bay-Delta and was an important food item for fish, including juvenile striped bass. Following the overbite clam invasion, mysid shrimp abundance decreased sharply. Additional mysid species (e.g., *Acanthomysis bowmani*) have invaded the Bay-Delta, and compete with native mysid shrimp for food. Nonnative amphipod crustaceans may substitute for a depressed mysid shrimp population and a food source for juvenile fish; however, the relative contribution of this substitution is not well understood (Feyrer et al. 2003; Toft et al. 2003).

As filter feeders, overbite clams consume phytoplankton, bacterioplankton, and small zooplankton such as rotifers and copepod nauplii (Werner and Hollibaugh 1993; Kimmerer et al. 1994). The coincident decline of phytoplankton with the proliferation of the overbite clam indicates that the clams are over-grazing the systems (CALFED 2008; Cloern and Nichols 1985). Alternative consumers have partially replaced those existing before the overbite clam invasion. For example, introduced copepods such as *Pseudodiaptomus forbesi* have replaced *Eurytemora affinis*, and nonnative mysids have partially compensated for the loss of *Neomysis mercedis*.

Overbite clams eliminated summer-long phytoplankton blooms starting in 1987, but responses of zooplankton and most fish were somewhat muted. When the overbite clam invaded, northern anchovy shifted in distribution seaward, reducing summer abundance by 94% in the Bay-Delta in direct response to reduced food availability. After overbite clams became abundant, all planktivores exhibited reduced food consumption and anchovy left; the departure of the anchovy mitigated the effects of the loss of phytoplankton productivity, making a greater proportion of the reduced zooplankton productivity available to other fish species (Kimmerer 2006). The departure of the anchovy from the Delta could potentially have resulted in additional food web-related effects in the Delta that have not been evaluated.

In Suisun Bay, overbite clams are more reproductively active in wet years than in dry years, and this is believed to be a response to food availability/quality. During wet years, organic matter from upstream riverine sources augment food in Suisun Bay. During dry years, oceanic inputs provide a supplemental, but qualitatively different food source. Initiation and maintenance of reproductive activity is closely correlated with shifts in food availability/quality. The ability of the overbite clam to use a wide variety of food sources is a key to its success as an invasive species (Parchaso and Thompson 2002).

Overbite clams are preyed upon heavily by migratory waterfowl, to the point of localized depletion during winter (Pulton et al. 2004) in San Pablo Bay and Grizzly Bay. Additional predators on overbite clams include white sturgeon, green sturgeon, Sacramento splittail and dungeness crab (Stewart et al. 2004). The role of overbite clams as prey in the Bay-Delta is an important step in the transfer of contaminants to higher trophic levels. Overbite clams have been observed to bioaccumulate selenium in their tissues at concentrations high enough to induce reproductive anomalies in predators, such as waterfowl and benthic-feeding fish, including white sturgeon and Sacramento splittail, and perhaps dungeness crab (Stewart et al. 2004). The clams exhibit high tissue concentrations, which is passed up through the food web to consumers of clams.

Introduced Copepods

The species composition of copepods has changed dramatically as a result of species introductions, primarily from mainland Asia (Kimmerer and Orsi 1996; Orsi and Ohtsuka 1999). The species changes coincide with the changes in nutrient concentrations, increase in ammonia, and the pelaogic organism decline (Glibert 2011). During the late 1980s and early 1990s, the nonnative copepod *Pseudodiaptomus forbesi* largely replaced *Eurytemora affinis* as the overbite clam became abundant in the low-salinity reaches of the estuary. *E. affinis* still achieves high population levels during spring, but is replaced by *P. forbesi* in late spring-early summer. While small native fish such as longfin smelt and delta smelt can switch between both prey species, *P. forbesi* is a faster swimmer than *E. affinis*, and may therefore be able to avoid predators more effectively. The introduced cyclopoid copepod *Limnoithona tetraspina* has, since the early 1990s, become the most abundant copepod in the upper estuary (Bouley and Kimmerer 2006). However, the relatively non-motile, or sedentary, nature of this species makes it less available as a food source for smelt and other small predatory fish.

The nonnative cyclopoid copepod *Limnoithona tetraspina* increased in abundance in the Suisun Bay region in the mid-1990s (Bouley and Kimmerer 2006). Because of its small size, sedentary behavior, and ability to detect and avoid predators, this species is considered an inferior prey item relative to the native copepod species. An additional nonnative calanoid copepod, *Acartiella sinensis*, also achieved high densities in Suisun Bay during the past decade. The suitability of this species as a fish prey item has yet to be fully determined. From 1993 to 1996, *L. tetraspina* rarely made up more than 10% of the diet of juvenile delta smelt, although they represented up to 80% of the total phytoplankton community (Bouley and Kimmerer 2006).

The calanoid copepod *Pseudodiaptomus forbesi*, which replaced *Eurytemora affinis* as the most abundant prey item for delta smelt in summer in response to the invasion of overbite clam during 1987 and 1988, declined in the Suisun Marsh and confluence regions from 1995 to 2004, while simultaneously increasing in the southern Delta region.

Eight East Asian pelagic copepods are known to have been introduced over the period from the early 1960s to the mid-1990s: *Acartiella sinensis*, *Limnoithona sin*ensis, *Limnoithona tetraspina*, *Oithona davisae*, *Pseudiodiaptomus forbesi*, *Pseudodiaptomus marinus*, *Sinocalanaus doerri*, and *Tortanus dextrilobatus* (Orsi and Ohtsuka 1999). *A. sinensis*, a stenothermal tropical species that is native to south China and Thailand, has become abundant in Suisun Bay during the past decade. The suitability of this species as a fish prey item has yet to be fully determined. Both species of *Limnoithona* are native to China, with *L. sinensis* occupying freshwater reaches of its native estuaries (e.g., the Yangtze River) and *L. tetraspina* occurring in low-salinity reaches. *L. tetraspina* is now the most abundant copepod in the upper San Francisco Estuary (Bouley and Kimmerer 2006). This species is small and, in contrast to most native copepods, feeds on ciliates rather than phytoplankton. Because of its size and sedentary nature, *L. tetraspina* does not appear to be an important prey item for Bay-Delta fish. *O. davisae* is regarded as a coastal species in East Asian estuaries where it originates, although it may occur throughout the brackish water zone. *P. forbesi* replaced *E. affinis* as the most abundant prey item for delta smelt in summer, in response to the invasion of the overbite clam. This species declined in the Suisun Marsh and confluence regions from 1995 to 2004, while simultaneously increasing in the southern Delta region. *S. doerri*, like *L. sinensis*, occurs primarily in the freshwater reaches of its native East Asian estuaries. *Tortanus dextrilobatus*, native to Chinese and Korean estuaries, is carnivorous, preying upon other copepods, including *Oithona* and *Acartia*. This species has been recorded to achieve densities in excess of 1,000 individuals per cubic meter in the Bay-Delta (Hooff and Bollens 2004).

Chinese Mitten Crab

The Chinese mitten crab is native to coastal rivers and estuaries of China and South Korea that drain to the Yellow Sea. Chinese mitten crabs were introduced to Germany in the early 1900s, colonized, and became established in numerous estuaries throughout Europe during the early 20th century. Chinese mitten crabs were first collected in the San Francisco Estuary in the early 1990s, but likely introduced to South San Francisco Bay (South Bay) in the late 1980s Interagency Ecological Program 2006). Chinese mitten crabs reached the Delta by 1996, and by 1998 had traveled up the watershed as far north as Colusa County and east to Merced County. During their invasion, the crabs became a nuisance among commercial fishing activities in the lower estuary and were reported in high densities on intake screens at water withdrawal facilities throughout the Bay-Delta.

After several years of rapid population growth and expanding distribution, Chinese mitten crabs experienced a population boom in the late 1990s. All data sources indicate that the population has been declining since then (Interagency Ecological Program 2006, 2007, 2008). In 2005, the San Francisco Bay Study adult mitten crab mean catch-per-unit-effort was the lowest since 1996 (Interagency Ecological Program 2006). The combined SWP and CVP estimated total salvage was 18 adults during fall 2005, the lowest since mitten crabs were first detected at the CVP fish salvage facility during fall 1996 (Interagency Ecological Program 2006). In 2006, the combined mitten crab salvage at the SWP and CVP fish facilities was 12 adults (Interagency Ecological Program 2007). In fall and winter of 2007–2008, no mitten crabs were collected at either fish facility, or by the San Francisco Bay Study or the University of California (U.C.) at Davis Suisun Marsh trawl surveys (Interagency Ecological Program 2008). Also, there were no reports of adult mitten crabs in the South Bay, the first year since 1994 that none were collected there (Interagency Ecological Program 2008). USFWS monitoring for juvenile mitten crabs in Delta tributaries detected no mitten crabs in 2005, 2006, or fall and winter of 2007–2008 (Interagency Ecological Program 2006, 2007, 2008).

From 2000 through 2003, the highest numbers of adult mitten crabs at the SWP and CVP fish facilities occurred from September through December, during their downstream migration for reproduction (Interagency Ecological Program 2001, 2002, 2003, 2004). Chinese mitten crabs were considered a nuisance at the fish facilities because they interfered with the effective salvage of fish (Interagency Ecological Program 2001, 2002, 2003, 2004). However, mitten crabs have generally become undetectable in the Delta surveys and at the SWP and CVP fish facilities in recent years. Because it is not yet understood what controls the estuary's mitten crab population (Interagency Ecological Program 2006), mitten crabs could potentially become a concern again in the future.

Other Invasive Invertebrates

Other invasive invertebrates in the Bay-Delta include the mysid shrimp, which has largely replaced *N. mercedis*; the amphipod, *Gammarus daiberi*, which may have partially taken the place of native mysids in the food web (Kimmerer 2004); and the grass shrimp, which supports a commercial bait fishery along with several species of native Crangonid shrimp. CALFED (2000a) recommended that the potential interactions between grass shrimp and mitten crabs be examined. Two species of jellyfish, believed to be native to the Black and Caspian Seas, are now established in Suisun Bay. There is concern regarding the potential of these predatory jellyfish to alter zooplankton communities and feed directly on larvae and early juveniles of native and nonnative fish, although the extent to which this has occurred remains undocumented (Rees and Gershwin 2000).

Quagga mussels have become established in several reservoirs in southern California, and zebra mussels are established in San Justo Reservoir in San Benito County in central California. Thus, it is possible that Quagga and zebra mussels may invade the Bay-Delta in the near future. San Justo Reservoir is closed to public access, thereby reducing the risk of that as a source for zebra mussels spreading to the Delta. However, many of the Quagga-infested southern California reservoirs are still open to boating and fishing, and with these multiple sources, Quagga mussels are expected to arrive in the Delta first. Quagga and zebra mussels are filter feeders like the Asian and overbite clams and would likely further deplete phytoplankton and zooplankton resources in upper, freshwater portion of the Delta. Conservation Measure (CM) 20 will establish a Recreational Users Invasive Species Program, which will include education and outreach and water inspection programs to help prevent the introduction of Quagga and zebra mussels and other nonnative species into the Delta.

Macrophytes

Brazilian Waterweed

Brazilian waterweed *Egeria* became established in shallow littoral areas of the upper Bay-Delta during the mid 1980s. From 2004 to 2006, the distribution of Brazilian waterweed increased by more than 10% per year.

Brazilian waterweed has many detrimental effects on the Bay-Delta ecosystem, as it traps suspended sediment in the water column, inducing deposition and a change in the texture and organic content of underlying shallow-water sediments. Water circulation is impeded in areas of dense waterweed growth, and local increases in water temperature may occur. This increase in water clarity reduces habitat suitability for native fish such as the delta smelt, and simultaneously enhances habitat suitability for nonnative species, notably centrarchids (e.g., black bass and sunfish). Small prey species which use turbidity as a refuge from predation are potentially at an increased risk indirectly in a system with increased water clarity. Proposals to breach levees and create shallow water habitat in portions of the Delta carry the risk of spreading Brazilian waterweed, further exacerbating these habitat changes. Currently, the only option for removal or control of Brazilian waterweed is intensive mechanical removal and herbicide application.

Other Invasive Aquatic Plants

In addition to Brazilian waterweed *Egeria*, a number of other nonnative aquatic plant species have become established in the Bay-Delta.

- Water hyacinth, which was first identified in the Bay-Delta in 1904, and is locally abundant in quiet waters
- Milfoils
- Curly-leaf pondweed
- Carolina fanwort

Water hyacinth has proliferated and displaced beds of the native pennywort although pennywort will expand where water hyacinth has been removed or died back. California began controlling water hyacinth in the early 1980s via aerial spraying of herbicide, or direct application to the beds from boats. Mechanical removal causes the plant to multiply, as new plants can develop from plant fragments (California Department of Boating and Waterways 2010). Chapter 12, *Terrestrial Biological Resources*, provides additional discussion of nonnative invasive plant species including aquatic plants.

11.1.5.4 Harvest and Hatchery Management

California's anadromous fish hatcheries, constructed to mitigate for the salmon and steelhead production lost as a result of dam construction, provide a substantial portion of the harvest of California fall-run Chinook salmon. Barnett-Johnson et al. (2007) found that approximately 10% (±6%) of Chinook salmon harvested in the central California ocean fishery were of wild origin, with the remainder believed to be hatchery-produced. In supplying fish for commercial and recreational use, California's hatcheries are to be operated in such a way that the populations and genetic integrity of salmon and steelhead stocks are maintained, with management emphasis placed on natural stocks (California Department of Fish and Game and National Marine Fisheries Service 2001).

There is little information on steelhead harvest rates in California. The average annual harvest rate of adult steelhead above RBDD for the 3-year period from 1991–1992 through 1993–1994 was 16% (McEwan and Jackson 1996). Since 1998, all hatchery steelhead have been marked with an adipose fin clip allowing anglers to distinguish hatchery and wild steelhead to protect wild steelhead. Current regulations restrict anglers from keeping unmarked steelhead in Central Valley streams. Overall, this regulation has greatly increased protection of naturally produced adult steelhead. However, the total number of Central Valley steelhead contacted might be a significant fraction of basin-wide escapement, and even low catch-and-release mortality may pose a problem for wild populations (Good et al. 2005).

Harvest

Commercial, recreational, and tribal fisheries represent a potential stressor to Delta fish. The ocean commercial, and ocean and inland recreational fisheries for Chinook salmon are of mixed stock, comprised of both wild and hatchery-produced salmon. Because there are fewer naturally produced Chinook salmon, their populations likely are less able to withstand high harvest rates compared to hatchery-based stocks. Thus, harvest has the potential to result in detrimental effects on wild spawners in the mixed stock fishery. However, although harvest is considered a serious stressor on Chinook salmon populations, it is not considered a serious stressor in the Delta.

There are no commercial fisheries for steelhead in the ocean. However, inland steelhead fisheries include tribal and recreational fisheries. An important recreational fishery for steelhead occurs throughout the Central Valley, but harvest is restricted to visibly marked fish (adipose fin clip) of hatchery origin, thereby reducing the likelihood of impacting naturally spawned wild fish. The effects of recreational fishing and the unknown level of illegal harvest on the abundance and population dynamics of wild Central Valley steelhead have not been quantified (SAIC 2009).

In California, it is unlawful for green sturgeon to be taken or possessed for commercial or recreational purposes (California Department of Fish and Game 2010c). Green sturgeon can be caught incidentally while fishing for white sturgeon, but must be released. Hooking mortality may occur due to incidental catches. Reductions in productivity may occur if gravid females abort their spawning runs following capture and return downstream without spawning due to excessive stress from the capture and release process. The proportion of the population that exhibits this behavior is unknown. Illegal harvest of sturgeon is known to occur in the Sacramento River, particularly in areas where sturgeon have become concentrated, as well as throughout the Delta.

Poaching also represents a form of harvest. California has the lowest game warden-to-population ratio in the nation, with fewer than 200 field wardens for the entire state. The Delta-Bay Enhanced Enforcement Program is a 10-warden squad that was formed specifically to increase enforcement on poaching of anadromous fish species in Bay-Delta waterways. The Delta is a particular hot spot for poaching because of the large number of sportfish, particularly gravid female white sturgeon, whose roe are used for caviar. Illegal harvest is thought to have high impacts on sturgeon populations, particularly white sturgeon. Poaching may be less significant than incidental take associated with white sturgeon sportfishing (Williamson 2003). However, the tendency for green sturgeon to form aggregations for long periods may make them easy targets for poachers (Erickson et al. 2002).

Hatcheries

Five anadromous fish hatcheries upstream of the Plan Area contribute to the propagation of steelhead and Chinook salmon. There are no hatcheries in the Plan Area. The influence of anadromous fish hatchery practices on salmon population viability is an ongoing concern based on the potential risks the hatcheries can have on wild salmonid population genetics, ecology, health, behavior, and on overfishing (National Marine Fisheries Service 2010). The risks described by NMFS (2010) and summarized below apply to conventional hatcheries; current hatchery practices, such as conservation hatcheries and program (e.g., Livingston Stone Fish Hatchery for winter-run Chinook salmon), are designed to reduce these risks. Despite the potential risks, hatcheries have valuable roles for meeting conservation and recovery goals for salmonids and other species, as well as commercial and recreational harvest needs. However, the extent that hatchery produced adults can alter the population dynamics or fitness of natural populations remains largely unquantified (Naish et al. 2007).

Genetic Risks

Human intervention in the rearing of wild animals such as within conventional anadromous fish hatcheries has the potential to cause genetic change. These genetic changes impact salmon diversity and the health of salmon populations. Hatchery programs vary as can the risks identified below vary by hatchery. NMFS (2010) reported the following genetic risks of artificial propagation on wild populations.

- ***Inbreeding*** – Inbreeding can occur when the hatchery broodstock comes from a small percentage of the total wild and/or hatchery fish stock (e.g., 100 adults are used out of a population of 1 million). Using a small portion of a population to create a hatchery stock can reduce genetic diversity. Inbreeding can affect the survival, growth, and reproduction of salmon.
- ***Intentional or artificial selection for a desired trait (e.g., growth rate or fecundity)*** – Some hatchery programs intentionally select for specific traits that change the genetic makeup of the hatchery stock, moving it further away from naturally reproducing salmon stocks.
- ***Selection resulting from nonrandom sampling of broodstock*** – The makeup of a hatchery population comes from a selection of wild salmon and/or returning hatchery salmon that are taken into captivity (i.e., broodstock). If, for example, only early-returning adults are used as broodstock instead of adults that are representative of the population as a whole (i.e., early-, normal-, and late-returning adults), there will be genetic selection for salmon that return early.
- ***Unintentional or natural selection that occurs in the hatchery environment*** – Conditions in hatchery facilities differ greatly from those in natural environments. Hatcheries typically rear fish in vessels (i.e., circular tanks and production raceways) that are open and have lower and more constant water flow than that which occurs in natural streams and rivers. They also tend to hold fish at higher densities than those that occur in nature. This type of environment has the potential to alter selection pressures in favor of fish that best survive in hatchery, not natural, environments.
- ***Temporary relaxation during the culture phase of selection that otherwise would occur in the wild*** – Artificial mating disrupts natural patterns of sexual selection. In hatcheries, humans—not the salmon—select the adult males and females to mate. Humans have no way of knowing which fish would make the best natural breeders. In addition, selection is relaxed up until the time when juveniles are released from the hatchery (because they do not face the same

predation and foraging challenges as wild juvenile fish). Fish raised in hatchery environments face very different pressures than those raised in the wild.

Ecological Risks

Hatchery-produced fish often differ from wild fish in their behavior, appearance, and/or physiology. Ecological risks of artificial propagation on wild populations as reported by NMFS (2010) include:

- ***Competition for food and territory*** – Competition between wild and hatchery fish is most likely to occur if the fish are of the same species (e.g., wild Chinook salmon and hatchery- reared Chinook salmon) and they share the same habitat and diet in the freshwater/estuarine environment.
- ***Predation by larger hatchery fish*** – If hatchery-released salmon are larger than wild salmon, evidence suggests that, for certain species, hatchery-released salmon may prey on wild salmon.
- ***Negative social interactions*** – Juvenile salmon establish and defend foraging territories through aggressive contests. When large numbers of hatchery fish are released in streams where there are small numbers of wild fish, hatchery fish are more likely to be more aggressive, disrupting natural social interactions.
- ***Carrying capacity issues*** – Carrying capacity is a measure of the amount of a population (i.e., number of salmon) that can be supported by a particular ecosystem. Carrying capacity changes over time with the abundance of predators and resources such as food and habitat. When hatchery fish are released into streams where there are wild fish, there can be competition for food and space.

Behavioral

Hatchery environments are different than stream environments that can produce fish that tend to have different foraging, social, and predator-avoidance behavior during the freshwater and estuarine rearing and outmigration life stage (National Marine Fisheries Service 2010).

Overfishing

Large-scale releases of hatchery Chinook salmon have supported commercial, tribal, and sportfishing practices for many years. Hatchery fish are more productive than natural fish and they can produce more recruits per spawner. The commercial and recreational harvest of hatchery fish in mixed-stock ocean fisheries at harvest rates which naturally produced stocks can sustain will usually result in underharvest of hatchery fish. Hatchery fish returns to the Central Valley have increase substantially in recent years, and so have the levels of in-river recreational harvest (California Department of Fish and Game and National Marine Fisheries Service 2001). Because hatchery populations have high survival in the hatcheries, they can generally support higher harvest rates. Wild stocks, on the other hand, are typically much smaller, and their population could be harmed by such high harvest rates. NMFS and fisheries managers are currently implementing programs that allow for the selective harvest of hatchery fish (i.e., harvest that does not impact wild stocks). Selective harvest opportunities could be supported through catch and release programs, based on marking/tagging hatchery fish for easy recognition, and/or in places where hatchery stocks are isolated from wild stocks (i.e., if hatchery stocks use a different stream or enter the stream at a different time than wild stocks) (National Marine Fisheries Service 2010).

Fish Health

The effects of disease on hatchery fish and their interaction with wild fish are not well understood. Hatcheries can have disease outbreaks, which can result in the transfer of disease from released hatchery fish to wild fish. Once released, these fish can transmit disease to wild fish (National Marine Fisheries Service 2010). For example, infectious hematopoietic necrosis virus is of particular significance on the Feather River, as there have been rather severe outbreaks of this virus in the Feather River Fish Hatchery (California Department of Water Resources 2004b).

11.1.5.5 Pelagic Organism Decline

The four primary pelagic fish of the upper estuary (delta smelt, longfin smelt, striped bass, and threadfin shad), have shown substantial variability in their populations, with evidence of long-term declines for the first three of these species (Baxter et al. 2008). However, surveys showed that population levels for these four pelagic species began to decline sharply around 2000, despite relatively moderate hydrology, which typically supports at least modest fish production (Sommer et al. 2007). Data showed continuing declines over the next several years; abundance indices for 2002 to 2009 included record lows for delta smelt and age-0 striped bass, and near-record lows for longfin smelt and threadfin shad. By 2004, these declines became widely recognized and discussed as a serious management issue, and collectively became known as the "pelagic organism decline" (POD). Delta smelt numbers increased in 2011 but were still low (http://cdfgnews.wordpress.com/2011/12/22/ endangered-delta-smelt-population-improves-2/) The POD focuses on fish that rely on the pelagic zone for spawning, early life history, and perennial habitat. The POD's integration of the many factors that comprise the Delta's complex ecosystem addresses the disturbance and loss of aquatic habitats common within the Delta. In evaluating this phenomenon, an interagency team has attempted to integrate the wide range of potential stressors and threats to the POD species. Evaluation of the Delta fish community will rely heavily on these evaluations and extend consideration of these relationships to all pertinent aquatic resources in the Delta. The apparent simultaneous declines of these four fish species occurred despite differences in their life histories and in how each species utilizes Delta habitats. These differences suggested one or more Delta-wide factors to be important in the declines (Baxter et al. 2008). The following description of the POD is taken directly from Sommer et al. (2007:273–274).

> "…The San Francisco Estuary is physically very dynamic, so it is not surprising that annual abundance of all of these populations is extremely variable, and that much of this variability is associated with hydrology…the grazing effects from Corbula are thought to have resulted in a substantial decline in phytoplankton and calanoid copepods, the primary prey of early life stages of pelagic fishes…"

A conceptual model was developed to aid in the evaluation of the POD, and to describe possible mechanisms by which a combination of long-term and recent changes in the ecosystem could produce the observed pelagic fish declines (Baxter et al. 2008). The conceptual model is intended to assess how different stressors may be linked to the POD, and is based on classical food web and fisheries ecology. It contains four major components: (1) prior fish abundance levels; (2) habitat; (3) top-down effects; and (4) bottom-up effects (Baxter et al. 2008). This conceptual model is being used by various groups to evaluate the recently observed declining trends in pelagic species in the Delta. Some of the concepts associated with the model are important for understanding potential effects of anthropogenic changes to the aquatic ecosystem.

- **Prior fish abundance levels.** Describes how continued low abundance of adults leads to reduced juvenile production (i.e., stock-recruit effects). Stock-recruitment mechanisms and survival among life stages have changed from that reported in earlier pre-POD work. Striped bass, longfin smelt, and threadfin shad previously were able to recover from low abundances, but now show limited resilience. Delta smelt reportedly exhibit a significant stock-recruitment relationship, possibly because adult abundance is exceptionally low and thus summer survival is a less important factor than it may have been in controlling the population abundance (Baxter et al. 2008).

- **Habitat.** Describes how water quality variables (including contaminants and toxic algal blooms) affect estuarine species, and assumes that habitat quality and abundance (e.g., water quality and hydrology) affect survival and reproduction. New analyses of water quality data collected concurrently with fish data highlight the importance of Secchi depth (i.e., water clarity or turbidity), specific conductance (a surrogate for salinity), and water temperature. These relationships vary according to season for the three POD species inhabiting the Delta for which data were analyzed and have focused discussions regarding "good habitat" for pelagic fish. Some incidences of contaminant effects have been observed in bioassay tests of Delta waters; however, the importance of these results for POD fish or other Delta species has yet to be determined (Baxter et al. 2008).
- **Top-down effects.** Assumes that predation and SWP and CVP water project operations (e.g., entrainment at the pumps) affect mortality rates. Striped bass and largemouth bass are believed to be the major predators on larger fish in the Delta. The importance of striped bass as a predator on fish is well known, and there is no indication of a major change during the years of the POD. Largemouth bass have become more abundant concurrent with the invasion of Brazilian waterweed *Egeria*, which has increased habitat for largemouth bass and other invasive species. Although the increase in largemouth bass seems an unlikely single cause for the POD declines, the increase may be a contributing factor and could make recovery more difficult. Entrainment at the SWP and CVP pumps also appears to be an unlikely single cause of the POD, but may be important for some species during certain years. Removal of pre-spawning delta smelt by the SWP and CVP pumps may be especially important. Recent analyses have focused on the importance of reverse flows in Old and Middle Rivers and the possible importance of turbidity as an environmental trigger for upstream migration of delta smelt and longfin smelt (Baxter et al. 2008).
- **Bottom-up effects.** Assumes that food web interactions affect survival and reproduction, and focuses on food availability and food web interactions (e.g., competition, invasives, nutrients, X2, food quality, and co-occurrence) in Suisun Bay and the west Delta. The importance of co-occurrence of fish with food continues to be a key area of interest. Much of this discussion of bottom-up effects in the conceptual model focuses on food resources for delta smelt. Overall, the total biomass of zooplankton has not changed substantially in delta smelt summer habitat; however, species composition reportedly has changed. New investigations focus on zooplankton availability (i.e., can delta smelt catch them) and whether there are differences in energetic profitability among prey (i.e., does it take more energy to catch) (Baxter et al. 2008).

An update to the POD work plan and synthesis of results also reports that an emerging conclusion is that POD was driven by multiple and interacting factors (Baxter et al. 2010). Consequently, two additional approaches are being considered. One approach focuses on how major drivers differ for each of the four POD species and their individual life stages. The second approach considers whether an ecological regime shift may be affecting the entire estuarine ecosystem and considers the effects of changing drivers through different historical periods leading up to the POD.

11.2 Regulatory Setting

This section provides the regulatory setting for aquatic resources, including potentially relevant federal, state, and local requirements applicable to the BDCP.

11.2.1 Federal Plans, Policies, and Regulations

11.2.1.1 Federal Endangered Species Act

The ESA requires that both USFWS and NMFS maintain lists of threatened and endangered species. An "endangered species" is defined as "…any species which is in danger of extinction throughout all or a significant portion of its range." A "threatened species" is defined as "…any species that is likely to become an Endangered Species within the foreseeable future throughout all or a significant portion of its range" (Title 16 U.S. Code [USC] Section 1532). Section 9 of the ESA makes it illegal to "take" (i.e., harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in such conduct) any endangered species of fish or wildlife, and regulations contain similar provisions for most threatened species of fish and wildlife (16 USC 1538).

The ESA also requires the designation of "critical habitat" for listed species. "Critical habitat" is defined as: (1) specific areas within the geographical area occupied by the species at the time of listing, if they contain physical or biological features essential for the conservation of the species, and those features may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species if the agency determines that the area itself is essential for conservation of the species (U.S. Fish and Wildlife Service and National Marine Fisheries Service 1998:xiii; National Marine Fisheries Service 2009a).

Section 7 (a)(2) of the ESA requires all federal agencies to ensure that any action they authorize, fund, or carry-out is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of designated critical habitat. To ensure against jeopardy, each federal agency must consult with USFWS or NMFS, or both, if the federal agency determines that its action might affect listed species. NMFS jurisdiction under the ESA is limited to the protection of marine mammals, marine fish, and anadromous fish; all other species are within USFWS jurisdiction.

If an activity proposed by a federal agency would result in the take of a federally listed species, the consulting agency will issue a Biological Opinion analyzing the effects of the proposed action on listed species and an Incidental Take Statement if appropriate. The Incidental Take Statement typically requires various measures to avoid and minimize species take.

Where a federal agency is not authorizing, funding, or carrying out a project, take that is incidental to the lawful operation of a project may be permitted pursuant to Section 10(a) of the ESA through approval of an HCP and issuance of an incidental take permit.

Critical Habitat Designations for Species

Delta smelt critical habitat was designated on December 19, 1994 (59 FR 65256), and includes "areas of all water and all submerged lands below ordinary high water and the entire water column bounded by and constrained in Suisun Bay (including the contiguous Grizzly and Honker Bays); the length of Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma sloughs; and the existing contiguous waters contained within the Delta."

NMFS designated critical habitat for winter-run Chinook salmon on June 16, 1993 (58 FR 33212). Critical habitat was delineated as the Sacramento River from Keswick Dam at river mile (RM) 302 to Chipps Island (RM 0) at the westward margin of the Sacramento-San Joaquin Delta (Delta), including Kimball Island, Winter Island, and Brown's Island; all waters from Chipps Island westward to the Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and the Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge, and all waters of San Francisco Bay north of the San Francisco-Oakland Bay Bridge. In the Sacramento River, critical habitat includes the river water column and substrate and the adjacent riparian zone. Westward of Chipps Island, critical habitat includes the estuarine water column and essential foraging habitat and food resources used by Sacramento River winter-run Chinook salmon as part of their juvenile emigration or adult spawning migration.

Critical habitat was designated for Central Valley spring-run Chinook salmon on September 2, 2005 (70 FR 52488). Critical habitat for Central Valley spring-run Chinook salmon occurs in the Plan Area, and includes stream reaches such as those of the Feather and Yuba rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear creeks, the main stem of the Sacramento River from Keswick Dam through the Delta; and portions of the network of channels in the northern Delta. Critical habitat includes the stream channels in these designated waters up to the ordinary high-water line or bankfull elevation (elevation generally with a recurrence interval of 1 to 2 years).

Critical habitat was designated for steelhead in the Central Valley on September 2, 2005 (70 FR 52488). Critical habitat for Central Valley steelhead occurs within the Plan Area, and includes the stream channels to the ordinary high water line within designated stream reaches such as those of the American, Feather, and Yuba rivers, and Deer, Mill, Battle, Antelope, and Clear creeks in the Sacramento River basin; the Calaveras, Mokelumne, Stanislaus, and Tuolumne rivers in the San Joaquin River basin; and the Sacramento and San Joaquin rivers and the entire Delta.

Critical habitat was designated for the southern DPS of North American green sturgeon on October 9, 2009, (74 FR 52345). The designation includes the stream channels and waterways in the Sacramento – San Joaquin River Delta to the ordinary high water line, and also includes the main stem Sacramento River upstream from the I Street Bridge to Keswick Dam, and the Feather River upstream to the fish barrier dam adjacent to the Feather River Fish Hatchery, as well as the estuaries of San Francisco Bay, Suisun Bay, and San Pablo Bays.

11.2.1.2 Long-Term Central Valley 2008 and 2009 USFWS and NMFS Biological Opinions

In 2008, Reclamation and DWR prepared a Biological Assessment on the continued long- term operation of the CVP and SWP. The Biological Assessment described how Reclamation and DWR intended to operate the CVP and the SWP to divert, store, and convey water consistent with applicable law from 2008 through 2025 (Bureau of Reclamation 2008a).

U.S. Fish and Wildlife Service Biological Opinion

The 2008 USFWS BiOp concurred with Reclamation's determination that the coordinated operations of the SWP and CVP are not likely to adversely affect listed species, with the exception of delta smelt (U.S. Fish and Wildlife Service 2008). The USFWS concluded that the coordinated operation of the

SWP and CVP, as proposed, was likely to jeopardize the continued existence of the delta smelt, and adversely modify delta smelt critical habitat.

The USFWS, in cooperation with Reclamation, developed a reasonable and prudent alternative (RPA), consisting of a number of components and actions to avoid the likelihood of jeopardizing the continued existence or the destruction or adverse modification of critical habitat for delta smelt. These actions include: (1) preventing/reducing entrainment of delta smelt at Jones and Banks pumping plants; (2) providing adequate habitat conditions that will allow the adult delta smelt to successfully migrate and spawn in the Bay-Delta; (3) providing adequate habitat conditions that will allow larvae and juvenile delta smelt to rear; and (4) providing suitable habitat conditions that will allow successful recruitment of juvenile delta smelt to adulthood. In addition, USFWS specified that it is essential to monitor delta smelt abundance and distribution through continued sampling programs through the IEP. The RPA reduced reverse flows in Old and Middle Rivers, channels leading to the state and federal diversions, when delta smelt are at increased risk of entrainment. Limiting reverse flows may reduce pump operations and can limit or delay deliveries of water to SWP and CVP contractors south of the Delta.

In March, 2009, SWP and CVP contractors and others filed lawsuits in federal court challenging the 2008 BiOp. On December 14, 2010, Judge Wanger issued a Memorandum Decision on cross motions for summary judgment in litigation concerning the USFWS 2008 BiOp which found several aspects of the BiOp flawed and directed that they be addressed on remand. An amended Final Judgement issued May 28, 2011 remanded the BiOp to USFWS for further consideration and directed USFWS to issue a revised BiOp in accordance with the Memorandum Decision.

The operations of the SWP and CVP are currently subject to the terms and conditions of this BiOp until a new BiOp is issued.

National Marine Fisheries Service Biological Opinion

The NMFS BiOp (National Marine Fisheries Service 2009a) concluded that the SWP and CVP operations are likely to jeopardize the continued existence of the species listed below.

- Sacramento River winter-run Chinook salmon
- Central Valley spring-run Chinook salmon
- Central Valley steelhead
- Southern DPS of North American green sturgeon
- Southern resident killer whale

NMFS (2009a) also concluded that the proposed action is likely to destroy or adversely modify the designated critical habitats of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and green sturgeon.

The operations of the SWP and CVP are currently subject to the RPA and terms and conditions of this BiOp, until a new BiOp is issued. The actions included in the RPA to the proposed action are summarized below (National Marine Fisheries Service 2009a).

- A new year-round temperature and Shasta Reservoir storage management program to minimize effects on endangered winter-run Chinook salmon that spawn only in the Sacramento River, as well as long-term passage prescriptions at Shasta Dam and re-introduction of winter-run Chinook salmon to its native habitat in the McCloud River and/or upper Sacramento River.

- Maintenance of current flow and water temperature conditions in Clear Creek.
- Modified RBDD gate operations while an alternative diversion structure is being built; complete gate removal by 2012.
- Short-term and long-term actions for improving juvenile rearing habitat in the lower Sacramento River and northern Delta.
- Additional DCC gate closures to keep young fish out of artificial channels in the Delta and allow them to migrate safely toward the ocean.
- New Old and Middle River reverse flow levels to limit the strength of reverse flows and reduced entrainment at the SWP and CVP facilities.
- Use of additional technological measures at the SWP and CVP facilities to enhance screening and increase survival of fish.
- Additional measures to improve survival of San Joaquin steelhead smolts, including increased San Joaquin River flows and export curtailments, and a new study of acoustic tagged fish in the San Joaquin River Basin to evaluate and refine these measures.
- A new American River flow management standard, temperature management plan, additional technological fixes to temperature control structures, and, in the long-term, restoration of steelhead passage at Nimbus and Folsom Dams.
- A year-round minimum flow regime on the Stanislaus River necessary to minimize project effects on each life stage of steelhead, including new springtime flows that will support rearing habitat formation and inundation, and create pulses that allow salmon to migrate out successfully.
- Development of hatchery genetic management plans to increase the diversity, and therefore, resiliency of salmon to withstand a wide range of conditions.

11.2.1.3 Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act (Public Law 104 to 297), was enacted primarily to establish a management system for conserving and managing commercial fisheries within the 200-mile federal waters boundary of the United States. The act also requires that all federal agencies consult with NMFS on activities or proposed activities authorized, funded, or undertaken by that agency that may adversely affect essential fish habitat (EFH) of commercially managed marine and anadromous fish species. EFH includes specifically identified waters and substrate necessary for fish spawning, breeding, feeding, or growing to maturity. EFH also includes all habitats necessary to allow the production of commercially valuable aquatic species, to support a long-term sustainable fishery, and contribute to a healthy ecosystem (16 USC 1802[10]).

The Pacific Fishery Management Council has designated the Delta, San Francisco Bay, and Suisun Bay as EFH to protect and enhance habitat for coastal marine fish and macroinvertebrate species that support commercial fisheries such as Pacific salmon. Because EFH only applies to commercial fisheries, this means that all Chinook salmon habitats are included, but not steelhead habitat. There are three fishery management plans (for Pacific salmon, coastal pelagic, and groundfish species) issued by the Pacific Fishery Management Council that cover species occurring in the project area, and designate EFH within the entire Bay-Delta Estuary:

- Starry flounder and northern anchovy – Identified as a Monitored Species by the Pacific Coast Groundfish Fishery Management Plan (Pacific Fishery Management Council 1998, 2008)
- Pacific Sardine – Identified as an Actively Managed Species by the Coastal Pelagic Species Fishery Management Plan (Pacific Fishery Management Council 1998)
- Pacific salmon – Identified as an Actively Managed Species by the Pacific Coast Salmon Plan (Pacific Fishery Management Council 2003)

The northern anchovy and starry flounder are managed as Monitored Species by the Coastal Pelagic Species Fishery Management Plan and the Pacific Coast Groundfish Fishery Management Plan of the Pacific Fishery Management Council, respectively, and are subject to EFH consultation as a result.

Although groundfish or coastal pelagic species EFH does not occur in the Plan Area, the Plan Area is within the region identified as EFH for Pacific salmon in Amendment 14 of the Pacific Salmon Fisheries Management Plan. Freshwater EFH for Pacific salmon (Sacramento River winter-run, Central Valley spring-run, and Central Valley fall-/late fall-run Chinook salmon) in the Plan Area includes waters currently or historically accessible to salmon within the Central Valley ecosystem as described in Myers et al. (1998).

11.2.1.4 Recovery Plan for Sacramento-San Joaquin Delta Native Fish Species

Since the *Recovery Plan for Sacramento-San Joaquin Delta Native Fishes* was released in 1996 (U.S. Fish and Wildlife Service 1996), new information regarding the status, biology, and threats to Delta native species has emerged (California Department of Fish and Game 2008b). Ongoing revision of the plan will review the new information and develop a strategy for the conservation and restoration of Delta native fish through the identification of recovery actions that specifically address the threats to their existence. Species covered by this plan are delta smelt, longfin smelt, Sacramento splittail, and Sacramento perch.

The basic goal of the plan is to establish self-sustaining populations of the species of concern that will persist indefinitely (U.S. Fish and Wildlife Service 1996). A variety of actions may be needed to achieve this goal. To be effective, recovery planning must consider not only species or assemblages of species but also habitat components, specifically their structure, function and change processes. Restoration actions may also include the establishment of genetic refugia for delta smelt (California Department of Fish and Game 2008b).

11.2.1.5 Recovery Planning for Salmon and Steelhead in California

The public *Draft Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of Central Valley Steelhead* was released in October 2009 (National Marine Fisheries Service 2009b). The California Central Valley Recovery Domain extends from the upper Sacramento River Valley to the northern portion of the San Joaquin River Valley (National Marine Fisheries Service 2009b).

For the Central Valley Chinook salmon ESUs and the steelhead DPS to achieve recovery, each diversity group must be represented, and population redundancy within the groups must be met to achieve diversity group recovery. Several priority recovery actions to address specific limiting factors were identified by NMFS (2009b) to help meet recovery objectives.

- Protect and restore watershed and estuarine habitat complexity and connectivity.
- Improve understanding of life stage survival through focused research and monitoring.
- Establish at least two additional populations of winter-run Chinook salmon that are spatially diverse and secure from natural and human-made threats.
- Develop more effective and efficient federal and state mechanisms to correct already documented threats to listed salmonids.
- Collaboratively balance water supply and allocation with fisheries' needs through improving criteria for water drafting, storage and dam operations, water right programs, development of passive diversion devices and/or offstream storage, elimination of illegal diversions in priority watersheds and streams, and other such opportunities.
- Screening appropriate water diversions and providing adequate downstream flows.
- Provide outreach to federal action agencies regarding ESA Section 7(a)(1) and carrying out programs to conserve and recover federally listed salmonids.
- Identify and treat point and non-point source pollution to streams from wastewater, agricultural practices, and urban environments.

11.2.1.6 Recovery Planning for Green Sturgeon

A federal recovery outline has been written for the North American green sturgeon southern district population segment (NMFS 2010). The recovery plan draft has not been released.

The Green Sturgeon Recovery Team's vision statement is: "Healthy, self-sustained, viable populations of southern DPS green sturgeon exist within their historic range. This includes spawning in multiple rivers, with the DPS represented by multiple strong year-classes. These green sturgeon are sufficiently abundant, productive, and diverse in healthy ecosystems to provide ecological and public benefits."

Several key recovery needs and implementation measures to address specific limiting factors were identified by NMFS (2010) to help meet recovery objectives.

Additional spawning and egg/larval habitat

- Restore access to suitable habitat
- Improve potential habitat
- Establish additional spawning populations
- Ensure adequate spatial separation of spawning populations
- Ensure all spawning populations are of sufficient size to meet genetic diversity criteria

Research/Monitoring

- Determine current and future population abundance and distribution of all life stages

- Obtain data needed for population viability assessment
- Determine fisheries-specific discard mortality rates and effects of capture
- Identify feeding habitats and prey resources
- Determine effects of non-native species
- Determine contaminant exposure and its effects
- Determine potential effects from proposed nearshore ocean energy projects
- Determine risk from sea lion predation

11.2.1.7 Fish and Wildlife Coordination Act (16 USC Section 651 et seq.)

The Fish and Wildlife Coordination Act (FWCA) gives the U.S. Secretary of the Interior the authority to provide assistance to federal, state, public, or private agencies in developing, protecting, rearing, or stocking all wildlife, wildlife resources, and their habitats (16 USC 661). Under the FWCA, whenever waters of any stream or other water body are proposed to be impounded, diverted, or otherwise modified by any public or private agency under federal permit, that agency must consult with USFWS and, in California, CDFW (16 USC 661-667e, March 10, 1934, as amended 1946, 1958, 1978, and 1995). Coordination and consultation among the USACE, USFWS, and CDFW under the FWCA has taken place and will continue to do so over the course of the environmental process for the BDCP.

11.2.1.8 Clean Water Act

The Clean Water Act (CWA) is a comprehensive set of statutes aimed at restoring and maintaining the chemical, physical, and biological integrity of the nation's waters. The CWA is the foundation of surface water quality protection in the United States (U.S. Environmental Protection Agency 2008) Initial authority for the implementation and enforcement of the CWA rests with the U.S. Environmental Protection Agency (USEPA); however, this authority can be exercised by states with approved regulatory programs. In California, this authority is exercised by the State Water Board and the Regional Water Quality Control Boards (Regional Water Boards).

The CWA contains a variety of regulatory and non-regulatory tools to significantly reduce direct pollutant discharges into waters of the United States, to finance municipal wastewater treatment facilities, and to manage polluted runoff. These tools (e.g., Section 303[d] List of Impaired Waters and Section 404 permitting process) are employed to achieve the broader goal of restoring and maintaining the chemical, physical, and biological integrity of the nation's waters so that they can support "the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water."

Constituents of Concern Listed Under Clean Water Act Section 303(d)

Section 303(d) of the federal CWA requires states to identify water bodies that do not meet water quality standards and are not supporting their designated beneficial uses. These waters are placed on the Section 303(d) List of Impaired Waters. This list defines low, medium, and high priority pollutants that require immediate attention by federal and state agencies. Placement on this list triggers development of a Total Maximum Daily Load (TMDL) Program for each water body and associated pollutant/stressor on the list. The Central Valley Regional Water Quality Control Board

(Central Valley Water Board) is responsible for implementing the TMDL Program in California. Completed or ongoing TMDLs in the Bay-Delta region include chlorpyrifos and diazinon, DO, mercury/methylmercury, pathogens, pesticides, organochlorine pesticides, salt and boron, and selenium (Central Valley Regional Water Quality Control Board 2010). For further information on TMDLs in the Bay-Delta region, refer to Chapter 8, *Water Quality*.

Clean Water Act Section 404

Section 404 of the CWA authorizes the USACE and the EPA to issue permits to regulate the discharge of "dredged or fill materials into waters of the United States" (33 USC 1344). Should activities such as dredging or filling of wetlands or surface waters be required for project implementation, then permits obtained in compliance with CWA Section 404 would be required for the project applicant(s).

Clean Water Act Section 401

Section 401 of the CWA specifies that states must certify that any activity subject to a permit issued by a federal agency (e.g., USACE) meets all state water quality standards. In California, the State Water Board and the Regional Water Boards are responsible for certifying activities subject to any permit issued by the USACE pursuant to Section 404 or pursuant to Section 10 of the Rivers and Harbors Act of 1899.

11.2.1.9 Rivers and Harbors Act of 1899

Regulated under the CWA, the Rivers and Harbors Act of 1899 makes it unlawful to excavate, fill, or alter the course, condition, or capacity of any port, harbor, channel, or other areas within the reach of the act without a permit. Under Section 10 of the Rivers and Harbor Act, the USACE regulates all structures and work in navigable waters.

11.2.1.10 Executive Order 11990 – Protection of Wetlands

Executive Order 11990 calls for each federal agency, in carrying out its ordinary responsibilities, to take actions to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands. Federal agencies must avoid undertaking new construction located in wetlands unless no practicable alternative is available and the action includes all practicable measures to minimize harm to wetlands.

11.2.1.11 Central Valley Project Improvement Act

The Reclamation Projects Authorization and Adjustment Act of 1992 (Public Law 102-575), includes Title 34, the CVPIA. The CVPIA amends the authorization of the CVP to include fish and wildlife protection, restoration, and mitigation as project purposes of the CVP having equal priority with irrigation and domestic uses of CVP water and elevates fish and wildlife enhancement to a level having equal purpose with power generation. Among the changes mandated by the CVPIA was dedication of 800 thousand acre-feet of CVP yield annually to fish, wildlife, and habitat restoration. The Department of the Interior's May 9, 2003 decision on implementation of Section 3406(b)(2) of CVPIA explains how Section 3406(b)(2) water will be dedicated and managed. Dedication of CVPIA 3406(b)(2) water occurs when Reclamation takes a fish and wildlife habitat restoration action based on recommendations of USFWS (and in consultation with NMFS and CDFW), pursuant to Section

3406 (b)(2). Water exports at the CVP pumping facilities have been reduced using (b)(2) water to decrease the risk of fish entrainment at the salvage facilities and also to augment river flows.

11.2.1.12 Anadromous Fish Restoration Program

An important goal identified to meet the fish and wildlife purposes of the CVPIA is to restore natural populations of anadromous fish (e.g., Chinook salmon, steelhead, green sturgeon, white sturgeon, American shad, and striped bass) in Central Valley rivers and streams to double their recent average abundance levels. The CVPIA directs the Secretary of the Interior to develop and implement a program, known as the Anadromous Fish Restoration Program, to ensure the sustainability of anadromous fish in Central Valley rivers and streams.

11.2.1.13 National Invasive Species Act of 1996

The National Invasive Species Act (Public Law 104-332), reauthorizes and amends the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 to mandate regulations to reduce environmental and economic impacts from invasive species and to prevent introduction and spread of aquatic nuisance species, primarily through ballast water. The primary federal law regulating ballast water discharges, the act calls primarily for voluntary ballast water exchange by vessels entering the United States after operating outside of the Exclusive Economic Zone.

The authority to regulate ballast water discharges in the United States has recently shifted to include the USEPA in addition to the U.S. Coast Guard. Since February 2009, the USEPA must regulate ballast water, and other discharges incidental to normal vessel operations, under the CWA. U.S. Coast Guard regulations, developed under authority of the revised and reauthorized act, also require ballast water management (i.e., ballast water exchange) for vessels entering United States waters from outside of the 200-nautical mile Exclusive Economic Zone of the United States. Vessels that experience undue delay are exempted from the ballast water management requirements. The act also authorized funding for research on aquatic nuisance species prevention and control in the Bay-Delta, the Pacific Coast, and other areas of the United States.

11.2.2 State Plans, Policies, and Regulations

11.2.2.1 California Endangered Species Act

CESA (Fish and Game Code Sections 2050 to 2089) establishes various requirements and protections regarding species listed as threatened or endangered under state law. California's Fish and Game Commission is responsible for maintaining lists of threatened and endangered species under CESA. CESA prohibits the "take" of listed and candidate (petitioned to be listed) species (Fish and Game Code Section 2080). In accordance with Section 2081 of the California Fish and Game Code, a permit from CDFW is required for projects "that could result in the incidental take of a wildlife species state-listed as threatened or endangered". "Take" under California law means to "…hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch capture, or kill…" (Fish and Game Code Section 86). The state definition does not include "harm" or "harass," as the federal definition does. As a result, the threshold for take under CESA is typically higher than that under the federal ESA. Therefore, the CESA requirements would be met by complying with federal ESA requirements, as is the case with the SWP complying with the USFWS and NMFS BiOps.

11.2.2.2 Fully Protected Species under the California Fish and Game Code

Protection of fully protected species is described in four sections of the Fish and Game Code that lists 37 fully protected species (Fish and Game Code Sections 3511, 4700, 5050, and 5515). These statutes prohibit take or possession of fully protected species at any time. CDFW is unable to authorize incidental take of fully protected species when activities are proposed in areas inhabited by these species, except pursuant to an approved Natural Community Conservation Plan. Fish and Game Code section 5515 provides that the following fish species are fully protected:

(1) Colorado River squawfish (*Ptychocheilus lucius*).

(2) Thicktail chub (*Gila crassicauda*).

(3) Mohave chub (*Gila mohavensis*).

(4) Lost River sucker (*Catostomus luxatus*).

(5) Modoc sucker (*Catostomus microps*).

(6) Shortnose sucker (*Chasmistes brevirostris*).

(7) Humpback sucker (*Xyrauchen texanus*).

(8) Owens River pupfish (*Cyprinoden radiosus*).

(9) Unarmored threespine stickleback (*Gasterosteus aculeatus williamsoni*).

(10) Rough sculpin (*Cottus asperrimus*).

11.2.2.3 California Fish and Game Code Section 1602 – Lake and Streambed Alteration Program

Diversions, obstructions, or changes to the natural flow or bed, channel, or bank of any river, stream, or lake in California that supports wildlife resources are subject to regulation by CDFW, pursuant to Section 1600 of the California Fish and Game Code. The regulatory definition of a stream is a body of water that flows at least periodically or intermittently through a bed or channel having banks and supports wildlife, fish, or other aquatic life. This includes watercourses having a surface or subsurface flow that supports or has supported riparian vegetation. CDFW's jurisdiction within altered or artificial waterways is based on the value of those waterways to fish and wildlife.

11.2.2.4 The Salmon, Steelhead Trout, and Anadromous Fisheries Program Act

Enacted in 1988, the Salmon, Steelhead Trout, and Anadromous Fisheries Program Act was implemented in response to reports that the natural production of salmon and steelhead in California had declined dramatically since the 1940s, primarily as a result of lost stream habitat on many streams in the State. The Salmon, Steelhead Trout, and Anadromous Fisheries Program Act declares that it is the policy of the State of California to increase the State's salmon and steelhead resources, and directs CDFW to develop a plan and program that strives to double the salmon and steelhead resources (Fish and Game Code Section 6902[a]). It is also the policy of the State that existing natural salmon and steelhead habitat shall not be diminished further without offsetting the impacts of lost habitat (Fish and Game Code Section 6902[c]).

11.2.2.5 Marine Invasive Species Act

The Marine Invasive Species Act of 2003 (Assembly Bill 433) revised and expanded the Ballast Water Management for Control of Nonindigenous Species Act of 1999 to more effectively address the threat of nonindigenous species introductions. The law charged the California State Lands Commission with oversight of the State's program to prevent or minimize the introduction of nonindigenous species from commercial vessels. The Marine Invasive Species Act requires all vessels over 300 gross registered tons that arrive at a California port or location to have a ballast water management plan and ballast tank logbook specific to the vessel. A ballast water reporting form detailing the ballast water management practices must be submitted by each vessel upon departure from each port of call in California. Since July 2006, over 22,000 reporting forms have been submitted to the California State Lands Commission. To verify that vessels have submitted reporting forms, received forms are matched with arrival data from the State's Marine Exchanges (Falkner et al. 2009). The 2009 *Biennial Report on the California Marine Invasive Species Program* reports that rates with ballast water management requirements in California remained extremely high from mid-2006 to mid-2008; between about 85 and 98% of vessel-reported ballast water carried into California waters was managed through legal ballast water exchange and was in compliance with California law (Falkner et al. 2009).

11.2.2.6 Natural Community Conservation Planning Act

The Natural Community Conservation Planning Act (NCCPA) authorizes the NCCP Program, which is designed to promote conservation of natural communities at the ecosystem scale, while accommodating compatible land use. The NCCP Program is broader in its orientation and objectives than the CESA and ESA (California Department of Fish and Game 2010d). The ESA laws are designed to identify and protect individual species that have already significantly declined in number, while the primary objective of the NCCP program is to conserve natural communities at the ecosystem level while accommodating compatible land use (California Department of Fish and Game 2010d). The program seeks to anticipate and prevent the controversies and gridlock caused by species' listings by focusing on the long-term stability of wildlife and plant communities and including key interests in the process (California Department of Fish and Game 2010d). Working with landowners, environmental organizations, and other interested parties, a local agency oversees the numerous activities that compose the development of a conservation plan. CDFW and USFWS provide the necessary support, direction, and guidance to NCCP participants (California Department of Fish and Game 2010d).

11.2.2.7 California Aquatic Invasive Species Management Plan

The California Aquatic Invasive Species Management Plan State surveys indicate that at least 607 species of aquatic invasive species can be found in California's estuarine waters. These invaders cause major impacts: disrupting agriculture, shipping, water delivery, recreational and commercial fishing; undermining levees, docks, and environmental restoration activities; impeding navigation and enjoyment of the State's waterways; and damaging native habitats and the species that depend on them. As the ease of transporting organisms across the Americas and around the globe has increased, so has the rate of aquatic species introductions (California Department of Fish and Game 2008c). The California Aquatic Invasive Species Management Plan meets federal requirements to develop statewide nonindigenous aquatic nuisance species management plans under Section 1204 of the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990. The Plan identifies the steps that need to be taken to minimize the harmful ecological, economic, and human health impacts of aquatic invasive species in California by providing a comprehensive, coordinated effort to prevent new invasions, minimize impacts from established aquatic invasive species, and establish priorities for action statewide.

11.2.2.8 Central Valley Flood Protection Board

The Central Valley Flood Protection Board (CVFPB) (formerly the California Reclamation Board) of the State of California regulates the modification and construction of levees and floodways in the Central Valley defined as part of the Sacramento Valley and San Joaquin Valley flood control projects. Rules promulgated in Title 23 of the California Code of Regulations (CCR) (Title 23, Division 1, Article 8 [Sections 111–137]) regulate the modification and construction of levees to ensure public safety. The rules state that existing levees may not be excavated or left partially excavated during the flood season, which is generally November 1–April 15 for the Plan Area levees.

According to California Government Code Sections 65302.9 and 65860.1, every jurisdiction located within the Sacramento–San Joaquin Valley is required to update its General Plan and Zoning Ordinance in a manner consistent with the Central Valley Flood Protection Plan (CVFPP) In addition, the locations of the state and local flood management facilities, locations of flood hazard zones, and the properties located in these areas must be mapped and consistent with the CVFPP.

11.2.2.9 Sacramento–San Joaquin Delta Reform Act of 2009

In late 2009, the California Legislature enacted a package of related water bills that included the Sacramento–San Joaquin Delta Reform Act of 2009 (Delta Reform Act). One of the many objectives of the Delta Reform Act is to "[r]estore the Delta ecosystem, including its fisheries and wildlife, as the heart of a healthy estuary and wetland ecosystem." The Delta Reform Act also addressed issues that should be considered in the development of the EIR alternatives if, under California Water Code section 85320, the BDCP is to be included by operation of law within the Delta Plan prepared by the Delta Stewardship Council (DSC). To qualify for inclusion in the BDCP under this process, the BDCP must take the form of an NCCP under California law and a HCP under federal law. The EIR for the BDCP must address, among other topics, "[t]he potential effects on migratory fish and aquatic resources."

11.2.3 Regional and Local Plans, Policies, and Regulations

11.2.3.1 CALFED Bay-Delta Program

The CALFED Program is a collaborative effort of over 20 federal and state agencies focusing on restoring the ecological health of the Bay-Delta while ensuring water quality improvements and water supply reliability to all users of the Bay-Delta water resources. The CALFED Program includes a range of balanced actions that are used in a comprehensive, multi-agency approach to managing Bay-Delta resources (California Department of Fish and Game 2008b). The objectives of the CALFED Program are listed below.

- Provide good water quality for all beneficial uses
- Improve and increase aquatic and terrestrial habitats and improve ecological functions in the Bay-Delta to support sustainable populations of diverse and valuable plant and animal species

- Reduce the mismatch between Bay-Delta water supplies and current and projected beneficial uses dependent on the Bay-Delta system
- Reduce the risk to land use and associated economic activities, water supply, infrastructure, and the ecosystem from catastrophic breaching of Delta levees

The program objectives have been implemented among numerous CALFED Program elements since the CALFED Program Record of Decision was issued in 2000 (CALFED Bay-Delta Program 2000c).

11.2.3.2 CALFED Levee System Integrity Program

CALFED's Levee System Integrity Program provides long-term protection for vast resources in the Delta by maintaining and improving the integrity of the estuary's extensive levee system.

11.2.3.3 Environmental Water Account

The CALFED Program Record of Decision (2000c) identified an Environmental Water Account (EWA) as one element of its overall strategy for meeting the goals of the CALFED Program (Bureau of Reclamation 2008b). The EWA was a cooperative management program to protect the fish of the Bay-Delta through environmentally beneficial changes in SWP and CVP operations at no uncompensated water cost to SWP and CVP water users. The EWA consisted of two primary elements: (1) assisting in protecting and restoring at-risk native fish species; and (2) increasing water supply reliability for SWP and CVP water service contractors by reducing uncertainty associated with fish protective actions. To accomplish these two elements, the EWA helped protect/restore at-risk fish by primarily curtailing pumping at the Banks and Jones pumping plants, and helped ensure water supply reliability by purchasing water from willing sellers used to replace contract water supplies not diverted from the Delta during pumping curtailments (U.S. Bureau of Reclamation 2010). The EWA was implemented until 2007.

11.2.3.4 CALFED Ecosystem Restoration Program Conservation Strategy

The Ecosystem Restoration Program (ERP) is the principal CALFED Program component designed to restore the ecological health of the Bay-Delta ecosystem. The approach of the ERP is to restore or mimic ecological processes and to increase and improve aquatic and terrestrial habitats to support stable, self-sustaining populations of diverse and valuable species (California Department of Fish and Game 2008b). Stage 1 of the ERP Conservation Strategy is being used to facilitate coordination and integration of actions, not only within CALFED, but among all resource planning, conservation, and management decisions affecting the Delta, Suisun Marsh, and San Francisco Bay planning areas (California Department of Fish and Game 2008b). The Conservation Strategy is essentially the guidance to plan activities for Stage 2 of the ERP concerning the Delta and Suisun Marsh, and has evolved into the Delta Regional Ecosystem Restoration Implementation Plan (DRERIP).

CALFED End of Stage 1 Report/Stage 2 Planning

The End of Stage 1 Evaluation, produced by the CALFED Program staff (CALFED 2007), qualitatively assessed the effectiveness of actions that met program objectives during Stage 1 of the ERP and if these actions will allow the Program to meet future objectives (CALFED 2007). This assessment will be used to assist with Stage 2 planning.

Delta Regional Ecosystem Restoration Implementation Plan

The original intent of the ERP was to develop multiple implementation plans, including one for the Delta. The DRERIP serves to refine the planning foundation specific to the Delta, refine existing Delta-specific restoration actions and provide Delta-specific implementation guidance, program tracking, performance evaluation and adaptive management feedback.

DRERIP implements adaptive management by incorporating scientific evaluation of restoration actions in light of the current state of knowledge and restoration projects implemented to date. The DRERIP science input process is divided into four phases: (1) process design; (2) development of species life history models and ecosystem element conceptual models; (3) development and evaluation of proposed ERP actions; and (4) analysis of the feasibility and prioritization of the actions.

11.2.3.5 CALFED Integrated Storage Investigation

DWR and Reclamation are conducting planning and feasibility studies to evaluate the five potential surface storage projects (e.g., the In-Delta Storage Project and Los Vaqueros Reservoir Expansion) identified in the CALFED Program Record of Decision. The goal of the storage investigation is to increase water supply reliability, improve water quality, and support ecosystem restoration through expanded storage capacity and increased operational flexibility. Additional surface storage will provide flexibility to the State's water management system, which can be operated to contribute to the long-term sustainability of the Delta ecosystem, maintaining water quality and supply reliability, and preventing and planning for catastrophic failure of the Delta levee system. With additional storage capacity and integrated operations, water diversion and deliveries also can be timed in ways that will allow for better response to the effects of earthquakes, floods, and climate change. The Los Vaqueros Reservoir Expansion project is now proceeding with construction (http://www.ccwater.com/lvexpansion/index.asp). The other projects are in various stages of investigation (http://www.water.ca.gov/storage/index.cfm).

11.2.3.6 Interagency Ecological Program Pelagic Organism Decline Studies and the CALFED State of the Bay-Delta Science Report

Since observation of the POD, numerous studies have been conducted to help understand and describe the processes, mechanisms, and interrelationships of the Delta ecosystem. An initial synthesis of this information has been compiled in two documents: the *Pelagic Fish Action Plan* (California Department of Water Resources and California Department of Fish and Wildlife 2007) and the *POD Synthesis Report* (Baxter et al. 2008). The first document includes actions that address the three possible categories of courses of the ecosystem decline being investigated by the IEP POD Team: water project operations, contaminants, and invasive species. The *State of Bay-Delta Science 2008* report is the CALFED Science Program's first extensive effort at compiling, synthesizing, and communicating the current scientific understanding of the San Francisco Bay Estuary and the Delta ecosystems (CALFED Bay-Delta Program 2008). The POD team has continued studies and evaluation. Their most recent work plan and synthesis of results was released in December 2010 (Baxter et al. 2010).

11.2.3.7 The Delta Plan

The Delta Stewardship Council (DSC) was created by SB 1X7, which made comprehensive changes to the governance of the Delta. The bill established that the Delta Stewardship Council has jurisdiction over land use projects in the Delta area. The DSC is composed of members who represent different parts of the State and offer diverse expertise in fields such as agriculture, science, the environment, and public service. Of the seven members, four are appointed by the Governor, one each by the Senate and Assembly, and the seventh is the chair of the Delta Protection Commission. In addition, they are advised by a 10-member board of nationally and internationally renowned scientists.

The mission of the DSC is to achieve coequal goals through development of a Delta Plan[2]. As stated in the California Water code, "'Coequal goals' means the two goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. The coequal goals shall be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place" (CA Water Code § 85054). The Delta Plan is a comprehensive, long-term management plan to achieve these goals for the Delta and it is anticipated to be one of the most complex and comprehensive planning efforts in the State's history.

The Delta Plan generally covers five topic areas and goals: increased water supply reliability, restoration of the Delta ecosystem, improved water quality, reduced risks of flooding in the Delta, and protection and enhancement of the Delta. The DSC does not propose constructing, owning, or operating any facilities related to these five topic areas. Rather, the Delta Plan sets forth regulatory policies and recommendations that seek to influence the actions, activities, and projects of cities and counties and state, federal, regional, and local agencies toward meeting the goals in the five topic areas.

The DSC is in the process of finalizing and approving the Delta Plan. Five draft plans were developed between January and August 2011. The Fifth Staff Draft Delta Plan, released in August 2011, consists of 12 policies and 61 recommendations, as well as other background information. The Final Draft of the Delta Plan was released on November 30, 2012, and the Proposed Final Delta Plan was released May 16, 2013.

11.2.3.8 Long-Term Management Strategy for Dredged Materials in the Delta

The Long Term Management Strategy for Dredged Materials in the Delta improves operational efficiency and coordination of the collective and individual agency decision-making responsibilities resulting in approved dredging and dredged material management actions in the Delta and San Francisco Bay. Approved dredging and dredged material management actions will take place in a manner that protects and enhances Delta water quality, identifies appropriate opportunities for the beneficial reuse of Delta sediments for levee rehabilitation and ecosystem restoration, and establishes safe disposal for materials that cannot be reused.

[2] Part 4 of the Sacramento–San Joaquin Delta Reform Act of 2009 describes the responsibilities of DSC with respect to the development of the Delta Plan

11.2.3.9 Assembly Bill 1200

Assembly Bill 1200 (2005) added Sections 139.2 and 139.4 to the California Water Code. These require DWR to evaluate the potential effects on water supplies derived from the Delta resulting from subsidence, earthquakes, floods, changes in precipitation, temperature, and ocean levels, and a combination of those effects.

11.2.3.10 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary

The 1995 State Water Board WQCP is one component of the comprehensive management package for the protection of the Bay-Delta's beneficial uses. The 1995 WQCP includes objectives for salinity (from saltwater intrusion and agricultural drainage), water project operations (flows and diversions), and DO levels in the Delta. Additionally, the 1994 Bay-Delta Accord committed the SWP and CVP to a set of water quality objectives that were eventually incorporated by the State Water Board into Water Right Decision 1641 (D-1641) (State Water Resources Control Board and U.S. Environmental Agency 2000). Significant new elements of D-1641 compared to Decision 1485 include: (1) spring X2 salinity standards; (2) export to inflow ratios; (3) DCC gate closures; (4) San Joaquin River standards; and (5) a recognition of the CALFED Operations Coordination Group process for operational flexibility in applying or relaxing certain protective standards. In March 2000, the State Water Board revised D-1641 amending the SWP and CVP water rights. In effect, D-1641 obligates the SWP and CVP to comply with the 1995 WQCP standards for fish and wildlife protection, municipal and industrial water quality, agricultural water quality, and Suisun Marsh Salinity Control (National Marine Fisheries Service 2004).

The State Water Board has previously adopted WQCPs and policies to protect water quality and control water resources, which affect the beneficial uses of the Bay-Delta. The 1995 WQCP supersedes both the 1978 D-1485 WQCP for the Delta and Suisun Marsh, and the 1991 WQCP for salinity in the Bay-Delta. The State Water Board adopted a new Bay-Delta WQCP on December 13, 2006. However, the 2006 WQCP made only minor changes to the 1995 WQCP. For these reasons, Bay-Delta Plan objectives and the resultant SWP and CVP operations required to meet those objectives, are incorporated into the hydrologic modeling assumptions used to characterize SWP and CVP operations as part of this study's hydrologic analyses of impacts on fisheries and aquatic resources. The 2006 WQCP is currently undergoing an update and implementation comprehensive review through CEQA environmental documentation in a State Water Board Substitute Environmental Document. As part of this review the State Water Board may also consider information that is produced as part of the BDCP.

11.2.3.11 Strategic Workplan for Activities in the Bay-Delta

During July 2008, the State Water Board adopted the Strategic Workplan for Activities in the San Francisco Bay/Sacramento San Joaquin Delta Estuary, which describes actions the State Water Board, the Central Valley Water Board, and the San Francisco Bay Regional Water Quality Control Board (collectively, the Water Boards) will take to protect beneficial uses in the Bay-Delta. Workplan activities are intended to: (1) implement the Water Boards' core water quality responsibilities; (2) continue meeting prior Water Board commitments; (3) be responsive to priorities identified by the Governor and the Delta Vision Blue Ribbon Task Force; and (4) build on existing processes, such as the BDCP.

Workplan activities include a suite of actions and are divided into nine broad elements that address: (1) water quality and contaminant control; (2) south Delta salinity and San Joaquin River flow objectives; (3) Suisun Marsh salinity objectives; (4) the BDCP, water rights, and other requirements to protect fish and wildlife beneficial uses; (5) SWP and CVP Delta diversion operations that are reasonable, beneficial, and protect the public trust; (6) water right compliance and enforcement to ensure adequate flows to meet water quality objectives; (7) actions to address water use efficiency for urban and agricultural water users; (8) development and implementation of a comprehensive monitoring program in the Delta; and (9) other actions (State Water Resources Control Board et al. 2008).

11.2.3.12 Delta Vision Strategic Plan

The intent of the Delta Vision process is to identify a strategy for managing the Delta as a sustainable ecosystem that will continue to support environmental and economic functions critical to the people of California (Governor's Delta Blue Ribbon Task Force 2008). The Governor's Delta Vision Blue Ribbon Task Force, a governor-appointed panel, is charged with developing recommendations on priority actions that should be taken to achieve a sustainable Delta in the long-term (California Department of Fish and Game 2008b). The Delta Vision has a broader focus than the ERP, and the Governor's Delta Blue Ribbon Task Force will issue recommendations that address the full array of natural resources, infrastructure, land use, and governance issues necessary to achieve a sustainable Delta. The Delta Vision is based on a growing consensus that: (1) environmental conditions and the current water conveyance configuration of the Delta are not sustainable for environmental and economic purposes; (2) current land and water uses and related services dependent on the Delta are not sustainable based on current management practices and regulatory requirements; (3) major "drivers of change" (e.g., seismic events, land subsidence, sea level rise, regional climate change, and urbanization) will affect the Delta in the future; (4) the current fragmented and complex governance systems within the Delta are not conducive to effective management of the Delta in light of these threats; and (5) failure to address these challenges and threats could result in significant environmental and economic consequences.

11.2.3.13 Local Habitat Conservation Plans and Natural Community Conservation Plans in the Delta

Regional HCPs establish a coordinated process for permitting and mitigating the incidental take of federal and state special-status species. This process creates an alternative to the current project-by-project approach. Rather than individually surveying, negotiating, and securing mitigation and permit coverage, project proponents typically receive an endangered species permit by paying a fee and/or dedicating land and performing limited surveys and avoidance measures.

Within the Delta, several local or regional HCPs and/or NCCPs have been developed, and are described below.

- ***CALFED Multi-Species Conservation Strategy*** – The MSCS identifies a process for development of Action Specific Implementation Plans to be prepared for each CALFED action or groups of actions as they are proposed for implementation. These plans are designed to provide the information necessary to initiate project-level compliance with the federal ESA, CESA, and NCCPA (CALFED Bay-Delta Program 2000b).
- ***East Contra Costa County HCP/NCCP*** – This approved HCP/NCCP was developed partially to address indirect and cumulative effects on terrestrial species from development supported by

increases in water supply provided by Contra Costa Water District. The HCP/NCCP permit area is primarily outside of the statutory Delta, with the exception of the Dutch Slough/Big Break area, lower Marsh Creek, and lower Kellogg Creek. Investments in land acquisition and habitat improvements are also focused outside of the statutory Delta. Fish species, including salmonids, were not covered in the HCP/NCCP. Impacts on fisheries are addressed through separate consultation and permitting (California Department of Fish and Game 2008b).

- ***Yolo County HCP/NCCP*** – This county-wide HCP/NCCP will provide for the conservation of between 70 to 80 species in five habitat types: wetland, riparian, oak woodland, grassland, and agriculture. No aquatic species are being addressed in this HCP; project-specific mitigation will be developed for projects affecting aquatic resources (California Department of Fish and Game 2008b). Draft environmental documentation is currently under development (Yolo Natural Heritage Foundation 2010).
- ***Solano Multispecies HCP*** – The Solano Multispecies HCP aims to address species conservation in conjunction with urban development and flood control/infrastructure improvement activities. Covered species include federally and state-listed fish species and other species of concern. The geographic scope includes lands within the statutory Delta. The administrative draft of the HCP was released in 2009 (Solano County Water Agency 2009).
- ***San Joaquin County Multi-Species Conservation Plan*** – This approved plan was developed to provide guidelines for converting open space to other land uses, preserving agriculture, and protecting species. The geographic scope includes lands within the statutory Delta (California Department of Fish and Game 2008b).

11.2.3.14 Suisun Marsh Charter and Habitat Management, Preservation, and Restoration Plan

Agencies with primary responsibility for actions in Suisun Marsh formed a Charter Group to develop a regional plan for Suisun Marsh (i.e., the *Suisun Marsh Habitat Management, Preservation, and Restoration Plan*) that would guide ongoing operations in managed wetlands, and protect and enhance Pacific Flyway and existing wildlife values, endangered species, and water project supply quality. Principal agencies include USFWS, NMFS, Reclamation, CDFW, DWR, and the California Bay-Delta Authority. Because Suisun Marsh includes private lands, the Suisun Resource Conservation District also serves on the Charter Group to represent the interests of private landowners. The Charter Group has also consulted other participating agencies, including the San Francisco Bay Conservation and Development Commission (BCDC), U.S. Geological Survey, USACE, San Francisco Bay-Delta Science Consortium, and the San Francisco Bay Water Board, in developing the Suisun Marsh Plan. The Bureau of Reclamation, USFWS and CDFW issued a Final EIS/EIR for this plan in December 2011. That plan recognizes its relationship to the BDCP process including the mutual objective of habitat protection and restoration for many of the same species. Similarly, the BDCP EIR/EIS recognizes the same relationship.

11.2.3.15 Regional Real-Time Decision Making and Information Sharing

Water Operations Management Team

The Water Operations Management Team (WOMT) is comprised of senior representatives from CDFW, USFWS, NMFS, DWR and Reclamation. The recommendations of the technical groups, along with summaries of supporting information are conveyed to WOMT. The team considers the recommendations of the technical groups, water supply costs and other factors and then provides DWR and Reclamation with appropriate operations guidance (CDFW no date).

WOMT has several technical teams that meet on a recurring basis. The technical teams analyze data and propose operation actions. A technical team can be associated with endangered species (delta smelt and winter-run Chinook salmon), real-time fish monitoring, or be a temporary workgroup formed to address a particular operation issue. (California Department of Water Resources 2013).

Fisheries and Operations Technical Teams

Delta Operations for Salmon and Sturgeon (DOSS)

The Delta Operations for Salmon and Sturgeon group is a technical advisory team that provides recommendations to Water Operation Management Team and NMFS on measures to reduce adverse effects of Delta operation of the CVP and SWP to salmonids and green sturgeon. The DOSS group shall also provide a coordinating function for the other technical working groups, to assure that relevant information from all technical groups is considered in actions. The DOSS group is comprised of biologists, hydrologists, and other staff with relevant expertise from Reclamation, DWR, CDFW, USFWS, and NMFS (NMFS 2013).

Smelt Working Group

The Smelt Working Group (SWG) evaluates biological and technical issues regarding delta smelt and longfin smelt and develops recommendations for consideration by USFWS. Since the longfin smelt became a state-listed species in 2009, the SWG has also developed recommendations for CDFW to minimize adverse effects on longfin smelt. The SWG consists of representatives from USFWS, CDFW, DWR, USEPA, and Reclamation. USFWS chairs the group, and members are assigned by each agency.

The SWG compiles and interprets the latest near real-time information regarding federally and state-listed smelt, such as stages of development, distribution, and salvage. After evaluating available information, and if they agree that a protection action is warranted, the SWG will submit their recommendations in writing to USFWS and CDFW. The SWG may meet at any time at the request of USFWS, but generally meets weekly during December through June, when smelt salvage at Jones and Banks pumping plants has occurred historically. However, the Delta Smelt Risk Assessment Matrix and Longfin Smelt Flow Measures (see below) outline the conditions when the SWG will convene to evaluate the necessity of protective actions and provide USFWS with recommendations. Further, with the State listing of longfin smelt, the group will also convene based on longfin smelt salvage history at the request of CDFW. The USFWS maintains a public record of SWG recommendations and its subsequent determinations on its website (http://www.fws.gov/sfbaydelta/ocap/).

Delta Smelt Risk Assessment Matrix

The SWG employs a Delta Smelt Risk Assessment Matrix (DSRAM) to assist in evaluating the need for operational modifications of SWP and CVP to protect delta smelt. This is a product and tool of the SWG, and will be modified by the SWG with the approval of USFWS, in consultation with Reclamation, DWR and CDFW, as new knowledge becomes available. The currently approved DSRAM is provided in Attachment A of Reclamation's 2008 long-term CVP/SWP Operation BA. If an action is taken, the SWG will follow up on the action to attempt to ascertain its effectiveness. The ultimate decision-making authority rests with USFWS. An assessment of effectiveness is attached to the notes from the SWG's discussion concerning the action.

Longfin Smelt Risk Assessment Matrix

As described above for delta smelt, the SWG employs a Longfin Smelt Risk Assessment Matrix to assist in evaluating the need for operational modifications of the SWP and CVP to protect longfin smelt during the December through May adult longfin smelt migration and spawning period, as well as the January through July period to protect larval and juvenile longfin smelt (California Fish and Game Commission 2008).

Sacramento River Temperature Task Group

The Sacramento River Temperature Task Group (SRTTG) is a multiagency group formed pursuant to State Water Resources Control Board (SWRCB) Water Rights Orders 90-5 and 91-1, to assist with improving and stabilizing Chinook population in the Sacramento River. Annually, Reclamation develops temperature operation plans for the Shasta and Trinity divisions of the CVP. These plans consider impacts on winter-run and other races of Chinook salmon, and associated project operations. The SRTTG meets initially in the spring to discuss biological, hydrologic, and operational information, objectives, and alternative operations plans for temperature control. Once the SRTTG has recommended an operation plan for temperature control, Reclamation then submits a report to the SWRCB, generally on or before June 1st each year. (NMFS 2013)

After implementation of the operation plan, the SRTTG may perform additional studies and commonly holds meetings as needed typically monthly through the summer and into fall. To develop revisions based on updated biological data, reservoir temperature profiles and operations data. Updated plans may be needed for summer operations protecting winter-run Chinook salmon, or in fall for fall-run Chinook salmon spawning season. If there are any changes in the plan, Reclamation submits a supplemental report to SWRCB. (NMFS 2013)

Clear Creek Technical Working Group

Since 1995, CVPIA and later CALFED have undertaken extensive habitat and flow restoration in Clear Creek. The restoration has increased stocks of fall Chinook and re-established populations of spring Chinook and steelhead. The Clear Creek Technical Team (CCTT) has been working since 1996 to facilitate implementation of CVPIA anadromous salmonid restoration actions. Members include Whiskeytown National Recreation Area, NMFS, USFWS, Reclamation, Bureau of Land Management, CDFW, DWR, RWQCB, Western Shasta Resource Conservation District, Point Reyes Bird Observatory and several consultant groups. Team attendance has varied over the years depending on what topics are being covered in the meetings. The majority of the topics have involved physical habitat restoration funded by CVPIA and CALFED (Brown 2011).

The objectives of the Clear Creek working group are as follows:

- Encourage spring-run movement to upstream Clear Creek habitat for spawning.
- Minimize project effects by enhancing and maintain previously degraded spawning habitat for spring-run and CV steelhead.
- Enhance and maintain previously degraded spawning habitat for spring-run and CV steelhead.

- Reduce adverse impacts of project operations on water temperature for listed salmonids in the Sacramento River.
- Reduce thermal stress to over-summering steelhead and spring-run during holding, spawning, and embryo incubation.
- Decrease risk to Clear Creek spring-run and CV steelhead population through improved flow management designed to implement state-of-the-art scientific analysis on habitat suitability. (Brown 2011)

Stanislaus Operations Group

The NMFS Biological Opinion (2011) calls for Reclamation to create a Stanislaus Operations Group to provide a forum for real-time operational flexibility and implementation of the alternative actions defined in the RPA. This group provides direction and oversight to ensure that the East Side Division actions are implemented, monitored for effectiveness and evaluated. Reclamation, in coordination with SOG, shall submit an annual summary of the status of these actions. Members of this group are from NMFS, Bureau of Reclamation, USFWS, CDFW, DWR, and SRCB (NMFS 2012). Also provide technical advice to WOMT.

American River Group

The American River Group conducts discussion regarding the biological and operational status of the lower American River, and provides information and formulates recommendations for the protection of fisheries and other instream resources. The group also provides input regarding operation of Folsom and Nimbus dams as part of the Central Valley Project (Water Forum 2007). The objectives for the American River as outlined by NMFS RPA Actions are as follows (Delta Council 2010):

- Provide minimum flows for all steelhead life stages.
- Maintain suitable temperatures to support over-summer rearing of juvenile steelhead in the lower American River.
- Reduce stranding and isolation of juvenile steelhead through ramping protocol.
- Reclamation and DWR shall participate in the design, implementation, and funding of the comprehensive CV steelhead monitoring program.

Other Groups

CALFED Operations and Subgroups

The CALFED "Ops Group" consists of the project agencies, the fishery agencies, State Water Board staff, and the USEPA. The CALFED Ops Group generally meets 11 times a year in a public setting so that the agencies can inform each other and stakeholders about current operations of the SWP and CVP, implementation of the CVPIA, ESA, and CESA, and additional actions to contribute to the conservation and protection of federally and state-listed species. The CALFED Ops Group held its first public meeting in January 1995, and during the next 6 years, the group developed and refined its process. The CALFED Ops Group has been recognized within State Water Board D-1641, and elsewhere, as one forum for coordination on decisions incorporated into the Delta standards for protection of beneficial uses (e.g., export/import [E/I] ratios and some DCC gate closures). Several teams were established through the Ops Group process, as described below.

Data Assessment Team

The Data Assessment Team (DAT) consists of technical staff members from the project and fishery agencies, as well as stakeholders. The DAT meets frequently during fall, winter, and spring. The purpose of the meetings is to coordinate and disseminate information and data among agencies and stakeholders that is related to water project operations, hydrology, and fish surveys in the Delta.

B2 Interagency Team

The B2 Interagency Team consists of technical staff members from the project agencies. The team meets weekly to discuss implementation of Section 3406 (b)(2) of the CVPIA, which defines the dedication of CVP water supply for environmental purposes. It communicates with the Water Operations Management Team to ensure coordination with the other operational programs or resource-related aspects of project operations, including flow and temperature issues.

Interagency Fish Passage Steering Committee

On June 4, 2009, the NMFS issued its Biological Opinion and Conference Opinion on the Long-Term Operations of the Central Valley Project and State Water Project (NMFS BiOp). The NMFS BiOp included the requirement that Reclamation create the Interagency Fish Passage Steering Committee (IFPSC). The IFPSC's role is to provide oversight and technical, management, and policy direction for a Fish Passage Program. The RPA includes development of a Fish Passage Program to evaluate reintroduction of listed species upstream of Shasta, Folsom, and New Melones dams. Because the duration of the consultation covers more than two decades NMFS anticipates that long-term future events, including increased water demand and climate change, will increase the frequency of temperature related mortality. Substantial areas of higher elevation habitat exist above these dams and could provide a refuge for cold water fish in the face of climate change. The IFPSC consists of representatives from Reclamation, NMFS, FWS, CDFG, DWR, Forest Service, and an academic member from UC Davis. The near-term goal is to increase the geographic distribution and abundance of listed species. The long-term goal is to increase abundance, productivity, and spatial distribution, and to improve the life history and genetic diversity of the target species. (Interagency Fish Passage Steering Committee 2010).

11.3 Environmental Consequences

This section describes the environmental consequences of the proposed alternatives, including the potential direct (both temporary and permanent construction-related and permanent operations-related) and indirect effects, on fish and aquatic resources within the affected environment that would result from implementation of each alternative. An analysis of the impact of each of the alternatives on covered species and non-covered aquatic species of primary management concern is provided. Impacts are also discussed with respect to the geographic locations in which they occur. These locations vary by action and species and range from the immediate vicinity of specific construction activities to broad flow changes within the Delta Plan area or upstream tributaries such as the Trinity, Sacramento, Feather, San Joaquin, and Mokelumne, or Stanislaus rivers.

This analysis of environmental consequences is presented in the following subsections.

11.3.1 Impact Mechanisms provides a general discussion of the construction, operations and maintenance activities and processes associated with each group of conservation measures, and the associated stressors that could potentially affect fish and other aquatic species. These impact mechanisms and stressors are associated with specific activities that are common to all or some of the alternatives. Impact mechanisms for the following categories are presented separately: construction and maintenance of water conveyance facilities (CM1) (Section 11.3.1.1); water operations (CM1) (Section 11.3.1.2); restoration measures (CM2, CM4–CM7, and CM10) (Section 11.3.1.3); and other conservation measures (CM12–CM19 and CM22) (Section 11.3.1.4).

11.3.2 Methods of Analysis presents information on how the impacts of entrainment (Section 11.3.2.1); flow, passage, salinity, and turbidity (Section 11.3.2.2); biological stressors such as invasive aquatic vegetation and fish predation (Section 11.3.2.3); contaminants (Section 11.3.2.4); and habitat restoration (Section 11.3.2.5) were assessed.

11.3.3 Determination of Adverse Effects describes the criteria for determining if an impact is adverse and/or significant.

11.3.4 Effects and Mitigation Approaches provides a full discussion of impacts and mitigation approaches for each alternative. Impacts for each alternative are presented grouped by species, and within the species subsections, impacts are grouped by construction and maintenance, water operations and restoration. Where impacts are common to multiple alternatives, the reader is referenced back to the first alternative where the impact is fully discussed. Mitigation approaches are also identified and described for each identified significant impact. Impacts are described for all sub areas listed in Section 11.1.1 and for all species listed in Section 11.1.3.

Only impacts that have or reasonably could be expected to have impacts on fish or the aquatic environment are included in the analysis.

The key questions to be addressed in this analysis of impacts to fish and aquatic resources are:

1. Would implementation of the alternative cause or substantially contribute to a significant adverse impact on fish and aquatic resources?

2. If so, is feasible mitigation available to reduce this impact to a level of insignificance or does the implementation of another conservation measure(s) render this otherwise significant impact insignificant?

The following table presents a summary of the impacts to fish and aquatic resources based on impact mechanisms, location and potential impact. It also displays if those impacts are significant, whether mitigation is available to reduce that impact, and under which alternatives each impact would occur.

11.3.1 Impact Mechanisms

This section presents information on potential impacts from the following categories.

- Construction and maintenance of water conveyance facilities (e.g., intakes, pipelines and tunnels, barge unloading facilities)
- Water operations
- Restoration measures

- Other conservation measures

Table 11-3 presents an overview of the primary construction elements associated with the conservation measures associated with the BDCP alternatives, and the area where potential impacts would occur. Detailed descriptions of all conservation measures are provided in Chapter 3 of this EIR/EIS in Section 3.6, *Components of the Alternatives*. Appendix 3C contains construction assumptions for CM1 under all alternatives. These impact mechanisms are discussed in more detail in the subsequent subsections.

Table 11-3. Main Construction Elements of BDCP Conservation Measures with Potential to Affect Aquatic Environments

CM	Title	Construction Elements (Aquatic Only)	Area
1	Water Facilities and Operation	• Clearing and grubbing/demolition on the river bank at each of the intake locations • Detour and levee reinforcement on the river bank at each of the intake locations • Sheet pile cell (coffer dam) at each of the intake locations on the river bank and in the river channel • Dewatering/unwatering of each coffer dam • Excavation and dredging at each of the intake locations on the river bank and in the river channel after the coffer dam is constructed • Foundation piles for each of the intakes on the river bank and channel after the coffer dam is constructed • Armor and restoration at each of the intake locations on the river bank and in the river channel after the coffer dam is constructed • Barge unloading facilities that would include clearing and grubbing (most likely limited to any riparian areas in the path of equipment used to construct the facilities as well as access for equipment and onloading and offloading supplies from the facilities), pile driving, construction of the dock on top of the piles, and ultimately dismantling of the dock and cutting off the piles	North Delta South Delta East Delta
2	Yolo Bypass Fisheries Enhancement	• Physical modifications to Fremont Weir and Yolo Bypass (e.g., new/modified fish ladders, new gated seasonal floodplain channel) • Fish screens at Yolo diversions • New/replaced Tule Canal and Toe Drain impoundment structures and agricultural crossings • Lisbon Weir improvements (e.g., fish gate) • Lower and upper Putah Creek improvements (e.g., realignments) • Fish barriers at Knights Landing Ridge Cut and Colusa Basin Drain • Physical and nonphysical barriers in Sacramento River (e.g., bubble curtains, log booms) • Levee improvements • Removal of berms and levees, and construction of berms and levees, re-working of agricultural and delivery channels) • Sacramento Weir improvements (could include a channel from Sacramento River to Sacramento Weir and from Sacramento Weir to Toe Drain)	Yolo Bypass

CM	Title	Construction Elements (Aquatic Only)	Area
3	Natural Communities Protection and Restoration	• No construction is associated with this measure; therefore, it would not result in construction-related effects on covered fish species.	NA
4	Tidal Natural Communities Restoration	• Restore and create channel networks; deepen/widen channels • Removal and construction of levees and embankments	Suisun Marsh Cache Slough East Delta West Delta South Delta
5	Seasonally Inundated Floodplain Restoration	• Set back, remove, and/or breach levees • Removal of riprap and bank protection between set-back levees • Modify channels • Create floodway bypasses	South Delta
6	Channel Margin Enhancement	• Removal of riprap from channel margins • Modify or set back levees • Installation of large woody material in levees	North Delta East Delta South Delta
7	Riparian Natural Community Restoration	• Removal of riprap • Modify levees and/or channel modification, including possible bench construction • Installation of riparian plantings	North Delta East Delta South Delta
8	Grassland Natural Community Restoration	• This conservation measure would not result in any effects on covered fish species because the aquatic habitat would not be affected.	NA
9	Vernal Pool Complex Restoration	• Excavate or recontour historical vernal pools. Because vernal pools typically have no outlets to receiving waters used by covered fish, this conservation measure would not affect covered fish species.	Yolo Bypass Cache Slough Suisun Marsh Suisun Bay South Delta
10	Nontidal Marsh Restoration	• Establish connectivity with existing waterways • Grade to create wetland topography	Yolo Bypass North Delta Cache Slough
11	Natural Communities Enhancement and Management	• This conservation measure would not result in any effects on covered fish species because the aquatic habitat would not be affected.	NA
12	Methylmercury Management	• Perform site-specific characterization and monitoring to mitigate methylmercury production during construction and operations. • No construction is associated with this measure; therefore, it would not result in construction-related effects on covered fish species. However, methylmercury and this conservation measure are discussed in the context of potentially disturbing sediment containing methylmercury during construction.	Yolo Bypass Suisun Marsh Cache Slough East Delta West Delta South Delta

CM	Title	Construction Elements (Aquatic Only)	Area
13	Invasive Aquatic Vegetation Control	• No construction is associated with this measure; therefore, it would not result in construction-related effects on covered fish species.	Plan Area
14	Stockton Deep Water Ship Channel Dissolved Oxygen Levels	• Possible construction of additional aeration facilities	South Delta
15	Localized Reduction of Predatory Fishes	• Removal of unused potential predator-habitat structures (e.g., old piers and abandoned boats)	North Delta South Delta East Delta
16	Nonphysical Fish Barriers	• Installation of nonphysical fish barriers (e.g., sounds light, or bubble barriers)	South Delta North Delta Yolo Bypass East Delta
17	Illegal Harvest Reduction	• No construction is associated with this measure; therefore, it would not result in construction-related effects on covered fish species.	NA
18	Conservation Hatcheries	• Possible bank and channel construction	West Delta
19	Urban Stormwater Treatment	• Establish vegetative buffer strips • Construct bioretention systems	North Delta South Delta
20	Recreational Users Invasive Species Program	• No construction is associated with this measure; therefore, it would not result in construction-related effects on covered fish species.	NA
21	Nonproject Diversions	• Removal/relocation of unscreened diversions	Plan Area
22	Avoidance and Minimization Measures	• Incorporate measures into BDCP activities that will avoid or minimize direct take of covered species and minimize impacts to critical habitat or natural communities that provide habitat for covered species.	NA

11.3.1.1 Potential Impacts Resulting from Construction and Maintenance of Water Conveyance Facilities

All in-water construction activities is expected to be restricted to the period between June 1 and October 31, when the potential for fish and aquatic species of concern to be present would be at a minimum. Construction outside this period would only be allowed if authorized by relevant permitting agencies, and additional construction timing restrictions could also be imposed by these agencies, to protect specific species. The potential for exposure of covered fish species to these activities is determined by species and life stage, as shown in Table 11-4.

Table 11-4. Life Stages of Covered Species Present in the North, East and South Delta Subregions during the In-Water Construction Window (June 1–October 31)

	North Delta			East Delta			South Delta		
Fish Species	**Life Stage**	**Timing**	**Size[a]**	**Life Stage**	**Timing**	**Size**	**Life Stage**	**Timing**	**Size**
Delta smelt	Adult	Jun	>2g	Adult	Jun	>2g	Adult	Jun	>2g
	Larva	Jun–Jul	<2g	Larva	Jun–Jul	<2g	Larva	Jun–Jul	<2g
Longfin smelt	Adult	Not Present	>2g	Adult	Not Present	>2g	Adult	Not Present	>2g
	Larva	Not Present	<2g	Larva	Not Present	<2g	Larva	Not Present	<2g
Central Valley steelhead	Adult	Jun–Sep Oct	>2g	Adult	Not Present	>2g	Adult	Not Present	>2g
	Juvenile	Jun–Oct	>2g	Juvenile	Jun–Oct	>2g	Juvenile	Jun–Oct	>2g
Winter-run Chinook salmon	Adult	Jun-Jul	>2g	Adult	Not Present		Adult	Not Present	
	Juvenile	Aug–Oct	<2g, >2g	Juvenile	Not Present	<2, >2	Juvenile	Not Present	<2, >2
Spring-run Chinook salmon	Adult	Jun Jul–Aug	>2g	Adult	Not Present		Adult	Not Present	
	Juvenile	Jun	<2g, >2g	Juvenile	Jun	<2g, >2g	Juvenile	Jun	<2g, >2g
Late fall–run Chinook salmon	Adult	Oct	>2g	Adult	Not Present		Adult	Not Present	
	Juvenile	Jun–Oct	>2g	Juvenile	Jun–Oct	>2g	Juvenile	Jun–Oct	>2g
Fall-run Chinook salmon	Adult	Aug–Sep Oct	>2g	Adult	Aug–Sep Oct	>2g	Adult	Aug–Sep Oct	>2g
	Juvenile	Jun	>2g	Juvenile	Jun	<2g, >2g	Juvenile	Jun	<2g, >2g
Splittail	Larva	Jun	<2g	Larva	Jun		Larva	Jun	<2g
	Juvenile	Jun–Jul	<2g	Juvenile	Jun–Jul		Juvenile	Jun–Jul	<2g
Green sturgeon	Adult	Jun–Oct	>2g	Adult	Jun–Oct	>2g	Adult	Jun–Oct	>2g
	Juvenile	Jun–Oct	>2g	Juvenile	Jun–Oct	>2g	Juvenile	Jun–Oct	>2g
White sturgeon	Adult	Jun–Oct	>2g	Adult	Jun–Oct	>2g	Adult	Jun-Oct	>2g
	Larva	Jun	<2g	Larva	Jun	<2g	Larva	Jun	<2g
	Juvenile	Jun–Oct	>2g	Juvenile	Jun–Oct	>2g	Juvenile	Jun–Oct	>2g
Pacific lamprey	Adult	Jun–Aug	>2g	Adult	Jun–Aug	>2g	Adult	Jun–Aug	>2g
	Ammocoetes	Jun–Oct	>2g	Ammocoetes	Jun–Oct	>2g	Ammocoetes	Jun–Oct	>2g
River lamprey	Adult	Sep–Oct	>2g	Adult	Sep–Oct	>2g	Adult	Sep–Oct	>2g
	Ammocoetes	Jan–Dec	>2g	Ammocoetes	Jan–Dec	>2g	Ammocoetes	Jan–Dec	>2g
	Macropthalmia	Jun–Jul	>2g	Macropthalmia	Jun–Jul	>2g	Macropthalmia	Jun–Jul	>2g

Black =abundant | Medium Gray=semi-abundant | Light Gray=low abundance | White=unsure if present

Source: California Department of Water Resources 2013.

[a] Size categories represent thresholds for assessing potential injury to fish from pile driving underwater noise (see "Underwater Noise").

Intakes

Construction

Intake structures would be constructed and operated along the Sacramento River. Elements of these intakes that could affect the aquatic environment are described below.

The Sacramento River channel and bank would be affected by construction and operation of the intakes. The location, dimensions, and construction footprints of the intakes considered are shown in Table 11-5.

Table 11-5. Dimensions of Potential North Delta Intakes and Associated Construction Footprints[a]

North Delta Intake	Location (River Mile)	Length of Screened Intake (feet)	Total Structure Length—Intake & Transitions (feet)	Temporary and Permanent Cofferdam Area (acres)	Permanent Screened Intake Footprint (acres)	Dredge and Channel Reshaping Area (acres)
East Alternatives						
1	44	700–1,450	1,100–2,050	1.2–5.0	1.0–3.8	2.5–4.7
2	41	1,100–1,800	1,300–2,400	1.7–6.0	1.4–4.5	3.0–5.5
3	40	700–1,450	1,300–2,250	1.3–5.2	1.1–4.0	3.0–5.2
4	38	950–1,600	1,350–2,400	1.5–5.6	1.3–4.3	3.1–5.5
5	37	1,200–2,000	1,600–2,800	1.9–6.9	1.6–5.2	3.7–6.4
6	32	950–1,600	1,350–2,600	1.5–5.9	1.3–4.6	3.1–6.0
7	30	850–1,450	1,250–2,050	1.4–5.0	1.2–3.8	2.9–4.7
West Alternatives Totals						
W-1	44	1,200–2,000	1,800–2,800	2.0–6.9	1.7–5.2	4.1–6.4
W-2	41	1,350–2,300	1,750–3,100	2.1–7.8	1.8–5.9	4.0–7.1
W-3	39	1,100–1,800	1,700–2,800	1.9–6.5	1.6–5.0	3.9–6.4
W-4	37	1,100–1,800	1,500–2,600	1.8–6.3	1.5–4.8	3.4–6.0
W-5	36	850–1,450	1,250–2,250	1.4–5.2	1.2–4.0	2.9–5.2

[a] Individual estimates for each intake would be added in different combinations to estimate the total potential effects for the various alternatives.

Constructing each of the intakes would involve installing a sheet-pile cofferdam in the river on the waterward edge of the on-bank intake structure (Figure 3-20) during the first construction season to isolate a majority of the in-water work area around each intake. Some clearing and grubbing at the construction site may be required prior to installing the sheet pile cofferdam, depending on site conditions (e.g., presence of vegetation or bank protection). Clearing and grubbing activities may include removing riprap, vegetation, and garbage from the levee or channel area, and channel dredging and reshaping, within the aquatic habitat, depending on the specific placement of the sheet piles and the existing conditions. Any dredging outside of the cofferdams would be isolated from the river within a silt curtain enclosure.

Once the cofferdam is installed, the area within the cofferdam would be dewatered using pumps with screened intakes. To minimize fish exposure to construction activities, the cofferdams would be, to the extent practicable, cleared of fish before construction activities are initiated. Although fish would likely avoid the noise and activity of sheet pile installation, cofferdams have the potential to entrap some fish. While the number of fish affected is unknown, entrapment could include a few hundred fish (total of all species). When the water level in the work area dropped to a manageable level, entrapped fish would be captured and released to the river using a combination of beach seines, dip nets, and electrofishing equipment. Fish removal would result in handling stress and possibly in some physical injuries or incidental mortality.

Fish removal activities from construction areas would be implemented according to 3B.8–*Fish Rescue and Salvage Plan* (see Appendix 3B, *Environmental Commitments*). The plan would be consistent with NMFS electrofishing guidelines (National Marine Fisheries Service 2000), identify minimum qualifications for fish handling personnel, and include protective measures to minimize harm to fish. Protective measures would include practices such as using knotless mesh netting that is sufficiently fine to prevent the gilling of juvenile salmonids, limiting holding time, specifying appropriate release locations, limiting the number of fish per unit volume in transfer containers, and minimizing handling to limit the risk of injury during fish removal.

Following dewatering, work in the area behind the newly constructed cofferdam is no longer considered in-water work. Work within the cofferdam (e.g., excavation and pile driving) would proceed. Water pumped from the cofferdams would be treated (removing all sediment) and returned to the river.

Constructing each of the intakes would take between 3.5 and 4.5 years. All intakes would be constructed simultaneously, with in-water work anticipated to begin in June 2019. Each of the cofferdams (one installed at each intake) also would be constructed simultaneously from June to October 2019. Multiple vibratory pile drivers would likely be needed to construct each intake cofferdam due to their size.

Activities associated with construction of the intakes that could affect aquatic resources are listed in Table 11-6. The table shows the general location of the activity and its general type of impact. The impacts are further described in Section 11.3.4, *Effects and Mitigation Approaches*.

Table 11-6. Effects Associated with Construction of Intakes

Activity	Location	Potential Impact
Installation of sheet pile for cofferdam	In-water	Water quality Noise Direct impact Loss of habitat
Foundation pile driving	Behind dewatered cofferdam	Noise
Dredging	Behind dewatered cofferdam	None
Dewatering	Discharge of treated water to river	Water quality
Fish rescue activities	Behind cofferdam	Direct impact
Dredging and channel shaping	Outside of cofferdam	Water quality Direct impact Change in habitat substrate
Bank and channel reinforcement/ protection	River bank and channel	Change in habitat substrate

Maintenance

The proposed intake facilities would require routine or periodic adjustment and tuning to ensure that operations are managed consistent with design intentions. Facility maintenance is part of long-term asset management and includes activities such as painting, cleaning, repairs, and other routine tasks to ensure the facilities are operated in accordance with design standards after construction and commissioning.

Routine visual inspection of the facilities would be conducted to monitor performance and prevent mechanical and structural failures of project elements. Maintenance activities associated with river intakes could include removal of sediments, debris, and biofouling materials. These maintenance actions could require suction dredging or mechanical excavation around intake structures; dewatering; or use of underwater diving crews, boom trucks or rubber wheel cranes, and raft- or barge-mounted equipment.

Dewatering

It is expected that all panels would require annual removal (at a minimum) for pressure washing. Additionally, individual intake bays would require dewatering (one pair at a time) for inspection and assessment of biofoul growth rates. Dewatering would be accomplished by closing off portals with prefabricated bulkheads.

Underwater Diving

Underwater diving crews may be used to examine intakes and remove any large debris buildup. A deliberate monitoring program would increase awareness of conditions compromising operational performance and basic function.

Raft- and Barge-Mounted Equipment

A small barge with rigs and leads could be used during maintenance activities to haul and remove debris from restoration areas and project facilities (e.g., after storm events). Should substantial debris become lodged at the leading edge or adjacent to the intake structure, removal of the material may require equipment and specialized labor. Although historically the in-river intake technology has not been a debris trap, there may be incidents where large debris deposits in the vicinity of the structure compromise its function. In the wake of heavy-to-extreme hydrologic events, inspections should be conducted to visually confirm debris presence or the lack thereof. If large debris is found to have accumulated, removal would require boom trucks or rubber wheel cranes, and possibly a small barge and crew to rig the leads to the debris.

Dredging

Sediment deposition is a problem that commonly plagues manmade infrastructure in natural waterways. It can bury intakes and either reduce intake capability to divert or force shutdowns completely until working conditions are restored. Attention to this issue during engineering and design can reduce or avert this problem. However, the dynamic riverine environment can be unpredictable, and sedimentation can inhibit function and operations. Typical maintenance activities associated with river intakes can include the following.

- Suction dredging around intake structures using raft- or barge-mounted equipment and pumping sediment to a landside spoil area.
- Mechanical excavation around intake structures using track-mounted equipment and clamshell dragline from the top deck.
- Dewatering of intake/sedimentation basin/pumping plant bays to remove sediment buildup in conduits and channels using small front-end loading equipment and manual labor.

The planned operation of proposed intakes would help mitigate sediment deposition within the intake bays and conveyance conduits when turbidity in the river exceeds a certain threshold. The sediment removal systems would be designed to keep sedimentation channels and wet well bays free of sediment buildup. It is expected that only extreme conditions would give cause for the activities listed above.

Levee Maintenance

Maintenance activities may include replacement of riprap necessary to protect the hydrodynamic conditions, restoration features, and conveyance features and facilities.

Pipelines and Tunnels

Construction

The BDCP alternatives would involve conveyance pipelines and tunnels in various configurations. Impacts on the aquatic environment associated with both pipelines and tunnels would be limited to surface water crossings. Surface waters would be crossed by siphon structures in most cases, while drilled tunnels would be used forcrossing larger surface water bodies.

The tunnels would be drilled from portals that would provide access for equipment and materials. These portals are located in upland areas and would not affect the aquatic environment. The areas would be designed to minimize the potential for stormwater runoff to surface waters.

Maintenance

Maintenance of the conveyance pipelines is dependent on the materials of construction as summarized in Table 11-7.

Table 11-7. Summary of Pipeline Maintenance Considerations

Material and Conduit Configuration	Maintenance Considerations
Steel pipe	Maintenance and operation of an impressed current cathodic protection system. Periodic internal inspections and repair of cement mortar lining.
RCCP or RCP	Periodic internal inspections and repair of cement mortar lining at the joints. Periodic inspections of internal concrete. Repairs to concrete, as needed, including sealing cracks and repairing spalling to prevent exposure of steel.
CIP	Periodic inspections of internal concrete and joints. Repairs to concrete, as needed, including sealing cracks and repairing spalling to prevent exposure of steel.
All	Regular periodic operation of radial gates. Repairs as needed. Vent inspection and repairs. Regular inspections along the line for signs of leakage or erosion of soil cover.

CIP = cast-in-place.
RCCP = reinforced concrete cylinder pressure pipe.
RCP = reinforced concrete pipe.

Barge Unloading Facilities

Temporary barge unloading facilities would be necessary to provide access for equipment and materials to the construction sites. The barge unloading facilities would be constructed at some of the locations listed below, depending on alternative; these locations are shown in Mapbooks M3-1, M3-2, M3-3, and M3-4.

- State Route 160 west of Walnut Grove (Alternatives 1A, 2A, 3, 5, 6A, 7, and 8).
- Venice Island (Alternatives 1A, 2A, 3, 5, 6A, 7, and 8).
- Bacon Island (Alternatives 1A, 2A, 3, 4, 5, 6A, 7, 8, and 9).
- Woodward Island (Alternatives 1A, 2A, 3, 5, 6A, 7, and 8. Two barge facilities would be constructed at this location under Alternative 9).
- Victoria Island (Alternatives 1A, 2A, 3, 4, 5, 6A, 7, and 8).
- Tyler Island (Alternatives 1A, 2A, 3, 5, 6A, 7, and 8).
- Hog Island (Alternatives 1B, 2B, and 6B).
- Ryer Island (Alternatives 1C, 2C, and 6C).
- Brannan Island (Alternatives 1C, 2C, and 6C).
- Byron Tract on Italian Slough (Alternative 4).
- Bouldin Island on San Joaquin River (Alternative 4).
- Staten Island on South Mokelumne River (Alternative 4).
- Webb Tract (two barge facilities would be constructed on Webb Tract under Alternative 9—one at the northwest corner, and one on the eastern side).
- Upper Jones Tract (Alternative 9).
- Victoria Island (Alternative 9).

These temporary barge unloading facilities could consist of the landing approach over the levees and construction of a temporary dock to facilitate loading and unloading of the barges. The temporary docks would be supported by piles that would be driven in the river. The number and type of piles driven for each barge landing is unknown but could entail approximately 36, 24-inch diameter (type) piles per landing. The dimensions of the docks are anticipated to be approximately 50 by 300 feet. Where feasible, floating or existing docks could be used to reduce the amount of in-water construction activities required to construct the uploading facilities.

At the barge unloading facilities, piles likely would need to be driven to secure the barges or support docks for the transit of equipment and material to and from the portal sites. Sediments could be disturbed by propeller wash or wakes from the vessels used for transport and landing of the barges.

Approximately 3,000 barge trips are projected to carry construction materials to the sites listed above. The landings would be in operation through construction activities at each associated portal (from 1 to 3 years, depending on which portals are serviced).

After construction serviced by a landing is completed, the dock would be removed, and the area of the landing would be restored to pre-construction conditions.

Bank and Channel Reinforcement/Protection

Rock protection would be installed along the river banks approximately 100 feet upstream and downstream, and along the front of the intakes to protect the intakes and to prevent bank and channel erosion. The intake structures and associated bank protection would permanently change existing substrates and local hydraulic conditions in the immediate vicinity of the intakes.

Intake pumping plants, sedimentation basins, and solids handling facilities for each intake would be constructed on the land side of the Sacramento River levees and, therefore, would not be considered in-water work. Stormwater best management practices (BMPs) would be installed to avoid or minimize the potential for sediment-laden runoff from entering surface waters.

Underwater Noise

Underwater noise can be generated by a variety of activities associated with the construction and operation of North Delta intakes and the barge landings, the most notable being pile driving. Cofferdam installation will be required to construct the intakes. DWR proposes to use a vibratory driver to install the sheet piles comprising the cofferdams to the extent that geologic conditions at the construction sites allow. Vibratory driving does not result in underwater sound great enough to injure fish. However, it is possible that some sheet piles will require impact driving due to as yet undetermined geologic conditions at the intake construction sites.

Research indicates that impact pile driving can result in injuries to fish if the peak sound pressure levels are high enough or the exposure is long enough. Dual interim criteria were developed to provide guidance for underwater sound levels protective of injury to fish. The dual thresholds for impact pile driving are (1) 206 decibels (dB) for the peak sound pressure level; and 187 dB for the cumulative sound exposure level ($SEL_{cumulative}$) for fish larger than 2 grams, and 183 dB $SEL_{cumulative}$ for fish smaller than 2 grams. The $SEL_{cumulative}$ threshold is based on the cumulative daily exposure of a fish to noise from sources that are discontinuous (i.e., noise that occurs only for about 8 to12 hours in a day, with 12 to16 hours between exposure).This assumes that the fish is able to recover from any effects during this 12 to 16 hour period. In addition, the exposures do not accumulate beyond the range (distance from the sound source) where the SEL is attenuated below 150 dB.

Based on underwater sound measurements collected during sheet pile installation with an impact pile driver, source sound levels (the level measured at 10 meters [33.3 feet] from the pile), could be as high as 205 dB maximum peak, and a single strike sound exposure level (SEL) of 180 dB (California Department of Transportation 2009). The peak sound level is not expected to exceed the interim criteria of 206 dB. The $SEL_{cumulative}$ level is dependent on the source single-strike SEL and the number of pile strikes in a day. Figure 11-2 illustrates the attenuation of $SEL_{cumulative}$ to the 187-dB and 183-dB interim criteria for a number of sheet pile driving scenarios ranging from 5 to 8,000 strikes in a day. The specific number of piles that will be driven per day with an impact pile driver, and thus the number of pile strikes per day will depend on the geologic conditions at the construction sites. Using preliminary estimates for illustrative purposes, if eight sheet piles were impact driven in a day, and assuming a source sound level of 180 dB single-strike SEL and 500 strikes per sheet pile (4,000 strikes in a day), $SEL_{cumulative}$ levels would exceed the 183-dB $SEL_{cumulative}$ criterion (for fish smaller than 2 grams) out to a distance of about 3,280 feet from the pile being driven, and would exceed the 187-dB $SEL_{cumulative}$ criterion (for fish larger than 2 grams) out to approximately 2,950 feet. For comparison, if only two sheet piles were impact driven in a day (1,000 strikes), the distance to the 187-dB $SEL_{cumulative}$ criterion would be approximately 1,050 feet.

While these distances would extend across the entire river channel, the distance upstream and downstream would vary by construction location, as sound does not radiate around river bends. As a result, there would be limited overlap in the sound fields generated from pile driving at two intake locations simultaneously.

The cofferdams (the number of cofferdams varies from 1 to 5 by alternative) may be constructed during one in-water work window or construction may be spread across more than one window. In order to construct the cofferdams within one in-water work window, exceedance of these criteria over some distance of the river would likely be unavoidable if impact driving is required. No effective methods are available to attenuate sound from impact driving of sheet pile because the sheets need to be interlaced, and individual sheets cannot be isolated by sound attenuation devices (e.g., isolation casings or air bubble rings) as they are driven.

After the cofferdam is constructed and dewatered, foundation piles would be installed to support the intakes and pumping plant. The foundation piles would either be cast-in-drilled hole (CIDH) piles, which do not require pile driving (only drilling) or 24-inch-diameter steel pipe piles that are driven and then filled with concrete. It is anticipated that, if piles are driven, they would be primarily vibrated. However, as with the sheet pile, some of these foundation piles may require impact driving. Figure 11-3 illustrates the attenuation of the $SEL_{cumulative}$ level to the 183-dB and 187-dB interim criteria for a number of 24-inch pipe pile driving scenarios ranging from 5 to 8,000 strikes in a day. This figure represents the piles being driven in a dewatered cofferdam, which is estimated to attenuate sound transmittance to water by approximately 10 dB. With this 10 dB reduction, the source maximum peak level is estimated to be 193 dB, and the single-strike SEL level is estimated to be 167 dB based on data from other measured piles (California Department of Transportation 2009).

Behind a cofferdam, a daily impact strike total of 4,000 strikes, for example, would result in the $SEL_{cumulative}$ level above 187 dB extending approximately 390 feet from the pile. Other than the 10 dB attenuation provided by the dewatered cofferdam, no other methods could be used to attenuate the sound further. In order to proceed with the construction, foundation piles could be driven at various times of the year, not only within the in-water work windows. In that event, the potential for covered fish to be exposed to increased sound levels is greater than that described for noise increases from impact sheet pile installation.

DWR anticipates that most or all of the barge landings will utilize floating docks, however it is possible that the contractors would use pile supported docks. For pile supported barge landings, up to 36 24-inch diameter pipe piles would be needed to support the temporary docks at each of the six landings. Although vibratory methods would be predominantly used to drive these piles, geological conditions at the sites are not known at this time, and some piles may require impact driving. The maximum peak source level for an impact-driven 24-inch pipe pile would be 203 dB based on data from other measured piles (California Department of Transportation 2009). This level is below the peak criterion of 206 dB. Figure 11-4 illustrates the attenuation of the $SEL_{cumulative}$ level to the 187-dB and 183-dB interim criteria for a number of 24-inch pipe pile driving scenarios ranging from 5 to 8,000 strikes in a day. This figure represents the piles being driven in open water without attenuation devices. The source single-strike SEL level is estimated to be 177 dB based on data from other measured piles (California Department of Transportation 2009). If it is assumed that each pile requires 500 strikes, and eight piles are impact driven in a day (4,000 strikes total) as a reasonably conservative scenario, the $SEL_{cumulative}$ level above 187 dB is calculated to extend approximately 1,800 feet from the pile. If an attenuation device is used (e.g., isolation casing or bubble curtain), source sound levels would be 10 dB SEL less (167 dB), and the distance to attenuation to 187 dB $SEL_{cumulative}$ would be reduced to approximately 390 feet. Similarly, the distance to attenuate to the 183 dB $SEL_{cumulative}$ would be 453 feet.

As noted earlier, installation of piles with a vibratory driver does not produce underwater sound sufficient to exceed the interim criteria and would not cause direct physical injury to fish. However, vibratory driving can result in non-injurious adverse effects on fish (modification of behavior). Fish may respond by avoiding the area during active vibratory driving, which could result in temporary delays in migration, or place the fish at greater risk of predation by forcing them into areas with greater densities of predators or conditions that increase predator efficiency.

Should impact driving of piles be required, fish in the vicinity of the intake and barge unloading facilities on days when impact driving occurs could be exposed to underwater noise levels exceeding the $SEL_{cumulative}$ interim criteria (data show that the peak criterion would not be exceeded based on the pile size/type assumed for this project). Mapbooks M3-1, M3-2, M3-3, and M3-4 show the locations of the intakes and barge unloading facilities. Table 11-4 illustrates the potential for presence of covered species (by life history stage) in the areas of the Delta where the intakes (north Delta) and the barge unloading facilities (east and south Delta) are located. Table 11-8 indicates the approximate area of waterbodies exposed to underwater sound levels exceeding the183-dB $SEL_{cumulative}$ level.

Table 11-8. Length, Width, and Area of Waterbodies Potentially Exposed to Impact Pile Driving Noise above the 183-dB $SEL_{cumulative}$ Level Based on Preliminary Estimates

Intake or Barge Unloading Facility	Length of Water Body Experiencing Sound Levels above 183 dB $SEL_{cumulative}$ (feet)	Width of Water Body Experiencing Sound Levels above 183 dB $SEL_{cumulative}$ (feet)	Area of Water Body Experiencing Sound Levels above 183 dB $SEL_{cumulative}$ (square feet [acres])
Intake 1	6,560[a]	425	2,788,000 [64]
Intake 2	6,560[a]	645	4,231,200 [97]
Intake 3	6,560[a]	560	3,673,600 [84]
Intake 4	6,560[a]	615	4,034,400 [93]
Intake 5	6,560[a]	535	3,509,600 [91]
Walnut Grove Landing	906[b]	300	271,800 [6.2]
Tyler Island Landing	906[b]	400	362,400 [8.3]
Venice Island Landing	906[b]	150	135,900 [3.1]
Bacon Island Landing	906[b]	350	317,100 [7.3]
Woodward Island Landing	906[b]	380	344,280 [7.9]
Victoria Island Landing	906[b]	380	344,280 [7.9]
Byron Tract Italian Slough Landing	900	400	362,400 [8.3]
Bouldin Island San Joaquin River Landing	900	900	815,400 [18.7]
Staten Island South Mokelumne River Landing	900	800	724,800 [16.6]

[a] Note—based on NMFS model—the single-strike sound exposure level (SEL) for impact cofferdam pile driving would attenuate to 150 decibels (dB), [which is not considered to harmfully accumulate] at 1,000 meters (3,280 feet); thus the maximum distance [upstream plus downstream combined] that would be exposed to 183 dB $SEL_{cumulative}$ would be 6,560 feet.

[b] Note—based on NMFS model—for 24-inch-diameter impact pile driving with bubble curtain, the single-strike SEL would attenuate to 150 dB, (which is not considered to harmfully accumulate) at 138 meters (453 feet); thus the maximum distance [upstream plus downstream combined] that would be exposed to 183 dB $SEL_{cumulative}$ would be 906 feet.

Depending on the number of strikes in a day, impact pile driving could result in injury to fish near the pile driving. Table 11-9 summarizes the species that are potentially present between June and October.

Table 11-9. Species Present during Cofferdam Installation

Species/Life Stage Present	Lifestage and Month(s) Present in Areas Affected by Underwater Sound during Cofferdam Installation
Delta smelt	Adult—June Larval—June, July
Chinook (fall-run)	Adults—August through October Juveniles—May
Chinook (late fall-run)	Adults—October Juveniles—June through October
Chinook (winter-run)	Adults—June/July Juveniles—September through October
Chinook (spring-run)	Adult—June through August
Steelhead	Adult—June through October Juvenile—June through October
Sacramento splittail	Adults—June through October Larvae—June Juveniles—June/July through October
Green sturgeon	Adult—June through October Juveniles—June through October
White sturgeon	Adults—June through October Juveniles—June through October Larvae—June
Pacific lamprey	Adults—June through August Ammocoetes—June through October
River lamprey	Adults—September/October Ammocoetes—June through October Macropthalmia—June/July

Other underwater noise generated from surface equipment during construction of the water conveyance, such as that from boats and barges, may temporarily elevate underwater noise levels above ambient conditions.

Effects on Water Quality

The majority of intake construction would occur within the channel and channel banks behind cofferdams, although some channel contouring dredging would likely be required outside of the cofferdams. However, such dredging would be isolated from the river within a silt curtain enclosure. Therefore, any water quality effects would be minimal during construction. In addition, construction activities are likely to result in minimal effects on water quality because permit requirements would require implementation of BMPs and would restrict impacts on water quality. The potential effects of turbidity and suspension of potentially toxic sediments and accidental spills associated with construction activities are described below. Potential effects on water quality related to aquatic resources are summarized in Table 11-10.

Table 11-10. Potential for Construction Activities to Affect Water Quality

Activity	Location	Potential Effects	Avoidance and Minimization Measures
Installation of sheetpile for coffer dam	In-water	• Increased suspension of bottom sediments and turbidity • Suspension of toxic-contaminated sediment	• Section 404 and Section 10 permits would require implementation of BMPs to minimize suspension of bottom sediments • Basin Plan requirements limit turbidity levels
Pile driving	In-water	• Increased suspension of bottom sediments and turbidity • Suspension of toxic-contaminated sediment	
Foundation pile driving at intakes and dredging	Behind dewatered coffer dam	• None	
Discharge of treated water from dewatering activities	In-water	• None	• Water would be treated prior to discharge and would meet NPDES permit requirements
Channel contour dredging	In-water	• Increased suspension of bottom sediments and turbidity • Suspension of toxic-contaminated sediment	• Section 404 and Section 10 permits would require implementation of BMPs to minimize suspension of bottom sediments • Basin Plan requirements limit turbidity levels
Stormwater discharge (from upland construction areas)	In-water	• Small discharges from upland construction areas	• Subject to NPDES permit requirements
Accidental spills (from construction equipment)	In-water	• Small discharges of petroleum products	• Pollution prevention programs
Excavation for restoration	In-water	• Increase in suspended sediment • Mobilization of toxic-contaminated sediment	• Section 404 and Section 10 permits would require implementation of BMPs to minimize suspension of bottom sediments • Basin Plan requirements limit turbidity levels

Basin plan = Central Valley Regional Water Quality Control Board *Water Quality Control Plan for the Sacramento and San Joaquin River Basins.*

BMPs = best management practices.

NPDES = National Pollutant Discharge Elimination System.

11.3.1.2 Potential Impacts Resulting from Water Operations

Consistent with the operational scenarios fully described in Chapter 3, Project Alternatives, changes in water operations could result in changes in flow and potentially changes in water quality, habitat, impingement, entrainment, and predation. Operational impacts on fish may include changes in spawning, migration, and rearing habitat associated with changes in reservoir operations, diversion of water, and the consequent changes in flow in the Sacramento River and water circulation and quality through the Delta. Potential entrainment or impingement of fish may be associated with the north Delta intakes and the change in the rate of entrainment or impingement by the south Delta diversions. Placement and operation of intakes may also result in changes in the potential for predation. Detailed discussions of these potential impacts are provided below for each alternative, beginning with the NAA (Section 11.3.4.1).

11.3.1.3 Potential Impacts Resulting from Restoration Measures

Restoration construction activities could affect covered fish species. Such effects include potential spills of construction equipment fluids; increased turbidity; increased exposure to methylmercury, pesticides and other contaminants when upland soils are inundated; and increased exposure to contaminants from disturbed aquatic sediments. However, these effects would be temporary and typically offset by the long-term benefits of the restored habitat.

Restoration would likely include pre-breach management of the restoration site to promote desirable vegetation and elevations within the restoration area and levee maintenance, improvement, or redesign. This may require substantial earthwork outside but adjacent to tidal and other aquatic environments. Levee breaching would require removing levee materials from within and adjacent to tidal and other aquatic habitats. These materials could be placed on the remaining levee sections, placed within the restoration area, or hauled to a disposal area. Some restoration may include much more extensive construction activities, specifically restoration activities in the Yolo Bypass, where drainage and other agricultural facilities may need to be installed or relocated. Table 11-3 summarizes this information by conservation measure. In addition, maintenance activities associated with some of the conservation measures could entail limited in-water work, such as sediment removal, maintenance or replacement of water control structures, and replacement of instream woody material. Specific activities associated with the restoration-related conservation measures are discussed below.

CM2 Yolo Bypass Fisheries Enhancements

Construction activities for Fremont Weir and Yolo Bypass are expected to include the following.

- Modifying Fremont Weir and Yolo Bypass
- Constructing a deep fish passage channel in Yolo Bypass
- Replacing the Fremont Weir fish ladder
- Constructing experimental sturgeon ramps at Fremont Weir
- Modifying the stilling basin
- Modifying the Sacramento Weir
- Modifying at the Tule Canal/Toe Drain

- Modifying lower Putah Creek

On a periodic basis, maintenance activities in the Yolo Bypass may include sediment removal from the Fremont Weir area using graders, bulldozers, excavators, dump trucks, or other machinery. A recent record of maintenance activities indicates that it would be reasonable to expect that approximately 1 million cubic yards (MCY) of sediment may be removed within 1 mile of the weir an average of every 5 years. An additional 1 MCY of sediment is conservatively anticipated to be removed inside the new channel every other year as part of routine sediment management activities. Where feasible, work will be conducted under dry conditions; if necessary, some dredging may be required to maintain connection along the deepest part of the channel for fish passage.

CM4 Tidal Natural Communities Restoration

Restoration of tidal natural communities would be undertaken in the Suisun Marsh, Cache Slough, West Delta, South Delta, and Cosumnes/Mokelumne ROAs. Construction for tidal habitat restoration is likely to involve the following activities.

- Excavating channels to encourage the development of sinuous, high-density dendritic channel networks within restored marsh plain.
- Modifying ditches, cuts, and levees to encourage more natural tidal circulation and better flood conveyance based on local hydrology.
- Infrastructure removal or relocation, including levee breaching to restore tidal connectivity.
- Removal of existing levees or embankments or creation of new structures to allow restoration to take place while protecting adjacent land.
- Prior to breaching, recontouring the surface to maximize the extent of surface elevation suitable for establishment of tidal marsh vegetation (marsh plain) by scalping higher elevation land to provide fill for placement on subsided lands to raise surface elevations.
- Prior to breaching, importing dredge or fill and placing it in shallowly subsided areas to raise ground surface elevations to a level suitable for establishment of tidal marsh vegetation (marsh plain).
- Prior to breaching, cultivating stands of tules through flood irrigation for sufficiently long periods to raise subsided ground surface to elevations suitable to support marsh plain, and breaching levees when target elevations are achieved. Irrigation infrastructure and levees would need to be installed or retained to control irrigation during the establishment period.
- Tidal habitat restored adjacent to farmed lands or lands managed as freshwater seasonal wetlands may require construction of dikes to maintain those land uses.

CM5 Seasonally Inundated Floodplain Restoration

The following activities may be associated with restoration of floodplains.

- Lowering the elevation of restored floodplain surfaces or modifying river channel morphology to increase inundation frequency and duration, and to establish elevations suitable for the establishment of riparian vegetation by either active planting or allowing natural establishment.
- Setting levees back along selected river corridors and removing or breaching levees.

- Removing existing riprap or other bank protection to allow for channel migration between the set-back levees through the natural processes of erosion and sedimentation.
- Modifying channel geometry in unconfined channel reaches or along channels where levees are set back in order to create backwater habitat.
- Selectively grading restored floodplain surfaces to provide for drainage of overbank flood waters such that the potential for fish stranding is minimized.
- Actively establishing riparian habitat on floodplains.

CM6 Channel Margin Habitat Enhancement

Channel margin enhancement actions will often be implemented in conjunction with seasonally inundated floodplain and riparian habitat restoration conservation measures (CM5 and CM7, respectively), and could consist of the following.

- Removal of riprap from channel margins where levees are set back to restore seasonally inundated floodplains.
- Modification of the outboard side of levees or setback levees to create low floodplain benches with variable surface elevations that create hydrodynamic complexity and support emergent vegetation.
- Installation of large woody material (e.g., tree trunks and stumps) into constructed low benches or into existing riprapped levees to provide physical complexity.
- Planting of riparian and emergent wetland vegetation on created benches.

CM7 Riparian Natural Community Restoration

Riparian habitat restoration would include establishment or re-establishment of forest and scrub vegetation in restored floodplain areas (CM5), consistent with floodplain land uses and flood management requirements.

CM10 Nontidal Marsh Restoration

Nontidal marsh restoration would include establishment of connectivity with the existing water conveyance system and grading to create wetland topography.

11.3.1.4 Potential Impacts Resulting from Other Conservation Measures

Other conservation measures that include construction activities with the potential to affect covered fish species are CM12–CM19 and CM21**.** All of these conservation measures would require at least some in-water work to install and/or remove facilities. Additionally, some work would be on the levee or bank adjacent to aquatic habitat. CM16 specifically involves installing piles to support the nonphysical barrier structure within the channel, in addition to placing telemetry equipment upstream and downstream of the barrier. Depending on the exact location, vegetation or riprap may need to be removed to ready the channel for the piles and the remainder of the structure (light, sound, and air supply).

11.3.2 Methods for Analysis

11.3.2.1 Entrainment Analysis

Entrainment occurs when fish are removed from a water body as water is diverted. In the Delta, entrainment occurs at several locations, including the south Delta SWP/CVP intake facilities, Mirant power plants, agricultural diversions, and other intake facilities such as those operated by Contra Costa Water District (CCWD) and Freeport Regional Water Authority (FRWA) (ICF International 2012; USFWS 1008; California Department of Water Resources 2005). Entrainment has been a major issue of concern related to the aquatic species covered in the BDCP, and as such must be evaluated carefully in the EIR/EIS. A key element of the BDCP is the proposed new intake facilities in the north Delta, which would allow for more effective screening of fish and less reliance on the south Delta facilities. This component of the BDCP is intended to reduce entrainment through changes in Delta water management.

The methods used to assess entrainment risk are based on historical salvage data, CALSIM outputs, assumed and measured locations of fish, previous studies in the Delta, Delta Regional Ecosystem Restoration Implementation Plan (DRERIP) analyses, life cycle models, and professional judgment. The methods used reflect the best available tools and data regarding fish abundance, movement, and behavior. These methods were applied to a comparison of baseline conditions with conditions under the alternatives. For some methods, five water-year types were modeled based on the historical CALSIM record to determine the variation in entrainment under different flow conditions. In general, however, there is a lack of population level data species and their baseline populations are not well understood. For a complete description of the methods, please see *BDCP Effects Analysis – Appendix B, Entrainment, Section B.5 Methods of Biological Analysis (hereby incorporated by reference)*.

The methods used to evaluate entrainment are listed below.

- **Salvage density:** uses historical salvage data and CALSIM outputs to estimate entrainment under various flow conditions.
- **Old and Middle River (OMR) flow proportional entrainment regressions:** uses linear regression (based on USFWS 2008) and incorporates the adjustment of Kimmerer (2011) and CALSIM data to estimate the proportion of delta smelt population that would be entrained.
- **DSM2 particle-tracking model:** uses data from Interagency Ecological Program (IEP) from trawls to estimate the movement of larval delta smelt and larval longfin smelt that are assumed to be influenced primarily by flows.
- **Effectiveness of nonphysical barriers:** uses results of recent studies at Georgiana Slough and Old River to determine potential effectiveness of barriers in other Delta locations that would exclude fish from diversions.
- **North Delta intakes screening effectiveness analysis:** estimates direct loss and impingement at screens for different sizes of fish based on literature and professional judgment.
- **DRERIP analysis of nonproject diversions:** assumes that removal of nonproject diversions would result in a reduction in entrainment.

No single one of these methods could be used for all life stages of all species. Accordingly, it was necessary to use these methods in combination to complete the assessment of entrainment. For example, the OMR regression is applicable only to delta smelt. Similarly, the assessment of the north Delta screening efficiency was specific to that facility and focused primarily on larval life stages. Each of these analytical methods have technical limitations, which are generally described in the Entrainment Appendix to Chapter 5.

These methods were applied to each species and life stage as appropriate, and the results of the assessment are presented in *Determination of Adverse Effects*. The conclusions presented in the analysis synthesize multiple results because multiple methods were applied to some species and life stages.

11.3.2.2 Flow, Passage, Salinity, and Turbidity Analysis

The methods used to assess flows and the various flow-related parameters are based on CALSIM and DSM2 outputs, upstream temperature models (e.g., Reclamation temperature model, Sacramento River Water Quality Model [SRWQM]), Particle Tracking Model (PTM), multiple biological models, assumed and measured locations of fish, previous studies in the Delta, Delta Regional Ecosystem Restoration Implementation Plan (DRERIP) analyses, life cycle models, and professional judgment. A full description of these methods and a complete analysis can be found in the *BDCP Effects Analysis – Appendix C*, *Flow, Passage, Salinity, and Turbidity Appendix (hereby incorporated by reference)*. Fifteen different models or indices were used to evaluate flow-related effects. As with all analytical tools, these methods have technical limitations that are discussed in the appendices to Chapter 5. These methods were applied to a comparison of the alternatives with existing conditions and the No Action Alternative. For some methods, five water-year types were modeled based on the historical CALSIM record to determine the variation in flow-related effects under different flow conditions. Data and analyses are presented in *Appendix 11C CALSIM II Model Results Utilized in Fish Analysis* and are incorporated into tables and discussion throughout this chapter. Although it is recognized that there are statistically significant correlations between freshwater flow and abundances of several fish species (e.g., Kimmerer 2002, USFWS 2005), these correlations were not used in the EIR/EIS analysis to estimate fish population responses to alternatives because they do not directly include the effects of tidal marsh and floodplain restoration on fish populations.

Physical modeling outputs each month and water year type were compared for between model scenarios at multiple locations to determine whether there were differences between scenarios at each location. A “difference” was defined as a >5% difference between the pair of model scenarios in at least one water year type in at least 1 month. If a difference was found at a location, subsequent biological modeling and analyses for fish species that occur in that location were conducted and reported for that location. If no differences were found, subsequent biological modeling and analyses for fish species that occur in that location were deemed unnecessary and were not conducted. These instances are noted in the text as they occur. Locations include individual rivers or river reaches and vary according to the species and life stage analyzed. The time ranges analyzed also vary by species and life stage.

Following is a summary of the primary models or indices used to evaluate flow-related effects.

- **CALSIM**: The CALSIM II planning model simulates the operation of the CVP and SWP over a range of hydrologic conditions based on an assumed set of demands, regulatory requirements and climate-related factors using an 82-year record of hydrology. CALSIM II produces key outputs that include river flow volumes and diversion volumes, reservoir storage, Delta flow volumes and export volumes, Delta inflow volumes and outflow volumes, deliveries to project and nonproject users, and controls on project operations. The model operates at a monthly time step, but for the BDCP analysis daily flows on the Sacramento River were used to estimate Fremont Weir diversions and north Delta intake bypass flow requirements. These daily Sacramento River flows were estimated from the historical daily patterns adjusted to match the monthly CALSIM flows.

- **DSM2-HYDRO**: DSM2-HYDRO estimates flow rates, velocities, and depths for the Delta for a given scenario (e.g., the BDCP or climate change). It is tidally averaged. Outputs are used to determine the effects of these hydrodynamic parameters on covered terrestrial and fish species and as inputs to other biological models. The model operates at a 15-minute time step.
- **Reclamation Temperature Model**: The Reclamation Temperature Model is used to assess the effects of operations on water temperatures in the Feather, Stanislaus, Trinity, and American river basins, which are then used as inputs to the Reclamation Salmon Mortality Model and species-specific habitat evaluations. The model operates at a monthly time step.
- **Sacramento River Water Quality Model**: SRWQM is an application developed to use the HEC-5Q model to simulate mean daily (using 6-hour meterology) reservoir and river temperatures at key locations in the Sacramento River from Shasta Dam to Knights Landing. Output (temperature and flow) from the SRWQM is used as an input to a number of biological models for upstream life stages of salmonids and sturgeon. The model operates at a daily time step.
- **Delta Passage Model**: DPM simulates migration and mortality of Chinook salmon smolts entering the Delta from the Sacramento, Mokelumne, and San Joaquin Rivers through a simplified Delta channel network, and provides quantitative estimates of relative Chinook salmon smolt survival through the Delta to Chipps Island. DPM is used to estimate through-Delta survival for winter-, spring-, fall-, and late fall–run juvenile Chinook salmon passing through the Delta, as well as estimates of salvage in the south Delta export facilities. Model inputs are DSM2-HYDRO and CALSIM data. The model operates at a daily time step.
- **Sacramento Ecological Flows Tool**: Links flow management actions to changes in the physical habitats and predicts effects of habitat changes to several fish species. The model operates at a daily time step.
- **Reclamation Egg Mortality Model**: The Salmon Mortality Model is used to assess temperature-related proportional losses of eggs and fry for each race of Chinook salmon in the Trinity, Sacramento, Feather, American, and Stanislaus Rivers. The model operates at a daily time step and provides output on an annual time step.
- **DRERIP**: Used to assess importance of stressors, develop methods, and aid in qualitative assessments of covered activities in the Plan Area.
- **Longfin Smelt Winter-Spring X2–Abundance Regression**: Used to estimate relative abundance of longfin smelt in the fall based on winter-spring X2 (as an indication of outflow). Model input is from CALSIM data.
- **Delta Smelt Abiotic Habitat Index**: Used to calculate area of delta smelt abiotic habitat in fall (September–December) based on the relationship described by Feyrer et al. (2011). Model input is CALSIM data for Fall X2.

11.3.2.3 Biological Stressors Analysis

Biological stresses are associated with the diverse interactions that occur among organisms of the same or different species. Biological stresses can result from competition, herbivory, predation, parasitism, toxins, and disease. As such, a wide variety of human activities can cause or enhance biological stress. In the Delta, the introduction of invasive species is recognized as a major stressor for the covered fish species (Mount et al. 2012, Aquatic Ecosystem Stressors; USFWS 1996, Delta Native Fishes Recovery Plan)[3].The Delta is considered one of the most invaded estuaries in the world (Cohen & Carlton 1995). Species introductions and the relative biomass of nonnative species have been increasing since at least the nineteenth century as a function of increasing trade, boat traffic, recreation, as well as resource management activities. Introductions include numerous taxa, including copepods, shrimp, amphipods, bivalves, fish and both rooted and floating plants. Many planktonic species have been introduced through ballast water releases from large ships directly into the estuary. As a result, many of these introduced species originate from estuaries around the Pacific Rim, particularly copepods and mollusks. More than 250 nonnative aquatic and plant species have been introduced into the Delta (Cohen & Carlton 1995). Of these, at least 185 species have become established, and contribute to the alteration of the Delta's ecosystem. Current estimates suggest that more than 95% of the biomass in the Delta in composed of nonnative species. These introductions have resulted in a whole host of potential pathways that resulted in biological stress for covered fish.

The biological stress analysis focuses on the effects of invasive aquatic vegetation and predation by non-native fishes, two major stressors that are likely to be affected by implementation of the BDCP conservation measures. The scientific basis, analytical methods, and technical sources for evaluating potential project effects on these stressors and covered species are summarized below

Invasive Aquatic Vegetation

Within the Delta, invasive aquatic vegetation (IAV) reduces the amount and suitability of habitat for covered fish species in a number of ways through adverse effects on water quality, the foodweb and by physically obstructing covered fish species' access to habitat. Dense stands of IAV displace native aquatic plants and also provide suitable habitat for nonnative invasive fish species, which in turn reduce native species through predation. Native fish may also avoid the habitat conditions created by dense IAV (e.g., high water clarity, low DO).

The two most abundant aquatic invasive plants in the Delta are Brazilian waterweed (*Egeria densa*) and water hyacinth (*Eichhornia crassipes*). Brazilian waterweed has been present in the Delta for about 25 years and water hyacinth for over 100 years. Brazilian waterweed is a rooted aquatic perennial that grows in shallow, freshwater areas of the Delta. The plant grows long (up to 15 feet), and frequently branches stems that form very dense strands below the water surface. Brazillian waterweed is now the most abundant submerged aquatic vegetation (SAV) species in the Delta. Water hyacinth is a floating aquatic perennial that inhabits calm backwaters and other areas with low velocities. Individual plants join together and form thick, dense mats on the water surface. Because water hyacinth plants are not rooted in the substrate, their distribution is influenced by water currents and prevailing wind. During spring and summer, the dominant westerly winds often

[3] For the purposes of this discussion, invasive species are generally considered those nonnative species that adversely affect the habitats and bioregions they invade economically, environmentally, and/or ecologically.

hold the plants against the lee shorelines or in backwaters of the Delta. In off-channel and backwater sites, hyacinth mats can become dense enough to close off open water completely. In fall, when the seasonally predominant westerly winds decline, mats of hyacinth float out into the main channels where they are moved about by the river and tidal currents. Current management programs have found that herbicide application is the most effective treatment for Brazilian waterweed in the Delta, and herbicide plus some mechanical treatment is the best available treatment for water hyacinth. While construction, maintenance, and operation effects of the BDCP are expected to alter the current distribution and densities of invasive species, a number of BDCP conservation measures are likely to reduce the biological stress associated with invasive aquatic vegetation. These include CM1, CM13, and CM20.

The analysis used for IAV is a qualitative evaluation of potential outcomes (beneficial and/or detrimental) of implementing BDCP conservation measures associated with reducing the effects of IAV on BDCP covered fish. It is based on information obtained from the scientific literature; consultations with local experts; and conceptual models of key processes, habitats, and covered fish species in the Delta. Review of existing conceptual models included models developed previously by the CALFED Ecosystem Restoration Program (ERP) implementing agencies (CDFW, USFWS, and NMFS) as part of the Delta Regional Ecosystem Restoration Implementation Plan (DRERIP). Those conceptual models were developed to aid in CALFED's planning of potential ecosystem restoration actions in the Delta and are relevant to the BDCP.

A complete description of scientific basis, analytical methods, assumptions, and uncertainties for the IAV analysis can be found in *BDCP Effects Analysis – Appendix 5.F - Biological Stressors on Covered Fish.*

Fish Predation

Predator-prey dynamics are influenced by many interacting factors that directly and indirectly influence prey encounter and capture probabilities (Mather 1998; Nobriga and Feyrer 2007; Lindley and Mohr 2003). Factors affecting the opportunity and magnitude of predation include habitat overlap between predator and prey, foraging efficiency by predators, energetic demands of predator, size, life stage, behavior and relative numbers of predators and prey.

Although predation is a natural part of aquatic community dynamics, the possibility of increased predation rates by nonnative fish species has been identified as a stressor for BDCP covered fish species, such as delta smelt (Baxter et al. 2008), steelhead (Clark et al. 2009; National Marine Fisheries Service 2009b), and juvenile Chinook salmon (Good et al. 2005; Moyle 2002; National Marine Fisheries Service 2009b). Elevated predation rates are considered a potential indirect effect of water diversion operations (Brown et al. 1996) and a potential hindrance to shallow-water habitat restoration (Brown 2003; Nobriga and Feyrer 2007). Predatory fish species of particular concern in the Delta are striped bass (*Morone saxatilis*), largemouth bass (*Micropterus salmoides*) and Sacramento pikeminnow (*Ptychocheilus grandis*). Nobriga and Feyrer (2007) found numerous invertebrate and fish taxa in the diets of these common species. Many predatory fish species, including striped bass and largemouth bass, are nonnative. Habitat structure and heterogeneity can affect opportunities for encounter and capture by predators. In open water habitats, striped bass are the most likely primary predator of juvenile and adult delta smelt. Other species, such as largemouth bass, are ambush predators that remain close to cover such as in water structures or aquatic vegetation. A number of BDCP conservation measures are likely to reduce the biological stress associated with fish predation. These include CM1–CM6, CM13, CM16, and CM21.

For fish predation, best professional judgment based on the available scientific information was used to characterize predator distribution and abundance within Delta habitats, covered fish species losses attributed to predation, and the anticipated effectiveness of the predator control conservation measures on predation impacts in Delta. This included information from studies of marked or radio tagged steelhead, Chinook salmon and delta smelt at the SWP CCF (Gingras 1997; Clark et al. 2009; Castillo et al. 2012) and Chinook salmon at the San Joaquin River and head of Old River (Bowen et al. 2009). Other studies provided information on Delta habitat use by covered fish species and nonnative predators (Nobriga et al. 2005; Nobriga and Feyrer 2007) and the effectiveness of fish predator control efforts in the Delta (Cavallo et al. 2012) and elsewhere (Mueller 2005; Porter 2010).

Three quantitative analyses were used to estimate predation-related effects of water diversions and facilities (CM1). For the south Delta facilities, pre-screen entrainment losses that are typically ascribed to predation were presumed to be commensurate with salvage density.

For the new north Delta intakes, bioenergetics modeling was used to estimate relative consumption of Chinook salmon by striped bass. The original model estimated consumption based on water temperature, striped bass size, striped bass density at the screen, and the density and size of prey encountered (Loboschefsky and Nobriga 2010; Loboschefsky et al. 2012). Another rough estimate of predation losses at the north Delta intakes was an assumption of a fixed 5% loss for each intake passed by outmigrating juvenile Chinook salmon, as proposed by NMFS. A complete description of methods and the resulting analysis can be found in the *BDCP Effects Analysis – Appendix F*, *Biological Stressors, Section 5F.0.2.2 Fish Predation and Section 5F.3.2 Fish Predation Analysis (hereby incorporated by reference*).

11.3.2.4 Contaminants Analysis

To evaluate effects on covered fish species, published data on occurrence, biogeochemical behavior, mass balances, quantitative modeling tools, and studies of impacts of specific toxic constituents on covered fish species were reviewed. A broad range of studies are available specific to the Central Valley and Delta region, some of which are referenced in this analysis. The objective of the analysis is to provide an overview of how these constituents could become more bioavailable to covered fish species in the Plan Area and whether there is potential for the alternatives to result in effects on covered fish species. A complete analysis can be found in the *BDCP Effects Analysis – Appendix D*, *Contaminants (hereby incorporated by reference)*.

The action alternatives involve substantial restoration that would be implemented throughout the Delta over the 50-year implementation period as well as changes in water operations that could change how some toxins move through the Delta. Restoration of land with metals and pesticides in soils that could be mobilized into the aquatic system when inundated is expected to increase the bioavailability of some toxins to covered fish species. Conversely, taking lands out of agricultural use may result in an overall reduction of agriculture-related toxin loading, including pesticides, copper, and in some cases, concentrated selenium in irrigation drainage.

Given the current understanding of the complex processes involved in mobilizing these toxins, it cannot be modeled or quantified on a BDCP wide basis with any confidence. The analysis presented here provides a conceptual framework to understand the relevant processes. Site-specific analyses of restoration areas will be required to estimate the magnitude of the effects. The amount of toxins that would be mobilized and made more bioavailable to covered fish species due to inundation of

ROAs is uncertain. This uncertainty is most critical for methylmercury, and to a lesser extent for pesticides and other metals. For each of the toxins, the chemical-specific and site-specific factors that will determine resultant effects vary. CM12 is included in the project (see Chapter 3) to support site specific evaluation and monitoring of methylmercury production in restored areas. Data from this monitoring will assist in evaluating the effects of restoration actions and reduce the uncertainty associated with the potential exposure of covered fish to methylmercury mobilized by these actions.

11.3.2.5 Habitat Restoration Analysis

This analysis relies on a combination of qualitative and quantitative methods to evaluate the effects of the proposed restoration activities. In addition to literature review, these methods include a habitat suitability index (HSI) approach, based on data obtained from trawls and CALSIM, DSM2, and RMA Bay-Delta model outputs, and a Habitat Productivity Analysis. The habitat suitability analysis focuses on the direct benefits to fish in terms of increased habitat availability. The analysis of habitat productivity considers the indirect benefits to fish from improved ecological functions in restored habitats, with a focus on food production. A summary of methods for each conservation measure is provided below. A complete discussion of methods for each conservation measure can be found in the *BDCP Effects Analysis – Appendix E*, *Habitat Restoration (hereby incorporated by reference)*.

Detailed plans for restoration, enhancement, and preservation areas have not been prepared for multiple reasons: (1) because the habitat restoration and enhancement would occur, if feasible, in areas with willing sellers, none of whom have been identified; (2) to maintain flexibility in the BDCP for adaptive management; and (3) because BDCP implementation has a long timeframe. However, although specific locations proposed for habitat restoration and enhancement have not been defined at this time, the EIR/EIS must quantify the environmental effects to the degree of specificity available for the project description. Therefore, the assessment of the effects for the habitat restoration and enhancement was programmatic. The analysis focused on the restoration opportunity areas (ROAs) identified in the BDCP. ROAs were established to assist in the development of the BDCP conservation strategy. ROAs encompass those locations considered to be the most appropriate for the restoration of tidal habitats within the Plan Area and within which restoration goals for tidal and associated upland natural communities will be achieved. The ROAs are large land areas centered on Suisun Marsh, the West and South Delta areas, Cache Slough and the Cosumnes/Mokelumne area in the east Delta (Figure 3-1). Individual project-level environmental review based on more detailed plans will be required for these actions before implementation.

CM4 Tidal Habitat Restoration

Habitat Suitability Analysis

The analysis of tidal marsh restoration focuses on the change in the quantity and quality of habitat available to each species and life stage. The potential value of the restored habitat is determined using a habitat suitability approach (Schamberger et al. 1982). This technique captures knowledge about the habitat requirements of species in the form of ratings that are integrated to derive a Habitat Suitability Index or HSI. The HSI is a measure of the dynamic quality of habitat condition with respect to the species/life stage requirements. The species-specific HSI is then applied to the total quantity of available or restored habitat to derive habitat units (HUs). HUs are the interpretation of the habitat types (e.g., deep water, intertidal, shallow water) from the perspective of a species and life stage.

The analysis addresses habitat at a macro-scale ranging from hundreds to thousands of acres of land that potentially would be flooded to provide aquatic habitat. The analysis does not address specific restoration actions that will occur at smaller scales. Specific actions or restoration sites have not been identified as part of the BDCP. Instead, the measure provides a general outline of areas and schedules for habitat restoration. The general description of actions in the conservation measure has been expanded for this analysis by estimating acreages, tidal condition, and depth of areas in each ROA that potentially would be flooded as dikes were breached. These estimates were derived through application of the RMA Bay-Delta model, CALSIM, DSM2, and geographic information systems (GIS). These refined estimates of restored areas then were evaluated using the habitat suitability analysis.

Application of Habitat Suitability Analysis integrates habitat suitability models for multiple habitat attributes for different life stages of species. Habitat suitability models describe the suitability of a habitat attribute such as temperature to the survival of the life stage, for example Delta smelt eggs. As such, for each species evaluated using the habitat suitability approach (delta smelt, salmonids, etc.), specific characteristics were assigned ratings for each life stage (Table 11-11). These individual suitability models attempt to capture how the species perceives the environmental condition presented currently or what might occur due to habitat restoration. Suitability models were derived from review of available literature and consultation with regional species experts. The results of the analysis are captured as Habitat Units (HUs) that are the product of the area of various habitat types (shallow, intertidal and deep) and the HSI ratings for the same areas. The determination of HUs also incorporates the concept of key habitat types for life stages. This allows consideration of life stages selecting particular types of environments over others. However, this is not a comprehensive evaluation of habitat because not all species and life stages have been modeled, only a few of the many habitat attributes have been included, and habitat beneficial to one species is not necessarily beneficial to others. In addition, the attributes are averaged over relatively large areas, at the ROA level.

Table 11-11. Attributes Evaluated Using the Habitat Suitability Index

Species Life Stage	Attributes
Delta smelt eggs	Temperature, salinity
Delta smelt larvae	Temperature, salinity, turbidity
Delta smelt juveniles	Temperature, salinity, turbidity
Salmonid fry	Temperature, turbidity, dissolved oxygen
Splittail juveniles	Depth
Splittail adults	Depth

The results of the HSI are combined for each evaluated species in each ROA and presented in HUs to show the estimated quantity and quality of the restored habitats for each of the species evaluated.

Habitat Productivity

The Habitat Productivity Analysis was designed to optimistically assess potential food web enhancements that may result from proposed tidal habitat restoration activities. The analysis examined two main sources of foodweb support: phytoplankton production and marsh-derived production.

The relationship between phytoplankton growth rate and depth developed by Lopez and coauthors (2006) was used to characterize how habitat restoration could contribute to the phytoplankton-based foodweb. This relationship was applied to the estimated depths for each tidal-area stratum. In addition, a consideration of the area of habitat of an average depth was added to the estimates of phytoplankton growth rate. It was assumed that a larger area of a given phytoplankton growth rate has a greater value than a smaller area with the same rate. To capture this notion, the phytoplankton growth rate was first calculated from the estimated average water depth of each tidal-area stratum, and then multiplied by the area of the stratum, resulting in a metric termed "prod-acres" (phytoplankton growth rate X area). The analysis provided estimates of phytoplankton growth rate, depth, and calculated prod-acres by ROA and implementation period. The contribution of the detrital pathway to marsh production was examined on the basis of an analysis by Kneib (2003), which included estimates of the amount of production flowing to resident nekton (actively swimming aquatic species) as well as the export of production to the estuary by means of a "trophic relay" by migrant nekton.

CM5 Seasonally Inundated Floodplain

The analysis of seasonally inundated floodplains follows The Delta Conceptual Models (Opperman 2012), which include both ecosystem element models (including process, habitat, and stressor models); and species life history models. The Delta Conceptual Models are qualitative models which describe current understanding of how the system works (DiGennaro et al. 2012). They are designed and intended to be used by experts to identify and evaluate potential restoration actions. They are not quantitative, numeric computer models that can be "run" to determine the effects of actions. Rather they are designed to facilitate informed discussions regarding expected outcomes resulting from restoration actions and the scientific basis for those expectations.

The floodplain restoration will be evaluated by measuring;

- Seasonally inundated floodplain restoration sites along channels in the north, east, and south Delta.
- Large-scale floodplain restoration in the south Delta along the San Joaquin River, Old River, and Middle River.
- Increases in food availability (phytoplankton, zooplankton, insects, and small fish) resulting from increased floodplain inundations. Enhancement of both primary production and zooplankton growth.
- Increases in the quantity quality of accessible rearing habitat for juvenile salmon and splittail.
- Levee setbacks, removal of riprap, and grading of floodplain activities.

CM6 Channel Margin Enhancement

Existing channel margin habitat conditions of importance to fish were summarized using the Sacramento River Bank Protection Project revetment database (U.S. Army Corps of Engineers 2007). This database covers levees that are part of the Sacramento River Flood Control Project. Within the Plan Area, the major channels important to covered fish species that are included in the database are:

- Sacramento River: full extent
- Georgiana Slough: full extent

- Sutter and Steamboat Sloughs: full extents
- Miner Slough: full extent
- Cache Slough: partial extent

The revetment database was used to summarize several features of existing habitat that may be important to covered fish species, including water depth, presence of revetment, emergent vegetation coverage, overhead cover, and woody material. The summary of bankline features was used together with a literature review to provide context for the potential benefits of CM6 Channel Margin Habitat Enhancement.

CM7 Riparian Habitat Restoration

Methods for evaluation include both quantitative and qualitative methods to estimate the effects of the proposed restoration activities. In addition to literature review, these methods include a habitat suitability index (HSI) approach, based on data obtained from trawls and CALSIM, DSM2, and RMA Bay-Delta model outputs, and a Habitat Productivity Analysis. The habitat suitability analysis focuses on the direct benefits to fish in terms of increased habitat availability. The analysis of habitat productivity considers the indirect benefits to fish from improved ecological functions in restored habitats, with a focus on food production. This includes the evaluation and use of monitoring strategies and results from relevant studies in the watershed (Sacramento River Riparian Monitoring and Evaluation Plan by Shilling et al. 2011 and Golet et al. 2008).

11.3.2.6 Reservoir Coldwater Fish Habitat Analysis

Upstream reservoirs that may be affected by changes in delivery of water are analyzed to determine the effects on coldwater fish habitat. According to Moyle (2002, pg 36, 37), foothill water supply reservoirs of the Central Valley can be described with four major habitat zones: 1) the littoral or edge-water habitat around the shoreline of the reservoir, 2) the epilimnetic or near-surface habitat located above the thermocline (water temperature gradient) and generally in the euphotic zone (>1% of surface light) where phytoplankton grow, 3) hypolimnetic or deep-water habitat located below the thermocline, where the water temperatures remain less than 15^{0}C (59^{0}F) during the stratified spring-summer and fall months, and 4) the deepwater benthic habitat located near the bottom of the hypolimnetic portion of the reservoir. There are relatively distinct fish assemblages within each of these habitat zones, with different feeding and reproductive behaviors (strategies). Reservoirs are generally less productive (lower fish biomass and growth rates) than lakes of a comparable surface area because reservoir water surface elevations fluctuate more and have steeper slopes, which limits the littoral benthic zone, and may interfere with reproduction (Moyle 2002 pg 36).

Seasonal temperature stratification (vertical water temperature gradient) and phytoplankton production in the epilimnetic near-surface zone are the dominant seasonal habitat features of reservoirs. The evaluation of possible effects of reservoir operations simulated for the action alternatives on reservoir fish populations considers the effects on warm-water fish in the epilimnetic and littoral habitat zones together, and will consider the coldwater fish in the hypolimnetic and deep water benthic habitat zones together. In some lakes and reservoirs, the dissolved oxygen in the hypolimnion can become depleted from inflowing organic materials or, more commonly, by settling of detritus from the productive epilimnion. Lake Almanor is a good example of this condition in California. Low dissolved oxygen is not a problem in the major CVP and

SWP reservoirs, however, and will not be included in the coldwater habitat evaluation. Because the water depths are relatively shallow and water surface elevations of the regulating reservoirs (i.e., Lewiston, Whiskeytown, Keswick, Thermalito, Natoma, and Tulloch Reservoirs) are largely independent of flow, the habitat conditions are similar from year to year, and the fish populations in the regulating reservoirs are stable; fish populations in these regulating reservoirs are not evaluated for the BDCP alternatives.

Although the seasonal variations in water surface elevations (storage level), temperature stratification and primary production (light availability) in the major water supply reservoirs are somewhat similar from year to year, the end-of-water-year (end-of September) storage volumes can be quite different. Because the water supply reservoirs are generally filled in the spring and are drawn-down during the summer and fall for water supply releases, the minimum storage each year usually occurs in September (or October) and can be greatly reduced in a sequence of dry years (i.e., drought). Drawdown of reservoir storage from June through October can diminish the volume of cold water, thereby reducing the amount of habitat for coldwater fish species during these months. Kokanee salmon and rainbow trout are common coldwater species that support important recreational fisheries in Central Valley reservoirs. Potential impacts can therefore be assessed based on the availability of suitable water temperatures for these species during the late summer or early fall when coldwater habitat is most restricted. Preferred habitat for kokanee is well-oxygenated open water in reservoirs where temperatures are 50–59° F, while rainbow trout growth is optimal when temperatures are around 59°F–64°F (Moyle 2002). Thus, a water temperature index of 60 °F was used in the following assessment as a general indicator of the availability of coldwater habitat in Central Valley reservoirs. This temperature index is specific to analysis of reservoir operations, while areas downstream of the reservoirs use a different temperature index (National Marine Fisheries Service 2009a, 2009b).

The basic approach is to determine the relationship between total storage volume and the coldwater volume in each reservoir. The maximum suitable temperature for the coldwater habitat was assumed to be 60°F. The minimum coldwater habitat volume or the reduction in coldwater habitat volume that would be classified as a substantial change must be identified for each reservoir. Finally the percentage of additional years (out of the 82-year simulation period) that would be considered an adverse effect on the fish populations within each reservoir must be determined. The methods for coldwater reservoir fish is based on an analysis of Shasta Reservoir; the approach for Shasta Reservoir is then combined with the results from the CALSIM modeling for the other major CVP and SWP reservoirs, along with the selected minimum coldwater habitat volumes. This information is used for the coldwater habitat impact evaluation for each alternative (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

11.3.2.7 Methods Used to Consider Mitigation

The construction and operation of the project or its alternatives would result in a range of short-term and long-term effects on environmental conditions in the Sacramento River and the Delta. This would in turn result in a range of direct and indirect effects on fish and aquatic resources that depend on the affected habitats. The BDCP conservation measures have been designed to avoid and minimize such impacts where possible and improve habitat conditions. The project also incorporates environmental commitments (referred to as Avoidance and Minimization Measures in the BDCP Effects Analysis) which have been designed to avoid and minimize effects where possible. To the extent that effects remain, and such effects are deemed to be adverse or significant, feasible measures will be implemented to mitigate these effects to less-than-significant levels.

The potential environmental effects of the alternatives have been analyzed independently below. The potential effects on fish species created by each BDCP element (the CMs) have also been independently identified. All effects identified as adverse and potentially significant have been evaluated for the feasibility of mitigation after first considering whether the conservation measures or environmental commitments built into the BDCP would lessen the significant adverse environmental effects. Permanent and temporary impacts have been treated the same for considering the need for mitigation.

In situations where neither the conservation measures or the environmental commitments (which include Best Management Practices [BMPs]) are capable of adequately avoiding or minimizing potential adverse effects, mitigation measures are presented, to the extent feasible, that will reduce adverse effects to levels that are not adverse or less than significant. In situations where feasible mitigation for significant adverse effects is not identified, the effect is considered significant and unavoidable.

11.3.2.8 Critical Habitat and Essential Fish Habitat

For federally listed species for which critical habitat has been designated, the analysis of whether there is an adverse effect to critical habitat is included within the analysis of effects to all habitat for the species. Prior to deciding whether to issue permits, USFWS and NMFS will undertake an analysis of the BDCP pursuant to the Section 7 consultation process to ensure that issuance of the permits and implementation of the BDCP is not likely to result in the destruction or adverse modification of critical habitat.

The agencies will undertake an Essential Fish Habitat (EFH) consultation. More information about critical habitat and EFH is provided in the BDCP Effects Analysis (BDCP Chapter 5 – *Effects Analysis*, hereby incorporated by reference).

11.3.3 Determination of Effects

The covered and non-covered fish and aquatic resource species discussed above have similar life history requirements (i.e., habitat, water quality) as all aquatic resource species in the project area. Because there are so many aquatic species in the project area, the covered and non-covered aquatic resource species are used as assessment species for the impact analysis. The impacts of the action alternatives on fish and aquatic biological resources may result from construction, maintenance, and operation of BDCP water conveyance facilities, and construction and implementation of conservation measures. This impact analysis assumes that an action alternative would have an impact on fish and aquatic resources if it directly or indirectly harmed or harassed individuals or populations of the species considered in this chapter, or removed or damaged the habitat of these species. Action alternatives that meet this initial screening threshold are then analyzed using the criteria described below.

The CEQA Guidelines (Title 14, Division 6, Chapter 3 of the California Code of Regulations [CCR]), at Section 15064.7, encourage public agencies to develop thresholds of significance to use in determining the significance of environmental effects when complying with CEQA. In this same section, the CEQA Guidelines define a threshold of significance as “an identifiable quantitative, qualitative or performance level of a particular environmental effect, non-compliance with which means the effect will normally be determined to be significant by the agency and compliance with which means the effect normally will be determined to be less than significant.” Although Section

15064.7 authorizes a public agency subject to CEQA to conduct a formal public process for formulating significance thresholds that would apply to all of the agency's projects, the courts have recognized that, in preparing an individual CEQA document, a lead agency may informally develop significance criteria applicable to particular projects, provided that such criteria are supported by substantial evidence[4].

Here the significance criteria used to evaluate impacts on fish and aquatic resources are based on and incorporate guidance contained in Section 1508.27 of the Council on Environmental Quality (CEQ) NEPA regulations regarding significance determinations; the mandatory findings of significance, as listed in Section 15065 of the State CEQA Guidelines (Title 14, Chapter 3 of the CCR); and criteria contained in Appendix G, "Environmental Checklist Form," of the State CEQA Guidelines.

Section 1508.27 of the CEQ NEPA regulations defines the word "significantly," which comes into play in the statutory mandate under NEPA for federal agencies to prepare Environmental Impact Statements for major federal actions *significantly* affecting the human environment. (42 U.S.C. § 4321.) Under section 1508.27, federal agencies, in determining whether a major federal action significantly affects the human environment, should consider both the "context" and the "intensity" of the effects at issue. Context relates to the setting for the proposed action (i.e., whether it is regional or local in scale). Intensity "refers to the severity of impact." Among the factors to be considered in assessing intensity are "[t]he degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the Endangered Species Act of 1973."

In enacting CEQA, the California Legislature found and declared that it was the policy of the state, among other things, to "[p]revent the elimination of fish or wildlife species due to man's activities" and "insure that fish and wildlife populations do not drop below self-perpetuating levels[.]" (Cal. Pub. Resources Code section 21001[c]). CEQA Guidelines section 15065, which echoes this policy statement, identified several broadly framed impact categories that often serve as significance thresholds.

Similarly, the sample Initial Study Checklist found in Appendix G to the CEQA Guidelines identifies questions lead agencies should generally ask with respect to a proposed project's potential impacts on Biological Resources. The impact categories from CEQA Guidelines section 15065 and the Appendix G questions are often used to formulate more specific significance thresholds. For this analysis impact categories from CEQA Guidelines section 15065 and the Appendix G questions have been refined to apply to potential impacts on fish and other aquatic resources and impacts are considered significant under CEQA or adverse under NEPA if the BDCP Alternative would

- substantially reduce the habitat of a fish, aquatic, or wildlife species*;*
- cause a fish or wildlife population to drop below self-sustaining levels*;*
- threaten to eliminate a plant or animal community*;*
- substantially reduce the number or restrict the range of an endangered, rare or threatened species;

[4] See, e.g., Oakland Heritage Alliance v. City of Oakland (2011) (2011) 195 Cal.App.4th 884.896-897; Citizens for Responsible Equitable Environmental Development v. City of Chula Vista (2011) 197 Cal.App.4th 327, 336.)

- have a substantial adverse effect, either directly or through habitat modifications, on any [aquatic] species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service [or by the National Marine Fisheries Service];
- have a substantial adverse effect on any … sensitive [aquatic] natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or US Fish and Wildlife Service; or
- interfere substantially with the movement of any native resident or migratory fish … species.

These seven enumerated thresholds have been applied to all determinations of effect, adverse for purposes of NEPA, and significant for purposes of CEQA, for each impact mechanism discussed in the following pages. All aspects of the alternatives are subject to these criteria, including the construction, maintenance, and operation of BDCP water conveyance facilities (CM1), and implementation of CM2–CM22. Consistent with the impact categories in CEQA Guidelines 15065, these thresholds are broadly framed and leave room for expert judgement and application to the numerous aspects of the alternatives and the multiple species evaluated.

Each alternative is analyzed in comparison to its relevant baseline. Under the CEQA analysis, each action alternative is compared against existing conditions at the time the NOP was prepared (State CEQA Guidelines, section 15125[a]). Under the NEPA analysis, each action alternative is compared against the anticipated future condition (CEQ Regulations, sections. 1502.14, 150216[d]) that would occur under the No Action Alternative in 2060. CEQA and NEPA baselines are more fully described in Chapter 4, Section 4.2.1.1. The NEPA baseline includes the projected climate change (changed precipitation patterns) and sea level rise, and many other programs, projects, and policies expected to occur by 2060, as well as the implementation of most of the required actions under both the December 2008 USFWS BiOp and the June 2009 NMFS BiOp (e.g., inclusion of Fall X2 criteria). As a result of differences between the CEQA and NEPA baselines, it is sometimes possible for CEQA and NEPA significance conclusions to vary between one another under the same impact discussion. Although the NAA represents projected future conditions, the manner in which some of the required actions under the BiOps remain uncertain at present. As a result, some of these required actions were not incorporated, and could not be accurately incorporated, into modeling for the NAA or for any of the action alternatives. While it is possible that the implementation of these unmodeled actions over time could alter the resultant magnitude of effects under the implementation of BDCP action alternatives, the unmodeled actions are intended to improve conditions for fisheries, so that their full implementation over time should contribute to reduced adverse environmental effects and to increased environmental benefits. Thus, the analyses contained in this EIR/EIS are considered conservative with respect to any potential adverse environmental consequences related to the implementation of these unmodeled actions, and likely somewhat overstate the adverse effects of both the No Action Alternative and the proposed action alternatives. As a result, the future conditions in 2060 will likely be more environmentally benign than is reflected in the modeling results presented in the EIR/EIS.

Under CEQA, the absence of sea level rise and climate change in Existing Conditions results in model-generated impact conclusions that include the impacts of sea level rise and climate change with the effects of the action alternatives. As a consequence, the CEQA conclusions in many instances either overstate the effects of the action alternatives or suggest significant effects that are largely attributable to sea level rise and climate change, and not to the action alternatives.

In both sets of analyses, the Lead Agencies have relied on computer models that represent best available science; however, any predictions of conditions 50 years from the present are inherently limited and reflect a large degree of speculation. In the interest of informing the public of what DWR believes to be the reasonably foreseeable impacts of the action alternatives, DWR has focused in its CEQA analysis primarily on the contribution of the action alternatives, as opposed to the impacts of sea level rise and climate change, in assessing the significance of the impacts of these action alternatives. The opposite approach, which would treat the impacts of sea level rise and climate change as though they were impacts of the action alternatives, would overestimate the effects of the action alternatives. The approach taken here by DWR also has the effect of highlighting the substantial nature of the consequences of sea level rise and climate change on California's water system.

11.3.4 Effects and Mitigation Approaches

The analysis of effects of each alternative is organized by species. The effects on each species are considered by category, as shown below.

- Construction and Maintenance of CM1
    - Effects of construction of water conveyance facilities
    - Effects of maintenance of water conveyance facilities
- Water Operations of CM1
    - Effects of water operations on entrainment
    - Effects of water operations on spawning habitat
    - Effects of water operations on rearing habitat
    - Effects of water operations on migration conditions
- Restoration Measures (CM2, CM4–CM7, and CM10)
    - Effects of construction of restoration measures
    - Effects of contaminants associated with restoration measures
    - Effects of restored habitat conditions
- Other Conservation Measures (CM12–CM19 and CM21)
    - Effects of methylmercury management (CM12)
    - Effects of invasive aquatic vegetation management (CM13)
    - Effects of dissolved oxygen level management (CM14)
    - Effects of localized reduction of predatory fishes (CM15)
    - Effects of nonphysical fish barriers (CM16)
    - Effects of illegal harvest reduction (CM17)
    - Effects of conservation hatcheries (CM18)
    - Effects of urban stormwater treatment (CM19)
    - Effects of removal/relocation of nonproject diversions (CM21).

The construction and operation of the BDCP action alternatives would result in a range of short-term and long-term effects on environmental conditions in the Sacramento River and the Delta. This would in turn result in a range of direct and indirect effects on fish and aquatic resources that depend on the affected habitats. The BDCP conservation measures have been designed to avoid and minimize such impacts where possible and improve habitat conditions. The project also incorporates environmental commitments which have been designed to avoid and minimize effects where possible. To the extent that effects remain, and such effects are deemed to be adverse or significant, feasible mitigation measures will be implemented to reduce effects.

11.3.4.1 No Action Alternative

The No Action Alternative for the BDCP EIR/EIS means that the BDCP would not be completed and incidental take permits would not be issued. This alternative entails programs, projects, and policies by federal, state and local agencies included in Existing Conditions assumptions and those with clearly defined management and/or operational plans, including facilities under construction as of February 13, 2009. The No Action Alternative assumptions also include facilities and programs that received approvals and permits in 2009 because those programs were consistent with existing management direction as of the NOP. As the NEPA baseline, the No Action Alternative includes continuation of operations of the SWP and CVP, with through-Delta conveyance only under currently authorized operational criteria as described in the 2008 BA with operational assumptions modified by the 2008 USFWS and 2009 NMFS BiOps and other relevant plans and projects that would likely occur in the absence of BDCP actions. This also assumes implementation of the Fall X2 action, which requires additional water releases in wet and above normal years to meet salinity targets in the western Delta in September and October, plus releases in November to augment Delta outflow. The No Action Alternative scenario (NAA) takes into account sea level rise and climate change that would occur around Year 2060.

The NAA assumes compliance with the California Endangered Species Act (CESA) and the federal Endangered Species Act (ESA) will continue on a case-by-case basis for future programs and projects that have a potential to take listed species under each act. It also assumes utilization of senior water rights in the Sacramento and San Joaquin river watersheds by Year 2025 utilizing facilities currently available or under construction.

The NAA assumes continued operations of flood management facilities by the federal, state, and local agencies. It also assumes that future levee failures due to flooding, erosion, subsidence, wave action, seismic events, burrowing animals, physical encroachment (such as barge collisions), or other causes would be repaired under ongoing programs.

Existing Conditions, the CEQA baseline, are defined in Appendix 3D, *Defining Existing Conditions, No Action Alternative, No Project Alternative, and Cumulative Impact Conditions*. Briefly, Existing Conditions include the 2008 USFWS and 2009 NMFS BiOps, facilities and ongoing programs in place as of February 13, 2009, but do not include implementation of Fall X2.

A summary of the programs, plans, and projects included under the NAA and Existing Conditions, as well as detailed descriptions of these baselines, are provided in Appendix 3D, *Defining Existing Conditions, No Action Alternative, No Project Alternative, and Cumulative Impact Conditions*. The projects that could affect fish and aquatic resources are summarized here in Table 11-12, along with their anticipated effects on covered fish species (see Section 11.1.3.1) and aquatic resources.

Table 11-12. Effects on Covered Fish Species from the Plans, Policies, and Programs for the No Action Alternative

Agency	Program/Project	Status	Description of Program/Project	Effects on Covered Fish Species
California Department of Water Resources	FERC License Renewal for Oroville Project	Draft Water Quality Certification issued December 6, 2010 and comments on Draft received December 10, 2010. FERC license will be issued and operations will be in accordance with NMFS BiOp and final FERC license.	The renewed federal license will allow the Oroville Facilities to continue providing hydroelectric power and regulatory compliance with water supply and flood control.	No adverse effects on aquatic habitat or covered fish species are expected based upon environmental documentation for this project (California Department of Water Resources 2008).
Contra Costa Water District	Contra Costa Canal Fish Screen Project	Completed in 2011.	The project installed a fish screen at the Contra Costa Canal diversion at Rock Slough.	Beneficial effects on aquatic habitat or covered fish species are expected.
Contra Costa Water District, U.S. Bureau of Reclamation, and California Department of Water Resources	Middle River Intake and Pump Station (previously known as the Alternative Intake Project)	Completed in 2011.	The project includes a 250 cfs pump station, a screened intake structure along Victoria Canal on Victoria Island, and a pipeline across Victoria Island tunneled under Old River to the District's Old River Pump Station where it connects to existing conveyance facilities.	No adverse effects on aquatic habitat or covered fish species are expected based upon environmental documentation for this project (Contra Costa Water District 2006).
Freeport Regional Water Authority and U.S. Bureau of Reclamation	Freeport Regional Water Project	Completed in 2010.	The project includes an intake/pumping plant near Freeport on the Sacramento River and a conveyance structure to transport water through Sacramento County to the Folsom South Canal. The pumping plant diverts 185 million gallons per day.	No adverse effects on aquatic habitat or covered fish species are anticipated based upon environmental documentation for this project (Freeport Regional Water Authority 2003).
City of Stockton	Delta Water Supply Project	Completed in 2012.	This project consists of a new intake structure and pumping station adjacent to the San Joaquin River; a water treatment plant along Lower Sacramento Road; and water pipelines along Eight Mile, Davis, and Lower Sacramento Roads.	No adverse effects on surface water resources or covered fish species are anticipated based upon environmental documentation for this project (City of Stockton 2005).

Agency	Program/Project	Status	Description of Program/Project	Effects on Covered Fish Species
Reclamation District 2093	Liberty Island Conservation Bank	Completed in 2011.	The project consists of restoration of 186 acres on Liberty Island in unincorporated Yolo County. Restoration was focused on enhancing and creating tidal aquatic habitat suitable for special-status fish species (including salmon and delta smelt).	No adverse effects on aquatic habitat or covered fish species are anticipated based upon environmental documentation for this project (Bureau of Reclamation 2009).
Tehama Colusa Canal Authority and U.S. Bureau of Reclamation	Red Bluff Diversion Dam Fish Passage Project	Pumping plant and fish screen was completed in 2012. Operations of the pumping plant began September 2012. Expected decommissioning of the old structure to begin September 2013.	Proposed improvements include modifications made to upstream and downstream anadromous fish passage and water delivery to agricultural lands within CVP.	No adverse effects on aquatic habitat or covered fish species are anticipated based upon environmental documentation for this project (Bureau of Reclamation 2002).
U.S. Bureau of Reclamation and State Water Resources Control Board	Battle Creek Salmon and Steelhead Restoration Project	Construction is being implemented in three phases and is currently underway. The final phase is estimated to occur between 2013 and 2015.	This project includes modification of facilities at Battle Creek Hydroelectric Project diversion dam sites located on the North Fork Battle Creek, South Fork Battle Creek, and Baldwin Creek. Fish screens and ladders will be installed at various location; a fish barrier will be installed on Baldwin Creek; an Inskip Powerhouse tailrace connector and bypass will be installed on the South Fork; a South Powerhouse tailrace connector will be installed; and Lower Ripley Creek Feeder, Soap Creek Feeder, Coleman and South diversion dams, and appurtenant conveyance systems will be removed.	
U.S. Bureau of Reclamation, California Department of Fish and Game, and Natomas Central Mutual Water Company	American Basin Fish Screen and Habitat Improvement Project	Expected completion in 2012.	This three-phase project includes consolidation of diversion facilities; removal of decommissioned facilities; aquatic and riparian habitat restoration; and installing fish screens in the Sacramento River. Total project footprint encompasses about 124 acres east of the Yolo Bypass.	No adverse effects on aquatic habitat or covered fish species are anticipated based upon environmental documentation for this project (Bureau of Reclamation 2008c).

Agency	Program/Project	Status	Description of Program/Project	Effects on Covered Fish Species
Yolo County	General Plan Update	Adopted in November 2009.	The Yolo County general plan provides comprehensive and long-term policies for the county and determines land use planning throughout the unincorporated area.	No adverse effects on aquatic habitat or covered fish species are anticipated.
Zone 7 Water Agency and Department of Water Resources	South Bay Aqueduct Improvement and Enlargement Project	Under construction. Estimated completion in 2012.	This project includes upgrades to the South Bay Pumping Plant; raised linings on open channel sections of the aqueduct; the addition of a 450 acre-foot Dyer Reservoir; and 4.5 miles of pipeline connecting to the South Bay Pumping Plant	No adverse effects on aquatic habitat or covered fish species are anticipated based upon environmental documentation for this project (California Department of Water Resources 2004c).

Covered Fish Species

Many of the projects and programs that would occur under the No Action Alternative would be similar to those included in the BDCP alternatives and would have similar potential effects. These effects would also be similar between the different covered species. Therefore, the following assessment addresses all the covered species as a group for some potential effects (e.g., water quality effects), but addresses individual species for other mechanisms where the effects could be measurably different among species (e.g., entrainment).

Construction and Maintenance of CM1

Impact AQUA-NAA1: Effects of Construction of Facilities on Covered Fish Species

Following is a summary of the potential exposure of covered fish species to impacts from construction of other projects under NAA. Impacts include turbidity, accidental spills, disturbance of contaminated sediment, underwater noise, fish stranding, in-water work activities, loss of spawning, rearing or migration habitat, and predation. The construction and maintenance activities occurring under the No Action Alternative, would have similar effects on all the covered fish species; therefore, the analysis below is combined for all the covered species instead of analyzed by individual species.

Turbidity

Under the NAA, existing facilities and operations would be continued and none of the conservation measures CM1–CM22 associated with the action alternatives would be implemented, except for any similar programs that were approved or permitted prior to the 2009 NOP. Detailed discussions of these programs are provided in Appendix 3D, *Defining Existing Conditions, No Action Alternative, No Project Alternative, and Cumulative Impact Conditions*. Construction and maintenance of projects or programs under the NAA (Table 11-12), such as the Battle Creek Salmon and Steelhead Restoration Project which would involve substantial in-channel and/or near-channel construction activities (e.g., dredging, dam removal), would result in the temporary generation and release of suspended sediments to the water column, and other potential construction-related water quality effects.

Similarly, routine construction activities that may occur for urbanization and infrastructure to accommodate population growth would generally be anticipated to involve relatively dispersed, temporary, and intermittent land disturbances across the affected environment. Further, certain maintenance activities, such as levee repair and maintenance, could result in temporary increases in water turbidity. Erosion of disturbed soils and associated sediment load would potentially enter surface water bodies. Increased suspended sediments would temporarily increase water column turbidity, altering habitat conditions in the Plan Area for fish and other aquatic species. However, effects on fish from increases in turbidity during in- or near-water construction and maintenance activities would be minimized through adherence to applicable federal, state, and local regulations, project-specific designs, BMPs, and environmental commitments intended to avoid, prevent or minimize turbidity (e.g., implementation of site-specific erosion and sediment control plans). Each project implemented under the NAA would require its own separate environmental compliance process.

As described in Chapter 6, *Surface Water* water conveyance operations under the NAA (by 2060) would alter the magnitude and timing of water releases from reservoirs upstream of the Delta as well as alter downstream river flows relative to Existing Conditions (conditions that existed in February 2009) (see Appendix 3D, *Defining Existing Conditions, No Action Alternative, No Project Alternative, and Cumulative Impact Conditions*). The changes in mean monthly average river flows under the NAA are not expected to cause river turbidity levels (highs, lows, typical conditions) to be outside the ranges occurring under Existing Conditions.

Delta turbidity levels are affected by turbidity levels of Delta inflows (and associated sediment load), and by fluctuations in flows within the Delta channels due to tides; sediments deposit as flow velocities and turbulence are low at periods of slack tide, and sediments become suspended when flow velocities and turbulence increase when tidal currents are near the maximum. Under the NAA, turbidity levels in the rivers contributing to Delta inflows would be similar to Existing Conditions. Finally, turbidity levels in the SWP/CVP Export Service Areas under the NAA and Existing Conditions are not expected to be different from each other. Therefore, because no significant changes in turbidity would occur under the NAA upstream of the Delta, in the Plan Area or in the SWP/CVP Export Service Areas, covered fish species would not be adversely affected by turbidity changes related to water conveyance operations under this alternative.

Changes in land use in the Plan Area under the NAA that would occur relative to Existing Conditions could have minor effects on turbidity throughout the affected environment. Site-specific and temporal exceptions may occur due to localized temporary construction activities, dredging, development, or other land use changes. These localized actions would generally require agency permits that would regulate and limit both their short-term and long-term effects on total suspended solids (TSS) concentrations and turbidity.

Accidental Spills

Potential construction-related water quality effects associated with other project and program actions that may occur under the NAA, may include the inadvertent release of construction-related chemicals (e.g., fuels, solvents, and oils) and construction-related wastes (e.g., concrete, asphalt, cleaning agents, paint, and trash) to surface waters, which would result in localized water quality degradation. This could in turn result in adverse effects on covered fish species through direct injury and mortality or delayed effects on growth and survival, depending on the nature and extent of the spill and the contaminants involved. It is expected that adverse effects on fish from inadvertent spills would be avoided through adherence to applicable federal, state, and local regulations, project-specific design, BMPs, and environmental commitments intended to avoid, prevent or minimize hazardous spills and other construction-related hazards and/or mitigate for such occurrences (e.g., spill prevention and control plans and hazardous materials management plans). Each project implemented under the NAA would require its own separate environmental compliance process.

Disturbance of Contaminated Sediments

Sediment in many locations throughout the Plan Area has been contaminated by historical and current urban discharges (e.g., hydrocarbons, metals, and PCBs), agricultural runoff containing persistent pesticides (e.g., organochlorines), and mercury from historic mining. Construction and maintenance projects and programs implemented under the NAA that require disturbance of sediment (e.g., periodic channel dredging) have the potential resuspend contaminated sediments, which could result in direct and indirect effects on covered fish species. Individual fish could be directly exposed to the suspended contaminants if they are in the immediate vicinity of disturbed contaminated sediments. The potential effects of such events on covered fish species would depend on the types and concentrations of the toxicants in disturbed sediments and exposure time, and therefore cannot be predicted at this time. However, it is unlikely that covered fish species would stay in the vicinity of in-channel construction activities because most of these species are migratory and unlikely to be exposed for a prolonged period of time; the duration of these activities would also be limited. Therefore the potential for adverse effects on fish related to toxicants is minimal. Further, individual project permit restrictions on in-water work would limit activities to work windows when covered fish species are typically least abundant in the construction or maintenance area.

Covered fish species may also eat invertebrates that are stirred up with resuspended contaminated sediment. Any such exposures through the food chain will typically be short-term and localized so that they affect very few individual fishes. In addition, project-specific BMPs and environmental commitments would minimize the disturbance and spread of suspended sediment (e.g., employ silt curtains).Each project implemented under the NAA would require its own separate environmental compliance process. Therefore, any changes in water quality are expected to be limited in intensity, duration and extent. For these reasons, the effect would not be adverse.

Underwater Noise

Construction of projects or programs under the NAA requiring the installation of in-channel structures where the use of pile driving is necessary (e.g., cofferdams and diversion intakes) has the potential for adverse effects on covered fish species if they are present in the vicinity of pile driving. Impact pile driving produces impulsive sound pressure waves that can damage fish organs and tissues. The effects of exposure can range from temporary hearing loss to physical injury sufficient to cause direct mortality or increased predation risks. The degree of effect is a function of the intensity of the sound, the distance from the source, the duration of exposure, the size of the fish exposed (smaller fish are more sensitive), and the species-specific sensitivity.

However, adverse effects on covered fish species under this alternative from pile driving would be avoided or minimized through project-specific AMMs, BMPs, environmental commitments and/or mitigation measures, which could include seasonal timing restrictions on in-water activities; the use of vibratory pile drivers when possible; the use of noise attenuation devices; and limitations on the duration of impact pile driving activities. Each project implemented under the NAA would require its own separate environmental compliance process, which is expected to reduce, eliminate, or mitigate adverse effects.

Fish Stranding and Direct Injury

In-water work activities (e.g., dredging, cofferdam installation, placement of riprap) associated with the implementation of maintenance and restoration projects under the NAA have the potential to cause take of covered fish species through direct impact from construction activities and through the process of trapping and rescuing fish from construction areas. Although most fish would likely avoid the noise and activity of in-water construction and maintenance activities, depending on the nature of the activity, its seasonal timing and duration, there could be a potential for fish (of multiple species) to be harmed, harassed, injured, or killed. However, take of fish related to construction and maintenance activities would be minimized by implementation of project-specific AMMs, BMPs, environmental commitments and/or mitigation measures, which could include seasonal timing restrictions on in-water activities, and implementation of species-specific fish rescue and salvage plans. As a result, effects are not expected to be adverse.

Loss of Spawning, Rearing, or Migration Habitat

In-water construction and maintenance activities of programs and projects implemented under the NAA (e.g., levee repair, "OCAP" related restoration projects) could temporarily or permanently alter habitat conditions for covered fish species in the vicinity of these activities and thereby adversely affect spawning, rearing and/or migration habitat. For example, any activities that occurs in a species' migration corridor have the potential to affect species behavior (i.e., through a change in migration route within the channel, delay from a noise deterrent, artificial light sources, etc.). Cofferdams used during in-water construction to isolate the work areas, temporarily reduce the area of habitat available to fish for migration and rearing. Further, in-water maintenance activities such as dredging and riprap placement can reduce habitat suitability. For example, dredging decreases the number of macroinvertebrates in the dredged area, which can cause a temporary loss of prey resources for benthic feeders such as splittail, green sturgeon, and juvenile Chinook salmon.

The fish species affected and the severity or magnitude of any negative effects on spawning, rearing or migration habitat would depend on several factors including the seasonal timing of the activity, the suitability and/or quality of the habitat to begin with, and the quantity of habitat disturbed or permanently altered. As indicated above, for other in-water construction factors, effects are not expected to be adverse due to the implementation of project-specific AMMs, BMPs, environmental commitments and/or mitigation measures, which could include seasonal timing restrictions on in-water activities, and implementation of species-specific fish rescue and salvage plans. Each project implemented under the NAA would require its own separate environmental compliance process. As a result, it is assumed that appropriate mitigation would be implemented and effects would not be adverse.

Predation

Programs and projects implemented under the NAA that involve the construction of in- and over-water structures (e.g., docks and associated pilings) could potentially result in increased predation on covered fish species relative to Existing Conditions. These types of structures can provide suitable predator habitat by providing shade and cover for predatory fishes, and perching areas for piscivorous birds.

Predation loss at the SWP/CVP south Delta facilities is assumed to be proportional to entrainment loss for covered fish species. In addition, the CCF has a large population of striped bass and other predator fish (Brown et al. 1996), and these predators are estimated to consume approximately 75% or more, of the prey fish entrained into the CCF (Gingras 1997; Clark et al. 2009; Castillo et al. 2012). Average pre-screen predation loss varies according to species, time of year, and pumping rate.

In the Plan Area ecosystem, predation rates on covered fish species are expected to increase under NAA due to the expected continued spread of nonnative species (Moyle and Bennett 2008), as well as invasive aquatic plants, such as water hyacinth and *Egeria* (Santos et al. 2011), and other projected environmental trends that are expected to decrease native fish habitat suitability over time (Brown et al. 2013). Non-native aquatic vegetation provides habitat for non-native predators, such as bass and sunfish, which can prey on and otherwise exclude native fish species; it also increases water clarity which can improve foraging efficiency of all visual predators. Specifically, *Egeria* is thought to reduce turbidity through a reduction in water velocity, which has been hypothesized to increase predation rates on some native fish (Brown and Michniuk 2007). However, the effect of increased predation rates on covered fish species at the population level is uncertain (in *Appendix 5F Biological Stressors, Section F.5.1 Fish Predation*).

Under NAA, improvements and programs implemented at the SWP/CVP south Delta facilities as per NMFS (2009) are expected to reduce site-specific predation levels. This will include modifications to the collection facilities and the release procedures for fish salvaged at these facilities. Improvements are also expected to occur at temporary diversion structures, to minimize attracting predator species. In addition, the expected amount of in-water and overwater structures likely to be permitted would be small compared to the overall habitat occurring in the Plan Area. Therefore, the effect would not be adverse.

NEPA Effects: Overall, the potential impact mechanisms on covered fish species from construction of other projects under NAA would include effects from increased turbidity, accidental spills, disturbance of contaminated sediment, underwater noise, fish stranding, in-water work activities, loss of spawning, rearing or migration habitat, and predation. However, as described above, these effects would not be adverse because of the limited extent, intensity, and duration of expected construction and maintenance projects in the Plan Area. In addition, any such construction projects would be subject to a separate environmental compliance process, with permit stipulations which would include the implementation of project-specific AMMs, BMPs, environmental commitments and/or mitigation measures. This would include project-specific erosion and sediment control plans; hazardous materials management plans; SWPPPs; spill prevention and control plans; and limiting in-water activities to periods of low flow and/or to times when covered fish species are not likely to be present. Therefore, the effects of construction projects on covered fish species would not be expected to be adverse, and no additional mitigation would be required. However, if the effects were determined to be adverse, it is assumed that appropriate mitigation would be implemented.

CEQA Conclusion: For any projects implemented under the NAA that include in-water construction and maintenance activities, there would be the potential to stress, injure, or kill covered fish species through direct or indirect effects, and the potential to alter spawning, rearing and/or migration habitat of covered fish species through direct loss or modification. However, such projects would be subject to specific environmental permitting processes, which would minimize potential effects through the implementation of project-specific AMMs, BMPs, environmental commitments and/or mitigation measures. Thus, the construction-related effects under the NAA would be less than significant, and no additional mitigation would be required.

Impact AQUA-NAA2: Effects of Maintenance of Facilities on Covered Fish Species

NEPA Effects: The discussion of maintenance activity effects are provided above with the construction effects (Impact AQUA-NAA1), and the conclusions would also not be adverse.

CEQA Conclusion: The conclusion provided above for the construction activity effects (Impact AQUA-NAA1), would typically be very similar to those expected to occur during maintenance activities, and conclusions would also not be significant.

Water Operations of CM1

Impact AQUA-NAA3: Effects of Water Operations on Entrainment of Covered Fish Species

Numerous methods were used to estimate entrainment losses under NAA, and a complete analysis can be found in the *BDCP Effects Analysis – Appendix B*, *Entrainment, Section B.5 – Methods of Biological Analysis and Section B.6 – Results (hereby incorporated by reference).*

Delta Smelt

Simulations of entrainment for baseline conditions differ depending on the time period modeled because the climate change scenarios change operations somewhat. However, the average annual proportion of the delta smelt population lost to entrainment at the south Delta facilities under Existing Conditions, increased under model simulations of future conditions (NAA), most notably in wet, above-normal and below-normal water years. This proportional entrainment loss reflects differences attributable to simulated differences in south Delta export pumping (which influences OMR flows) and Delta outflows (which influences Fall X2). Despite these modeled increases in entrainment, the differences are not expected to reach the level of adverse effects on delta smelt populations (less than 5% of the population), primarily due to the implementation of restrictions implemented as part of the USFWS 2008 BiOp and the NMFS 2009 BiOp, and continued improvements in water export and fish salvage operations at the south Delta facilities, as well as efforts to divert delta smelt from exposure to these facilities. Overall the effect would not be adverse.

Delta smelt are also entrained at agricultural and waterfowl management diversions in the Plan Area (Pickard et al. 1982; Cook and Buffaloe 1998; Nobriga et al. 2004). Water export operations (through their effects on Delta flow and residence time) may also affect delta smelt entrainment in irrigation diversions (Kimmerer and Nobriga 2008), although Delta smelt are not considered highly vulnerable to entrainment at Delta agricultural diversions (Nobriga and Herbold 2009; Nobriga et al. 2004).

NEPA Effects: As indicated above, despite the modeled increases in entrainment, the differences are not expected to reach the level of adverse effects on delta smelt populations (less than 5% of the population). This is primarily due to the compliance with the USFWS 2008 BiOp and the NMFS 2009 BiOp, and continued improvements in water export processes, fish screens, and fish salvage operations at the south Delta facilities. Therefore, the effect would not be adverse.

CEQA Conclusion: Implementation of south Delta export pumping restrictions under the USFWS (2008) BiOp has considerably limited entrainment loss of adult delta smelt. This would continue into the future, under the No Action Alternative. Along with other improvements in SWP/CVP facilities and operations expected to occur in the future, the effect would be less than significant and no mitigation would be required.

Longfin Smelt

Entrainment at the SWP and CVP facilities is not believed to be an important stressor influencing the survival of longfin smelt larvae. However, if entrainment were to be a problem for longfin smelt, its effect would be seen in dry years when recruitment is expected to be lower relative to wet years. Consequently, the population-level impact of this stressor on longfin smelt larvae is believed to be low. Further, entrainment of longfin smelt is expected to remain low, primarily due to the restrictions implemented as part of the USFWS 2008 BiOp and the NMFS 2009 BiOp, as modeled in the NAA. Overall the effect of entrainment would not be adverse.

Longfin smelt are also entrained at agricultural and waterfowl management diversions in the Plan Area (Pickard et al. 1982; Cook and Buffaloe 1998; Nobriga et al. 2004; Enos et al. 2007), and water export operations, through their effect on Delta flow and residence time may affect longfin smelt entrainment in irrigation diversions (Kimmerer and Nobriga 2008). Longfin smelt are not considered highly vulnerable to entrainment in Delta agricultural diversions.

NEPA Effects: Under the NAA, entrainment would be reduced by continued efforts to screen these intakes. Therefore, the effect would not be adverse.

CEQA Conclusion: Operational activities associated with water exports from SWP/CVP south Delta facilities during the NAA period, would not result in an overall substantial increase in entrainment for longfin smelt under most circumstances. Improvements in water export and fish salvage operations as a result on on-going studies, the implementation of the USFWS 2008 BiOp (U.S. Fish and Wildlife Service 2008) and actions taken by the water project operators in accordance with this BiOp are expected to result in an overall beneficial effect. Consequently, no mitigation would be required.

Chinook Salmon

Four races of Chinook salmon can occur in the Plan Area: Sacramento winter, spring, fall, and late fall-run ESUs. Each of these Chinook salmon races uses the Delta as migratory and rearing habitat during their respective life histories, implying that they would be subject to a similar range of effects from water export operations. Although the duration, extent, and timing of occurrence in the lower Sacramento River and the Delta varies between these races, and they would be subject to different stressor exposures and degree of potential effects, the mechanisms of effect would be very similar.

Winter-Run Chinook Salmon

Under baseline conditions, losses of juvenile winter-run Chinook salmon begin in December and climb to peaks in March at both facilities, before sharply declining in April. In general, entrainment losses of winter-run Chinook salmon, as estimated by the salvage density method, were approximately five to 10 times greater at the SWP facility than those estimated for the CVP export facility. Estimated annual losses at SWP across all water years averaged approximately 6,000 fish, while the annual average loss at CVP was approximately 830–860 fish under baseline. Only a small proportion of the population would be lost to entrainment based on the simplified assumption that the annual number of winter-run Chinook salmon juveniles approaching the Delta is 500,000 fish. Proportional losses averaged across all years were 1.4% under NAA.

Spring-Run Chinook Salmon

In general, estimated losses of spring-run Chinook salmon at the SWP facility were approximately two to three times greater than those estimated for the CVP export facility. Estimated annual losses at SWP across all water years averaged approximately 22,000–24,000 juvenile spring-run Chinook salmon under baseline; for the CVP, the annual average loss was approximately 15,000 fish under baseline conditions. Losses were greatest in wet years (>40,000 fish) and lowest in below-normal years (1,000–5,000 fish) at both facilities under baseline conditions. The estimated percentage of juvenile spring-run Chinook salmon salvaged at the SWP/CVP south Delta export facilities averaged approximately 0.06–0.10% for baseline scenarios. Under the assumption that the annual number of juvenile spring-run Chinook salmon juveniles approaching the Delta was 750,000 fish, the percentage of the population lost to entrainment across all years averaged approximately 5.0–5.3% under baseline scenarios. However, genetic testing indicates that many fall-run juveniles are misidentified as spring-run based on the length-at-date criteria that are currently used to assign run origin of juveniles salvaged at the export facilities (Harvey pers. comm.). As with winter-run Chinook salmon, the estimates of salvage from the Delta Passage Model were considerably less than the entrainment loss estimates from the salvage density method, even accounting for losses not included in the Delta Passage Model estimates.

Fall- and Late-Fall Run Chinook Salmon

As noted above for juvenile spring-run Chinook salmon, the seasonal entrainment pattern is the best index of entrainment—as opposed to the actual numbers of fish—because of the overlap between juvenile fall- and spring-run Chinook salmon and the length-at-date criteria used to characterize race. Entrainment loss of fall-run Chinook salmon peaks in May at both the SWP and CVP facilities, with a second similar peak in February at the CVP facility.

In general, estimated losses of fall-run Chinook salmon were approximately 1.5 to three times greater at the SWP export facility compared to the CVP export facility. Estimated losses of late fall–run Chinook salmon varied between the two facilities, with entrainment loss at the CVP generally being lower than at the SWP, but not in all water-year types.

For fall-run Chinook salmon, estimated annual losses at the SWP across all water years averaged approximately 36,000 fish, and approximately 19,000 fish at the CVP, under baseline conditions. Losses of fall-run Chinook salmon were greatest in wet years (77,000–82,000 fish at SWP; 50,000 fish at CVP), and lowest in below-normal years at the SWP (8,000 fish) and in dry years at the CVP (2,500–2,700 fish) under baseline conditions.

For late fall–run Chinook salmon, estimated annual losses averaged across all water years at the SWP and CVP facilities were nearly 900 and 1,000 fish, respectively under baseline scenarios. Entrainment losses of late fall–run Chinook salmon were greatest in wet years (SWP: 2,600–2,800 fish); CVP: 3,200–3,400 fish) under baseline conditions. Entrainment losses in other water-year types were one or two orders of magnitude lower than in wet years.

Under the assumption that the annual number of juvenile fall-run Chinook salmon approaching the Delta was 23 million fish, the percentage of the population lost to entrainment across all years averaged 0.24% under baseline scenarios. The percentage of all juveniles lost to entrainment was greatest in wet years (0.6%). The percentage of fall-run and late fall–run Chinook salmon estimated to be lost to entrainment from the salvage density method was well below 1%, and the estimated salvage from the Delta Passage Model for Sacramento River–origin fish was also very low (below

0.1%). The estimated salvage of San Joaquin–origin fall-run Chinook salmon was above 1% for baseline conditions, reflecting the greater likelihood of fish from the San Joaquin watershed reaching the south Delta export facilities than the Sacramento River–origin fish.

NEPA Effects: General improvements implemented during the NAA timeframe are expected to reduce entrainment losses of Chinook salmon through the implementation of the NMFS and USFWS BiOp requirements (National Marine Fisheries Service 2009a; U.S. Fish and Wildlife Service 2008), particularly the reduced reverse OMR flow criteria and actions taken by the water project operators in accordance with this BiOp. The improvements expected to occur in the rate of entrainment at the SWP/CVP south Delta facilities, under NAA are likely to be generally beneficial, and would not be adverse to Chinook salmon.

CEQA Conclusion: General on-going improvements implemented under Existing Conditions during the NAA timeframe are expected to reduce entrainment losses of Chinook salmon through the implementation of the NMFS and USFWS BiOp requirements (National Marine Fisheries Service 2009a; U.S. Fish and Wildlife Service 2008), particularly the reverse OMR flow criteria, court-ordered restrictions on water operations, and actions taken by the water project operators in accordance with this BiOp. Therefore, the overall effects for the NAA period are expected to be less than significant, and likely to be generally beneficial. Consequently, no mitigation would be necessary.

Steelhead

Under baseline conditions, entrainment peaks in February at both SWP and CVP facilities and is also relatively high in January and March. Estimated entrainment losses for juvenile steelhead were approximately four times greater at the SWP export facilities compared to the CVP export facilities, with losses at both facilities, due to entrainment, generally from 1,000 to 10,000 fish per year. Losses were greatest in above-normal and below-normal years, and least in critical water years. However, on-going and future operational improvements at the SWP and CVP south Delta facilities would likely result in a general decrease in entrainment for juvenile steelhead under NAA.

NEPA Effects: Consequently, the effect would likely be slightly beneficial, and would not be adverse.

CEQA Conclusion: On-going and future operational improvements at the SWP and CVP south Delta facilities would likely result in a general decrease in entrainment for juvenile steelhead under NAA. Potential impacts of the No Action Alternative on entrainment of steelhead could be slightly beneficial, and no mitigation would be required.

Sacramento Splittail

The methods used to estimate juvenile splittail entrainment were designed to account for the very large effect of Sacramento splittail abundance on entrainment (detailed in *Appendix 5B Entrainment, Section B.5.4.5*), and the bulk of salvage occurs in wet years. Across all water years, May–July salvage of juvenile Sacramento splittail was generally several times higher at the CVP facilities than the SWP facilities, with the differences in salvage estimates between the facilities diminishing with lower Delta inflow.

NEPA Effects: Overall, the effects of the No Action Alternative on Sacramento splittail entrainment in the NAA period are not expected to be adverse, and may be somewhat beneficial due to on-going structural and operational improvements at the south Delta export facilities.

CEQA Conclusion: Structural and operational changes associated with water exports from SWP/CVP south Delta facilities are not expected to result in an overall increase in per capita entrainment for Sacramento splittail in the NAA, and could be somewhat beneficial. Therefore, impacts of the No Action Alternative on entrainment are considered less than significant, and no mitigation would be required.

Sturgeon

Available information on the distribution and abundance of sturgeon in the Plan Area is provided in Appendix 11A, *Covered Fish Species Descriptions*. Total annual average baseline salvage of juvenile green sturgeon at the SWP south delta facilities was estimated at approximately 70 fish while baseline salvage levels at the CVP ranged from 37 to 45 green sturgeon. Total annual average salvage of juvenile white sturgeon at the SWP was estimated to be somewhat higher at 135–160 fish under baseline scenarios, and from 110 to 130 fish at the CVP.

Structural and operational changes associated with water exports from south SWP/CVP facilities are expected to continue to improve over time, as more information is obtained from studies regularly conducted in the area regarding the fish behavior, project operations, and entrainment. This information, and any resulting structural and operational changes, are expected to result in a slight decrease in entrainment of white and green sturgeon.

NEPA Effects: Based on available information, overall entrainment effects on sturgeon, at the south Delta water export facilities are not expected to substantially change under the NAA. Consequently, the effect would not be adverse.

CEQA Conclusion: As described above, structural and operational changes associated with water exports from south SWP/CVP facilities are not expected to substantially change the entrainment of sturgeon in the NAA, based on continued improvements implemented under the 2009 NMFS and 2008 USFWS BiOps. Overall, impacts of water operations on sturgeon entrainment would be less than significant and no mitigation would be required.

Lamprey

Although somewhat limited, the available information on the distribution and abundance of lamprey in the Plan Area is provided in Appendix 11A, *Covered Fish Species Descriptions*. The analysis for Pacific and river lamprey was combined because the CVP and SWP fish salvage facilities do not distinguish between the two species. Estimated average expanded salvage densities of lamprey for each month as reported by the facilities during water years 1996–2009 used in this analysis reflect historical expanded salvage density data. Estimated average expanded salvage under baseline scenarios (all time periods) ranged from zero in September at the SWP to more than 1,300 at the CVP in January, for average annual totals of approximately 720–740 lamprey at the SWP and 2,600 lamprey at the CVP.

NEPA Effects: Based on available information, overall entrainment effects on lamprey populations are not expected to substantially change under the NAA. Therefore it is anticipated that there will not be an adverse effect on lamprey.

CEQA Conclusion: As described above, structural and operational activities associated with water exports from south SWP/CVP facilities are not expected to substantially change entrainment of lamprey through the NAA period. Overall, the impacts of water operations to Pacific and river lamprey are considered less than significant, and no mitigation is required.

Impact AQUA-NAA4: Effects of Water Operations on Spawning and Egg Incubation Habitat for Covered Fish Species

Water operations in the NAA are not expected to substantially or consistently affect spawning habitat for most covered fish species. Upstream of the Delta, flows could be affected by changes in water storage volumes associated with meeting the Fall X2 targets included in the USFWS BiOp. Such changes could affect upstream spawning conditions for some covered fish species.

Shasta Reservoir storage volume at the end of May influences flow rates below the dam during the May through September winter-run Chinook salmon spawning and egg incubation period. Although results of various analyses did not show appreciable differences for winter-run Chinook salmon. The other Chinook salmon populations typically spawn in tributaries—in which spawning habitat and egg mortality would not be substantially affected by the project operations.

Reduced summer flows could affect green sturgeon spawning conditions in some water years and could have the potential to increase exposure of a number of other covered fish species to their respective upper temperature thresholds.

NEPA Effects: The effect of the NAA operations on delta smelt, longfin smelt, and Sacramento splittail spawning habitat is not adverse, because there would be little change spawning conditions that the Project can influence under NAA. Longfin smelt spawning flows would be slightly reduced by 2% relative to Existing Conditions when climate change effects are accounted for (NAA), but not to an adverse level. Decreased summer flows could adversely affect spawning habitat and egg survival for some covered fish species, such as winter-run Chinook salmon and green sturgeon, although no major or consistent impacts were found on upstream spawning and egg incubation habitat conditions. Consequently, impacts on spawning and incubation for the covered species are considered less than significant.

CEQA Conclusion: As described above, operations under NAA would be similar to Existing Conditions, and would typically have no biologically meaningful effect on spawning habitat of most covered fish species. However, Shasta Reservoir storage volume at the end of May would be lower than storage volume under Existing Conditions in below normal, dry, and critical water years, indicating a small–to-moderate impact from summer water flows and temperatures. These conditions could affect spawning habitat and egg survival for some covered fish species, such as winter-run Chinook salmon and green sturgeon, although no major or consistent effects were identified. The effect could be significant for sturgeon over the NAA period. No other major or consistent significant impacts were found on upstream spawning and egg incubation habitat conditions for other covered fish species. Consequently, overall, impacts for these other covered species are considered less than significant.

Impact AQUA-NAA5: Effects of Water Operations on Rearing Habitat for Covered Fish Species

The SWP/CVP operations are managed to meet instream flow requirements, water rights agreements, and refuge water supply agreements in the Sacramento and San Joaquin Valleys. Water supplies are provided in a consistent manner under Existing Conditions, and this would be expected to continue into the future under the NAA. However, the NAA includes sea level rise and other anticipated climate changes, as well as expected increase in water rights demands, implementation of facilities currently under construction, and on-going implementation of Fall X2 criteria, all of which affect operations relative to current conditions. Detailed discussions of what is included in the NAA are provided in Appendix 3D, *Defining Existing Conditions, No Action Alternative, No Project*

Alternative, and Cumulative Impact Conditions. Operations to meet Fall X2 criteria would require release of water from the SWP/CVP reservoirs in the fall of wet and above-normal years to increase Delta outflow, which would increase rearing habitat in the Delta in the fall, but would also likely reduce flows (and rearing habitat) at other times of the year. Habitat suitability would also decrease slightly over time, because of anticipated increases in summer-early fall air (and thus water) temperatures associated with climate change. Changes in temperature and salinity, due to sea level rise and climate change, and associated operational responses, are expected to alter the distribution of covered fish species, based on behavioral responses of the fish to these stressors.

Lower summer flows in some areas are expected to affect rearing conditions for most, if not all covered fish species, somewhere in the system. For example, reduced summer flows would have the potential to reduce the quality and quantity of rearing habitat for the covered fish species, such as spring- and fall-run Chinook salmon and green sturgeon in the Feather River, and delta smelt, sturgeon and splittail in the estuary. In tributary streams, lower summer flows may increase the frequency of water temperatures exceeding the upper tolerance thresholds for some species. Thus, the effect of lower summer river flows could be adverse for covered fishes under the NAA operations relative to Existing Conditions.

Under the No Action Alternative, peak monthly flows into the Yolo Bypass at Fremont Weir would be less than under Existing Conditions and less than the Yolo Bypass capacity of 343,000 cfs at Fremont Weir. This would result in a reduction in the rearing habitat in the Yolo Bypass, particularly for salmon populations, as well as a reduced spawning habitat for Sacramento splittail. As a result, the availability and quality of tributary stream and Delta floodplain rearing habitat would likely be reduced in the NAA, relative to Existing Conditions; Delta outflows would also be reduced, relative to Existing Conditions.

NEPA Effects: While these reductions could be greater than 5%, compared to the overall available habitat in the Plan Area, the loss of this restored habitat is not expected to be adverse for the covered fish species.

CEQA Conclusion: The abiotic habitat index would be increased in all water years through the NAA period, compared to Existing Conditions, even without habitat restoration. Upstream flows would also be generally similar to, or greater than, flows under Existing Conditions throughout most months and water flow years, although some reductions are expected. For example, reduced summer flows would affect rearing habitat conditions for winter-run Chinook salmon, and green and white sturgeon, which would include increased water temperatures, and could result in decreased survival over the NAA period. The effect could be significant for these covered species over the NAA period. The overall effects of the No Action Alternative would be less than significant for the other covered fish species.

Impact AQUA-NAA6: Effects of Water Operations on Migration Habitat for Covered Fish Species

Reverse flow conditions for Old and Middle River flows on a long-term average basis under NAA would be similar to Existing Conditions, except in September through November. During wet and above-normal years, fall flows in Old and Middle River could be more positive due to compliance with Fall X2, which may reduce water diversion rates at the SWP/CVP south Delta intakes during September-November. This is expected to benefit fall-run Chinook salmon migration conditions by providing improved olfactory cues, thereby potentially reducing straying.

Changes in water operations under the No Action Alternative would typically result in lower summer flows, compared to Existing Conditions, although such changes would be largely due to the overall effects of climate change on upstream reservoir management. This would affect migration conditions for some covered fish species, particularly juvenile winter-run Chinook and green sturgeon.

The No Action Alternative would not affect the first flush of winter precipitation and the turbidity cues associated with adult delta smelt, long-fin smelt, splittail, and steelhead migration. In-Delta water temperatures would change only slightly due to flow changes, because the water temperatures are in thermal equilibrium with atmospheric conditions and not strongly influenced by flows. Therefore, there would be no substantial change in the number of stressful or lethal temperature days, due to the expected flow changes.

Mean monthly flows at Rio Vista under the No Action Alternative through most of the fall through spring period, averaged across all years, would be limited(<10% difference) from those under Existing Conditions, but up to 28% lower than Existing Conditions in drier water year types.

NEPA Effects: The proportion of Sacramento River flows in the Delta under the No Action Alternative would be similar to Existing Conditions, and represent 57-66% of Delta outflows. This is not expected to adversely affect migration conditions or olfactory cues for the covered fish species.

CEQA Conclusion: As described above, operations under the No Action Alternative would not substantially alter the turbidity cues associated with winter flush events that may initiate migration, nor would there be appreciable changes in water temperatures. Consequently, the impact on adult delta smelt migration conditions would be less than significant, and no mitigation is required. Average Delta outflow would be similar to Existing Conditions during the majority of the winter and spring, which would have limited effects on migration and survival of covered fish species migrating downstream in the spring.

Restoration Measures (CM2, CM4–CM7, and CM10)

Impact AQUA-NAA7: Effects of Habitat Restoration on Covered Fish Species

Under the No Action Alternative, the assumption is that no large-scale, long-term comprehensive habitat restoration program would occur. Tidal wetland restoration would continue to occur on a much smaller scale throughout the Delta. For example, 8,000 acres of tidal wetland restoration would occur as required by the USFWS BiOp. Small amounts of freshwater wetland and riparian woodland restoration are also likely to occur as part of voluntary restoration efforts or as mitigation for small projects under the No Action Alternative.

Restoration activities from various programs in the region would occur, and although the extent of these activities would typically be limited they would likely include enhancing existing habitat, breaching levees and converting agricultural and other upland areas to tidal, shallow water, open water, and floodplain habitats, as well as enhancement of channel margin habitat.

The construction of these restoration measures under the No Action Alternative is likely to result in a range of effects similar to those described above for construction and maintenance of the projects and programs under the No Action Alternative (see Impact AQUA-1). Such in-water and shoreline restoration measures may result in short-term adverse effects on the covered species through direct disturbance of contaminated soils and sediments, short-term water quality impacts, or increased exposure to contaminants, especially methylmercury, but the overall effects on covered fish species are expected to be localized and of low magnitude. It is assumed that these effects would be minimized by limiting in-water restoration activities to the approved in-water construction window, when the least numbers of covered species would typically be present in or near the restoration sites, and other environmental permit stipulations. These would include the implementation of the environmental commitments, such as erosion and sediment control plans, hazardous materials management plans, spill prevention, containment and countermeasure plans, and SWPPPs. As a result, the effects of short-term restoration activities would likely not be adverse to the covered fish species, relative to Existing Conditions.

NEPA Effects: The No Action Alternative assumes that no large-scale reserve system that would protect and link a wide diversity of natural communities and habitat for native and covered species would occur. The No Action Alternative also does not include a comprehensive long-term management and monitoring program to ensure the continued maintenance and improvement of natural communities and native species habitat. Small amounts of habitat protection would occur under the No Action Alternative associated with mitigation for specific projects.

CEQA Conclusion: As described above, the No Action Alternative assumes that no long-term, large-scale comprehensive habitat restoration program would occur, to restore habitat functions in the Plan Area, and benefit the covered fish species. Although conservation measures on a smaller-scale, and over shorter time periods would continue to occur into the future, it is expected that there would be no comprehensive monitoring program, or adaptive management process to ensure that these actions were providing a net improvement over Existing Conditions, or providing a benefit to the species. Despite these uncertainties, the effects would be less than significant.

Other Conservation Measures (CM12–CM19 and CM21)

Impact AQUA-NAA8: Effects of Other Conservation Measures on Covered Fish Species

As indicated above, the No Action Alternative would not likely provide a long-term comprehensive program to address other stressors on the covered fish, although some existing and future conservation measures are anticipated to occur into the future under the No Action Alternative. For example, the Department of Boating and Waterways would continue to control IAV, and DWR will continue to implement the Watercraft Inspection Program to reduce the spread of IAV and invasive bivalves. Similarly, DWR is expected to continue to install some non-physical fish barriers to try to increase survival of salmonids migrating through the Delta. Predator control measures are also expected to be implemented on a limited basis. CDFW will also continue to conduct warden patrols within the Plan Area, to reduce illegal harvest of the covered fish species. Lastly, the existing University of California, Davis conservation hatchery would continue to operate, but the proposed expansion plan under the BDCP (*CM18, Conservation Hatcheries*) would be uncertain to occur.

All major urban centers in the Delta, including Sacramento, Stockton, and Tracy, and multiple smaller cities will continue to comply with National Pollutant Discharge Elimination System (NPDES) MS4 permits to develop and implement stormwater management plans or programs with the goal of reducing the discharge of pollutants under the Clean Water Act (CWA).

Upgrades to existing nonproject diversions to reduce entrainment of covered fish species, and their prey, are also expected to continue to occur over time. There are currently over 2,000 nonproject diversions in the Plan Area, used primarily for diverting water for agriculture, and about 95% of these diversions are unscreened (Herren and Kawasaki 2001). Currently, Reclamation's Anadromous Fish Screen Program and CDFW's Fish Screen and Passage Program are available to redesign and/or screen nonproject diversions, and have implemented over 30 projects in recent years throughout the Central Valley. These programs primarily focus on the protection of anadromous salmonids, so protection for other covered fish species may be limited.

NEPA Effects: The conservation measures anticipated to occur under NAA are intended to reduce stressors to covered species, so they are expected to have neutral or beneficial effects. Therefore, the overall effects would be beneficial, relative to Existing Conditions.

CEQA Conclusion: As indicated above, the conservation measures currently being implemented in the Plan Area are expected to continue into the future, under the NAA, and are expected to be beneficial. Therefore, the effect would be less than significant.

Non-Covered Fish Species of Primary Concern

Construction and Maintenance

The construction and maintenance activities occurring under the No Action Alternative, would have similar effects on the non-covered fish species, as those discussed above for the covered fish species. These effects would also be similar for all non-covered species; therefore, the analysis below is combined for all non-covered species instead of analyzed by individual species.

Impact AQUA-NAA9: Effects of Construction of Facilities on Non-Covered Fish Species

The effects described for the covered fish species in Impact AQUA-NAA1 would be similar in type, duration and magnitude to those expected for the non-covered species (e.g., turbidity, accidental spills, disturbance of contaminated sediment, underwater noise, fish stranding, in-water work activities, loss of spawning, rearing or migration habitat, and predation). However, as described above, these effects would not be adverse because of the limited extent, intensity, and duration of expected construction projects in the Plan Area under the NAA and Existing Conditions.

In addition, any such construction projects would be subject to a separate environmental compliance process, with permit stipulations which would include the implementation of project-specific AMMs, BMPs, environmental commitments and/or mitigation measures. This would include project-specific erosion and sediment control plans; hazardous materials management plans; SWPPPs; spill prevention and control plans; and limiting in-water activities to periods of low flow and/or to times when non-covered fish species are not likely to be present.

NEPA Effects: The effects of construction projects on the non-covered fish species would not be adverse, and no additional mitigation would be required.

CEQA Conclusion: For any projects implemented under the No Action Alternative within the NAA period, that include in-water construction and maintenance activities, there would be the potential to stress, injure, or kill non-covered fish species through direct or indirect effects, and the potential to alter spawning, rearing and/or migration habitat of non-covered fish species through direct loss or modification. However, such projects would be subject to specific environmental permitting processes, which would minimize potential effects through the implementation of project-specific AMMs, BMPs, environmental commitments and/or mitigation measures. Thus, the construction-related effects under the NAA would be less than significant, and no additional mitigation would be required.

Impact AQUA-NAA10: Effects of Maintenance of Facilities on Non-Covered Fish Species

NEPA Effects: The discussion of potential maintenance activity effects would be similar to the discussion provided above with the construction effects (Impact AQUA-NAA1) on the covered fish species, and as concluded, the effect would not be adverse.

CEQA Conclusion: The conclusion provide above for the construction activity effects (Impact AQUA-NAA1), would typically be very similar to those expected to occur during maintenance activities. Thus, the effect would be less than significant.

Water Operations

Impact AQUA-NAA11: Effects of Water Operations on Entrainment of Non-Covered Fish Species

Available information on the distribution and abundance of the non-covered fish species is provided in Appendix 11B, *Non-covered Fish and Aquatic Species Descriptions*. Under Existing Conditions, non-covered fish species are expected to occur in salvage operations at the south Delta facilities throughout the year. This would include eggs, larvae, juvenile, and adult life stages of the various fish species entrained at varying times throughout the year. This entrainment would continue into the future under the No Action Alternative, although improvements in the water export operations and the salvage processes are expected to reduce the rate of fish entrainment loss over time.

NEPA Effects: The effect of entrainment of the non-covered fish species would not be adverse.

CEQA Conclusion: The impact of water operations on entrainment of non-covered fish species would be the same as described immediately above. The changes in entrainment under the No Action Alternative would not substantially reduce the non-covered fish populations. Thus, the impact would be less than significant and no mitigation would be required.

Impact AQUA-NAA12: Effects of Water Operations on Spawning and Egg Incubation Habitat for Non-Covered Fish Species

As described above under AQUA-NAA4 for the covered fish species, water operations in the NAA are not expected to substantially or consistently affect spawning habitat, compared to Existing Conditions. Upstream of the Delta, flows could be affected by changes in water storage volumes, associated with meeting Fall X2 targets included in the USFWS BiOp. Such changes could affect downstream spawning conditions for some non-covered fish species, when climate change effects are accounted for (NAA).

NEPA Effects: The effect would not be adverse over the NAA period, because there would be little change in suitable spawning conditions under NAA, compared to Existing Conditions.

CEQA Conclusion: As discussed above, and in Impact AQUA-NAA4, existing water operations would continue into the future under the No Action Alternative, and the potential effects on spawning habitat for non-covered fish species would be similar. Therefore, the overall effect would be less than significant.

Impact AQUA-NAA13: Effects of Water Operations on Rearing Habitat for Non-Covered Fish Species

As described above under AQUA-NAA5 for the covered fish species, water operations under the No Action Alternative are not expected to substantially or consistently affect rearing habitat, compared to Existing Conditions. Existing water operations would continue into the future, and the potential effects on rearing habitat for non-covered fish species would be similar.

NEPA Effects: The overall effect would not be adverse.

CEQA Conclusion: As discussed above, in Impact AQUA-NAA5, existing water operations would continue into the future, under the No Action Alternative, and the potential effects on rearing habitat for non-covered fish species of primary concern would be similar. Therefore, the overall effect would be less than significant.

Impact AQUA-NAA14: Effects of Water Operations on Migration Habitat for Non-Covered Fish Species

As described above under AQUA-NAA6 for the covered fish species, water operations under the No Action Alternative are not expected to substantially or consistently affect overall migration conditions for the non-covered species. Existing water operations would continue into the future, and the potential effects on migration habitat of non-covered fish species would be similar.

NEPA Effects: The overall effects would not be adverse.

CEQA Conclusion: As described above under AQUA-NAA6 for the covered fish species, water operations under the No Action Alternative are not expected to substantially or consistently affect overall migration conditions for the non-covered species. Any existing effects are expected to continue into the future, under the No Action Alternative. As a result, the potential effects on migration habitat for non-covered fish species would likely be similar to Existing Conditions. Therefore, the overall effect would be less than significant.

Restoration Measures (CM2, CM4–CM7, and CM10)

Impact AQUA-NAA15: Effects of Habitat Restoration on Non-Covered Fish Species

NEPA Effects: As described in detail above for the covered fish species, under the No Action Alternative, no large-scale, long-term comprehensive habitat restoration program is expected to occur. While restoration activities from various programs and projects in the region would still occur, the extent of these activities would typically be limited in size or distribution. These activities would be expected to include enhancing existing habitat, breaching levees and converting agricultural and other upland areas to tidal, shallow water, open water, and floodplain habitats, as well as enhancement of channel margin habitat. Therefore, restoration actions would likely occur on a relatively small scale, and with a typically sporadic and inconsistent implementation schedule.

NEPA Effects: As the purpose of the restoration measures is intended to benefit aquatic species, the effects would be unlikely to be adverse.

CEQA Conclusion: As described above, the No Action Alternative would not include a long-term, large-scale comprehensive habitat restoration program, to restore habitat functions in the Plan Area, and benefit the covered and non-covered fish species. Although conservation measures on a smaller-scale would likely continue to occur into the future, it is unlikely for there to be a comprehensive monitoring program, or adaptive management process to ensure that these actions were providing a net improvement over Existing Conditions, or providing a substantial benefit to the species. Despite these uncertainties, the effects would be less than significant.

Other Conservation Measures (CM12–CM19 and CM21)

Impact AQUA-NAA16: Effects of Other Conservation Measures on Non-Covered Fish Species

As indicated above for the covered fish species, the No Action Alternative would be unlikely to provide a long-term comprehensive program to address other stressors on the covered and non-covered fish species. However, some existing and future conservation measures would continue to occur under the No Action Alternative. These conservation measures are intended to reduce stressors to covered and non-covered fish species and generally have only neutral or beneficial effects.

NEPA Effects: The overall effects would be beneficial.

CEQA Conclusion: As indicated above, the conservation measures occurring in the future under NAA are expected to benefit both covered and non-covered fish species. Therefore, the effect would be expected to be less than significant.

11.3.4.2 Alternative 1A—Dual Conveyance with Pipeline/Tunnel and Intakes 1–5 (15,000 cfs; Operational Scenario A)

Alternative 1A includes the construction of the five north Delta intake facilities (Intakes 1–5) between River Mile (RM) 44 (south of Freeport) and RM 37 (north of the town of Courtland). The locations, dimensions, and construction footprints of the intakes considered in Alternative 1A are provided in Table 11-5. The intakes, the associated bank armoring, and related structures would permanently modify the shoreline and channel of the Sacramento River, reducing habitat suitability for fish species of concern. Six temporary barge landings would be constructed at each of six tunnel shaft locations. These temporary facilities would be removed when construction is completed.

The construction of Alternative 1A would affect environmental conditions in the Sacramento River where the intakes are constructed, and at tunnel shaft locations in the Delta where temporary barge unloading facilities would be operated during pipeline construction (Mapbook M3-1). Construction activities would result in temporary water quality effects (e.g., turbidity); elevated underwater noise conditions (associated with pile driving and the use of equipment such as boats and barges); fish exposure to stranding and direct physical injury; and temporary exclusion or degradation of spawning, rearing, and/or migratory habitats. Short-term effects from project construction would be avoided and minimized by a range of environmental commitments (see Appendix 3B, *Environmental Commitments*).

Once constructed the new facilities will require periodic maintenance to function effectively, resulting in short-term effects on the environment that would occur at a variable frequency depending on planned and unplanned maintenance needs. The effects of maintenance activities are expected to be similar to those described for project construction. However, the scale of those effects will be commensurate with the nature and extent of the maintenance activities conducted during any given year. Project maintenance would include the same range of conservation measures and environmental commitments (see Appendix 3B, *Environmental Commitments*) used during project construction to avoid and minimize adverse effects on fish and aquatic habitats. Operations under Alternative 1A would modify the location and pattern of water withdrawals from the Delta relative to Existing Conditions and the no-action alternative. This would be expected to modify flow conditions in the Delta, producing potential changes in water quality and habitat conditions, and exposure of fish species of concern to impingement, entrainment, and predation. The long-term effects of Alternative 1A operations on habitat conditions would be mitigated through implementation of several large-scale habitat restoration efforts, which are designed to result in a net-beneficial improvement in habitat conditions for aquatic species. Habitat restoration will result in short-term construction-related impacts on habitat conditions.

The following discussion outlines construction and maintenance elements, and the operation of facilities and restoration actions associated with Alternative 1A that could affect fish or their habitat for the covered fish species.

Delta Smelt

Construction and Maintenance of CM1

Impact AQUA-1: Effects of Construction of Water Conveyance Facilities on Delta Smelt

The potential for delta smelt exposure to Alternative 1A construction effects would be minimized through construction timing and the fact that the affected areas provide marginal habitat for delta smelt. Intake facilities 1–5 are located upstream of the primary spawning and rearing habitats, indicating that the potential for direct effects on delta smelt spawning is likely to be low. However, the construction footprint overlaps some areas that provide potentially suitable spawning habitats, and occurs entirely within designated critical habitat. Therefore, the possibility of short-term adverse effects on delta smelt eggs, larvae and juveniles cannot be entirely discounted and impacts to habitat must be avoided or minimized to the extent practicable.

Temporary Increases in Turbidity

Turbidity is a measure of the scattering of light penetration by dissolved and particulate organic and inorganic matter in the water column, including, but not limited to suspended sediments. However, the term is commonly used to describe suspended sediment effects associated with construction and is applied accordingly here. The construction of Alternative 1A would unavoidably result in the generation and release of suspended sediments to the water column. Increased suspended sediments will temporarily increase water column turbidity, altering habitat conditions for delta smelt and other fish species. However, species such as delta and longfin smelt have evolved and adapted to life in turbid waters to avoid predators and to successfully forage on prey organisms, so increases in turbidity are expected to generally improve habitat conditions for these species.

Turbidity-producing construction activities in the Sacramento River include bed and bank disturbance during cofferdam placement and removal, channel dredging adjacent to the new intake locations, and the placement of bed and bank armoring. Propeller wash associated with barge traffic at the tunnel shaft construction sites would also be expected to produce localized turbidity pulses. These effects would occur periodically wherever in-water construction activities and/or associated vessel traffic are taking place.

While the construction of Alternative 1A would result in unavoidable turbidity effects, these effects would be minimized to the extent possible to minimize effects on other species and water quality by limiting the duration of in-water construction activities and through implementing the environmental commitments described below and in Appendix 3B, *Environmental Commitments.* These environmental commitments include *Conduct Environmental Training*; *Develop and Implement a Stormwater Pollution Prevention Plan* (SWPPP); *Develop and Implement an Erosion and Sediment Control Plan*; *Develop and Implement a Hazardous Materials Management Plan* (HMMP) that includes a *Spill Prevention, Containment, and Countermeasure Plan* (SPCCP); *Dispose of Spoils, Reusable Tunnel Material, and Dredged Material*; *Develop and Implement a Fish Rescue and Salvage Plan*; and *Develop and Implement a Barge Operations Plan*. While delta smelt are not expected to be substantially exposed to any changes in turbidity during construction, and any exposure would not be adverse because of their preference for turbid conditions, construction activities would still need to comply with the standard terms and conditions for in-water work.

As such, prior to the onset of construction activities, DWR and/or their contractors will conduct environmental training to inform field management and construction personnel of the need to avoid and protect sensitive resources during construction of the water conveyance facilities. Turbidity and sediment control measures that would be implemented by contractors as part of a SWPPP, Erosion and Sediment Control Plan, and the SPCCP include, but would not be limited to, the following.

SWPPP

- Capture sediment via sedimentation and stormwater detention features.
- Implement concrete and truck washout facilities and appropriately sized storage, treatment, and disposal practices.
- Implement appropriate treatment and disposal of construction site dewatering from excavations to prevent discharges to surface waters.
- Prevent transport of sediment at the construction site perimeter, toe of erodible slopes, soil stockpiles, and into storm drains.
- Reduce runoff velocity on exposed slopes.
- Inspection and monitoring. A Qualified SWPPP Developer (QSD) would determine the combined Risk Level (Level 1, 2, or 3) of each construction site, which involves an evaluation of the site's "Sediment Risk" and "Receiving Water Risk." The SWPPP will also include a site and BMP inspection schedule. Performance standards will be met by implementing stormwater pollution prevention BMPs that are tailored to specific site conditions, including the Risk Level of individual construction sites.
    - Common to all Risk Levels:
        - Dischargers will ensure that all inspection, maintenance repair, and sampling activities at the construction site will be performed or supervised by a QSP representing the discharger.
        - Develop and implement a written site-specific Construction Site Monitoring Program (CSMP).
    - Inspection, monitoring, and maintenance activities based on the Risk Level of the construction site (as defined in the SWRCB General Permit).
        - Risk Level 1 Sites:
            - Perform weekly inspections of BMPs, and at least once each 24-hour period during extended storm events.
            - At least two business days (48 hours) prior to each qualifying rain event (a rain event producing 0.5 inch or more of precipitation), visually inspect: (a) stormwater drainage areas to identify any spills, leaks, or uncontrolled pollutant sources; (b) all BMPs to identify whether they have been properly implemented in accordance with the SWPPP; and (c) stormwater storage and containment areas to detect leaks and ensure maintenance of adequate freeboard.
            - Visually observe stormwater discharges at all discharge locations within two business days (48 hours) after each qualifying rain event and identify additional BMPs and revise the SWPPP accordingly.

- ○ Conduct minimum quarterly visual inspections of each drainage area for the presence of (or indications of prior) unauthorized and authorized non-stormwater discharges and their sources.
- ○ Collect one or more samples during any breach, malfunction, leakage, or spill observed during a visual inspection which could result in the discharge of pollutants to surface waters that will not be visually detectable in stormwater.

- Risk Level 2 Sites:
  - Risk Level 2 dischargers will perform all of the same visual inspection, monitoring, and maintenance measure specified for Risk Level 1 dischargers.
  - Risk Level 2 dischargers will perform sampling and analysis of stormwater discharges to characterize discharges associated with construction activity from the entire disturbed area at all discharge points where stormwater is discharged off site.
  - At a minimum, Risk Level 2 dischargers will collect and analyze three samples per day for pH and turbidity of a qualifying rain event.
  - Dischargers who deploy an Active Treatment Systems (ATS) on their site, or a portion on their site, will collect ATS effluent samples and measurements from the discharge pipe or another location representative of the nature of the discharge.
- Risk Level 3 Sites:
  - Risk Level 3 dischargers will perform all of the same visual inspection, monitoring, and maintenance measure specified for Risk Level 1 and Risk Level 2 dischargers.
  - In the event that a Risk Level 3 discharger violates a numerical effluent limit (NEL) of the General Permit (i.e., pH and turbidity), and has a direct discharge into receiving waters, the discharger will subsequently sample receiving waters for all parameter(s) monitored in the discharge.
  - Risk Level 3 dischargers disturbing 30 acres or more of the landscape and with direct discharges into receiving waters will conduct or participate in a benthic macroinvertebrate bioassessment of receiving waters prior to commencement of construction activity. The SWPPP will also specify the forms and records that must be uploaded to SWRCB online Stormwater Multiple Application and Report Tracking System (SMARTS), such as quarterly non-stormwater inspection and annual compliance reports. If the QSP determines the site is Risk Level 2 or 3, water sampling for pH and turbidity will be required and the SWPPP will specify sampling locations and schedule, sample collection and analysis procedures, and recordkeeping and reporting protocols. In accordance with the CGP numeric action level requirements, the BDCP contractor will modify existing BMPs or implement new BMPs when effluent monitoring indicates that daily average runoff pH is outside the range of 6.5 to 8.5 and that the daily average turbidity is greater than 250 nephelometric turbidity units (NTUs). Additionally, if a given construction component is Risk Level 3, for that component will report to the SWRCB when effluent monitoring indicates that daily average runoff pH is outside the range of 6.0 to 9.0 and that the daily average turbidity is greater than 500 NTUs. In the event that the turbidity NEL is exceeded, it may also be required to sample and report to

the SWRCB pH, turbidity, and suspended sediment concentration of receiving waters for the duration of construction.

- The BDCP contractor will also conduct sampling of runoff effluent when a leak, spill, or other discharge of non-visible pollutants is detected.
- The CGP has specific monitoring and action level requirements for the Risk Levels, which are summarized in Table 3B-3 (Appendix 3B, *Environmental Commitments*).
- The QSP will be responsible for day-to-day implementation of the SWPPP, including BMP inspections, maintenance, water quality sampling, and reporting to SWRCB. If the water quality sampling results indicate an exceedance of allowable pH and turbidity levels, the QSD will modify the type and/or location of the BMPs by amending the SWPPP.

Erosion and Sediment Control Plan

- Install physical erosion control stabilization features (e.g., hydroseeding, mulch, silt fencing) to capture sediment and control both wind and water erosion.
- Design grading to be compatible with adjacent areas and result in minimal disturbance of the terrain and natural land features.
- Divert runoff away from steep, denuded slopes, or other critical areas with barriers, berms, ditches, or other facilities.
- Retain trees and natural vegetation to the extent feasible to stabilize hillsides, retain moisture, and reduce erosion.
- Limit construction, clearing of vegetation, and disturbance of soils to areas of proven stability.
- Implement construction management and scheduling measures to avoid exposure to rainfall events, runoff, or flooding at construction sites to the extent feasible.
- Use sediment ponds, silt traps, wattles, straw bale barriers or similar measures to retain sediment transported by runoff water onsite.
- Collect and direct surface runoff at non-erosive velocities to the common drainage courses.

SPCCP

- Absorbent pads, pillows, socks, booms, and other spill containment materials will be maintained at the hazardous materials storage sites for use in the event of spills.
- When transferring oil or other hazardous materials from trucks to storage containers, absorbent pads, pillows, socks, booms or other spill containment material will be placed under the transfer area.
- Absorbent pads and mats will be placed on the ground beneath equipment before refueling and maintenance.
- Equipment used in direct contact with water will be inspected daily to prevent the release of oil.
- Oil-absorbent booms will be used when equipment is used in or immediately adjacent to waters.

- Fuel transfers will take place a minimum distance from exclusion/drainage areas and streams, and absorbent pads will be placed under the fuel transfer operation.
- Equipment will be refueled only in designated areas.
- Staging areas will be designed to contain contaminants such as oil, grease, and fuel products so that they do not drain toward receiving waters or storm drain inlets.

By implementing measures and BMPs as part of these environmental commitments, the project would meet the requirements described in the Central Valley Regional Water Quality Control Board's *Water Quality Control Plan for the Sacramento and San Joaquin River Basins* (Basin Plan) for turbidity generation which are as follows.

- Where natural turbidity is between 0 and 5 nephelometric turbidity units (NTUs), increases shall not exceed 1 NTU.
- Where natural turbidity is between 5 and 50 NTUs, increases shall not exceed 20%.
- Where natural turbidity is between 50 and 100 NTUs, increases shall not exceed 10 NTUs.
- Where natural turbidity is greater than 100 NTUs, increases shall not exceed 10%.

Turbidity levels would be monitored throughout construction as part of the SWPPP (see summary above and Appendix 3B, *Environmental Commitments*). In the event that any of these thresholds were exceeded, all turbidity-producing activities would be halted until turbidity levels subsided and/or appropriate corrective measures were taken. Turbidity effects in the Sacramento River would be limited to the June 1 through October 31 in-water work period for the intake locations, a period with the least potential for most fish species to be in the vicinity of the in-water construction activities.

HMMP

The BDCP proponents will ensure that the BDCP contractor will develop and implement a HMMP before beginning construction. A specific protocol for the proper handling and disposal of hazardous materials will be established before construction activities begin and will be enforced by the BDCP proponents. The HMMP will include, but not be limited to, the following measures or practices.

- Storage and transfer of hazardous materials will not be allowed within 100 feet of streams or sites known to contain sensitive biological resources except with the permission of CDFW.
- Soils contaminated by spills or cleaning wastes will be contained and removed to an approved disposal site.
- Storage or use of hazardous materials in or near wet or dry streams will be consistent with the Fish and Game Code and other state laws.

Dispose of Spoils, Reusable Tunnel Material, and Dredged Material

Contractors will properly handle, manage, and dispose of spoils, reusable tunnel material (RTM), and dredged material. Spoils and RTM will be stored in designated spoils and RTM areas, respectively. Discharges from RTM dewatering operations will be done in such a way as to not cause erosion at the discharge point. Spoils materials will not be placed in sensitive habitat areas, such as wetlands, vernal pools, alkali wetlands or grassland, native grasslands, riparian, or in floodplains identified by the Federal Emergency Management Agency (FEMA). Debris, rubbish, and other materials not directed to be salvaged will be removed from the work site as the contractor's property. Removed material will be disposed of in an approved disposal site and the contractor will obtain permits required for such disposal.

Following completion of construction, restoration of the RTM dewatering sites will be designed to prevent surface erosion and subsequent siltation of adjacent water bodies.

Dredged material will be disposed of in upland disposal sites to help ensure that the material will not be in contact with surface water. Handling and management of dredged material will include, but not be limited to, the following measures in addition to complying with applicable local, state and federal regulations.

- Conduct dredging activities in a manner that will not cause turbidity increases in the receiving water, as measured in surface waters 300 feet down-current from the construction site, to exceed the Basin Plan objectives beyond an approved averaging period by the Regional Water Quality Control Board (RWQCB) and CDFW.
- Silt curtains will be utilized to control turbidity if turbid conditions generated during dredging exceed the agreed-upon implementation requirements for compliance with the Basin Plan objectives.
- Design, construct, operate, and maintain the dredge material disposal site to prevent inundation or washout due to floods with a 100-year return frequency.
- Maintain 2 feet of freeboard in all dredge material disposal site settling pond(s) at all times when they may be subject to washout from a flooding event.
- Constructed DMD sites using appropriate BMPs to prevent discharges of contaminated stormwater to surface waters or groundwater.

Under Alternative 1A, six barge landings would be constructed and approximately 3,000 barge trips are projected to carry construction materials to the barge unloading facilities. The barge trips would take place continuously throughout construction, indicating that periodic turbidity pulses from propeller wash and wakes at the barge landings could occur year-round at the tunnel shaft locations. This potential impact would be minimized by implementing measures as part of a Barge Operations Plan (Appendix 3B, *Environmental Commitments*).

Barge Operations Plan

BDCP construction contractors would implement the following avoidance measures to ensure that the goal of avoiding impacts on aquatic resources from tugboat and barge operations will be achieved.

- Training of tugboat operators.
- Prior to bringing equipment into the Delta, inspect and clean all in-water equipment such as barges and small work boats to prevent introduction of invasive aquatic species (plants, fish and animals)
- Dock approach and departure protocol
  - All vessels will approach and depart from the intake and barge landing sites at dead slow in order to reduce vessel wake and propeller wash at the sites frequented by tug and barge traffic.

- In order to minimize bottom disturbance, anchors and barge spuds will be used to secure vessels only when it is not possible to tie up.
- Barge anchoring will be pre-planned. Anchors will be lowered into place and not be allowed to drag across the channel bed.
- Vessel operators will limit vessel speed as necessary to maintain wake of less than 2 feet (66 cm) at shore.
- Vessel operators will avoid pushing stationary vessels up against the cofferdam, dock or other structures for extended periods since this could result in excessive directed propeller wash impinging on a single location. Barges will be tied up whenever possible to avoid the necessity of maintaining stationary position by tugboat or by the use of barge spuds.
- Limiting vessel speed to minimize the effects of wake impinging on unarmored or vegetated banks and the potential for vessel wake to strand small fish; limiting the direction and\or velocity of propeller wash to prevent bottom scour and loss of aquatic vegetation; and prevention of spillage of materials and fluids from vessels, among other potential effects.
- When transporting loose materials (e.g., sand, aggregate), barges will use deck walls or other features to prevent loose materials from blowing or washing off of the deck.

The plan would specify operating criteria during barge landing and departure designed to minimize erosion and turbidity generation associated with vessel wakes and propeller wash.

As noted above, delta smelt evolved in environments with relatively high natural turbidity levels, and seek out areas with low water clarity for cover from predatory birds and fish. They are well-adapted to turbidity, to the extent that larval and juvenile smelt are unable to forage effectively in clear water conditions (Baskerville-Bridges et al. 2004; Moyle 2002). Baseline turbidity conditions in the Delta range from 10 to 40 NTUs, increasing to 250 and 500 NTUs under high discharge conditions. Turbidity levels in tidal habitats are commonly higher than those in more freshwater areas, due to sediment resuspension off of mudflats by wind-driven waves. For example, baseline turbidity levels in Suisun Bay commonly range from 50 to 100 NTUs.

With environmental commitments, turbidity levels would be expected to be maintained within the natural range of variability likely to occur under baseline conditions. The environmental commitments summarized in this impact and contained in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*) would be expected to effectively limit any increases in turbidity, such that any effects on delta smelt would be minimal, and not adverse.

Accidental Spills

Construction of Alternative 1A could result in accidental spills of contaminants, including cement, oil, fuel, hydraulic fluids, paint, and other construction-related materials, resulting in localized water quality degradation. This could in turn result in adverse effects on delta smelt, through direct injury and mortality (e.g., damage to gill tissue causing asphyxiation) or delayed effects on growth and survival (e.g., increased stress or reduced feeding), depending on nature and extent of the spill and the contaminants involved.

The greatest potential for an adverse water quality impact is associated with an accidental spill from construction activities occurring in or near surface waters. The north Delta intakes and construction and operation of the temporary barge landings at the tunnel shafts both involve extensive in-water work. Other construction elements that occur in upland areas or are isolated from fish-bearing waters, and have little potential for accidental spills that could affect fish. Implementation of environmental commitments (*Environmental Training; Stormwater Pollution Prevention Plan; Erosion and Sediment Control Plan; Hazardous Materials Management Plan; Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material; and Barge Operations Plan*), described in the summary below and specifically the *Spill Prevention, Containment, and Countermeasure Plan* (see of Appendix 3B, *Environmental Commitments*) would be expected to minimize the potential for introduction of contaminants to surface waters and provide for effective containment and cleanup should accidental spills occur. On this basis, the likelihood of adverse effects on delta smelt resulting from accidental spills is considered negligible.

SPCCP

The BDCP proponents will ensure that the BDCP contractor will develop and implement SPCCPs. Multiple SPCCPs will be developed to take into account site-specific conditions, and implemented to minimize effects from spills of oil or oil-containing products during BDCP construction and operation. The SPCC Plans will include, but not be limited to, the following measures and practices.

- Personnel will be trained in emergency response and spill containment techniques, and will also be made aware of the pollution control laws, rules, and regulations applicable to their work.
- Petroleum products will be stored in non-leaking containers at impervious storage sites from which runoff is not permitted to escape.
- Absorbent pads, pillows, socks, booms, and other spill containment materials will be maintained at the hazardous materials storage sites for use in the event of spills.
- Contaminated absorbent pads, pillows, socks, booms, and other spill containment materials will be placed in non-leaking sealed containers until transport to an appropriate disposal facility.
- When transferring oil or other hazardous materials from trucks to storage containers, absorbent pads, pillows, socks, booms or other spill containment material will be placed under the transfer area.
- Absorbent pads and mats will be placed on the ground beneath equipment before refueling and maintenance.
- Equipment used in direct contact with water will be inspected daily to prevent the release of oil.
- Oil-absorbent booms will be used when equipment is used in or immediately adjacent to waters.
- All reserve fuel supplies will be stored only within the confines of a designated staging area.
- Fuel transfers will take place a minimum distance from exclusion/drainage areas and streams, and absorbent pads will be placed under the fuel transfer operation.
- Equipment will be refueled only in designated areas.
- Staging areas will be designed to contain contaminants such as oil, grease, and fuel products so that they do not drain toward receiving waters or storm drain inlets.

- All stationary equipment will be positioned over drip pans.
- In the event of a spill, personnel will identify and secure the source of the discharge and contain the discharge with sorbents, sandbags, or other material from spill kits and will contact appropriate regulatory authorities (e.g., National Response Center will be contacted if the spill threatens navigable waters of the United States or adjoining shorelines, as well as other response personnel).

Methods of cleanup may include the following.

- Physical—Physical methods for the cleanup of dry chemicals include the use of brooms, shovels, sweepers, or plows.
- Mechanical—Mechanical methods could include the use of vacuum cleaning systems and pumps.
- Chemical—Cleanups of material can be achieved with the use of appropriate chemical agents such as sorbents, gels, and foams.

Disturbance of Contaminated Sediments

The construction footprint for Alternative 1A includes areas with known or potentially contaminated sediments, indicating the potential for release and dispersal of these contaminants if these sediments are disturbed during construction. Individual delta smelt could be directly exposed to elevated levels of contaminants if they are in immediate proximity to construction activities that disturb contaminated sediments. Bed disturbance could also result in indirect effects on delta smelt. Toxins in river channel sediments can enter the food chain via benthic organisms. If contaminated sediments are disturbed and become suspended in the water column, they also become available directly to pelagic organisms, including covered fish species and planktonic food sources of covered species. Thus, construction-related disturbance of contaminated bottom sediments opens up another potential pathway to the food chain, and the potential bioaccumulation of these toxins in various fish species. The bioaccumulation of toxins can lead to lethal effects, as well as a number of sublethal effects (e.g., effects on behavior, tissues and organs, reproduction, growth, and immune system) (Connon et al. 2011).

The potential effects of toxins on covered fish species would depend on the types and concentrations of the toxins in disturbed sediments. Unfortunately, little chemical data are available related to sediments in the construction areas. Toxins that tend to bind to particulates do not mix homogeneously into the sediment, and concentrations can vary widely over a small area. A discussion of the available sediment chemical data and the factors that determine the potential for impacts from toxins in sediments is presented below.

The five water intakes would be located in the Sacramento River, downstream of the main urban area of the City of Sacramento. Sediments at these locations could be affected by historical and current urban discharges from the City of Sacramento. Metals (lead and copper), hydrocarbons, organochlorine pesticides, and PCBs are common urban contaminants with the greatest affinity for sediments; these contaminants could be present in sediments that would be disturbed during installation of the cofferdams and dredging. In addition, mercury is present in the Sacramento River system and could be sequestered in bottom sediments. The barge landings would be constructed on smaller waterways, which are more likely to contain agricultural-related toxins such as copper and organochlorine pesticides.

Metals, PCBs, and hydrocarbons (typically oil and grease) are common urban contaminants that are introduced to aquatic systems via nonpoint-source stormwater drainage, industrial discharges, and municipal wastewater discharges. Many of these contaminants readily adhere to sediment particles and tend to settle out of solution relatively close to the primary source of contaminants. PCBs are persistent, adsorb to soil and organics, and bioaccumulate in the food chain. Lead and other metals also will adhere to particulates and organics, and many metals will also bioaccumulate to levels sufficient to cause adverse biological effects. Hydrocarbons biodegrade over time in an aqueous environment and do not tend to bioaccumulate; thus, they are not persistent.

Because the toxins are entering the water column attached to sediment, their movement is closely linked to turbidity, which is an indicator of the amount of particulates in the water column. Turbidity, and in turn suspension of sediments, would be minimized by implementation of environmental commitments described in the summary below and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*). In addition, exposure of covered fish species to any disturbed contaminated sediments would be minimized because in-water construction activities would occur between June 1 and October 31 when most covered fish species are least abundant in the in-water construction area (see Section 11.3.1.1, *Potential Impacts Resulting from Construction and Maintenance of Water Conveyance Facilities*).

Prior to the onset of construction activities, BDCP proponents and/or their contractors will conduct environmental training to inform field management and construction personnel of the need to avoid and protect sensitive resources during construction of the water conveyance facilities. Turbidity and sediment control measures would be implemented by contractors as part of a SWPPP and an Erosion and Sediment Control Plan, as described above under *Temporary Increases in Turbidity*.

To avoid effects from disturbing contaminated sediments, the BDCP proponents will ensure that the BDCP contractor will develop and implement an HMMP before beginning construction. Multiple HMMPs would be developed to take into account specific site conditions. In addition to the measures described under *Temporary Increases in Turbidity*, HMMP measures to address contaminated sediments will include, but not be limited to, the following.

- Soils contaminated by spills or cleaning wastes will be contained and removed to an approved disposal site.
- Storage or use of hazardous materials in or near wet or dry streams will be consistent with the Fish and Game Code and other state laws.
- Hazardous waste generated at work sites, such as contaminated soil, will be segregated from other construction spoils and properly handled, hauled, and disposed of at an approved disposal facility by a licensed hazardous waste hauler in accordance with state and local regulations. The contractor will obtain permits required for such disposal.

Proper handling, storage, and disposal of contaminated sediments would avoid and minimize the entry of contaminants into water bodies. In addition to measures described in *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material* under *Temporary Increases in Turbidity,* above, measures relevant to this impact include the following (see Appendix 3B for the complete plan).

- RTM and RTM decant liquid will undergo chemical characterization by the contractor(s) prior to reuse or discharge, respectively, to meet NPDES and the Central Valley Water Board requirements.
- Should RTM or RTM decant liquid constituents exceed discharge limits, these tunneling byproducts will be treated to comply with NPDES permit requirements. Discharges from RTM dewatering operations will be done in such a way as to not cause erosion at the discharge point.
- If RTM liquid requires chemical treatment, chemical treatment will be nontoxic to aquatic organisms.
- Hazardous materials excavated during construction will be segregated from other construction spoils and properly handled in accordance with applicable state and local regulations. Riverine or in-Delta sediment dredging and dredge material disposal activities involve potential contaminant discharges not addressed through typical NPDES or SWRCB General Permit processes. Construction of Dredge Material Disposal (DMD) sites will likely be subject to the SWRCB General Permit (Order No. 2009-0009-DWQ).
- The BDCP proponents will implement BMPs such as, but not limited to:
    - Prior to initiating any dredging activity, contractors will prepare and implement a pre-dredge sampling and analysis plan (SAP) (as part of the water plan required per standard DWR contract specifications Section 01570) to evaluate the presence of contaminants that may impact water quality from a variety of discharge routes.
    - The DMD will be designed to contain all of the dredged material to the extent practicable, and all systems and equipment associated with necessary return flows from the DMD site to the receiving water will be operated to maximize treatment of return water and optimize the quality of the discharge.
    - DMD sites will be constructed using appropriate BMPs to prevent discharges of contaminated stormwater to surface waters or groundwater.

      To address contamination risk from barge operations, BDCP construction contractors will develop, submit, and implement a barge operations plan per standard DWR contract specifications as part of the traffic plans required in Section 01570. This plan is intended to protect aquatic species and habitat in the vicinity of barge operations. If and when avoidance is not possible, the plan will include provisions to minimize, reduce, or mitigate effects on aquatic species.

      The barge operations plan will be part of a comprehensive traffic control plan coordinated with the Coast Guard for large channels, which will address traffic routes and machines used to deliver materials to and from the barges. The plan will address contamination risks such as the following:
    - Accidental material spillage.
    - Sediment and benthic (bottom-dwelling) community disturbance from accidental or intentional barge grounding or deployment of barge spuds (extendable shafts for temporarily maintaining barge position).
    - Hazardous materials spills (e.g., fuel, oil, hydraulic fluids).

The plan will serve as a guide to barge operations and to a Biological Monitor who will evaluate barge operations with respect to stated performance measures. Construction contractors operating barges as part of BDCP facilities construction will be responsible for operating their vessels safely; developing and implementing the barge operations plan; reporting any spills, incidents or deviations from the plan that might pose risks to species or water quality to the Project Biological Monitor and/or DWR; and following all other relevant plans.

Underwater Noise

Alternative 1A construction involves the use of vibratory and impact pile driving to place temporary sheet piles (for cofferdams used to isolate the intake construction sites), and temporary steel piles for barge mooring and loading areas at the tunnel shaft construction sites. Impact pile driving produces underwater sound levels that have the potential to harm fish, while vibratory pile driving does not. DWR proposes to use vibratory methods wherever practicable to avoid adverse effects on delta smelt and other species. However, it is likely that impact pile driving would be required in some locations, indicating the potential for adverse effects on delta smelt that occur nearby.

As discussed earlier (*Section 11.3.1.1 Underwater Noise)*, the degree of effect is a function of the intensity of the sound (measured in decibels [dB]), the distance from the source, the duration of exposure, the size of the fish exposed and the species-specific sensitivity. The potential for injury is a function of cumulative sound exposure level ($SEL_{cumulative}$) during a 12-hour period.

Fish smaller than 2 grams are more sensitive to cumulative sound exposure levels than larger individuals, and are thought to experience injury when underwater noise exposure reaches 183-dB $SEL_{cumulative}$. Larval and juvenile delta smelt are uniformly smaller than 2 grams. Adult delta smelt are close to 2 grams (mature male and female delta smelt average 2.1 grams and 2.7 grams with a standard error of 0.3 and 0.6 grams, respectively [Foott and Bigelow 2010]). Because some portion of the adult delta smelt population weighs less than the 2-gram limit, the lower injury threshold should apply to this life stage as well.

The potential for delta smelt exposure to underwater noise impacts is determined by the overlap of construction activities (timing, location, duration) and delta smelt distribution by life history stage. The estimated duration of potential exposure to pile driving is 6 days each in June and July (Table 11-9). Delta smelt are generally found in the west Delta and Cache Slough/Liberty Island area during the spring and summer, meaning that the majority of individuals would not be exposed to construction-related underwater noise. However, individual delta smelt could be present at low abundance in the north, east, and south Delta during this period when in-water construction activity would occur, indicating some potential for exposure. Adult delta smelt complete their spawning cycle and die by mid- to late June. Adult delta smelt transiting areas where pile driving occurs could experience direct adverse effects. If smelt spawn upstream of construction areas, larvae could potentially drift through the areas affected by underwater sound. There is a slight potential for spawning adults (during June) or larval delta smelt (during June and July) to occur in the vicinity of the intakes and the barge landings during the in-water construction period (see Table 11-4). If an individual larval delta smelt was present in the area affected by underwater sound from impact pile driving above the 183-dB $SEL_{cumulative}$ level, it could experience direct injury or mortality.

Alternative 1A includes timing restrictions and limitations on the duration of impact pile driving activities. Implementation of Mitigation Measures AQUA-1a and AQUA-1b would minimize, but not completely avoid, adverse effects on delta smelt from exposure to underwater noise.

Other construction activities would be unlikely to result in underwater noise level sufficient to adversely affect delta smelt. Activities could involve divers and use of surface equipment such as boats and barges that may temporarily elevate underwater noise levels above ambient conditions. However, the resulting noise levels are not expected to reach a level that would harm juvenile or adult fishes. Routine maintenance activities of this kind typically produce noise levels below the behavioral effects threshold of 150 dB root-mean-squared (RMS). NMFS (2001) has determined that underwater sound pressure levels less than 150 dB RMS may temporarily alter fish behavior but do not result in permanent harm or injury.

Fish Stranding

In-water work activities have the potential to cause take of fish through the process of capturing and rescuing stranded or trapped fish from construction areas. In-water work activities at the north Delta intakes would include installation of sheet pile cofferdams at each intake location to isolate active construction activities from the Sacramento River and minimize the potential for increases in turbidity.

Although delta smelt larval and adult life stages are potentially present in the vicinity of the intakes from January through July, the timing of cofferdam installation (June through August) would avoid the majority of the spawning and larval recruitment season when delta smelt are most likely to be present (see Table 11-4). Potential effects of fish stranding typically result in direct or indirect injury or mortality from subsequent dewatering of work areas and other construction activities. These effects would be minimized by implementation of environmental commitments described in the summary below and in Appendix 3B, *Environmental Commitments* (*Fish Rescue and Salvage Plan*).Although fish would likely avoid the noise and activity of sheet pile installation, cofferdams have the potential to entrap some fish. While the number of fish affected is unknown, entrapment could include a few hundred fish (total of all species), potentially including a small number of delta smelt.

Fish Rescue and Salvage Plan

DWR will develop the Fish Rescue and Salvage Plan and submit it to the appropriate resource agencies (CDFW, USFWS, and NMFS) for their review and acceptance, and revise it accordingly. The plan will include detailed procedures for fish rescue and salvage to minimize the number of fish stranded during placement and removal of cofferdams at the intake construction sites. The plan will identify the appropriate procedures for removing fish from the construction zone, and preventing fish from re-entering the construction zone during construction, or prior to dewatering. The plan will include detailed fish collection, holding, handling, and release procedures.

Prior to construction site dewatering, fish will be captured and relocated to avoid direct mortality and to minimize take. The appropriate fish collection method will be determined by a qualified fish biologist, in consultation with the designated resource agency biologist, and based on site-specific conditions prior to dewatering the cofferdam. Collection methods may include use of seines (nets) and/or dip nets to collect and remove fish, and electrofishing techniques may also be permitted. Although the use of these methods can also result in fish injury or mortality, these effects are typically minor, and often avoided by appropriate training. In addition, these methods have varying degrees of effectiveness, resulting in some trapped or stranded fish not being rescued.

The results of the fish rescue and salvage operations (including date, time, location, comments, method of capture, fish species, number of fish, approximate age, condition, release location, and release time) will be reported to the appropriate resource agencies, as specified in the pertinent permits.

In-Water Work Activities

In-water work activities have the potential to injure or kill fish through direct physical injury from construction activities. In-water work activities at the north Delta intakes would include installation of sheet pile cofferdams at each intake location, piles at each barge landing, placement of riprap to protect the stream banks adjacent to the intakes from erosion, and dredging.

Although fish would likely avoid the noise and activity of pile installation and placement of riprap protection, these activities have the potential to result in direct and indirect injury or mortality; trapped or stranded fish would be susceptible to increased sound exposure effects from pile driving, riprap placement can crush or displace fish, and dredging activities can also crush or entrain fish. Delta smelt larval and adult life stages may potentially be present in the vicinity of the intakes and barge landings during January through July; however, the timing of cofferdam and riprap installation (June through October) would avoid most of the spawning season (January through June, with peak numbers in the north Delta during February through May) when delta smelt are most likely to be present (see Table 11-4). In addition to these timing restrictions, potential in-water activity effects would be minimized by implementation of the environmental commitments described in Appendix 3B, *Environmental Commitments*, including *Erosion and Sediment Control Plan*; *Dispose of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*. Pertinent aspects of these plans include, respectively the following.

- Install physical erosion control stabilization features (hydroseeding, mulch, silt fencing, fiber rolls, sand bags, and erosion control blankets) to capture sediment and control both wind and water erosion.
- Divert runoff away from steep, denuded slopes, or other critical areas with barriers, berms, ditches, or other facilities.
- Discharges from RTM dewatering operations will be done in such a way as to not cause erosion at the discharge point. If RTM liquid requires chemical treatment, chemical treatment will be nontoxic to aquatic organisms.
- Following completion of construction, restoration of the RTM dewatering sites will be designed to prevent surface erosion and subsequent siltation of adjacent water bodies.
- Conduct dredging within the allowable seasonal "work windows" established by the regulatory agencies.
- Conduct dredging activities in a manner that will not cause turbidity increases in the receiving water, as measured in surface waters 300 feet down-current from the construction site, to exceed the Basin Plan objectives beyond an approved averaging period by the RWQCB and CDFW.
- The DMD will be designed to contain all of the dredged material to the extent practicable, and all systems and equipment associated with necessary return flows from the DMD site to the receiving water will be operated to maximize treatment of return water and optimize the quality of the discharge.
- The Barge Operations Plan will include training of tugboat operators, limiting vessel speed to minimize the effects of wake impinging on unarmored or vegetated banks and the potential for vessel wake to strand small fish, limiting the direction and\or velocity of propeller wash to prevent bottom scour and loss of aquatic vegetation, and preventing spills of materials and fluids from vessels.

- In order to minimize bottom disturbance, anchors and barge spuds will be used to secure vessels only when it is not possible to tie up.
- Barges will not be anchored where they will ground during low tides.
- When transporting loose materials (e.g., sand, aggregate), barges will use deck walls or other features to prevent loose materials from blowing or washing off of the deck.

Loss of Spawning, Rearing, or Migration Habitat

In-water construction would temporarily or permanently alter habitat conditions in the vicinity of the construction activities, but the use of the affected habitats for delta smelt spawning and rearing is likely limited, based on available data (Merz et al. 2011). Therefore, the resulting habitat effects are not likely to be limiting to population productivity because it represents a very small portion of the available habitat in the Delta (Werner et al. 2010). Construction and channel dredging would result in a permanent loss of up to approximately 8,300 lineal feet of Sacramento River channel margin within potential delta smelt migration, spawning, and rearing habitat (see Table 11-5). Cofferdams would isolate the work areas, temporarily reducing the width of riverine habitat available to fish for migration and rearing, but this will have an insignificant effect on upstream and downstream fish passage because the cofferdams would typically occupy only about 10% of the cross section of the river, and cumulatively occupy only a couple of miles of the overall river length. These isolated areas also represent a very small portion of the available migration and rearing habitat in the Delta, and there is no indication that these areas are uniquely important to the overall viability of the delta smelt population. Alternative 1A will result in the permanent loss of low-quality migration, spawning, and rearing habitat where the existing river banks and bed areas would be replaced with permanent in-water structures. However, the affected areas have steeply sloped and armored stream banks lacking riparian vegetation, which are thought to be low suitability habitats for delta smelt spawning (U.S. Fish and Wildlife Service 2008).

Each of the five proposed barge landings would include in-water and over-water structures, such as piling dolphins, docks, ramps, and possibly conveyors for loading and unloading materials; and vehicles and other machinery. The barge landings would each occupy approximately 15,000 square feet of nearshore habitat within their respective delta channels (see Mapbook M3-1 for locations). In addition to effects of the constructed barge landings on habitat, barge operations have the potential to affect bottom sediments and benthic habitat through propeller wash effects. This is most relevant in the vicinity of the barge landings and in narrow channels where tugboats will be near the channel bottom and could stir up bottom sediments and submerged aquatic vegetation, potentially resulting in temporary disturbance of rearing habitat. Tugboat and barge speeds in the narrow channels would be low enough that vessel wakes are not expected to affect shoreline habitat.

Potential effects of these in-water structures and activities would be minimized by limiting the size of the in-water structures where practicable, limiting the amount of dredging and other habitat disturbing activities, adhering to the approved in-water construction window (expected to be June 1 through October 31), and implementing environmental commitments described in Appendix 3B, *Environmental Commitments*, including *Erosion and Sediment Control Plan*; *Dispose of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*. Specific measures of those plans previously described for turbidity, accidental spills, and in-water work activities also would address the loss of habitat. Additional potentially relevant elements of the Erosion and Sediment Control Plan include the following.

- Conduct frequent site inspections (before and after significant storm events) to ensure that control measures are working properly and to correct problems as needed.
- Deposit or store excavated materials away from drainage courses.
- Vegetative material from work site clearing will be chipped, stockpiled, and spread over the topsoil after earthwork is completed when practical and appropriate to do so.
- Rocks and other inorganic grubbed materials will be placed in the common backfill whenever possible. Debris, rubbish, and other materials not directed to be salvaged will be removed from the work site.

Predation

In-water pilings and over-water structures, such as those that would be constructed at the barge landings have the potential to attract predatory fish that may prey on delta smelt. Docks and associated pilings provide shade and cover that attract certain predatory fish species, including striped bass, largemouth bass, smallmouth bass, spotted bass, crappie, and Sacramento pikeminnow. In addition to fish, water birds (e.g., gulls, terns, cormorants, grebes, mergansers, egrets, and herons) prey on fish in the Delta. Pilings and other structures may provide perching habitat for avian predators and cover for introduced predacious fish species. While fish predators could use this cover to ambush prey, and potentially improve their foraging success, avian predators are unlikely to forage directly from the docks or piles. Therefore, the overwater piers and support structures would represent a very small increase in the overall predator habitat the Delta. Therefore, it is not likely that temporary structures associated with construction would increase habitat availability sufficiently to increase the abundance of avian and fish predators relative to baseline conditions.

This indicates that the likelihood of increased predation on delta smelt associated with project construction is minimal. However, it is plausible that localized increases in predation rates could occur if in-water and over-water structures provide suitable predator habitat in proximity to concentrations of delta smelt although these localized increases are not expected to have wide-spread or population level effects.

Summary

Construction of Alternative 1A includes several elements with the potential to cause adverse effects on delta smelt through spills of hazardous materials or underwater noise. However, adverse effects will be effectively avoided and minimized by siting construction in areas that are minimally used by this species, and through the use of in-water work windows, activity-specific timing restrictions, and environmental commitments.

Alternative 1A includes several environmental commitments that will avoid and limit spills, potentially leading to adverse water quality effects on delta smelt. These include *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan;* and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material* (see Appendix 3B, *Environmental Commitments*). These commitments would guide rapid and effective response in the case of inadvertent spills of hazardous materials. In combination with the species' natural tolerance to elevated turbidity levels, and limited occurrence in the construction areas, these environmental commitments would be expected to protect delta smelt from any adverse water quality effect resulting from project construction.

Delta smelt could be adversely affected by elevated underwater noise associated with impact pile driving and direct exposure to construction-related disturbance. The number of individuals affected is expected to be limited, based on the fact that delta smelt are typically present at low densities in the affected habitats during the in-water work window. This will minimize, but perhaps not completely avoid, the potential for injury or mortality. Mitigation Measures AQUA-1a and AQUA-1b, would also minimize adverse effects from impact pile driving. Implementation of environmental commitments *Fish Rescue and Salvage Plan* and *Barge Operations Plan* (as described in Appendix 3B, *Environmental Commitments*) would also minimize adverse effects from construction-related disturbance. Construction of the approach canal and Byron Tract Forebay would not affect fish-accessible waterways and therefore would not affect delta smelt. As a result, while these construction activities could adversely affect individual delta smelt, these effects would not result in adverse population level effects on delta smelt.

Construction would not be expected to measurably increase predation rates relative to baseline conditions because the locally increased predator habitat and predation from temporary construction structures would not have population level effects.

Construction of Alternative 1A will result in both temporary and permanent alteration of migration, spawning, and rearing habitats used by delta smelt. However, these effects are not expected to be adverse from a population standpoint, because local water quality conditions (very low electrical conductivity and typically low turbidity limit the suitability of this river reach for delta smelt (Werner et al. 2010). Moreover, any habitat losses will be offset by habitat restoration and the beneficial operational effects of Alternative 1A (described below) on the Delta as a whole.

NEPA Effects: As a result, these construction activities would not likely result in adverse effects on delta smelt.

CEQA Conclusion: The potential impact on delta smelt from construction activities is considered less than significant due to implementation of the measures described in Appendix 3B, *Environmental Commitments*, such as *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*. These measures would guide rapid and effective response in the case of inadvertent spills of hazardous materials. This species' natural tolerance to of turbidity, would likely avoid the risk of any adverse turbidity effects resulting from project construction. Construction would not be expected to increase predation rates relative to baseline conditions. Construction associated with Alternative 1A will result in both temporary and permanent alteration of rearing and migratory habitats used by delta smelt. However, these effects are not expected to be significant because the loss of habitat is not substantial compared to the amount of habitat currently available in combination with the amount of new habitat that would result from restoration under Alternative 1A. The direct effects of underwater construction noise on delta smelt could be a significant impact if delta smelt are exposed because of the high likelihood that it would cause injury or death to some fish in the immediate vicinity of the activity. However, implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the potential for effects from underwater noise and would reduce the severity of impacts to a less-than-significant level.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

BDCP proponents will include specification in any construction contracts involving the installation of in-water or nearshore pilings, that piles will be installed using vibratory methods, or other non-impact driving methods, wherever feasible. Such methods have been shown to effectively minimize physical or substantial behavioral effects on fish and other aquatic species. The method selected will be based on geotechnical studies that will be conducted to determine the feasibility of vibratory installation of sheet pile, intake pipe foundation piles, and dock piles for barge landings. Where impact pile driving is required, DWR will monitor underwater sound levels to determine compliance with the underwater noise effects thresholds at a distance appropriate for protection of the species (183 dB $SEL_{cumulative}$ for fish less than 2 grams; 187 dB $SEL_{cumulative}$ for fish greater than 2 grams). Based on the results of the geotechnical evaluations, a noise monitoring plan will be prepared which will specify where and how underwater sound levels will be measured, how data will be analyzed and reported to the resource agencies, and what corrective actions will be taken should the thresholds be exceeded.

Baseline underwater sound measurements will be collected prior to impact pile driving. A subsample of impact driven piles will be monitored to determine actual sound levels produced. Should the sound levels exceed the thresholds, corrective actions could range from reporting to reducing the number of piles that can be impact driven in a day.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

This mitigation measure would primarily apply to pile driving related to temporary barge landing construction, where the attenuation device can effectively surround or isolate the individual piles needed at these locations. This measure would not be applicable to sheet pile installations, where it would not be feasible to surround the entire sheet pile wall, although it would apply to any site where individual piles are driving with an impact hammer.

BDCP proponents will work with contractors to minimize pile driving, particularly impact pile driving, by using floating docks instead of pile-supported docks, wherever feasible considering the load requirements of the landings and the site conditions. If pile supported docks are required, the minimum number of piles to safely support the docks will be used. If dock piles for barge landings cannot be installed using vibratory methods, attenuation devices (e.g., isolation casings or bubble curtains) will be used to reduce the area that would be exposed to underwater sound levels above the $SEL_{cumulative}$ effects thresholds (183 dB $SEL_{cumulative}$ for fish less than 2 grams are present; 187 dB $SEL_{cumulative}$ for fish greater than 2 grams). Baseline underwater sound measurements will be collected prior to impact pile driving. A subset of impact driven piles will be monitored to determine actual sound levels produced. Should the sound levels exceed the thresholds, corrective actions could range from reporting to reducing the number of piles that can be impact driven in a day.

If dock piles for barge landings cannot be installed using vibratory methods, attenuation devices (e.g., isolation casings or bubble curtains) will be used to reduce the area that would be exposed to underwater sound levels above the $SEL_{cumulative}$ injury thresholds.

Impact AQUA-2: Effects of Maintenance of Water Conveyance Facilities on Delta Smelt

Once constructed, Alternative 1A structures and facilities will require ongoing periodic maintenance that includes in-water work activities with the potential to affect delta smelt. These activities include periodic cleaning and replacement of screens, trash racks, and associated machinery and dredging to maintain intake capacity. These activities will produce disturbance and underwater noise, and may generate turbidity or other water quality effects. In general, the likelihood of adverse effects on delta smelt from maintenance activities would be avoided and minimized through the same methods and rationale described for Impact AQUA-1.

Temporary Increases in Turbidity

Maintenance activities are not likely to result in turbidity impacts sufficient to adversely affect delta smelt because smelt prefer turbid conditions and because all in-water maintenance activities would occur during approved in-water work windows, when smelt are least likely to be present near the facilities. As discussed for construction-related effects on turbidity (Impact AQUA-1), the potential for delta smelt to be near the intakes during the expected in-water work window of June 1 to October 31 is low. Turbidity impacts during maintenance would be minimized by implementing the environmental commitments described under Impact AQUA-1 and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*). Pertinent details of these plans are provided under Impact AQUA-1. These measures, in combination with the naturally high tolerance of delta smelt for turbidity, would be expected to effectively avoid potential adverse effects.

Accidental Spills

Maintenance activities such as dredging, levee repair and placement of riprap involve the use of heavy equipment in the aquatic environment. Accidental spills of fuel or leakage of fluids and lubricants creates a potential pathway for the introduction of toxic substances into the aquatic environment. However, adverse effects on delta smelt from accidental spills associated with maintenance are considered unlikely based on the same rationale discussed for construction-related spill effects on delta smelt (see Impact AQUA-1). Implementation of environmental commitments described in Impact AQUA-1 (*Environmental Training; Stormwater Pollution Prevention Plan; Erosion and Sediment Control Plan; Hazardous Materials Management Plan; Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material; and Barge Operations Plan*), and specifically the *Spill Prevention, Containment, and Countermeasure Plan* (see Appendix 3B, Environmental Commitments) would be expected to minimize the potential for introduction of contaminants to surface waters and provide for effective containment and cleanup should accidental spills occur. Pertinent details of these plans are provided under Impact AQUA-1.

Underwater Noise

Maintenance activities would be unlikely to result in underwater noise level sufficient to adversely affect delta smelt. Maintenance activities that require in-water work include cleaning trash racks, checking and cleaning intake screens, and occasional maintenance dredging. These activities could involve divers and surface equipment such as boats and barges that may temporarily elevate underwater noise levels above ambient conditions.

However, the resulting noise levels are not expected to reach a level that would harm juvenile or adult fishes. Routine maintenance activities of this kind typically produce noise levels below the behavioral effects threshold (150 dB RMS). NMFS (2001) has determined that underwater sound pressure levels less than 150 dB RMS may temporarily alter fish behavior but do not result in permanent harm or injury.

Maintenance-Related Disturbance

Bank, bed and water column disturbance associated with maintenance activities have a similar potential to cause direct injury and mortality of delta smelt. Effects of this severity would be most likely to occur during maintenance dredging activities around the new intakes. Suction dredging, mechanical excavation, and possible front-end loading equipment could entrain or crush fish, causing injury or mortality. While these mechanisms are possible, the likelihood of smelt exposure would be low due to the nature of the affected habitats and the timing of maintenance activities. Delta smelt use main channel areas and the upper water column, which limits exposure to suction dredging. Moreover, dredging activities would be limited to periods when delta smelt are least likely to be present in the affected habitats. Collectively, this would be expected to significantly reduce exposure potential.

The potential effects of in-water maintenance activities would be similar to those discussed for construction-related effects on delta smelt (see discussion under Impact AQUA-1). Effects would be minimized by implementation of environmental commitments described under Impact AQUA-1 and in Appendix 3B, *Environmental Commitments*. These environmental commitments include *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Dispose of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*.

Loss of Spawning, Rearing, or Migration Habitat

Two maintenance activities, dredging and riprap placement, would reduce habitat values in the area around the intakes. Delta smelt may currently use the habitat near the proposed locations of the intake structures for migration, spawning, and short-term larval rearing. Offshore waters would be unaffected by dredging or riprap placement. Available rearing and migration habitat of similar quantity and quality in other locations would be readily accessible to delta smelt. Effects would be minimized by implementation of environmental commitments described under Impact AQUA-1 and in Appendix 3B, *Environmental Commitments*. These environmental commitments include *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan;* and *Dispose of Spoils, Reusable Tunnel Material, and Dredged Material*. Pertinent details of these plans are provided under Impact AQUA-1.

Predation

Maintenance activities would be unlikely to have any measurable effect on system-wide delta smelt predation rates. These activities may include the use of barges and other watercraft that could theoretically provide cover, shelter, and perching areas for delta smelt predators. However, the limited duration of maintenance activities and the associated noise and disturbance would be expected to dissuade predators from concentrating at sufficient density to measurably affect predation rates on delta smelt. Further, during the established work windows, few delta smelt are expected to occur during in the areas where water diversion facility maintenance would occur.

Summary

Alternative 1A would necessarily include a range of ongoing periodic maintenance activities with the potential to adversely affect delta smelt. In general, any effects that occur would be similar in nature to, but less intensive and extensive than, the range of effects described for construction activities. Implementation of the environmental commitments described in Appendix 3B, *Environmental Commitments*, would be expected to effectively avoid and minimize adverse effects on delta smelt by limiting hazardous material spills, and by rapid and effective response to spills should they occur. These include environmental commitments: *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*.

NEPA Effects: Implementation of these environmental commitments, along with the low numbers of delta smelt expected to occur in the maintenance areas during the approved in-water work windows and the limited frequency and duration of in-water maintenance activities would result in a very low potential for adverse effects on delta smelt. In addition, little or no spawning habitat occurs in the areas potentially affected by maintenance activities. As a result, the effects on delta smelt from short-term maintenance activities would not be adverse.

CEQA Conclusion: Delta smelt inhabit naturally turbid water and are not expected to be affected by temporary increases in turbidity during maintenance activities. In addition to the limited frequency and duration of in-water maintenance activities and implementation of the commitments identified above and described in detail in Appendix 3B, *Environmental Commitments*, would minimize the potential for maintenance activities to affect delta smelt by limiting turbidity increases, by limiting hazardous material spills, and by rapid and effective response to spills should they occur. These commitments include *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*. Potential changes to habitat would also be limited and temporary. Therefore, the potential impact of maintenance activities is considered less than significant because it would not substantially reduce delta smelt habitat, restrict its range, or interfere with its movement. Consequently, no mitigation would be required.

Water Operations of CM1

Delta smelt would be exposed to a range of operational effects under Alternative 1A, including the operation of existing and newly constructed water diversion and distribution systems.

Impact AQUA-3: Effects of Water Operations on Entrainment of Delta Smelt

Water Exports from SWP/CVP South Delta Facilities

Analysis of potential entrainment at the south Delta facilities under the action alternatives was estimated with the OMR proportional entrainment loss regression (Kimmerer 2008 and 2011). The full entrainment analysis method is detailed in the *BDCP Effects Analysis – Appendix 5.B*, *Entrainment, (B.5.5.1 Proportional Entrainment Loss Regressions: Delta Smelt* and *Section; Section*

B.6.1.5 Delta Smelt, hereby incorporated by reference). It should be noted that simulations of entrainment increased under model simulations of future conditions (NAA), most notably in wet, above-normal and below-normal water years. This was primarily a result of X2 moving upstream with sea level rise, resulting in more delta smelt larvae/juveniles being susceptible to entrainment by the south Delta export facilities for any given OMR flow, using this method. In order to account for climate change effects and isolate the effect of alternative operational scenarios, comparisons are discussed only for similar time periods (NAA versus A1A_LLT).

Alternative 1A would result in lower overall entrainment of delta smelt than the NAA (Figure 11-1A-1 and Figure 11-1A-2).

For larvae and juveniles (March-June), average proportional entrainment loss across all years under Alternative 1A was fairly similar to NAA, with 0.003 less entrainment (i.e., 0.3% of juvenile population, a 2% relative decrease) (Table 11-1A-1). Predicted larval/juvenile entrainment would decrease in wetter years (0.015–0.020 less, a 13–31% relative decrease) compared to NAA, but would increase 0.007–0.013 (a 4–6% relative increase) in below-normal, dry and critical years. This is due to Alternative 1A operations that result in reduced Old and Middle River flows in April and May.

For adult smelt under Alternative 1A, estimated average proportional entrainment across all years would be 0.021 less (a 28% relative decrease) compared to NAA. Proportional entrainment would decrease 0.016–0.04 under Alternative 1A in wet (59% relative decrease), above-normal (37% relative decrease) and below-normal (20% relative decrease) water years, and would be similar to the NAA in drier years (2–6% relative decrease).

Implementation of reduced negative OMR flows under the USFWS (2008) BiOp has considerably limited entrainment loss of adult delta smelt (Smelt Working Group 2010; U.S. Fish and Wildlife Service 2011). The reduced negative OMR flows aim to keep proportional adult entrainment loss below around 0.05 or 5% of the population (U.S. Fish and Wildlife Service 2008). These regulatory limits would be expected to remain in place under Alternative 1A, but the diversion rate in the South Delta would decrease as withdrawals were shifted to the Sacramento River intakes. This would result in higher OMR flows in winter and early spring (December–March) that would be expected to maintain or reduce the already low baseline-level of adult delta smelt entrainment in the south Delta.

Table 11-1A-1. Differences in Proportional Entrainment of Delta Smelt at SWP/CVP South Delta Facilities

	Proportional Entrainment[a] Difference in Proportions (Relative Change in Proportions)	
Water Year	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Total Population		
Wet	-0.035 (-32%)	-0.060 (-45%)
Above Normal	-0.016 (-10%)	-0.044 (-23%)
Below Normal	0.021 (10%)	-0.008 (-3%)
Dry	0.027 (10%)	0.008 (3%)
Critical	0.011 (3%)	0.011 (4%)
All Years	-0.002 (-1%)	-0.024 (-11%)
Juvenile Delta Smelt (March–June)		
Wet	0.006 (17%)	-0.020 (-31%)
Above Normal	0.014 (18%)	-0.015 (-13%)
Below Normal	0.039 (28%)	0.007 (4%)
Dry	0.033 (18%)	0.012 (6%)
Critical	0.018 (7%)	0.013 (5%)
All Years	0.021 (17%)	-0.003 (-2%)
Adult Delta Smelt (December–March)		
Wet	-0.041 (-59%)	-0.040 (-59%)
Above Normal	-0.031 (-38%)	-0.030 (-37%)
Below Normal	-0.018 (-22%)	-0.016 (-20%)
Dry	-0.006 (-8%)	-0.005 (-6%)
Critical	-0.007 (-9%)	-0.001 (-2%)
All Years	-0.023 (-30%)	-0.021 (-28%)

Shading indicates >5% or more increased entrainment.

Note: Negative values indicate lower entrainment loss under Alternative than under existing biological conditions.

[a] Proportional entrainment index (U.S. Fish and Wildlife Service 2008).

[b] Adult proportional entrainment adjusted according to Kimmerer (2011).

Water Exports from SWP/CVP North Delta Intake Facilities

Entrainment of delta smelt larvae at the north Delta intakes occurs only under the action alternatives, including Alternative 1A, because there are no north Delta intakes operational under Existing Conditions or the No Action Alternative. Entrainment risk of delta smelt under Alternative 1A is assumed to be low because delta smelt are thought to spawn only infrequently in the vicinity of the proposed north Delta intake facilities sites, based on survey data (CDFW Spring Kodiak Trawl and USFWS beach seining) and a review of literature (California Department of Fish and Game 2012a, Merz et al. 2011, and Moyle 2002). However, delta smelt may occur in this area under future climate conditions, if sea level rise induces movement of the spawning population farther upstream than is currently typical. The planned restoration of the Cache Slough complex under Alternative 1A is anticipated to increase the tidal excursion into Cache Slough and decrease the tidal excursion into this reach of the Sacramento River to help maintain positive flows at Georgiana Slough (*BDCP Effects*

*Analysis – Appendix 5.C, Flow, Passage, Salinity and Turbidity)*This is also expected to induce adult delta smelt to migrate preferentially into Cache Slough over the Sacramento River, reducing the likelihood that relative numbers of spawners will increase in the vicinity of the NDDs in response to climate change.

Larval entrainment was estimated using particle tracking modeling. As described in *BDCP Effects Analysis – Appendix 5.B Entrainment, Section B.6.1.5 Delta Smelt (hereby incorporated by reference),* 17 particle tracking model (PTM) runs were created using representative hydroperiods (e.g., Delta outflow May 1966) matched to suitable larval delta smelt starting distributions based on the CDFW 20mm larval survey (1997–2010). Potential entrainment at the north Delta intakes under Alternative 1A ranged from 0 to 2% based on the PTM results, with entrainment generally less than 0.1% under most hydrologic scenarios. The results were virtually identical between 30-day and 60-day particle tracking durations.

In recognition of the potential for smelt to occur near the north Delta intake facilities, the diversions will incorporate screens that meet design specifications developed to reduce the risks of entrainment and impingement. The screens would be expected to effectively exclude juvenile and adult delta smelt longer than 20 mm standard length (SL) (*BDCP Effects Analysis – Appendix 5.B Entrainment, Section B.5.9.2.1 Screening Effectiveness Analysis, hereby incorporated by reference*). Fish below 20 mm would be susceptible to entrainment (Swanson et al. 2005; Young et al. 2010 ; White et al. 2007); larger larvae would be less likely to become entrained but could be impinged on the screens. The project's adaptive management plan includes monitoring the screens to determine their effectiveness. If the screens are not meeting expectations, additional measures may be implemented to improve screen performance. These measures could include modifications to the screens or other structural components at the intakes, or changes in water diversion operations to reduce entrainment or impingement rates.

Water Exports with a Dual Conveyance for the SWP North Bay Aqueduct

Establishment of a dual diversion system for the NBA, with combined operations of a new intake on the Sacramento River (operated in conjunction with proposed BDCP north Delta facilities) and the existing intake at Barker Slough, would further reduce the level of entrainment of delta smelt by removing most of the export pumping from the Barker Slough facility to the new Sacramento River facility, located in a region where delta smelt are not commonly found.

Larval entrainment at NBA was estimated using particle tracking modeling. As described in *BDCP Effects Analysis – Appendix 5.B Entrainment, Section B.6.1.5 Delta Smelt (hereby incorporated by reference),* 17 particle tracking model (PTM) runs were created using representative hydroperiods (e.g., Delta outflow May 1966) matched to suitable larval delta smelt starting distributions based on the CDFW 20mm larval survey (1997–2010). Larval entrainment as modeled by PTM was low, averaging 1.3% under Alternative 1A compared to 2.0% under NAA, or 34% lower in relative terms (Table 11-1A-2). The results were virtually identical between 30-day and 60-day particle tracking durations. Entrainment risk for juvenile and adult delta smelt would be minimized with state-of-the-art screens on the existing and planned intakes.

Table 11-1A-2. Average Percentage (and Difference) of Particles Representing Larval Delta Smelt Entrained by the North Bay Aqueduct under Alternative 1A and Baseline Scenarios

Average Percent Particles Entrained at NBA			Difference (and Relative Difference)	
EXISTING CONDITIONS	NAA	A1A_LLT	A1A_LLT vs. EXISTING CONDITIONS	A1A_LLT vs. NAA
2.1	2.0	1.3	-0.79 (-38%)	-0.69 (-34%)

Note: 60-day DSM2-PTM simulation. Negative difference indicates lower entrainment under the alternative compared to the baseline scenario

Predation Associated with Entrainment

Pre-screen losses of delta smelt at the SWP/CVP south Delta facilities are believed to be high and are generally attributed to increased risk of predation and other unfavorable habitat conditions near the pumps (Castillo et al. 2012). Under Alternative 1A, the risk of pre-screen losses at the south Delta facilities would be reduced commensurate with the reductions in entrainment described above. Predation loss at the north Delta intakes may occur but would be limited because few delta smelt are anticipated to occur that far upstream.

NEPA Effects: In conclusion, under Alternative 1A, proportional entrainment and associated predation loss of delta smelt is expected to decrease overall at the south Delta facilities. The predicted reductions in entrainment in the south Delta and NBA are expected to exceed any potential entrainment-related loss that would occur at the new screened Sacramento River diversions in the north Delta. Therefore, the effect of Alternative 1A on entrainment loss would not be adverse to delta smelt and may provide a slight benefit.

CEQA Conclusion: As described above, implementation of OMR flows under the USFWS (2008) BiOp has considerably limited entrainment loss of adult delta smelt. Average proportional entrainment across all water years at the south Delta facilities under Alternative 1A would be reduced for adult delta smelt (0.023 less, a 30% relative decrease), but increased for larvae and juveniles (0.021 more, a 17% relative increase) compared to the Existing Conditions, which does not include the effects of climate change (Table 11-1A-1). The impact would be less than significant due to the small proportion (0.021 or 2%) of the larval/juvenile population affected.

It is worth considering how this result differs from the NEPA conclusion set forth above. Under the CEQA analysis, Alternative 1 could substantially increase larval/juvenile proportional entrainment relative to Existing Conditions. However, this interpretation of the biological modeling results is likely attributable to different modeling assumptions for four factors: sea level rise, climate change, future water demands, and implementation of the alternative. As discussed above (Section 11.3.3), because of differences between the CEQA and NEPA baselines, it is sometimes possible for CEQA and NEPA significance conclusions to vary between one another under the same impact discussion. The baseline for the CEQA analysis is Existing Conditions at the time the NOP was prepared. Both the action alternative and the NEPA baseline (NAA) models anticipated future conditions that would occur in 2060 (LLT implementation period), including the projected effects of climate change (precipitation patterns), sea level rise and future water demands, as well as implementation of required actions under the 2008 USFWS BiOp and the 2009 NMFS BiOp. Note that the analysis for larvae and juveniles includes both OMR flows and X2 as predictors of proportional entrainment; primarily because of sea level rise assumptions, X2 would be further upstream in the ELT and LLT even with similar water operations, so that the comparison of Alternative 1 in the ELT and LLT to Existing Conditions is confounded.

Therefore, the analysis of larval/juvenile delta smelt entrainment at the south Delta SWP/CVP water export facilities is better informed by the results from the NEPA analysis presented above, which accounts for sea level rise by considering the NAA in the LLT. When climate change is factored in, larval-juvenile delta smelt entrainment is generally similar to conditions without BDCP (average entrainment is reduced by 2% in relative terms).

Operational activities associated with water exports from SWP/CVP north Delta intake facilities may result in an increase in entrainment or a loss of individuals for delta smelt in the north Delta (where no intakes currently exist), but the low species occurrence and compliance with CDFW fish screen criteria for delta smelt would not result in appreciably greater risk. In addition, implementing a dual conveyance for the SWP North Bay Aqueduct would also likely reduce overall entrainment in Barker Slough and have minimal risk at the screened alternative intake site on the Sacramento River. PTM modeling of potential particle entrainment would always be less under Alternative 1A compared to Existing Conditions (Table 11-1A-2).

Overall, the impact is considered less than significant because of the small proportion of the juvenile population that would be affected at the south Delta facilities and because of the potential for a reduction in adult entrainment. Furthermore, any potential impacts would be reduced by monitoring and adaptive management by the Real-Time Response Team. Consequently, no mitigation would be required.

Impact AQUA-4: Effects of Water Operations on Spawning and Egg Incubation Habitat for Delta Smelt

Flows affect the amount of spawning habitat available to delta smelt (Hobbs et al. 2005; 2007), although spawning habitat is not known to be limited. The spawning habitat preferences of delta smelt are currently unknown, but areas with sandy substrates are known to be important for spawning of other smelt species (Sommer and Mejia 2013). Flow reductions below the north Delta intake facilities on the Sacramento River would not reduce spawning habitat in the sandy beaches of sloughs and channel edges used by delta smelt, as suggested by modeling of bench inundation (detailed in *BDCP Effects Analysis- Appendix 5.C Flow, Section 5C.4.4.3 Wetland Bench Inundation, hereby incorporated by reference).* Furthermore, there is little evidence that the delta smelt population is limited by availability of suitable spawning habitat.

Water temperature is a cue for spawning timing for delta smelt. In-Delta water temperatures are primarily affected by atmospheric conditions such as solar radiation, air temperature, and wind. Water temperatures are typically in thermal equilibrium with atmospheric conditions and would not be strongly influenced by the flow changes under Alternative 1A. The modeling results indicate no biologically significant changes in water temperature within the Delta under Alternative 1A and no substantial changes in the median spawning day of the year, or number of stressful or lethal condition days for juveniles (detailed in *BDCP Effects Analysis -Appendix 5.C, Flow, Attachment 5.C.C, Water Temperature, hereby incorporated by reference*).

NEPA Effects: The overall effect on delta smelt spawning habitat would not be adverse, because there would be little change in suitable abiotic spawning conditions under Alternative 1A.

CEQA Conclusion: Flow reductions below the north Delta intake facilities on the Sacramento River would not reduce spawning habitat in the sandy beaches of sloughs and channel edges used by delta smelt, and very little change in spawning timing is expected based on temperature. Therefore, this impact is considered less than significant, because there would be no substantial reduction in spawning habitat or spawning timing. Consequently, no mitigation would be required.

Impact AQUA-5: Effects of Water Operations on Rearing Habitat for Delta Smelt

Larval and juvenile delta smelt generally rear throughout the west Delta, Suisun Bay, Suisun Marsh, and in Cache Slough. Other areas in the Delta may also be used for rearing. The extent of abiotic habitat for delta smelt in the fall (September–December, the older juvenile rearing and maturation period) as a function of changes in flows was assessed using a technique based on the method of Feyrer and coauthors (2011) (as detailed in *BDCP Effects Analysis –Appendix 5.C, Flow, Section 5C.5.4.5.1 Delta Smelt Fall Abiotic Habitat Index hereby incorporated by reference*. *BDCP Effects Analysis –Appendix 5.E Habitat Restoration* presents additional analyses of effects on delta smelt related to juvenile habitat).

Feyrer and coauthors (2011) demonstrated that X2 in the fall correlates nonlinearly with an index of delta smelt abiotic habitat in the West Delta, Suisun Bay, and Suisun Marsh subregions, as well as smaller portions of the Cache Slough, South Delta, and North Delta subregions (see Figure 3 of Feyrer et al. 2011). Investigations in recent years have indicated that delta smelt occur year-round in the Cache Slough subregion, including Cache Slough, Liberty Island, and the Sacramento Deep Water Ship Channel (Baxter et al. 2010; Sommer et al. 2011). Whether the same individuals are residing in these areas for their full life cycles or different individuals are moving between upstream and downstream habitats is not known (Sommer et al. 2011). The delta smelt fall abiotic habitat index is the surface area of water in the west Delta, Suisun Bay, and Suisun Marsh (as well as smaller portions of the Cache Slough, South Delta, and North Delta subregions) weighted by the probability of presence of delta smelt based on water clarity (Secchi depth) and salinity (specific conductance) in the water. Feyrer and coauthors' (2011) method found these two variables to be significant predictors of delta smelt presence in the fall. They also concluded that water temperature was not a predictor of delta smelt presence in the fall, although it has been shown to be important during summer months (Nobriga et al. 2008).

Investigations in recent years have indicated that delta smelt occur year-round in the Cache Slough subregion, including Cache Slough, Liberty Island, and the Sacramento Deep Water Ship Channel (Baxter et al. 2010; Sommer et al. 2011). The degree of individual movement between upstream and downstream habitats has not been confirmed (Sommer et al. 2011), although emerging evidence suggests that a substantial fraction of the fish occurring in the upstream areas are residing there throughout the year (Hobbs in prep.).

It is worth noting that the National Research Council (2010) discussed some potential limitations of USFWS' (2008) analysis of fall habitat suitability and the potential implications of using linked correlations for quantitative conclusions. Nevertheless, this method was applied (in a modified form) in the BDCP and therefore is included in this analysis of relative comparisons between action alternatives and baseline conditions.

NEPA Effects: If it were assumed that BDCP habitat restoration did not produce the intended benefits to delta smelt, the abiotic habitat index under Alternative 1A flows averaged across all years would decrease 22% compared to NAA, with the greatest reductions in above normal (27% decrease) and wet (41% decrease) water years (Figure 11-1A-3, Table 11-1A-3). However, assuming the intended habitat benefits are realized, the abiotic habitat index under Alternative 1A averaged across all years would be similar to baseline conditions, though it would decrease 26% in wet years and increase 16% in below normal years compared to the NAA (Table 11-1A-3). The reduction in abiotic habitat index in Alternative 1A results from Operational Scenario A, which does not include Fall X2 requirements, while the NAA does.

Table 11-1A-3. Delta Smelt Fall Abiotic Index (hectares), Averaged by Water Year Type, with and without Restoration (100% Occupancy Assumed) under Alternative 1A

	Without Restoration		With Restoration	
Water Year	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
All	-168 (-4%)	-1,053 (-22%)	840 (21%)	-46 (-1%)
Wet	-666 (-14%)	-2,862 (-41%)	390 (8%)	-1,806 (-26%)
Above Normal	170 (4%)	-1,498 (-27%)	1,416 (37%)	-251 (-5%)
Below Normal	-23 (-1%)	125 (3%)	496 (12%)	644 (16%)
Dry	108 (3%)	199 (6%)	133 (4%)	224 (6%)
Critical	21 (1%)	20 (1%)	1,832 (61%)	1,832 (61%)

Note: Negative values indicate lower habitat indices under Alternative 1A. Water year 1922 was omitted because water year classification for prior year was not available.

Tidal habitat restoration under *CM4 Tidal Natural Communities Restoration* is intended to provide suitable rearing habitat adjacent to areas currently occupied by delta smelt, including in Suisun Marsh, Suisun Bay, the west Delta, and Cache Slough. Using a habitat suitability index for the entire Delta, analysis of larval and juvenile delta smelt habitat suitability in the ROAs indicates that Alternative 1A could result in considerably more habitat for delta smelt than currently exists (see *BDCP Effects Analysis – Appendix 5.E Habitat Restoration, Section E.4.2, hereby incorporated by reference*). In addition, *CM2 Yolo Bypass Fisheries Enhancement* may export food resources that benefit spawning adults and larvae (see discussion under Impact AQUA-9 *Effects of restored habitat conditions on delta smelt*). Habitat suitability may decrease slightly for larval delta smelt over time, and more so for juvenile delta smelt because of temperature and other effects associated with climate change during the summer and fall and uncertainty related to future trends in turbidity (Brown et al. 2013), but the predicted overall increases in habitat quantity are greater than decreases in quality. Use of restored areas by delta smelt will depend on the habitat characteristics within the habitats (e.g., the extent of tidal excursion and velocity, temperature, and turbidity) (Sommer and Mejia 2013). With sea level rise and increasing salinity, there may be greater occupation of upstream areas by delta smelt, in which case habitat restoration in the Cache Slough and West Delta ROAs would gain importance.

The restored areas may also provide additional food production and export to rearing areas which would be beneficial to delta smelt, particularly from the Suisun Marsh, West Delta, and Cache Slough ROAs which are closer to the species main range. A decrease in food resources (principally calanoid copepods) has been linked to declines in delta smelt abundance in several studies. Kimmerer (2008) demonstrated a strong positive correlation between survival of juvenile delta smelt from summer to fall and density of calanoid copepods during that period. Miller et al. (2012) found that minimum density of the calanoid copepods *Eurytemora affinis* and *Pseudodiaptomus forbesi* during the spring delta smelt larval period (April–June) and average density of *E. affinis* and *P. forbesi* during the fall

(September–December) were significantly related to interannual trends in fall delta smelt relative abundance. Maunder and Deriso (2010) found that April–June minimum density of *E. affinis* and *P. forbesi* before the larval life stage and July–August average density of *E. affinis* and *P. forbesi* after the juvenile life stage (July–August) were important factors associated to changes in delta smelt abundance in their life cycle model. Mac Nally et al. (2010) found some statistical evidence that summer calanoid copepod density was associated with annual trends in abundance of delta smelt in the fall. The decrease in food resources may have been because of a factor such as a change in phytoplankton and zooplankton assemblages related to biological invasions (e.g., the invasive clam *Corbula amurensis*) (Winder and Jassby 2011) and anthropogenic factors such as nutrient balance (Dugdale et al. 2007; Glibert et al. 2011).

CEQA Conclusion: Under Alternative 1A, rearing habitat as indicated by the abiotic habitat index would be similar to Existing Conditions across all years, as neither Alternative 1A nor Existing Conditions include Fall X2 criteria. Habitat restoration under *CM4 Tidal Natural Communities Restoration* is intended to provide an overall increase in suitable rearing habitat adjacent to areas currently occupied by delta smelt (see discussion under Impact AQUA-9 *Effects of restored habitat conditions on delta smelt*), while restored areas from *CM5 Seasonally Inundated Floodplain Restoration* and *CM2 Yolo Bypass Fisheries Enhancement* may provide additional food production and export to rearing areas that would be beneficial to delta smelt—particularly from the Suisun Marsh, West Delta, and Cache Slough ROAs which are closer to the species main range. Assuming the restored areas are fully occupied by delta smelt, the abiotic habitat index would increase 21% compared to Existing Conditions. Overall, there would be a minor beneficial impact on the species compared to Existing Conditions without Fall X2, primarily from implementation of the restoration. Therefore, the impacts of project operations are considered less than significant because they would not substantially reduce rearing habitat. Further, restoration components of Alternative 1A are intended to increase rearing habitat for delta smelt. Consequently, no mitigation would be required.

Impact AQUA-6: Effects of Water Operations on Migration Conditions for Delta Smelt

From December to March, many mature delta smelt migrate upstream from brackish rearing areas in and around Suisun Bay and the confluence of the Sacramento and San Joaquin Rivers (U.S. Fish and Wildlife Service 2008a; Sommer et al. 2011). The initiation of migration is associated with pulses of freshwater inflow, which are turbid, cool, and less saline (Grimaldo et al. 2009). Changes in flow under Alternative 1A could change turbidity, but is not expected to result in changes in water temperatures or pulses of local rainwater into the Delta. As described above in Impact AQUA-4, in-Delta water temperatures would not change in response to Alternative 1A flows. The modeling results indicate no biologically meaningful changes in water temperature within the Delta under Alternative 1A and no substantial changes in the number of stressful or lethal condition days for juveniles.

Turbid water is an important habitat characteristic for delta smelt (Nobriga et al. 2008; Feyrer et al. 2011), and has been correlated to long-term changes in delta smelt abundance or survival either by itself or in combination with other factors (Thomson et al. 2010; Miller et al. 2012). Therefore, it is assumed that turbidity is an attribute of critical importance to delta smelt larvae, juveniles, and adults. Operation of the north Delta intakes (*CM1 Water Facilities and Operation*) is estimated to result in around 8 to 9% less sediment entering the Plan Area from the Sacramento River, the main source of sediment for the Delta and downstream subregions. In addition, there could be sediment accretion capture in the ROAs (*CM4 Tidal Natural Communities Restoration*). Notching the Fremont Weir (*CM2 Yolo Bypass Fisheries Enhancements)* will also direct more Sacramento River water and sediment into the Bypass. These actions could limit sediment supply to areas currently important to delta smelt, such as Suisun Bay, which would result in less seasonal deposition of sediment that could be resuspended by wind-wave action to make/keep the overlying water column turbid. Therefore, there is a potential for a slight increase in water clarity, and a corresponding reduction in habitat quality for delta smelt. However, Alternative 1A is not expected to affect suspended sediment concentration during the first flush of precipitation that cues delta smelt migration. As such, turbidity cues associated with adult delta smelt migration should not change. With regard to suspended sediment concentrations at other times of the year, any effect will be minimized through the reintroduction of sediment collected at the north Delta intakes into tidal natural communities restoration projects (CM4), consistent with the Environmental Commitment addressing Disposal and Reuse of Spoils, Reusable Tunnel Material (RTM), and Dredged Material.

NEPA Effects: Alternative 1A may decrease sediment supply to the estuary by 8 to 9 percent, with the potential for decreased habitat suitability for delta smelt in some locations.

CEQA Conclusion: Reduced flows in the Sacramento River would not substantially alter the flow or turbidity cues or water temperature that are associated with the first flush of winter precipitation and that may be associated with delta smelt migration to their spawning grounds. Therefore, water operations would not substantially interfere with the movement of delta smelt. Consequently, no mitigation would be required.

Restoration Measures (CM2, CM4–CM7, and CM10)

Impact AQUA-7: Effects of Construction of Restoration Measures on Delta Smelt

Alternative 1A includes implementation of a suite of restoration activities intended to provide suitable habitat for delta smelt and by doing so, offset and mitigate for the short- and long-term effects of this alternative on habitat conditions for delta smelt and other species of concern. The construction of these restoration measures is likely to result in a range of effects similar, but not identical to, the range of effects described for construction and maintenance of Alternative 1A facilities.

The primary differences between this impact category and the other construction-related impact categories is that the timing and location of these effects will be different, as determined by where the various restoration activities are located, the nature of the habitats involved, and the short-term environmental response resulting from the conversion of the affected areas to productive habitats.

Temporary Increases in Turbidity

Restoration construction activities such as riprap removal, shoreline excavation, floodplain re-contouring, and planting riparian vegetation have the potential to result in temporary increases in turbidity in adjacent waterways. As discussed previously for Impact AQUA-1 and Impact AQUA-2, delta smelt are unlikely to be affected by temporary increases in turbidity associated with restoration activities, because delta smelt prefer turbid conditions and applicable environmental commitments will be used to keep suspended sediment levels within the current normal range. Implementation of environmental commitments described under Impact AQUA-1 and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged*

Material; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*), would minimize changes in turbidity. Pertinent details of these plans are provided under Impact AQUA-1.

Increased Exposure to Mercury and Methylmercury

Alternative 1A includes CM4, *Tidal Habitat Restoration*, which will restore aquatic habitats in the Delta by breaching levees and converting agricultural and other upland areas to tidal, open water, and floodplain habitats. Restoration construction activities could disturb sediments that could contain contaminants, including mercury. However, the BMPs put in place to reduce turbidity will also minimize suspension of potentially contaminated sediments. The implementation of CM12, *Methylmercury Management*, would provide for site-specific assessments of restoration areas, integration of design measures to minimize methylmercury production, and site monitoring and reporting. As a result, effects of methylmercury mobilization on covered fish at the tidal wetland restoration sites are expected to be minimized and not adverse.

Accidental Spills

Restoration activities involve the use of heavy equipment in proximity to aquatic environments, presenting the potential for spills of fuel, fluids, and lubricants that could potentially harm aquatic species and their habitats. As discussed under Impact AQUA-1 and Impact AQUA-2, adverse effects from accidental spills will be avoided through implementation of appropriate impact avoidance and minimization measures (*Environmental Training; Stormwater Pollution Prevention Plan; Erosion and Sediment Control Plan; Hazardous Materials Management Plan; Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material; and Barge Operations Plan;* see Appendix 3B, *Environmental Commitments* and Impact AQUA-1). Specifically, environmental commitment *Spill Prevention, Containment, and Countermeasure Plan* will be implemented to minimize the risk of spills occurring and to provide for rapid and effective response to contain any accidental spills. Therefore adverse effects from accidental spills would not be likely to occur.

Disturbance of Contaminated Sediments

Habitat restoration activities are expected to disturb contaminated sediments in and around aquatic habitats. The types of contaminants known to exist in sediments in the Delta, and the specific biogeochemistry, potential for increased bioavailability, and potential effects on covered species from exposures, is discussed in detail in *BDCP Effects Analysis – Appendix 5.D*, *Contaminants, hereby incorporated by reference*. In general, the types of contaminants that would be bound in sediments, have a natural affinity for sediments, so only limited amounts will become soluble when sediments are disturbed. These contaminants include metals, polychlorinated biphenyls (PCBs), and many types of pesticides. Thus, sediment disturbance may result in an increase in suspended particulates that could contain contaminants, with limited and temporary increases in contaminants dissolved in the water column. A possible exception would be if sediments were contaminated with a light oil mixture that could contain some lighter, more soluble components.

Implementation of BMPs to reduce turbidity, as discussed above, will also minimize the potential for suspension of contaminated sediments in the water column.

Any delta smelt that occupy areas near restoration sites that are under construction may be exposed to elevated contaminant concentrations, including bioavailable mercury. This may have negative impacts to some individual fishes, but individual restoration construction activities will be of short duration and it is not expected that they will cause population-level impacts to delta smelt viability or change the average contaminant body burdens accumulated by delta smelt during their life cycle. Thus, the effect of restoration construction would not be adverse under Alternative 1A compared to the NAA. Further, implementation of environmental commitments described in Appendix 3B, *Environmental Commitments,* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*) would minimize the potential for resuspended contaminants to affect delta smelt. Pertinent details of these plans are provided under Impact AQUA-1.

In-Water Work Activities

Restoration construction activities could temporarily produce noise levels and disturbances that could affect nearby fishes. However, these restoration construction activities do not include pile driving, which is the primary activity likely to produce underwater sound levels that could reach threshold levels capable of injuring or killing fish. Potential effects of in-water activity would be minimized by implementation of the environmental commitments described under Impact AQUA-1 and in Appendix 3B, *Environmental Commitments*, including *Erosion and Sediment Control Plan*; *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*.

Predation

Restoration construction activities would be unlikely to have any measurable effect on delta smelt predation rates. Much of the restoration construction would occur on dry land (e.g., recontouring, removing levees) which would have no in-water effects including any influence on the vulnerability of delta smelt to predators. In-water activities may include the use of barges and other watercraft that could theoretically provide cover, shelter, and perching areas for delta smelt predators. However, the limited duration of these activities and the associated noise and disturbance would be expected to dissuade predators from concentrating at sufficient density to measurably affect predation rates on delta smelt. Because silverside predation on post-hatch larval delta smelt in newly created restored tidal habitat areas remains quantified, its evaluation should become a portion of associated monitoring activities at these sites.

Summary

In-water and shoreline restoration construction activities may result in short-term effects on delta smelt through direct disturbance, short-term water quality impacts, and increased exposure to contaminants associated with the incidental disturbance of contaminated sediments. Overall, the effect of restoration construction activities on the bioavailability of contaminants is expected to be minimal, as they would likely be localized, sporadic, and of low magnitude, and typically offset by the collective benefits of broad-scale habitat restoration. Implementation of the environmental commitments described in Appendix 3B, *Environmental Commitments*, would minimize or eliminate effects on delta smelt. The relevant environmental commitments are: *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*. Pertinent details of these plans are provided under Impact AQUA-1.

NEPA Effects: The effects of short-term restoration construction activities would not be adverse to delta smelt.

CEQA Conclusion: Habitat restoration activities could result in short-term effects on delta smelt, primarily as a result of increased potential for contaminated sediments to enter the water column. However, these effects are likely to be localized, sporadic, and of low magnitude. Adverse effects during restoration would be avoided by limiting the frequency, duration, and spatial extent of in-water work and implementing the commitments identified above and described in detail under Impact AQUA-1 and in Appendix 3B, *Environmental Commitments*. In contrast habitat restoration would be expected to result in a significant long-term net benefit for delta smelt by substantially increasing the quality and quantity of key habitats required by this species. The potential impact of habitat restoration activities is considered less than significant because it would not substantially reduce delta smelt habitat, restrict its range or interfere with its movement. Additionally, there would be substantial long-term net benefits of habitat restoration. Consequently, no additional mitigation would be required.

Impact AQUA-8: Effects of Contaminants Associated with Restoration Measures on Delta Smelt

Effects of implementing the habitat restoration conservation measures (CM2, CM4–CM7, and CM10) on delta smelt will depend on the life stage present in the area of elevated toxins and the duration of exposure. Formation and release of toxic constituents from sediments (e.g., in restored areas) is tied to inundation, and so highest concentrations will occur during seasonal high water and to a lesser extent for short time periods on a tidal cycle in marshes. A complete analysis can be found in the *BDCP Effects Analysis – Appendix 5D*, *Contaminants, hereby incorporated by reference*.

Mercury

The analysis presented in *BDCP Effects Analysis – Appendix 5D*, *Contaminants, Section 5D.4.1 Mercury (hereby incorporated by reference),* indicate that Alternative 1A restoration efforts have the potential to increase the exposure of fish, including delta smelt, to methylmercury produced as a result of altered geochemistry associated with inundation of restored tidal wetlands and floodplains, which are used for rearing by delta smelt. It should be noted that the primary concern for methylmercury is its bioaccumulation into piscivorous wildlife (Melwani et al. 2009; Ackerman et al. 2012) and humans (Davis et al. 2012). Forage fishes similar to delta smelt show high spatial variability in the bioaccumulation of methylmercury (Gehrke et al. 2011; Greenfield et al. 2013) as do juvenile Chinook salmon (Henery et al. 2010). It has not been demonstrated that these accumulations impair these small fishes so similar exposures in restored habitats may not affect these species' viability, though they may be of concern for passing mercury up the food web to birds and humans. The areas expected to have the highest potential for methylmercury production are the Yolo Bypass and, to a lesser extent, the Cosumnes/Mokelumne Rivers and Suisun Marsh. As described in *BDCP Effects Analysis – Appendix 5D*, *Contaminants, Section 5D.4.1 Mercury (hereby incorporated by reference)*, the amounts of methylmercury mobilized and resultant effects on covered fish species are not currently quantifiable. Slotton and others (2000: 43) noted:

> Results to date indicate that wetlands restoration projects may result in localized mercury bioaccumulation at levels similar to, but not necessarily greater than, general levels within their surrounding Delta subregion. Nevertheless, high methylation potential, flooded wetland habitat may be the primary source of methylmercury production in the overall system…Careful monitoring will be essential to assess the actual effects of new wetlands restoration projects.

Although methylmercury will be produced and mobilized, *CM12 Methylmercury Management* was developed to minimize production and bioavailability of methylmercury associated with BDCP restoration. CM12 requires a site specific plan for each restoration project including site sampling for mercury, post-restoration monitoring, and adaptive management, where the potential for mercury to be present is indicated. CM12 also requires integration of design elements into restoration projects to attempt to minimize methylmercury production.

CM12 will be developed and implemented in coordination with the California Department of Water Resources (DWR) Mercury Monitoring and Evaluation Section which is working on DWR's compliance with the requirements of the *Sacramento–San Joaquin Delta Methylmercury Total Maximum Daily Load* (Central Valley Regional Water Quality Control Board 2011a) and *Amendments to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins for the Control of Methylmercury and Total Mercury in the Sacramento–San Joaquin Delta Estuary* (Mercury Basin Plan Amendments) (Central Valley Regional Water Quality Control Board 2011b). Under Phase I of the TMDL, the DWR Mercury Monitoring and Evaluation Section is planning control studies to research and identify effective measures to mitigate methylmercury generation and mobilization in connection with restored wetlands. The results of the Phase I control studies will be integrated into BDCP restoration planning to attempt to limit methylmercury production to keep it within acceptable bounds.

CM12 requires that as the Phase I and Phase II TMDL programs generate information on methylmercury distribution, effects, and the performance of mitigation measures, this information be reviewed for every restoration project, and design elements and BMPs that have proven successful be incorporated into the restoration design.

In summary, Alternative 1A restoration actions (CM2, CM4–CM7, and CM10) are likely to result in some increased production, mobilization, and bioavailability of methylmercury in the aquatic system. Modeling of Alternative 1A water operations (CM1) effects showed little changes in methylmercury concentrations in the water. To address the issue of methylmercury production at restoration areas, management measures will be implemented through CM12.

The following discussion is based on the assumption that some level of methylmercury would be mobilized at BDCP ROAs.

Eggs

Delta smelt spawn in or near areas that would be restored under Alternative 1A and therefore have the potential for increased exposure to methylmercury. Although no specific information is available, it is potentially possible that maternal transfer could occur, (i.e., prespawned eggs could be exposed to methylmercury from adult consumption of contaminated prey). Splittail, delta smelt, and longfin smelt all spawn in or near areas that would be restored under the BDCP and therefore have the potential for increased exposure to methylmercury. For delta smelt that spawn directly downstream of the Yolo Bypass or other ROAs in the west or north Delta, exposure of prespawned eggs to increased levels of methylmercury could affect the viability of fertilized eggs. It is not known what level of mercury would be assimilated and transferred to the larvae. Mercury exposure in eggs can lead to egg failure and developmental effects, but the levels of mercury that would result in these effects are not fully understood.

Larvae and Juveniles

Effects of increased methylmercury are expected to be minimal for fish rearing in the Delta. Larvae and juvenile delta smelt feed very low on the food chain and would bioaccumulate methylmercury at low rates. In addition, juvenile delta smelt occur primarily in the west Delta and Suisun Bay, where elevated levels of methylmercury from restoration are not likely. However, juvenile smelt remaining in the north Delta area would experience exposure from food in the Yolo Bypass and Cache Slough regions although not to levels that would have any direct effect on them.

Adults

Although adult life stages of delta smelt feed and spawn in areas with potential for elevated methylmercury levels, they feed primarily on lower trophic level food sources and therefore do not accumulate methylmercury at rates as high as if they preyed on fish. In addition, they are not expected to spend excessive amounts of time in these areas, so the uptake through their gills and food is expected to be minimal. Nevertheless, delta smelt have been shown to accumulate appreciable quantities of mercury: Bennett et al. (2001) found average levels of 0.18 µg/g, which is just under the 0.20 µg/g general threshold for effects on fish (Henery et al. 2010:561). There is no evidence for acute toxicity of mercury being related to recent declines of pelagic fish such as delta smelt, although mercury, selenium, and copper may have chronically affected these species (Brooks et al. 2012).

Selenium

Elevated selenium concentrations in the Delta ecosystem is widely recognized as posing a threat to aquatic species. Selenium in the Delta ecosystem and potential effects of BDCP conservation measures on covered fish species are fully described in the *BDCP Effects Analysis – Appendix 5.D, Contaminants, Section 5D.4.2.1 Selenium-Location, Environmental Fate, and Transport, and Appendix 5D, Attachment 5D.B Bioaccumulation Model Development for Selenium Concentrations in Whole Body Fish, Bird Eggs, and Fish Filets (hereby incorporated by reference)*. These effects include impaired reproduction, embryonic deformities and bioaccumulation.

Overall, loading of selenium to the Delta aquatic system has decreased significantly. The main controllable sources of selenium in the Bay-Delta estuary are agricultural drainage (generated by irrigation of seleniferous soils in the western side of the San Joaquin basin) and discharges from North Bay refineries (in processing selenium-rich crude oil). Both the San Joaquin River and North Bay selenium loads have declined in the last 15 years in response to, first, a control program in the San Joaquin Grassland area, and, second, National Pollutant Discharge Elimination System (NPDES) permit requirements established for refineries in the late 1990s.

Because the bioavailability of selenium increases in an aquatic system, inundation of ROAs could mobilize selenium sequestered in sediments and increase exposure of covered fish species. The rate at which selenium will become mobilized as part of restoration will depend on the amount of selenium stored in the sediments, the length of inundation (residence time), and whether sufficient time allows the selenium to cycle through the aquatic system and into the food chain.

The bioaccumulation and effects of selenium on fish have much to do with their feeding behavior. The overbite clam, *C. amurensis*, accumulates selenium and is key to mobilizing it into the food chain via benthic feeders. Delta smelt would be expected to have low exposure to selenium as they are feeding on pelagic organisms that are able to excrete most of the selenium they consume (Stewart et al. 2004).

In Suisun Bay, particulate concentrations of selenium (the most bioavailable) are considered low, typically between 0.5 and 1.5 micrograms per gram (µg/g), but the bivalve *Potamocorbula* *amurensis* (overbite clam) contains elevated levels of selenium that range from 5 to 20 µg/g (Stewart et al. 2004). Given the fact that *Potamocorbula* may occur in abundances of up to 50,000 per m^2, this area can be considered a sink for selenium because 95% of the biota in some areas are made up of this clam.

The longer the residence time of surface waters, the higher the particulate concentration resulting in higher selenium concentrations in wetlands and shallows (Presser and Luoma 2006, 2010). Aquatic systems in shallow, slow-moving water with low flushing rates are thought to accumulate selenium most efficiently (Presser and Luoma 2006; Lemly 1999). However, the ratio of selenium in particulates (which is more bioavailable) to selenium in the water column is a complex relationship that can vary across different hydrologic regimes and seasons (Presser and Luoma 2010).

An increase of residence time in areas with dense clam populations (such as Suisun Bay) and benthic-feeding covered fish species, could result in increased mobilization and bioaccumulation of selenium in the food chain of benthic-feeding fish. Residence time is directly related to outflow in Suisun Bay. However, CALSIM modeling results indicate that outflow and residence time will not change significantly under Alternative 1A, and effects on selenium biogeochemical cycling are not anticipated. Comparison of the monthly mean residence time (averaged over years 1992 through 2003) indicates that residence time in Suisun Bay may change from a decrease of 13 days to an increase of 5 days.

In summary, selenium currently sequestered in soils could be mobilized and become more bioavailable as a result of inundation of restoration areas. Because the magnitude of this mobilization and bioaccumulation of selenium would depend on the type of food sources (filter feeders vs. plankton), significant changes in residence time, and pre-existing concentrations of selenium in the specific area, effects on aquatic species would need to be determined on a site-specific basis. Given the decrease in loading of selenium to the Delta (from regulation of both Grasslands in the San Joaquin River basin and oil refineries near Suisun Bay) and that the selenium would be mobilized into the food chain under a narrow set of conditions, the overall effects within the Plan Area are likely low. The potential is highest for increased mobilization of selenium in and near the San Joaquin River and the South Delta ROAs, where selenium concentrations in soils are expected to be highest, and potentially in Suisun Bay where filter feeders are the food source for benthic-feeding covered fish species.

Impacts on Delta smelt from selenium are not expected from Alternative 1A restoration projects (CM2, CM4–CM7, and CM10), given that the Delta smelt planktonic food source does not efficiently accumulate selenium, limiting the exposure route. Further, overall loading of selenium to the Delta system has and will continue to significantly decrease. Added to the benefits from BDCP habitat restoration, little effects are expected from selenium on Delta smelt.

Copper

Copper is expected to be present in soils where copper-containing pesticides have been applied. Although copper is relatively immobile in terrestrial soils, its mobility increases in an aquatic system and it could be mobilized by inundation of restored habitat areas within the ROAs.

In general, the copper data sets discussed in Section 5.D.4.3 of the *BDCP Effects Analysis – Appendix 5D*, *Contaminants, Section 5D.4.3 Copper (hereby incorporated by reference),* indicate low levels of copper (less than 2 µg/L) throughout the Delta waterways, and elevated concentrations in agricultural drainage sloughs and near mines. Although data were not identified, it is assumed the agricultural soils will contain some level of copper given its affinity for soils in a terrestrial environment. Formerly agricultural ROAs, which are likely to have elevated levels of copper in soils, will result in some level of increased copper in the aquatic system over an undetermined time period. Currently, information on the concentrations of copper in soils of specific ROAs is insufficient to estimate the increase in concentrations.

Additionally, restoration of agricultural land to marshes and floodplains will result in decreased application of copper-containing pesticides and decreased copper loading to the Delta. This net benefit at least partially will counter the copper introduced to the aquatic system through mobilization during inundation.

It is difficult to establish precise concentrations at which copper is acutely toxic to fish, as a large number of water chemistry parameters (including temperature, pH, DOC, and ions) can affect the bioavailability of copper to the fish population (U.S. Environmental Protection Agency 2007). As discussed in Section D.5.3 of *BDCP Effects Analysis – Appendix 5.D*, *Contaminants, Section 5.D.4.3 Copper*, copper is present in the Sacramento River at low concentrations (2 μg/L). Connon with others (2011) demonstrated that the median lethal concentration of dissolved copper at which 10% of delta smelt juveniles died after 7 days of exposure under experimental conditions (LC10) was 9.0 μg/L; 50% of juveniles died (LC50) when exposed to a median concentration of 17.8 μg/L. Although 96-hour larval delta smelt mortality indicated higher concentrations than juveniles (median LC10 = 9.3 μg/L; median LC50 = 80.4 μg/L), these results were complicated by differences in exposure duration and experimental conditions (particularly for factors such as temperature and conductivity that may affect copper toxicity) (Connon et al. 2011).

There is some evidence that larval delta smelt swimming velocity decreases as dissolved copper concentration increases, although experimental testing did not find statistical differences between test subjects and controls (Connon et al. 2011). Various delta smelt genes have been shown to have altered expression in copper-exposed larvae (Connon et al. 2011).

There is insufficient data to estimate the amount of copper present in soils of Alternative 1A ROAs, or the amount of copper that would be mobilized into the aquatic system and become bioavailable. Given that the overall detected levels of copper are low and that applications of copper-containing pesticides at formerly agricultural ROAs will cease, which will reduce overall copper loading to the system, effects of copper on Delta Smelt due to Alternative 1A restoration activities are expected to be minimal.

Ammonia

Based on the analysis presented in *BDCP Effects Analysis – Appendix 5D*, *Contaminants, Section 5.D.4.4 Ammonia/um (hereby incorporated by reference)*, actions from Alternative 1A are not expected to result in substantial increases in ammonia concentrations in the aquatic system that could affect covered fish species. Analysis of the ability of the Sacramento River to dilute ammonia discharges from the Sacramento WWTP indicates that resultant concentrations would be within ecologically acceptable limits under the BDCP alternatives. Further, no appreciable addition or mobilization of ammonia to the aquatic system would result from restoration activities.

Pyrethroids, Organophosphate Pesticides, and Organochlorine Pesticides

Based on the analysis in *BDCP Effects Analysis – Appendix 5D, Contaminants, Sections 5D.4.5 Pyrethroids, 5D.4.6 Organochlorine Pesticides, 5D.4.7 Organophosphate Pesticides (hereby* *incorporated by reference)*, changes in concentrations of pyrethroids, organophosphate pesticides, and organochlorine pesticides resulting from the BDCP alternatives are expected in the vicinity of agricultural land restored to marshes and floodplains. These chemicals either have a strong affinity for sediment and will settle out of the water column, or will readily degrade in an aquatic system. Thus, it is expected that increases in concentrations due to BDCP alternatives would be of relatively short duration and localized near ROAs. Specific areas of these elevated toxins have not been identified, but they can be expected in any of the ROAs. Preliminary proposal restoration will take these agricultural areas out of production, therefore eliminating the source and reducing these chemicals in the Delta system, providing a long-term ecological benefit. In addition, CM19 would provide for treatment of stormwater discharges, a major contributor of pyrethroids to the Delta. Thus BDCP may result in reduced loading of pyrethroids to the Delta.

Pyrethroids have been shown to be lethal as low as 1 µg/L, although there are many different chemicals in this group with varying toxicities for fish. Likewise, little is known on the effects of organophosphates on fish, but elevated concentrations of organophosphates are more likely to affect the lower trophic levels that the covered fish species prey on than the fish directly (Turner 2002). As these pesticides are neurotoxins, behavioral effects are of primary concern; however, Scholz et al. (2000) points out that the effects are not well understood. Scholz et al. (2000) found that diazinon concentrations as low as 1 µg/L resulted in significant impairment of predator-alarm responses, and slightly higher concentrations of 10 µg/L caused the impairment of homing behavior in Chinook salmon. Organochlorine pesticides are neurotoxic, are likely carcinogenic, and have been implicated as endocrine disruptors because of their estrogenic nature and effects on reproductive development (Leatherbarrow et al. 2006). These pesticides are highly persistent and lipophilic, and as such, they strongly bioaccumulate (Werner et al. 2008). Because of their persistence in the environment and biomagnifications through the foodweb, the main concern with organochlorines is bioaccumulation in the higher trophic levels and implications for human consumption. However, organochlorine pesticides and degradation products can directly affect fish through toxicity to lower-level invertebrates on the food chain, and toxicity to small and early life stage fish, but there is little information specific to effects on individual species. Sublethal effects may include reproductive failure and behavioral changes. Ostrach's (2008) report indicates that largemouth bass have been experiencing reproductive failure due to organochlorine compounds in San Francisco Bay, which is likely due to concentrations accumulated through biomagnifications. Because they tend to adhere to soils and particulates, organochlorine compounds may take longer to flush out than some of the more environmentally mobile constituents discussed above (e.g., copper).

In the Delta, fish in higher trophic levels are particularly vulnerable to these pesticides, as the chemicals will biomagnify and bioaccumulate in their tissues. These fish include white and green sturgeon, salmonids, and lampreys. As smaller fish at lower trophic levels, smelt can be expected to have less biomagnification of these pesticides.

Summary

Methylmercury would be generated by both seasonal and tidal inundation of restoration areas, particularly in the vicinity of the Yolo Bypass, Cosumnes/Mokelumne Rivers, and Suisun Marsh. Implementation of CM12 Methylmercury Management could help to minimize increased mobilization of methylmercury at restoration areas, and its subsequent accumulation in the estuarine food web. Methylmercury concentrations in water would continue to exceed criteria with or without the BDCP habitat restoration conservation measures.

It is anticipated that any potential effects of methylmercury on delta smelt will be addressed through implementation of CM12. CM12 is intended to minimize methylmercury exposure associated with restoration measures for delta smelt at all life stages. Further analysis and tools may be developed to further reduce methylmercury exposure for delta smelt as the habitat restoration conservation measures are refined and analyzed in site-specific documents. The site-specific analysis is the appropriate place to assess the potential for risk of methylmercury exposure for delta smelt once site specific sampling and other information can be developed.

Delta smelt are expected to have lower exposure to selenium than some other covered fish species (e.g., splittail and sturgeon), because they feed primarily on planktonic, rather than benthic organisms. However, the higher contribution of San Joaquin River flow to Delta outflow in Alternative 1A relative to the NAA is expected to increase the loading and by extension possibly the bioaccumulation of selenium in the low-salinity zone food web. Impacts on Delta smelt from selenium are not expected from Alternative 1A restoration projects (CM2, CM4–CM7, and CM10), given that the Delta smelt planktonic food source does not efficiently accumulate selenium, limiting this exposure route. Therefore, the effects would not be adverse. Localized, short-term increases in copper concentrations are possible, but not presently quantifiable near ROA areas, particularly in the eastern Delta. However, Alternative 1A is not expected to result in increased toxicological effects of copper on delta smelt. In addition, the removal of agricultural areas through restoration activities would eliminate some sources of copper. It is concluded for delta smelt that BDCP restoration activities will not generate adverse effects on delta smelt of copper relative to the NAA. Similarly, no appreciable addition or mobilization of ammonia to the aquatic system would result from restoration activities.

The removal of agricultural areas through restoration activities would eliminate some sources of organophosphate and organochlorine pesticide contamination, potentially providing a long-term net benefit to delta smelt and their supporting food web. In addition, implementing *CM19 Urban Stormwater Treatment* would provide for treatment of stormwater discharges, a major contributor of pyrethroid pesticides to the Delta. Thus the BDCP may contribute to reduced loading of stormwater and agricultural sources of pesticides. Therefore, the effect of BDCP on pesticides would not be adverse to delta smelt.

NEPA Effects: Overall, the effects of contaminants associated with restoration measures would not be adverse for delta smelt with respect to selenium, copper, ammonia and pesticides. The effects of methylmercury on delta smelt are uncertain.

CEQA Conclusion: As described above, methylmercury could be generated by inundation of restoration areas, particularly in the Yolo Bypass, Cosumnes/Mokelumne Rivers, and at other ROAs closest to these source areas. However, implementation of *CM12 Methylmercury Management* would help to minimize the increased mobilization of methylmercury at restoration areas. While modeling of water operations effects showed little changes in methylmercury concentrations in the water, and methylmercury concentrations would continue to exceed criteria under Alternative 1A. However, implementation of Alternative 1A is not expected to result in substantial effects on delta smelt due to increased exposure to selenium, copper, ammonia, or organophosphate, organochlorine or pyrethroid pesticides for the reasons described above. In addition, Alternative 1A is not expected to substantially increase the potential exposure of fish because elevated bioavailability likely would be localized near ROAs and over a relatively short time period. In addition, restoration of agricultural land will result in an overall reduction in these chemicals in the Delta system. When balanced by the benefits of habitat modifications associated with restoration, the potential impact of contaminants is considered less than significant. Consequently, no mitigation would be required. Overall there would be a net ecological benefit to delta smelt.

Impact AQUA-9: Effects of Restored Habitat Conditions on Delta Smelt

As analyzed further below, proposed *CM4 Tidal Natural Communities Restoration*, *CM5 Seasonally Inundated Floodplain Restoration*, *CM6 Channel Margin Habitat Enhancement*, and *CM7 Riparian Natural Community Restoration* are intended to increase suitable habitat for delta smelt and restore important habitat functions of the Delta. For delta smelt, the intended purpose of BDCP habitat restoration is to increase the area of suitable spawning and rearing habitats in the Delta and to improve ecological functions, including the availability of food. Delta smelt are not expected to extensively utilize low order tidal marsh channels and other very shallow habitats; however, the presence of greater quantities of these habitats is intended to enhance the prey production and water quality of the higher order marsh channels and surrounding open-water areas used more extensively by delta smelt. The full analysis of habitat restoration can be found in the *BDCP Effects Analysis – Appendix 5E, Habitat Restoration, hereby incorporated by reference*.

The following section discusses expected effects of the proposed restoration activities on delta smelt.

CM2 Yolo Bypass Fisheries Enhancement

The enhancement elements associated with *CM2 Yolo Bypass Fisheries Enhancement* (listed in Table-11-3 and described in Section 11.3.1.3) are modifications designed to increase the frequency, duration and magnitude of seasonal floodplain inundation in the Yolo Bypass. Flow modeling results indicate that at least 3,000 acres of the Yolo Bypass are inundated for at least seven days in about four out of every five years, on average, under existing biological conditions and about seven out of every eight years, on average, under Alternative 1A (see *BDCP Effects Analysis – Appendix 5E*, *Habitat Restoration, hereby incorporated by reference*). The maximum level of inundation simulated by the model, just over 25,000 acres, is expected to occur in almost seven of every ten years under Alternative 1A. The Yolo Bypass would have a minimum of approximately 150,000 acres of inundated floodplain per decade.

This increased floodplain inundation may increase production of phytoplankton and other algae, particularly during the extended flooding that occurs in the spring. Yolo Bypass is a sediment depositional area (Singer et al. 2008), resulting from the settling of suspended solids, and reduced turbidity. The increased area of inundation and relatively shallow habitat would also result in an increased total irradiance available for phytoplankton growth in the water column.

Floodplain enhancement in the Yolo Bypass also may provide benefits to the larger estuary by exporting food resources to downstream systems, providing increased production for pelagic species such as delta smelt (Schemel et al. 2004; Ahearn et al. 2006; Lehman et al. 2008b). Ahearn et al. (2006) found that floodplains that are connected and disconnected in pulses can act as a “productivity pump” for the lower estuary by exporting food resources, especially algae, to support food webs in downstream communities (Sommer et al. 2001; Ahearn et al. 2006; Lehman et al. 2008b). Other studies indicate links between carbon produced on floodplains and the downstream foodweb (Sobczak et al. 2005; Opperman et al. 2010).

The more frequent inundation of the Yolo Bypass under Alternative 1A is expected to translate into more frequent temporary inoculations of the Cache Slough complex with prey for adult and larval delta smelt (Sommer et al. 2004). This in turn is expected to provide a notable fraction of the delta smelt population with a seasonally enhanced food source.

However, it is important to note that benefits would not be derived in all years, and that an adaptive management plan would be needed to determine an operational protocol that optimizes benefits both locally and in adjacent habitats.

CM4 Tidal Natural Communities Restoration

As described above, *CM4 Tidal Natural Communities Restoration* is intended to increase suitable habitat for delta smelt and contribute to the overall pelagic foodweb, although the extent of this benefit is highly uncertain and will depend on site-specific characteristics and other factors. Food that is produced in the expanded tidal environments could provide benefits to delta smelt occurring in those same environments and potentially be exported to other areas of the Delta to support delta smelt. Tidal habitat restoration is projected to provide substantial increases in suitable habitat for delta smelt compared to both Existing Conditions and the NAA.

The potential benefit of tidal habitat restoration under CM4 for phytoplankton production was examined using the relationship between phytoplankton growth rate and depth developed by Lopez et al. (2006). The modeled rate of phytoplankton growth was calculated for the estimated average water depth of each tidal-area stratum and then multiplied by the area of the stratum, resulting in a metric termed *prod-acres* (the phytoplankton growth rate multiplied by area). Model results indicate that phytoplankton production could increase in all ROAs as a result of BDCP restoration activities, with the greatest increases in the West Delta, Cache Slough, and South Delta subregions (Table 11-1A-4). Note, however, that the model does not incorporate the effects of invasive clams which filter feed on phytoplankton and zooplankton. If restoration efforts prove successful, delta smelt could benefit from increased production of zooplankton, particularly to the extent that food resources are exported to adjacent channels and the wider estuary. However, the potential for Delta habitat to provide benefits to fish is unproven, and may not occur in proportion to the actions taken (Rose 2000).

Tidal habitat restoration, including the flooding of currently terrestrial areas, has the potential for some negative impacts, including those described above regarding contaminants; establishment of undesirable species that may prey upon, compete with, or alter habitat conditions for delta smelt (e.g., centrarchids, Mississippi silverside, invasive clams, *Egeria*); or production of organic matter that could contribute to low DO. The actual effects of CM4 habitat restoration are likely to vary among restoration sites, providing varying degrees of benefit to delta smelt.

Table 11-1A-4. Modeled Prod-Acres under Current Conditions and by the NAA with BDCP Tidal Habitat Restoration

Scenario	Prod-Acres
Cache Slough	
Existing	10,100
with BDCP	29,569
Suisun Marsh	
Existing	13,940
with BDCP	24,420
West Delta	
Existing	22,591
with BDCP	26,670
East Delta	
Existing	4,820
with BDCP	8,940
South Delta	
Existing	15,060
with BDCP	38,090

CM5 Seasonally Inundated Floodplain Restoration

Under CM5, up to 10,000 acres of seasonally inundated floodplain will be restored, primarily through levee setbacks, removal of riprap, or grading of floodplain. Frequently inundated floodplains and secondary or seasonal channels and pools on the restored floodplain will create diverse, hydraulically complex habitat areas. The largest opportunity for large-scale floodplain restoration is in the South Delta along the San Joaquin River, Old River, and Middle River. CM5 is not expected to have any effects on delta smelt.

CM6 Channel Margin Enhancement

There may be limited benefits for delta smelt from channel margin habitat enhancements because they are largely found downstream of the proposed enhancement areas, and are not thought to use channel margin extensively (although they may use this habitat type for spawning). There is some potential for increased food production and export, but this conservation measure is generally intended for salmonid species. In addition to the potentially limited benefits expected from channel margin enhancement efforts, channel margin habitat enhancement has the potential to increase habitat in the Plan Area for nonnative fishes that prey on or compete with delta smelt. Monitoring from bank protection projects and other future studies will inform site designs to limit the potential increase in nonnative fishes.

CM7 Riparian Natural Community Restoration

Under CM7, *Riparian Natural Community Restoration*, there will be restoration of 5,000 acres of native riparian forest and scrub in association with *CM4 Tidal Natural Communities Restoration*, *CM5 Seasonally Inundated Floodplain Restoration*, and *CM6 Channel Margin Enhancement*. While riparian restoration would reestablish fluvial geomorphologic dynamics and regenerate native plant communities. CM7 is not expected to have any effects on delta smelt. Riparian restoration also will provide channel stabilization and improved water quality. Riparian zones may be natural or engineered for soil stabilization or restoration. These zones are important natural biofilters, protecting aquatic environments from excessive sedimentation, polluted surface runoff and erosion. Research shows riparian zones are instrumental in water quality improvement for both surface runoff and water flowing into streams through subsurface or groundwater flow. Particularly the attenuation of nitrate or denitrification of the nitrates from fertilizer in this buffer zone is important. Riparian zones can play a role in lowering nitrate contamination in surface runoff from agricultural fields, which runoff would otherwise damage ecosystems and human health.

CM10 Nontidal Marsh Restoration

CM10 will result in the establishment of 400 acres of nontidal marsh in three areas: Yolo Bypass, North Delta and Cache Slough. Since these communities are upland communities they would primarily provide indirect benefits to delta smelt and other aquatic species in the main river systems (Sacramento River, Yolo Bypass) and Delta. Upland wetlands provide hydrologic and water quality functions, e.g., storing water during floods, filtering contaminants), but CM10 is not expected to have any effects on delta smelt.

Habitat Restoration and Climate Change

Despite the improvements in habitat area and habitat functions in the Delta from floodplain, tidal, channel margin and riparian habitat restoration activities, habitat quality for delta smelt is expected to decline in the LLT primarily because of climate change (Cloern et al. 2011; Brown et al. 2013) and the associated increases in Delta water temperatures.

NEPA Effects: It is concluded that overall, the effect of restoration activities under Alternative 1A relative to NAA is expected to provide a net benefit for delta smelt, which may spend their entire lives in the Plan Area.

CEQA Conclusion: All of the impacts associated with the individual habitat restoration actions are considered beneficial because they are intended to increase suitable habitat and habitat functions. Consequently, no additional mitigation is required.

Other Conservation Measures (CM12–CM19 and CM21)

Impact AQUA-10: Effects of Methylmercury Management on Delta Smelt (CM12)

Details associated with methylmercury are provided in *BDCP Effects Analysis – Appendix 5D, Contaminants, Section 5D.4.4 Ammonia/um (hereby incorporated by reference),* and under Impact AQUA-8. CM12 will, where practicable, attempt to minimize conditions that promote production of methylmercury in restored areas and its subsequent introduction to the foodweb, and to covered species in particular. It describes pre-design characterization, design elements, and best management practices to attempt to minimize methylation of mercury, and requires monitoring and reporting of observed methylmercury levels.

NEPA Effects: The effects of methylmercury management on delta smelt would not be adverse.

CEQA Conclusion: Effects of *CM12 Methylmercury Management* in upstream areas and within the Delta is expected to reduce overall methylmercury levels resulting from BDCP habitat restoration activities. Since it is designed to improve water quality and habitat conditions, impacts would be less than significant and, with restoration, would be beneficial. Consequently, no mitigation is required.

Impact AQUA-11: Effects of Invasive Aquatic Vegetation Management on Delta Smelt (CM13)

The following analysis is based on the more detailed analysis included in *BDCP Effects Analysis – Appendix 5F, Biological Stressors, Section 5F.1.1 Invasive Aquatic Vegetation, Section 5F.4 Invasive Aquatic Vegetation, and 5F.5.3.2.3 Nonnative Aquatic Vegetation Control (Conservation Measure 13) (hereby incorporated by reference)*.

A general analysis of the effects on covered fish species has been conducted that is relevant to the effects on delta smelt. Control of invasive aquatic vegetation (IAV) in the Plan Area would occur through chemical and mechanical treatment in both areas restored under BDCP, as well as other areas throughout the Delta. CM13 includes control of IAV, especially submerged aquatic vegetation (SAV), which colonizes BDCP restoration sites to ensure that the benefits of these restoration projects are not eroded by IAV. Most IAV colonization is expected to occur in tidal wetlands. The primary concern is with *Egeria densa*, which has the ability to grow year-round in the Delta and very rapid growth rates, especially when densities are low. Therefore, it is a very effective invader of open water habitats such as would exist in newly restored shallow-water habitats. Effective control of IAV in restoration sites is likely feasible because infestations would be treated when first observed and relatively small.

There would also be support for SAV control efforts in the Plan Area outside restoration sites by providing additional funding for the current California Department of Boating and Waterways (DBW) water hyacinth and *Egeria densa* control programs. These programs tested a range of herbicides and mechanical control techniques, and conducted extensive toxicology and water quality testing required by the terms of its NPDES permit and under biological opinions issued by the USFWS and the NMFS. The results of post-treatment efficacy, toxicology, and water quality monitoring have been used to hone the programs to maximize the reduction in IAV while minimizing potential toxic and adverse effects.

Implementation of the DBW programs has been resource-limited and as a result, initially was not able to keep up with the rapid expansion of Egeria across the Delta. However, where applied, it has been effective at specific sites if treatment is continued and monitoring and follow-up treatment conducted, even on large areas such as Franks Tract. Enhancement of the current DBW programs is expected to provide benefits to covered fish species, including delta smelt, based on the current effectiveness of the program and the proposed expansion under the BDCP. However, these benefits are expected to be modest because of the current distribution and rate of spread of SAV in the Delta. Additional benefits could occur, given recent estimates of *Egeria* cover and the indication that the rate of spread is decreasing. For example, in 2006, DBW estimated that approximately 11,500–14,000 acres of the Delta are infested by Brazilian waterweed *Egeria* and that it is spreading at a rate of 10–20% per year, potentially doubling in acreage every 10 years (California Department of Boating and Waterways 2006). More recent estimates indicate that the total area is around 10,000 acres, and the rate of spread is about 10% per year (Ustin 2008). Under *CM13 Invasive Aquatic Vegetation Control*, BDCP is expected to treat an average of 1,679–3,358 acres per year in tidal habitat throughout the Delta (5–10% of the acreage of tidal habitat areas within and outside restoration sites).

Predation

SAV provides cover for ambush predators such as largemouth bass; controlling IAV may therefore assist in curbing predation. Turbidity in the Delta is lower than it was 30–40 years ago, and decreasing turbidity in the Delta may constrain the distribution of juvenile and possibly spawning delta smelt. Although the primary reason for decreasing turbidity is depletion of the erodible sediment pool (Schoellhamer 2011), SAV contributes by trapping suspended sediment and inhibiting resuspension. Delta smelt probably avoid overly clear water to reduce their risk of predation, as well as improve their ability to feed as described below.

Food Consumption

While the removal of SAV could result in localized increases in turbidity, and delta smelt larvae require turbidity to initiate feeding—the larvae do not feed in water that is too clear, and delta smelt feed more effectively in turbid water conditions, such changes are not expected to result in a measurable change in food consumption of delta smelt (see *BDCP Effects Analysis – Appendix 5F, Biological Stressors, Section 5F.4.2.1.6 Changes in Turbidity*).

Spawning and Rearing Habitat

Dense patches of SAV physically obstruct access for delta smelt to habitat for spawning and rearing, although the relatively small reductions in the overall distribution of SAV in the Delta are not likely to measurably increase available delta smelt spawning and rearing habitat. The effect of IAV control would not be adverse because, although modest, it is expected to provide some benefits to delta smelt. Control of IAV, and especially SAV, is expected to enhance natural community ecosystem functions by removing ecologically dominant invasive species. Dense SAV provides suitable habitat and cover for nonnative predatory fish, and reduces turbidity, which contributes to the predation rates on delta smelt. Reduced turbidity also decreases the ability of delta smelt to feed effectively, reducing growth rates. Invasive SAV also reduces accessible spawning and rearing habitat. Therefore, the control of SAV is expected to be slightly beneficial to delta smelt.

NEPA Effects: The control of IAV under *CM13 Invasive Aquatic Vegetation Control* should provide a modest net benefit to delta smelt by decreasing predator habitat, reducing water clarity, and improving feeding conditions. Reduced water clarity is expected to reduce the effectiveness of predators to prey on delta smelt, and may contribute to successful foraging by delta smelt. In addition, controlling IAV is expected to increase the suitability of spawning and rearing habitat for delta smelt, resulting in a potential beneficial effect.

CEQA Conclusion: The control of IAV should provide a modest net benefit to delta smelt by decreasing predator habitat and increasing turbidity. Increased turbidity is expected to reduce the effectiveness of predators to prey on delta smelt, and increases the foraging ability of delta smelt. In addition, controlling IAV is expected to increase the spawning and rearing habitat for delta smelt. Therefore, the control of IAV is expected to have a slight beneficial impact on delta smelt, consequently, no mitigation would be required.

Impact AQUA-12: Effects of Dissolved Oxygen Level Management on Delta Smelt (CM14)

As discussed in Chapter 8, *Water Quality*, dissolved oxygen levels would be very similar to Existing Conditions in the areas upstream of the Delta, in the Delta, and in the SWP/CVP export service areas (see discussion of Impacts WQ-10 and WQ-11). As noted there, however, *CM14 Stockton Deepwater Ship Channel Dissolved Oxygen Levels* management would improve the upstream DO conditions in the San Joaquin River basin, although few if any delta smelt would occur in the channel during this period.

NEPA Effects: No discernible effect of dissolved oxygen level management on delta smelt is expected to occur.

CEQA Conclusion: As discussed in Chapter 8, *Water Quality*, *CM14 Stockton Deepwater Ship Channel Dissolved Oxygen Levels* management would improve the upstream migration conditions in the San Joaquin River basin in the fall. Few if any delta smelt would occur in the channel during this time and therefore there would be no impact. Consequently, no mitigation would be required.

Impact AQUA-13: Effects of Localized Reduction of Predatory Fish on Delta Smelt (CM15)

CM15 Localized Reduction of Predatory Fish is intended to reduce localized abundance of fish predators of salmonids in the Delta.

NEPA Effects: There would be no effect on delta smelt from localized reduction of predatory fish.

CEQA Conclusion: *CM15 Localized Reduction of Predatory Fish* is intended to reduce localized abundance of fish predators of salmonids in the Delta. Therefore there would be no impact on delta smelt.

Impact AQUA-14: Effects of Nonphysical Fish Barriers on Delta Smelt (CM16)

Nonphysical barriers (NPBs) in the Delta are designed to alter juvenile salmon migration routes using sound, light, and bubbles. The potential to alter delta smelt migration is unknown, but the NPBs would not be operated for this purpose. Additionally, delta smelt juveniles have only limited swimming ability so it is unknown whether delta smelt have the escape ability to be deterred by and avoid the NPBs, especially in years with high flow rates. However, the in-water structures associated with these barriers may attract fish predators, increasing localized predation risk for delta smelt migrating past the barriers. The extent of this effect is highly uncertain.

NEPA Effects: There would be no demonstrable effect of NPBs on delta smelt.

CEQA Conclusion: Nonphysical barriers (NPBs) in the Delta are designed to alter juvenile salmon migration routes using sound, light, and bubbles. The potential to alter delta smelt migration is unknown, but the NPBs would not be operated for this purpose. Additionally, delta smelt juveniles have only limited swimming ability so it is unknown whether delta smelt have the escape ability to be deterred by and avoid the NPBs, especially in years with high flow rates. However, the in-water structures associated with these barriers may attract fish predators, increasing localized predation risk for delta smelt migrating past the barriers. The extent of this effect is highly uncertain.

Therefore, there would be no demonstrable effect of this conservation measure on delta smelt. Consequently, no mitigation would be required.

Impact AQUA-15: Effects of Illegal Harvest Reduction on Delta Smelt (CM17)

CM17 Illegal Harvest Reduction would be applied to Chinook salmon, Central Valley steelhead, green sturgeon and white sturgeon and are expected to have positive effects on their populations. Since this conservation measure is not applied to delta smelt, it would have no direct effect on them.

NEPA Effects: The effect of illegal harvest reduction on delta smelt is not adverse.

CEQA Conclusion: *CM17 Illegal Harvest Reduction* would be applied to Chinook salmon, Central Valley steelhead, green sturgeon and white sturgeon and are expected to have positive effects on their populations. Since this conservation measure is not applied to delta smelt, it would have no direct impact on them. Consequently, no mitigation would be required.

Impact AQUA-16: Effects of Conservation Hatcheries on Delta Smelt (CM18)

CM18 Conservation Hatcheries would establish new and expand existing captive conservation propagation programs for delta and longfin smelt. Two programs would be supported. One, a conservation hatchery to house a delta smelt refugial population and to provide a source of delta smelt and longfin smelt for experimentation, supplementation or reintroduction if deemed feasible by wildlife agencies. Two, expansion of the refugial population of delta smelt and establishment of a refugial population of longfin smelt at the University of California Davis Fish Conservation and Culture Laboratory in Byron. The effect of maintaining a refugial population is potentially beneficial, as it is intended to provide a safeguard against extinction. A detailed genetics management plan will be needed, to minimize problems inherent with hatchery programs (USFWS 2000; California Hatchery Science Review Group 2012). The effect of maintaining an experimental population would be modestly beneficial for the delta smelt as it would reduce the need to capture wild fish for scientific use.

NEPA Effects: The effect of conservation hatcheries on delta smelt would not be adverse.

CEQA Conclusion: *CM18 Conservation Hatcheries* would establish new and expand existing captive conservation propagation programs for delta smelt. Two programs include a conservation hatchery for refugial delta smelt (as well as to provide a population for experimentation) and to expand refugial populations at the Byron facility. The principal purpose of this measure is to ensure the existence of refugial captive populations thereby minimizing extinction risk. The fish used for controlled laboratory experimentation would address uncertainties about their biology which can provide important information that would contribute to more effective conservation. The impacts of establishing and maintaining both the refugial population and the experimental population would be beneficial for delta smelt because they may help to address their substantial reduction in number. Consequently, no mitigation would be required for operation of the facility. Construction would require a separate permitting process.

Impact AQUA-17: Effects of Urban Stormwater Treatment on Delta Smelt (CM19)

Urban stormwater treatment (CM19) would reduce contaminants associated with urban areas because it provides for the treatment of stormwater discharges. As discussed in Chapter 8, *Water Quality*, and previously under Impact AQUA-8 in the section titled *Pyrethroids, Organophosphate Pesticides, and Organochlorine Pesticides,* stormwater treatment would reduce urban loadings of pesticides (including pyrethroids), phosphorous, trace metals and other contaminants. These reductions would contribute to improved water quality in the Delta.

NEPA Effects: Based on the improved overall water quality conditions and reduced pesticides, the effect of urban stormwater treatment on delta smelt would be beneficial.

CEQA Conclusion: Urban stormwater treatment (CM19) would reduce contaminants associated with urban areas because it would provide for the treatment of stormwater discharges. As discussed in Chapter 8, *Water Quality*, and previously under Impact AQUA-8 in the section titled *Pyrethroids, Organophosphate Pesticides, and Organochlorine Pesticides,* stormwater treatment would reduce urban loadings of pesticides(including pyrethroids), phosphorous, trace metals and other water contaminants. These reductions would contribute to improved water quality in the Delta. Therefore, the impacts of urban stormwater treatment would be beneficial because it would have a beneficial effect both directly and through habitat modifications on delta smelt. Consequently, no mitigation would be required.

Impact AQUA-18: Effects of Removal/Relocation of Nonproject Diversions on Delta Smelt (CM21)

Alternative 1A has the potential to reduce entrainment related to agricultural diversions through conversion of agricultural lands into tidal habitat and the consolidation and screening of remaining intakes. Alternative 1A would restore 25,000 acres of tidal habitat in the project area in the early long-term and 65,000 acres in the late long-term. There are more than 2,600 agricultural diversions in the Plan Area (California Department of Fish and Game Passage Assessment Database 2010). It is not well known to what extent covered fish species are entrained in agricultural diversions although the available evidence indicates that it is not great (Cook and Buffaloe 1998; Nobriga et al. 2004). Information regarding the sizes and types of these diversions is limited and inconsistent. Information regarding their operation is largely nonexistent. For the purposes of this analysis, it is assumed that all of these diversions are of similar size and operate in a similar manner, recognizing that this assumption is an oversimplification. Based on a hypothetical restoration scenario, it is estimated that approximately 109 diversions would be removed by the early long-term, and approximately 236 would be removed by the late long-term. This corresponds to approximately 4.2 and 12.4% of the total number of diversions.

Larval entrainment at Delta agricultural diversions was estimated using particle tracking modeling and modeled flow scenarios (described in *BDCP Effects Analysis – Appendix 5.B Entrainment, Section B.6.4.1 Agricultural Diversions-Delta Smelt hereby incorporated by reference)*. A low percentage of particles representing larval delta smelt was entrained at Delta agricultural diversions, averaging 3.2% for Alternative 1A and 3.1% for NAA for 60-day PTM, a relative increase of 5% from NAA.

Based on the analysis, there is no evidence of substantial entrainment of covered fish species at agricultural diversions in the Plan Area, but some entrainment likely is occurring. Whatever entrainment is occurring would likely be reduced by decommissioning agricultural diversions in the BDCP ROAs. PTM modeling and extrapolations to a hypothetical number of diversions to be removed from the ROAs (i.e., approximately 4–12% of diversions) gave estimates of minor change in overall loss of delta smelt larvae because of such decommissioning. This estimate is uncertain because particle tracking is not necessarily an accurate representation of smelt larval behavior in relation to agricultural intakes.

NEPA Effects: It is concluded that based on these results above, the effect of removal/relocation of nonproject diversions on delta smelt would not be adverse and may be beneficial.

CEQA Conclusion: Based on PTM model runs delta smelt entrainment by agricultural diversions would be slightly reduced under Alternative 1A. Alternative 1A also has the potential to reduce entrainment related to agricultural diversions through conversion of agricultural lands into tidal habitat ranging from 25,000 acres in the early long-term and 65,000 acres in the late long-term. Based on a hypothetical restoration scenario, it is estimated that of more than 2,600 agricultural diversions approximately 109 would be removed by the early long-term and approximately 236 would be removed by the late long-term. PTM modeling predicts that larval entrainment would be increased by 1% under Alternative 1A compared to Existing Conditions. This estimate is uncertain because particle tracking is not necessarily an accurate representation of smelt larval behavior in relation to agricultural intakes. However, it is concluded based on these results that the effect is less than significant and may be beneficial. Consequently, no mitigation would be required.

Longfin Smelt

Construction and Maintenance of CM1

Impact AQUA-19: Effects of Construction of Water Conveyance Facilities on Longfin Smelt

Longfin smelt are not expected to be present in the project construction zones during the expected in-water construction window (June 1–October 31) (see Table 11-4). Therefore, there is a very low potential risk of effects from construction activities. In addition, longfin smelt are pelagic species and are less likely to be present in the construction zones than other fish species.

Temporary Increases in Turbidity

Similar to delta smelt, longfin smelt are pelagic fish that inhabit naturally turbid water and use turbid water as a way of hiding from predaceous fish (Moyle 2002), and are unlikely to be adversely affected by temporary increases in turbidity. As discussed for delta smelt (see Impact AQUA-1), environmental commitments would be implemented to reduce turbidity during construction activities (see Appendix 3B, *Environmental Commitments*: *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*). Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Accidental Spills

As described in Impact AQUA-1 for delta smelt, construction-related activities may affect water quality due to accidental spills of contaminants, including the inadvertent release of construction-related chemicals or waste (e.g., oil, fuel, solvents, hydraulic fluids, paint, concrete, and other materials) to surface waters, which would result in localized water quality degradation. Depending on the type and magnitude of an accidental spill, contaminants could result in adverse effects on covered fish species through direct injury and mortality or delayed effects on growth and survival of longfin smelt. However, longfin smelt are not expected to occur in the construction areas during the expected in-water construction window (see Table 11-4). Implementing the environmental commitments described under Impact AQUA-1 for delta smelt (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*) and specifically, the *Spill Prevention, Containment, and Countermeasure Plan* (see Appendix 3B, *Environmental Commitments)* is expected to minimize the potential for introduction of contaminants to surface waters and provide for effective containment and cleanup should accidental spills occur. Pertinent details of these plans are discussed under Impact AQUA-1 for delta smelt.

Disturbance of Contaminated Sediments

Impact AQUA-1 describes the potential for effects from disturbing contaminated sediments during construction, although turbidity, and in turn suspension of sediments, would be minimized by implementing environmental commitments described under Impact AQUA-1 for delta smelt and in

Appendix 3B, *Environmental Commitments*, (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*). Pertinent measures included in these plans are discussed under Impact AQUA-1 for delta smelt. Based on their overall distribution in the Delta, longfin smelt are not likely to occur in the construction area, and would otherwise only occur for short periods of time.

Underwater Noise

Table 11-4 illustrates the life stages of longfin smelt present in the north, east, and south Delta during the expected in-water construction window (June 1–October 31). Construction of the barge landings in the south Delta and east Delta would be the primary locations where longfin smelt could be affected by pile driving, as longfin smelt are only expected to occur at the intake construction sites during the early portion of the in-water work window. As discussed under Impact AQUA-1 for delta smelt, Mitigation Measures AQUA-1a and AQUA-1b are available to minimize this effect.

Fish Stranding

Fish removal activities would be associated with installation of cofferdams at the north Delta intakes (see Impact AQUA-1 for delta smelt). However, due to the limited number of longfin smelt expected to occur when the cofferdams are closed, along with the implementation environmental commitment *Fish Rescue and Salvage Plan* (Appendix 3B, *Environmental Commitments*), the impacts would be minimized (see AQUA-1 for delta smelt). Pertinent details of this plan are also discussed under Impact AQUA-1 for delta smelt.

In-Water Work Activities

As discussed for delta smelt (see Impact AQUA-1), although longfin smelt would likely avoid the noise and activity of pile installation and placement of riprap protection, these activities have the potential to result in direct impact. However, the low numbers of this species likely to be present during the work window would limit potential effects, along with implementing the environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments,* including *Erosion and Sediment Control Plan*; *Dispose of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*.

Loss of Spawning, Rearing, or Migration Habitat

As described in Impact AQUA-1, in-water construction would temporarily or permanently alter habitat conditions in the vicinity of the construction activities. As noted above, only a small number of juvenile longfin smelt are present during the expected in-water construction window and primarily in the south Delta and east Delta in June (see Table 11-4). Intake construction and associated channel dredging would result in a permanent loss of up to approximately 8,300 lineal feet of channel margin in low-quality rearing and migration habitat. Most spawning is believed to take place in the Sacramento River near or downstream of Rio Vista, and at or downstream of Medford Island on the San Joaquin River (Wang 1986). Therefore, fish passage and migration would not be affected by this loss of shoreline habitat. Construction of intake facilities would alter armored bank habitat, but is not substantially affect longfin smelt migration or rearing habitat.

As described in Impact AQUA-1, at the six barge landings, there would be in-water and over-water structures for several years each while the tunnel is constructed. The barge landings would each occupy approximately 15,000 square feet of shoreline habitat within their respective delta channels. However, development and implementation of environmental commitments described under Impact AQUA-1 and in Appendix 3B, *Environmental Commitments*, including *Erosion and Sediment Control Plan*; *Dispose of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan,* would minimize potential effects of construction and maintenance of the barge landings on longfin smelt habitat (see Impact AQUA-1 for delta smelt).

Predation

As discussed for delta smelt under Impact AQUA-1, in-water structures, such as those that would be constructed at the barge landings have the potential to attract predatory fish that may prey on longfin smelt. Although longfin smelt are rare and an open-water species, which are generally not found in the stomach contents of predatory fish that have been sampled in the Delta (U.S. Fish and Wildlife Service 2008; Nobriga and Feyrer 2008), it is plausible that some increased predation could occur if in-water and over-water structures provide an increase in suitable predator habitat. This impact would not adversely affect longfin smelt populations because these localized effects would not have population level effects.

Summary

Potential impacts from implementation of CM1 Water Facilities and Operations on longfin smelt would be similar to those outlined above for delta smelt (see Impact AQUA-1), although the magnitude of their effects is anticipated to be lower because longfin smelt occupy habitat seaward of delta smelt (e.g., Dege and Brown 2004; Rosenfield and Baxter 2007). In-water construction activities would be scheduled to occur during the approved in-water construction window, when the fewest longfin smelt would likely be present in or near the construction areas. Implementation of environmental commitments Environmental Training; Stormwater Pollution Prevention Plan; Erosion and Sediment Control Plan; Hazardous Materials Management Plan; Spill Prevention, Containment, and Countermeasure Plan; and Disposal of Spoils, Reusable Tunnel Material, and Dredged Material (see Appendix 3B, Environmental Commitments and Impact AQUA-1 for delta smelt)—as well as the species' tolerance to turbidity—would minimize effects of construction activities related to turbidity, accidental spills, onsite and offsite sediment transport to surface waters, and re-suspension and redistribution of potentially contaminated sediments. As a result, these effects would not be adverse to longfin smelt.

The low numbers of longfin smelt that would likely be present during the in-water work windows at most construction sites east of Suisun Marsh would also minimize the potential for longfin smelt to be injured or killed as a result of in-water construction activities (including impact pile driving during the construction of the new water diversions). The implementation of the avoidance and minimization measures included in Mitigation Measures AQUA-1a and AQUA-1b, would minimize or possibly even eliminate adverse effects to longfin smelt from impact pile driving (e.g., injury or mortality). Implementation of environmental commitments *Fish Rescue and Salvage Plan* and *Barge Operations Plan* (as described in Appendix 3B and under Impact AQUA-1 for delta smelt) would also offset potential effects of construction activities on any lingering individual longfin smelt. Construction of the approach canal and Byron Tract Forebay would not affect fish-accessible waterways and therefore would not affect longfin smelt. As a result, these construction activities would not result in adverse effects on longfin smelt.

Localized removal of specific predator hot spots, targeted predator removal, and other focused methods to reduce predation on longfin smelt may potentially offset any increases in predator habitat from the temporary construction structures (cofferdams and barge landing docks). Predation effects on longfin smelt from construction activities would not be adverse.

The effect of temporary and permanent rearing and migration habitat loss for longfin smelt would not be adverse due to the relatively small areas occupied by the construction and barge landing sites, and the extremely low abundance of longfin smelt anticipated to occur in the vicinity of these facilities during construction, as well as implementation of a *Barge Operations Plan* (see Appendix 3B, *Environmental Commitments* and the discussion under Impact AQUA-1 for delta smelt).

NEPA Effects: Overall, the effect would not be adverse for longfin smelt.

CEQA Conclusion: The potential impact on longfin smelt from construction activities is considered less than significant due to implementation of the measures described in Appendix 3B, *Environmental Commitments*, including *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*. These measures would reduce the amount of turbidity from in-water construction and would guide rapid and effective response in the case of inadvertent spills of hazardous materials. In combination with the species natural tolerance to elevated turbidity levels, they would be expected to protect longfin smelt from any adverse water quality effect resulting from project construction. Construction associated with Alternative 1A will result in both temporary and permanent alteration of rearing and migratory habitat used by longfin smelt. However these impacts are not expected to be significant due to the relatively small areas occupied by the construction and barge landing sites, and the extremely low abundance of longfin smelt anticipated to occur in the vicinity of these facilities during construction. Construction would not be expected to increase predation rates relative to Existing Conditions. The direct effects of underwater construction noise on longfin smelt would be a significant impact because of the high likelihood that it would cause death to most impacted fish in the immediate vicinity of the noise. However, Mitigation Measures AQUA-1a and AQUA-1b would minimize the potential effects from underwater noise and would reduce the severity of impacts to a less-than-significant level.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Impact AQUA-20: Effects of Maintenance of Water Conveyance Facilities on Longfin Smelt

Temporary Increases in Turbidity

As discussed for construction-related effects on turbidity (Impact AQUA-1), the potential for longfin smelt to be near the intakes during the expected window of June 1 to October 31 is low. Because longfin smelt inhabit naturally turbid waters, they would not be affected by a short-term increase in turbidity during maintenance activities. Effects would be minimized by implementing the environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*).

Accidental Spills

The potential effects of maintenance activities would be similar to those discussed for construction-related effects on delta smelt (see Impact AQUA-2). Effects would be minimized by implementation of environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*).

Underwater Noise

As discussed for delta smelt (see Impact AQUA-2), underwater noise levels produced by in-water maintenance activities are not expected to reach a level that would harm juvenile or adult fishes. NMFS has found that underwater sound pressure levels less than 150 dB RMS (behavioral effects threshold) may result in temporary altered behavior of fishes indicative of stress but would not result in permanent harm or injury (National Marine Fisheries Service 2001).

Maintenance-Related Disturbance

The potential effects of in-water maintenance activities would be similar to those discussed for construction-related effects on longfin smelt (see Impact AQUA-19). Effects would be minimized by implementation of environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*), and the limited use of these habitats during the expected in-water construction window.

Loss of Spawning, Rearing, or Migration Habitat

Two maintenance activities, dredging and riprap placement, would reduce habitat values in the area around the intakes. Removal of sediment would decrease the number of macroinvertebrates around the intakes. Because longfin smelt are not benthic feeders, removal of macroinvertebrates by dredging would not directly affect their prey abundance. However, changes in the food web even at the benthic level do have the potential to affect prey that longfin smelt consume. Longfin smelt are not expected to spawn in the areas affected by maintenance activities, and migration habitat farther out in the channel would be unaffected by dredging or riprap placement. Available rearing and migration habitat of similar quantity and quality would be readily accessible to longfin smelt. Effects would be minimized by implementation of environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*, including *Erosion and Sediment Control Plan*; *Dispose of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*.

Predation

Maintenance activities would be unlikely to have any measurable effect on longfin smelt predation rates. These activities may include the use of barges and other watercraft that could theoretically provide cover, shelter, and perching areas for longfin smelt predators. However, the limited duration of maintenance activities and the associated noise and disturbance would be expected to dissuade predators from concentrating at sufficient density to measurably affect predation rates on longfin smelt.

Summary

In-water maintenance activities would be scheduled to occur during the expected in-water work window, when the least numbers of longfin smelt would likely be present in or near the maintenance areas. In addition, longfin smelt are tolerant to increases in turbidity, which might occur during maintenance activities. Such activities would include maintenance dredging at the intake sites, and installation or repair of riprap bank armoring. Implementation of the environmental commitments described in Appendix 3B, *Environmental Commitments*, would further minimize or eliminate effects on longfin smelt by limiting hazardous material spills, and by guiding the rapid and effective response in the case of inadvertent spills of hazardous materials, should they occur. These environmental commitments are *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Implementation of these environmental commitments, along with the low numbers of longfin smelt expected to occur in the maintenance areas during the expected in-water work windows and the limited frequency and duration of in-water maintenance activities, would result in a very low potential for adverse effects on longfin smelt. In addition, little or no spawning habitat occurs in the areas potentially affected by maintenance activities.

NEPA Effects: Short-term maintenance activities would not adversely affect longfin smelt.

CEQA Conclusion: Longfin smelt inhabit naturally turbid water and are not expected to be affected by temporary increases in turbidity during maintenance activities. In addition to the limited frequency and duration of in-water maintenance activities and implementation of commitments identified above and described in detail in Impact AQUA-1 and Appendix 3B, *Environmental Commitments*, would minimize the potential for maintenance activities to affect longfin smelt by limiting turbidity increases, and by guiding the rapid and effective response in the case of inadvertent spills of hazardous materials. These environmental commitments are *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*. Potential changes to habitat would also be limited and temporary. Therefore, the potential impact of maintenance activities is considered less than significant because it would not substantially reduce longfin smelt habitat, restrict its range, or interfere with its movement. Consequently no mitigation would be required.

Water Operations of CM1

Impact AQUA-21: Effects of Water Operations on Entrainment of Longfin Smelt

Water Exports from SWP/CVP South Delta Facilities

Overall, entrainment of larval and adult longfin smelt at the south Delta export facilities may decrease under Alternative 1A, compared to the No Action Alternative. Entrainment for these life stages follows a familiar pattern evident in a number of the covered species: decreases in entrainment under Alternative 1A relative to NAA in higher-flow years coupled with modest changes (increases or decreases) in lower-flow years.

Entrainment at the SWP and CVP facilities is not believed to be an important stressor influencing the survival of longfin smelt larvae. If entrainment were to be a problem for longfin smelt, its effect would be seen in dry years when recruitment is expected to be lower relative to wet years (Sommer et al. 1997; DFW 2009 ; Grimaldo et al. 2009). Consequently, the population-level impact of this stressor on longfin smelt larvae is believed to be low. Entrainment loss of longfin smelt larvae to the south Delta facilities was simulated using a particle tracking model, using both wetter and drier starting distributions (detailed in *BDCP Effects Analysis – Appendix 5B Entrainment, Section 5B.6.1.6.1 hereby incorporated by reference)*. Average entrainment under Alternative 1A with the wetter starting distribution was 1.0% compared to 1.6% for NAA, a 40% relative reduction (Table 11-1A-5), Under the drier starting distribution, average entrainment was 1.2% under Alternative 1A compared to 2.2% for NAA, a 43% decrease in relative terms. Based on the limited change in entrainment under Alternative 1A, water exports from SWP/CVP south Delta facilities are not expected to measurably change the dry year entrainment risk for longfin smelt larvae.

Table 11-1A-5. Percentage of Particles (and Difference) Representing Longfin Smelt Larvae Entrained by the South Delta Facilities under Alternative 1A and Baseline Scenarios

	Percent Particles Entrained			Difference (and Relative Difference)	
Starting Distribution	EXISTING CONDITIONS	NAA	A1A_LLT	A1A_LLT vs. EXISTING CONDITIONS	A1A_LLT vs. NAA
Wetter	1.9	1.6	1.0	-0.90 (-48%)	-0.65 (-40%)
Drier	2.5	2.2	1.2	-1.27 (-51%)	-0.93 (-43%)

Longfin smelt entrainment at the south Delta facilities was calculated by normalizing salvage data against fall midwater trawl abundance indices. For juvenile longfin smelt, estimated entrainment loss in March -June varied considerably among water years, with highest loss (hundreds of thousands of fish) occurring in dry and critical years, and several orders of magnitude lower in other water year types (refer to *BDCP Effects Analysis - Appendix 5.B*, *Section 5B.6.1.6.2).* Overall entrainment loss averaged across all water years would be similar to NAA, in large part due to substantial reductions in entrainment in wet water years (Table 11-1A-6). In low-flow (dry and critical) years, when most entrainment of juvenile longfin smelt would occur, entrainment loss under Alternative 1A would be 14% more in dry years, but 5% less in critical years compared to baseline conditions. Entrainment would be 46% more in below-normal water years under Alternative 1A.

Table 11-1A-6. Longfin Smelt Entrainment Index at the SWP and CVP Salvage Facilities and Differences (Absolute and Percentage) between Model Scenarios

		Absolute Difference (Percent Difference)	
Life Stage	Water Year Types	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Juvenile (March–June)	Wet	-25,499 (-40%)	-30,942 (-45%)
	Above Normal	1,891 (42%)	1,602 (33%)
	Below Normal	1,713 (56%)	1,505 (46%)
	Dry	142,066 (27%)	83,759 (14%)
	Critical	-99,713 (-18%)	-25,842 (-5%)
	All Years	20,530 (8%)	-4,481 (-2%)
Adult (December–March)	Wet	-98 (-76%)	-101 (-77%)
	Above Normal	-353 (-54%)	-394 (-57%)
	Below Normal	-516 (-27%)	-438 (-24%)
	Dry	-342 (-29%)	-277 (-24%)
	Critical	-7,158 (-29%)	-5,025 (-23%)
	All Years	-2,250 (-62%)	-2,214 (-62%)
	Shading indicates >5% increase in entrainment index.		

A substantial proportion of the adult longfin smelt population is expected to be in the Delta during drier years. In wetter years, adult longfin smelt are expected to be distributed near the confluence of the Sacramento-San Joaquin River or in Suisun Bay or areas to the west (e.g., the Napa River). Estimated entrainment loss of adult longfin smelt from December to March under Alternative 1A would be 62% lower averaged across all water years, and 23-24% lower in dry and critical water years, compared to NAA (Table 11-1A-6).

The reductions in entrainment projected for adult longfin smelt under Alternative 1Awould partially offset the increases in juvenile entrainment in dry water years. If population size increases in the future, take at the south Delta facilities could increase, although the amount of take (as a proportion of the entire population) averaged across water years is expected to be lower under Alternative 1A relative to the NAA.

Water Exports from SWP/CVP North Delta Intake Facilities

Entrainment of longfin smelt larvae at the north Delta intakes occurs only under the action alternatives, including Alternative 1A, because there are no north Delta intakes operational under NAA. However, impingement and entrainment of longfin smelt would be very limited because it would be an exceptionally rare occurrence for longfin smelt to be this far upstream. In addition, the screened intakes are designed to meet CDFW criteria for smelt protection.

Water Exports with a Dual Conveyance for the SWP North Bay Aqueduct

Larval entrainment to NBA was assessed by particle tracking modeling, using starting distributions emulating longfin smelt distribution in wetter years (i.e. greater outflow, smelt spawn further west) and drier years (i.e., longfin smelt spawning occurs further east and deeper into the Delta). Particle entrainment at the NBA was low for both starting distributions (wetter and drier), averaging 0.13-0.16% under Alternative 1A, which was 0.05-0.06% less than NAA, or 54-60% increase in relative terms (Table 11-1A-7). Overall, it is expected that entrainment of larval longfin smelt to the NBA would be very low.

Table 11-1A-7. Average Percentage (and Difference) of Particles Representing Larval Longfin Smelt Entrained by the North Bay Aqueduct under Alternative 1A and Baseline Scenarios

	Percent Particles Entrained			Difference (and Relative Difference)	
Distribution	EXISTING CONDITIONS	NAA	A1A_LLT	A1A_LLT vs. EXISTING CONDITIONS	A1A_LLT vs. NAA
Wetter	0.20	0.08	0.13	-0.07 (-36.7%)	0.05 (60.3%)
Drier	0.25	0.11	0.16	-0.08 (-33.5%)	0.06 (54.4%)

Note: 60-day runs of PTM. Negative difference values indicate lower entrainment under the alternative compared to the baseline scenario.

In contrast to delta smelt, it was estimated that entrainment of longfin smelt larvae would increase at the Barker Slough Pumping Plant under Alternative 1A relative to NAA as often as it was predicted to decrease; however, the percentage of entrained particles was very low (as described above) and is anticipated to become even lower with implementation of a dual conveyance.

If unforeseen changes in distributions or other factors occur as a result of project operations that would increase proportional loss of longfin smelt to entrainment, monitoring and the BDCP-proposed Real-Time Response Team would implement measures to avoid or minimize any potential threats to the species that might occur. Based on current scientific understanding, this would not be necessary.

Summary

Alternative 1A is expected to decrease the entrainment of adult and larval longfin smelt and increase the entrainment of juvenile longfin smelt at the south Delta facilities (see Tables 11-1A-5 and 11-1A-7). If the longfin smelt population recovers, take at the south Delta facilities could increase, even though the proportional loss may be lower under Alternative 1A than the NAA. It is concluded that these changes in longfin smelt entrainment would be adverse under Alternative 1A.

It is concluded that north Delta entrainment and impingement will be higher in Alternative 1A than the NAA simply because there are no north Delta diversions in the NAA scenario; however, impingement and entrainment of adult and larval longfin smelt, respectively, will not be adverse because it is anticipated that very few individuals will use this river reach for migrating and spawning. If unforeseen changes in distributions or other factors occur as a result of project operations that would increase the proportional loss of longfin smelt to entrainment, monitoring and the BDCP-proposed Real-Time Response Team would implement measures to avoid or minimize any potential threats to the species that might occur. Based on the current analysis, this would not be necessary.

NEPA Effects: The overall effect of the Alternative 1A operations scenario would not be adverse to longfin smelt.

CEQA Conclusion: As described above, operational activities associated with water exports from SWP/CVP south Delta facilities under Alternative 1A would not result in reduced entrainment of adult and larval longfin smelt across all water year types (Table 11-1A-6). Juvenile entrainment under Alternative 1A would be 18% lower in critical years, but would increase in dry (27% more), below-normal (56%) and above-normal (42%) water year types compared to Existing Conditions. Operational activities associated with implementing a dual conveyance for the SWP NBA would not result in an increase in entrainment of longfin smelt. The overall impact of water operations under Alternative 1A on entrainment at SWP/CVP facilities is considered significant because of increased dry-year juvenile entrainment of longfin smelt. Management by the Real-Time Response Team would help reduce the extent of entrainment losses under Alternative 1A, especially in drier years, but not necessarily to a less-than-significant level.

Impact AQUA-22: Effects of Water Operations on Spawning, Egg Incubation, and Rearing Habitat for Longfin Smelt

Adult longfin smelt inhabit primarily brackish water and marine areas in San Pablo and San Francisco Bays and nearshore coastal marine waters. Prespawning adult longfin smelt use the Delta for staging and spawning. The planktonic larvae are transported downstream after hatching; within the Plan Area, the early juvenile life stages rear in the low-salinity areas of the West Delta and Suisun Bay subregions. Juvenile and adult longfin smelt occupying the Plan Area during fall through spring migrate westward into San Francisco Bay during the summer.

Longfin smelt spawn in the late winter and early spring months when water temperatures in the lower rivers and Delta are seasonally cool. Longfin smelt spawn adhesive eggs that are thought to be deposited on sand and gravel and possibly other hard substrates. Spawning occurs in the lower reaches of the Sacramento River in the vicinity of Cache Slough and Rio Vista, although some spawning occurs in the lower San Joaquin River based on presence of early larval and adult longfin smelt in CDFW larval trawl samples (California Department of Fish and Game 2009b). Spawning also occurs in Suisun Marsh and the Napa River.

Immediately after hatching from the incubating eggs, longfin smelt larvae are planktonic and drift passively with water flows; older larvae use a variety of behaviors to help retain themselves in favorable habitats (Bennett et al. 2002). Larvae are typically present in the Delta during the late winter and early spring months. Juvenile longfin smelt rear in the spring (approximately March to June) in the Suisun Bay and the West Delta subregions before migrating downstream of the Plan Area into San Pablo and San Francisco Bays and nearshore coastal marine waters, where they continue to rear for a year or more. Larval and early juvenile longfin smelt could be affected by covered activities when they are present in the Plan Area during the winter and spring months.

Adult longfin smelt are present in the Delta portions of the Plan Area typically from approximately November through March. Based on historical patterns, a substantial proportion of the adult longfin smelt population is expected to be in the Delta during these months in drier years. In wetter years, adult longfin smelt are expected to be distributed near the confluence of the Sacramento and San Joaquin Rivers in the lower West Delta subregion, in the Suisun Bay subregion, or in areas to the west of the Plan Area (e.g., the Napa River). During the fall, prespawning adult longfin smelt migrate upstream into the Suisun Bay subregion, the lower Sacramento River portion of the West Delta subregion, and other parts of the Delta prior to spawning. The indices of abundance of longfin smelt based on the fall midwater trawl (FMWT), bay otter trawl, and bay midwater trawl have been correlated to outflow (expressed as the location of X2) in the preceding winter and spring months, when spawning and rearing is occurring (January through June) (Kimmerer 2002a; Kimmerer et al. 2009; Rosenfield and Baxter 2007; Mac Nally et al. 2010; Thomson et al. 2010). Based on Kimmerer et al. 2009, reduced outflow in January through June under Alternative 1A compared to the NAA has the potential to reduce longfin smelt abundance. Other components of Alternative 1A have the potential to increase recruitment per unit of flow.

NEPA Effects: Modeling results based on Kimmerer et al. 2009 predict longfin smelt Fall Midwater Trawl and Bay Otter Trawl indices would decrease 8–10% relative to NAA, for all years combined, based on changes in winter-spring flow alone (Table 11-1A-8). The greatest decreases in longfin smelt indices based on Kimmerer et al. 2009 are predicted to occur in above normal, below normal and dry water year types (10–18% reduction compared to NAA), when changes in winter-spring outflow are greatest under Alternative 1A compared to the NAA. This analysis does not take into account any potential changes in spawning or rearing conditions related to non-operational components of Alternative 1A, including habitat restoration.

Table 11-1A-8. Estimated Differences between Scenarios for Longfin Smelt Relative Abundance in the Fall Midwater Trawl or Bay Otter Trawl

	Fall Midwater Trawl Relative Abundance		Bay Otter Trawl Relative Abundance	
Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
All	-1,501 (-31%)	-304 (-8%)	-4,757 (-36%)	-933 (-10%)
Wet	-6,055 (-33%)	-128 (-1%)	-24,993 (-38%)	-508 (-1%)
Above Normal	-2,825 (-36%)	-857 (-15%)	-9,794 (-42%)	-2,877 (-17%)
Below Normal	-1,378 (-37%)	-431 (-15%)	-4,124 (-42%)	-1,248 (-18%)
Dry	-557 (-29%)	-154 (-10%)	-1,470 (-34%)	-395 (-12%)
Critical	-144 (-16%)	-47 (-6%)	-331 (-19%)	-106 (-7%)
	Shading indicates 10% or greater decrease in relative abundance under Alt1A.			
Note: Based on the X2-Relative Abundance Regressions of Kimmerer et al. (2009).				

Larval longfin smelt may benefit from habitat restoration such as CM2 (Yolo Bypass Fisheries Enhancement) for smelt present in Cache Slough region, or CM4 (Tidal Natural Communities Restoration) for smelt in the west Delta and Suisun Bay. This restored habitat is intended to provide additional food production and export to rearing areas.

CEQA Conclusion: Under Alternative 1A, average Delta outflow compared to Existing Conditions would be slightly increased in winter (6% greater in January and February), similar in March, and decreased in spring (14% lower in April, 26% lower in May, 16% lower in June). Average relative abundance of longfin smelt is decreased 31–36% compared to Existing Conditions, based on Kimmerer et al. 2009 (Table 11-1A-7).

It is worth noting that this CEQA analysis predicts a greater decrease in juvenile relative abundance than estimated under the NEPA analysis set forth above. This interpretation of the biological modeling is likely attributable to different modeling assumptions for four factors: sea level rise, climate change, future water demands, and implementation of the alternative. As discussed above (Section 11.3.3), because of differences between the CEQA and NEPA baselines, it is sometimes possible for CEQA and NEPA significance conclusions to vary between one another under the same impact discussion. The baseline for the CEQA analysis is Existing Conditions at the time the NOP was prepared, which does not partition the effect of implementation of the alternative from the effects of sea level rise, climate change and future water demands using the model simulation results. Both the action alternative and the NEPA baseline (NAA) models anticipated future conditions that would occur in 2060 (LLT implementation period), including the projected effects of climate change (precipitation patterns), sea level rise and future water demands, as well as implementation of required actions under the BiOps. Because the action alternative modeling does not partition the effects of implementation of the alternative from the effects of sea level rise, climate change and future water demands, the comparison to Existing Conditions may not offer a clear understanding of the impact of the alternative on the environment. This suggests that the NEPA analysis, which compares results between the alternative and NAA, is a better approach because it isolates the effect of the alternative from those of sea level rise, climate change, and future water demands.

When compared to NAA and informed by the NEPA analysis above, longfin smelt abundance, based on Kimmerer et al. (2009) decreased 8% to 10% on average compared to NAA, with a 17% to 18% reduction in above normal and below normal water year types (Table 11-1A-7). These results represent the increment of change attributable to the alternative, and address the limitations of the comparison to the CEQA baseline (Existing Conditions).

As described above, other measures could reduce this potential impact. This includes habitat restoration (CM4), which may improve the quality of spawning and rearing habitat for longfin smelt by increasing suitable habitat area and food production in the Delta. The Adaptive Management and Monitoring Program could adjust spring operations as determined necessary through the adaptive management process. However, given the uncertainty of the outcome related to habitat restoration, the uncertainty regarding the actual mechanism for the outflow-abundance relationship included in Kimmerer et al. 2009, and the modeled change in winter-spring outflow, the impact may be significant, and mitigation would be required. Implementation of Mitigation Measures AQUA-22a through 22c, habitat restoration and adaptive management would reduce this impact to less than significant.

Mitigation Measure AQUA-22a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Longfin Smelt to Determine Feasibility of Mitigation to Reduce Impacts to Spawning and Rearing Habitat

Upon the commencement of operations of CM1 and continuing through the life of the permit, the BDCP proponents will monitor effects on spawning and rearing habitat in order to determine how to manage winter-spring outflow to minimize effects on longfin smelt, in light of the overall effects of Alternative 1A. This mitigation measure requires a series of actions to accomplish these purposes, consistent with the operational framework for Alternative 1A.

The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 1A operations only. Development of mitigation actions for the incremental effect on rearing habitat attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 1A.

Mitigation Measure AQUA-22b: Conduct Additional Evaluation and Modeling of Impacts on Longfin Smelt Rearing Habitat Following Initial Operations of CM1

Following commencement of initial operations of CM1 and continuing through the life of the permit, the BDCP proponents will conduct additional evaluations to define the extent to which modified operations could reduce impacts to rearing habitat under Alternative 1A. The additional evaluations would specifically consider March through May Delta outflow monitoring and the relationship between Delta outflow and longfin smelt abundance (Kimmerer et al.

2009). Despite this identified relationship, the specific timing and amount of outflow needed to conserve longfin smelt, especially in light of potential increases in food resources in the Plan Area, and other benefits to spawning and rearing habitat is unknown. The analysis required under this measure may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6) and used to adjust spring operations as determined necessary.

Mitigation Measure AQUA-22c: Consult with USFWS and CDFW to Identify and Implement Feasible Means to Minimize Effects on Longfin Smelt Rearing Habitat Consistent with CM1

In order to determine the feasibility of reducing the effects of CM1 operations on longfin smelt habitat, the BDCP proponents will consult with USFWS and CDFW to identify and implement any feasible operational means to minimize effects on rearing habitat. Any such action will be developed in conjunction with the ongoing monitoring and evaluation of habitat conditions required by Mitigation Measure AQUA-22a.

Impact AQUA-23: Effects of Water Operations on Rearing Habitat for Longfin Smelt

The analysis, NEPA Effects and CEQA Conclusion for effects of water operations on rearing habitat for longfin smelt is included in Impact AQUA-22: Effects of Water Operations on Spawning, Egg Incubation, and Rearing Habitat for Longfin Smelt.

Impact AQUA-24: Effects of Water Operations on Migration Conditions for Longfin Smelt

The analysis, NEPA Effects and CEQA Conclusion for effects of water operations on migration conditions for longfin smelt is included in Impact AQUA-22: Effects of Water Operations on Spawning, Egg Incubation, and Rearing Habitat for Longfin Smelt.

Restoration Measures (CM2, CM4–CM7, and CM10)

Impact AQUA-25: Effects of Construction of Restoration Measures on Longfin Smelt

Temporary Increases in Turbidity

Restoration activities such as riprap removal, shoreline excavation and re-contouring, and planting riparian vegetation have the potential to result in temporary increases in turbidity conditions in adjacent waterways. However, longfin smelt inhabit naturally turbid water and forage more effectively in turbid water. Therefore, longfin smelt are unlikely to be affected by temporary increases in turbidity during restoration construction. Furthermore, implementing the environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Fish Rescue and Salvage Plan*; and *Barge Operations Plan*) would minimize the potential for turbidity to affect longfin smelt.

Increased Exposure to Methylmercury

Methylmercury would be generated by both seasonal and tidal inundation of restoration areas, particularly in the vicinity of the Yolo Bypass, Cosumnes/Mokelumne Rivers, and Suisun Marsh (see discussion for delta smelt under Impact AQUA-8). However, the environmental commitments described above to reduce turbidity will also minimize suspension of potentially contaminated sediments. Implementation of CM12 Methylmercury Management is also expected to help minimize increased mobilization of methylmercury at restoration areas, and its subsequent accumulation in the estuarine food web. In addition, some habitat restorations, including constructing managed wetlands and tidal marsh habitat, would likely reduce the methylation of mercury. As described above for delta smelt, Alternative 1A restoration actions (CM2, CM4–CM7, and CM10) are likely to result in some increased production, mobilization, and bioavailability of methylmercury in the aquatic system. Modeling of Alternative 1A water operations (CM1) effects showed little changes in methylmercury concentrations in the water. To address the issue of methylmercury production at restoration areas, management measures will be implemented through CM12. As such, it is concluded that the mobilization of methylmercury, due to BDCP restoration actions would not be adverse for longfin smelt, relative to the NAA. Given current information however, it is not possible to determine the concentrations of methylmercury that would become available to longfin smelt as a result of these restoration activities.

Accidental Spills

Restoration activities such as levee construction or breaching, site grading, and placement of riprap involve the use of heavy equipment in proximity to aquatic environments, presenting the potential for spills of fuel, fluids, and lubricants that could potentially harm aquatic species and their habitats. Adverse effects from accidental spills will be avoided through implementation of appropriate impact avoidance and minimization measures (*Environmental Training; Stormwater Pollution Prevention Plan; Erosion and Sediment Control Plan; Hazardous Materials Management Plan; Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material; and Barge Operations Plan;* see Appendix 3B, *Environmental Commitments* and Impact AQUA-1). Specifically, the *Spill Prevention, Containment, and Countermeasure Plan* will be implemented to minimize the risk of spills occurring and to provide for rapid and effective response to contain any accidental spills. Therefore adverse effects from accidental spills would be unlikely to occur and if they did occur the effects would be short term. See discussion of sources and minimization measures under Impact AQUA-1).

Disturbance of Contaminated Sediments

Habitat restoration activities may result in the disturbance of contaminated sediments in and around aquatic habitats, with the potential for increased bioavailability, and potential effects on longfin smelt (see details in *BDCP Effects Analysis – Appendix 5.D, Contaminants, hereby incorporated by reference*). Runoff and resuspension of contaminated sediments could cause short-term, localized increases in the concentrations of contaminants in and near restoration sites (see discussion for delta smelt under Impact AQUA-8). The potential impacts of toxics on longfin smelt would be minimized to the extent possible by timing restoration activities so that vulnerable early life stages are not present, and implementation of environmental commitments (see Appendix 3B, *Environmental Commitments: Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*). Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

As with delta smelt, longfin smelt are expected to have lower exposure to selenium than some other covered fish species (e.g., splittail and sturgeon), because they feed primarily on planktonic, rather than benthic organisms. However, the higher contribution of San Joaquin River flow to Delta outflow in Alternative 1A relative to the NAA is expected to increase the loading and by extension possibly the bioaccumulation of selenium in the low-salinity zone food web. Similar to delta smelt, longfin smelt are expected to have low exposure to selenium as they are feeding on pelagic organisms that are able to excrete most of the selenium they consume (Stewart et al. 2004). Therefore, it is concluded that Alternative 1A restoration activities would not have an adverse effects on longfin smelt from selenium exposure relative to the NAA.

Localized, short-term increases in copper concentrations are also possible, although the removal of agricultural areas through restoration activities would eliminate some sources of copper and pesticides. Implementing *CM19 Urban Stormwater Treatment* would also reduce the discharge of pyrethroid pesticides to the Delta. Therefore, it is concluded that Alternative 1A restoration activities will not have adverse effects on longfin smelt from copper or pesticide exposure, relative to the NAA. Similarly, no appreciable addition or mobilization of ammonia to the aquatic system would result from restoration activities.

In-Water Work Activities

Restoration activities such as equipment mobilization, development of staging areas, and dry levee preparation could temporarily produce noise and physical disturbance levels that could affect nearby fishes. However, such activities are not expected to elevate underwater noise above the threshold sound pressure levels established for fish (see discussion for delta smelt under Impact AQUA-1). In addition, few longfin smelt are expected to occur in the areas where restoration activities would directly affect aquatic habitat, as these would occur during the expected in-water work windows when species use is expected to be minimal. Potential effects of in-water activity would be minimized by implementation of the environmental commitments described under Impact AQUA-1 and in Appendix 3B, *Environmental Commitments*, including *Erosion and Sediment Control Plan*; *Dispose of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt. Any effects would be of limited duration and short term.

Predation

Restoration activities would be unlikely to have any measurable effect on longfin smelt predation rates. Much of the restoration would occur on dry land (e.g., recontouring, removing levees) which would have no in-water effects including on predators. The limited duration of these activities and the associated noise and disturbance would be expected to dissuade predators from concentrating at sufficient density to measurably affect predation rates on longfin smelt.

Summary

In-water and shoreline restoration activities may result in short-term adverse effects on longfin smelt through direct disturbance, short-term water quality impacts, and through increased exposure to contaminants associated with the incidental disturbance of contaminated soils and sediments. These effects would be minimized by limiting restoration activities to the expected in-water construction window, when the least numbers of longfin smelt would likely be present in or near the restoration sites. Longfin smelt are also tolerant to increases in turbidity, reducing the potential for effects from turbidity. Implementation of the environmental commitments described in Appendix 3B, *Environmental Commitments*, would minimize or eliminate effects on longfin smelt by reducing the amount of turbidity and guiding the rapid and effective response in case of inadvertent spills of hazardous materials. These environmental commitments are *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials*

Management Plan; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt. As a result, the effects of short-term restoration construction activities are not adverse to longfin smelt.

The potential long-term effects of restoration on the bioavailability of contaminants is expected to be localized, sporadic, and of low magnitude. In addition, *CM12 Methylmercury Management* provides for site-specific assessment of restoration areas, integration of design measures to minimize methylmercury production, and site monitoring and reporting. With implementation of *CM12 Methylmercury Management*, effects of methylmercury mobilization on covered fish at the tidal wetland restoration sites are expected to be minimized.

NEPA Effects: Overall, the effects of habitat restoration are expected to be beneficial to longfin smelt by providing additional or improved habitat, and other minor effects would be more than offset by the collective benefits of broad-scale habitat restoration.

CEQA Conclusion: Longfin smelt inhabit naturally turbid water and are not expected to be affected by temporary increases in turbidity during restoration activities. In addition to in-water work window restrictions, the limited frequency, duration, and spatial extent of restoration activities would minimize potential habitat or movement effects on longfin smelt. The implementation of *CM12 Methylmercury Management* would also reduce the potential for effects. Implementation of the environmental commitments described under Impact AQUA-1 for delta smelt and in detail in Appendix 3B, *Environmental Commitments (see Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*) would also reduce the frequency, duration and spatial extent of any impacts. Therefore, the potential impact from restoration activities would be less than significant to longfin smelt because it would not substantially reduce habitat, restrict its range or interfere with its movement. Additionally, there would be beneficial long-term net benefits of habitat restoration. Consequently, no mitigation is required.

Impact AQUA-26: Effects of Contaminants Associated with Restoration Measures on Longfin Smelt

Effects of implementing the habitat restoration conservation measures (CM2, CM4–CM7, and CM10) on longfin smelt will depend on the life stage present in the area of elevated toxins and the duration of exposure. As previously mentioned, a complete analysis can be found in the *BDCP Effects Analysis – Appendix 5D*, *Contaminants (hereby incorporated by reference)*. Potential impacts on longfin smelt from effects of methylmercury, selenium, copper, ammonia, and pesticides associated with habitat restoration activities would be similar to those discussed for delta smelt (see Impact AQUA-10 as well as Impact AQUA-8), and may be somewhat less because longfin smelt do not utilize shallow habitats as much as delta smelt.

The large numbers of factors that influence the production of methylmercury in freshwater tidal habitat make it challenging to predict methylmercury conditions, covered species exposures or bioaccumulation. The limited data available from past restoration actions indicate that methylmercury production in wetlands and resulting bioaccumulation is highly variable. It is reasonable to expect that some increases in methylmercury are possible on a local or regional scale. The Delta is currently impaired for methylmercury and a TMDL from the Central Valley Regional Water Quality Control Board is guiding loading reduction for both point and non-point sources to insure that the aquatic life associated beneficial uses are protected (Central Valley Regional Water Quality Control Board 2011a and 2011b). The initial phase of the 2010 TMDL is underway and includes seven years of research on the management of methylmercury associated with Delta wetlands. Longfin smelt's food and habitat preferences should represent a reduced risk of methylmercury exposure compared to other estuarine fishes.

It is anticipated that any potential effects of methylmercury on longfin smelt will be addressed through implementation of CM12. CM12 is intended to minimize methylmercury exposure associated with restoration measures for longfin smelt at all life stages. Further analysis and tools may be developed to further reduce methylmercury exposure for longfin smelt as the habitat restoration conservation measures are refined and analyzed in site-specific documents. The site-specific analysis is the appropriate place to assess the potential for risk of methylmercury exposure for longfin smelt once site specific sampling and other information can be developed.

NEPA Effects: The potential contaminants associated with habitat restoration activities are not expected to adversely affect longfin smelt with respect to selenium, copper, ammonia and pesticides. The effects of mercury on longfin smelt are uncertain. In addition, the benefits associated with habitat restoration are expected to result in an overall benefit to the longfin smelt.

CEQA Conclusion: Alternative 1A actions are likely to result in increased production, mobilization, and bioavailability of methylmercury, selenium, copper, and pesticides in the aquatic system. However, any such releases would be short-term and localized, and would be unlikely to result in measurable increases in the bioaccumulation in longfin smelt. In addition, implementation of *CM12 Methylmercury Management* would help to minimize the increased mobilization of methylmercury at restoration areas. Therefore, the potential impact of contaminants is considered less than significant because it would not substantially effect longfin smelt either directly or through habitat modifications and, with restoration, would be beneficial in the long-term. Consequently, no mitigation would be required.

Impact AQUA-27: Effects of Restored Habitat Conditions on Longfin Smelt

The potential effects of restored habitat conditions on longfin smelt would be similar to those discussed for delta smelt (see the discussion under Impact AQUA-9).

CM2 Yolo Bypass Fisheries Enhancement

Similar to the discussion under Impact AQUA-9 for delta smelt, the primary benefit of Yolo Bypass fisheries enhancement would be increased food productivity and export to portions of the system used by longfin smelt.

CM4 Tidal Natural Communities Restoration

A small proportion of late-stage longfin smelt larvae may briefly occur in shallow tidal environments, and could experience direct benefits from habitat expansion and food production in the ROAs (see Impact AQUA-9), and supporting improved longfin smelt growth and survival rates. However, restored areas would be vulnerable to colonization by non-native species such as the overbite clam, which competes with native species for food. Even if desirable functions and processes become established, which can only be determined by long-term monitoring, linkages that result in benefits to fish are poorly understood and uncertain to occur (Rose 2000).

Although tidal habitat restoration could benefit longfin smelt, habitat conditions are likely to decrease for larval and juvenile longfin smelt over time, because of temperature effects associated with climate change during the late spring. It is anticipated that the overall effect of *CM4 Tidal Natural Communities Restoration* would be similar to that for delta smelt and therefore may be considered adverse, not adverse, or beneficial depending upon (1) the extent to which the actions reestablish lost or impaired habitat functions and processes and (2) the extent to which they are actually utilized by longfin smelt and remain beneficial by increasing habitat quantity, thereby providing a potential mechanism to at least partially offset the future effects of climate change (see Impact AQUA-9).

Longfin smelt spend less time in the Plan Area than delta smelt, which may result in less severe effects from a potential future decline in habitat quality. Because only a small proportion of the juvenile longfin smelt population that would be affected by these changes and the importance of food and habitat availability to the them, combined with the potential temporal compression in the availability of rearing habitat based on increased temperatures resulting from climate change, indicate that habitat restoration may potentially result in a small net benefit to juvenile longfin smelt.

CM5 Seasonally Inundated Floodplain Restoration

For discussion of the potential effects on longfin smelt, see the discussion under Impact AQUA-9 for delta smelt. Providing river–floodplain connectivity could increase production of lower trophic levels at relatively rapid time scales, with some food web organisms responding within days at high densities. Longfin smelt occur in low numbers and for a brief time in the south Delta so direct benefits for them would be limited. However, the potential export of nutrients to other areas could also benefit longfin smelt and other covered fish species although reverse flows in the south Delta reduce downstream export. Also, if longfin smelt were attracted to the south Delta they would be at increased risk of entrainment.

CM6 Channel Margin Enhancement

Restoration provided by *CM6 Channel Margin Enhancement* would be unlikely to provide additional rearing habitat, but an increase in downstream food resources for longfin smelt. While this would be considered potentially beneficial, longfin smelt would likely experience only minimal benefits because they tend to occur away from shore and are largely found downstream of the main channels proposed for channel margin enhancement. Similarly, the potential effects of exposure to toxins is also expected to be minimal.

CM7 Riparian Natural Community Restoration

The potential effects of *CM7 Riparian Natural Community Restoration* on longfin smelt are expected to be similar to those discussed for delta smelt (see Impact AQUA-9).

CM10 Nontidal Marsh Restoration

No direct benefits would be expected to accrue to longfin smelt as a result of CM10 Nontidal Marsh Restoration as they do not occur in non-tidal areas. However, as discussed under Impact AQUA-9 for delta smelt, some benefit may occur in proportion to their use of the downstream areas.

Summary

The effects of floodplain, tidal, channel margin and riparian habitat restoration activities on longfin smelt are likely to be similar to those discussed for delta smelt (see Impact AQUA-9) including increased habitat area and associated food resources. In general these effects are presumed to be not adverse or modestly beneficial for longfin smelt, although any benefits would minimal, because longfin smelt tend to occur in these habitat areas for brief periods.

Despite the improvements in habitat and habitat functions in the Delta from floodplain, tidal, channel margin and riparian habitat restoration activities, habitat quality is expected to decline in the LLT primarily because of climate change.

NEPA Effects: The overall effect of restoration activities is expected to remain not adverse for longfin smelt. However, it is important to note that any benefits would not be derived in all years, and that an adaptive management plan would be needed to determine an operational protocol that optimizes benefits both locally and in adjacent habitats.

CEQA Conclusion: As with delta smelt, the overall effects of floodplain, tidal, channel margin and riparian habitat restoration activities are expected to be beneficial for longfin smelt (see Impact AQUA-9) because of increased food production associated with the increased habitat and connectivity. While habitat quality is expected to decline in the LLT primarily because of climate change, the overall impact of restoration activities is expected to remain beneficial for longfin smelt because they increase habitat and food resources. Consequently, no mitigation is required.

Other Conservation Measures (CM12–CM19 and CM21)

Impact AQUA-28: Effects of Methylmercury Management on Longfin Smelt (CM12)

Details associated with methylmercury are provided under Impact 8 and Impact 10. The potential effects of methylmercury management on longfin smelt are expected to be similar to those discussed for delta smelt (see Impact AQUA-10 as well as Impact AQUA-8). However, the magnitude of effects would likely be marginally less for longfin smelt, because of their reduced occurrence in the expected restoration areas, relative to the delta smelt.

Impact AQUA-29: Effects of Invasive Aquatic Vegetation Management on Longfin Smelt (CM13)

The following analysis is based on the more detailed analysis included in *BDCP Effects Analysis – Appendix 5F, Biological Stressors, Section F.1.1 Invasive Aquatic Vegetation, Section F.4 Invasive Aquatic Vegetation, and F.5.3.2.3 Nonnative Aquatic Vegetation Control (Conservation Measure 13) (hereby incorporated by reference)*.

A general analysis of the effects on covered fish species has been conducted that was described above for delta smelt (see Impact AQUA-11). Potential impacts on longfin smelt from IAV control during operations are similar to those discussed for delta smelt. Longfin smelt are predominantly found in deeper water habitats and do not commonly occupy shallow waters where IAV is found. For the small proportion of juveniles that do inhabit these shallow areas, removal of IAV could reduce presence of largemouth bass and hence reduce predation impacts on longfin smelt. The control of IAV with implementation of *CM13 Invasive Aquatic Vegetation Control* is expected to maintain or improve turbidity conditions that would potentially benefit longfin smelt rearing conditions, reducing their susceptibility to predation. The control of IAV would also increase the amount of rearing habitat, as well as access to the habitat.

NEPA Effects: IAV control is expected to provide a potential benefit to longfin smelt.

CEQA Conclusion: While implementation of habitat restoration measures (under *CM2 Yolo Bypass Fisheries Enhancement, CM4 Tidal Natural Communities Restoration, CM5 Seasonally Inundated Floodplain Restoration, and CM6 Channel Margin Enhancement*) could allow IAV to become established and increase potential predation levels, implementation of IAV control measures under *CM13 Invasive Aquatic Vegetation Control* are expected to substantially reduce this potential effect. The control of IAV should provide a modest net benefit to longfin smelt by decreasing predator habitat and increasing turbidity. Increased turbidity is expected to reduce the effectiveness of predators to prey on longfin smelt. In addition, controlling IAV is expected to increase the spawning and/or rearing habitat for longfin smelt. Therefore, the control of IAV is expected to have a slight beneficial effect on longfin smelt, consequently, no mitigation would be required.

Impact AQUA-30: Effects of Dissolved Oxygen Level Management on Longfin Smelt (CM14)

As discussed in Chapter 8, *Water Quality*, dissolved oxygen levels would be very similar to Existing Conditions in the areas upstream of the Delta, in the Delta, and in the SWP/CVP export service areas (see discussion of Impacts WQ-10 and WQ-11). As noted there, however, *CM14 Stockton Deepwater Ship Channel Dissolved Oxygen Levels* management would improve the aquatic habitat conditions for fish in the river. Longfin smelt can occur in the channel and the increased dissolved oxygen levels could also provide improved habitat conditions for them which would be a benefit.

NEPA Effects: The effect of dissolved oxygen level management on longfin smelt would likely be beneficial.

CEQA Conclusion: As discussed in Chapter 8, *Water Quality*, *CM14 Stockton Deepwater Ship Channel Dissolved Oxygen Levels* management would improve the upstream migration conditions for fall-run Chinook salmon and steelhead in the San Joaquin River basin. Longfin smelt can occur in the channel and the increased dissolved oxygen levels also provide improved habitat conditions for them, which would be a benefit. Consequently, no mitigation would be required.

Impact AQUA-31: Effects of Localized Reduction of Predatory Fish on Longfin Smelt (CM15)

To the extent that localized predator control efforts of *CM15 Localized Reduction of Predatory Fish* reduce the overall abundance of fish predators in the Delta occupied by longfin smelt, it is possible, but not assured that there would be some reduction in losses to predation, although no quantitative information is available regarding the current magnitude of longfin smelt loss to predation (see Impact AQUA-13).

NEPA Effects: Due to the uncertainties of longfin smelt loss to predation, there would be no demonstrable effect of this conservation measure on longfin smelt.

CEQA Conclusion: Due to the uncertainties concerning overall fish predator reduction and actual predation rates on longfin smelt in the Delta, there would be no demonstrable effect from this conservation measure on longfin smelt. Consequently, no mitigation would be required.

Impact AQUA-32: Effects of Nonphysical Fish Barriers on Longfin Smelt (CM16)

Potential impacts on longfin smelt from the installation of NPBs are expected to be similar to those for delta smelt (see Impact AQUA-14) including that NPBs are not designed to deter longfin smelt and because they are too small to be effectively deterred.

NEPA Effects: There would be no demonstrable effect of NPBs on longfin smelt.

CEQA Conclusion: Potential impacts on longfin smelt from the installation of NPBs are expected to be similar to those for delta smelt (see Impact AQUA-14) including that NPBs are not designed to deter longfin smelt and because they are too small to be effectively deterred. There would be slight reductions in entrainment and they would not be subject to the salvage process which is generally inefficient. Therefore, we conclude that there would be no demonstrable effect on this conservation measure on longfin smelt. Consequently, no mitigation would be required.

Impact AQUA-33: Effects of Illegal Harvest Reduction on Longfin Smelt (CM17)

CM17 Illegal Harvest Reduction would be applied to Chinook salmon, Central Valley steelhead, green sturgeon and white sturgeon and are expected to have positive effects on their populations.

NEPA Effects: Because CM17 is not applied to longfin smelt it would have no direct effect on them. Therefore, this effect is not adverse.

CEQA Conclusion: *CM17 Illegal Harvest Reduction* would be applied to Chinook salmon, Central Valley steelhead, green sturgeon and white sturgeon and are expected to have positive effects on their populations. Since this conservation measure is not applied to longfin smelt it would have no direct effect on them. Consequently, no mitigation would be required.

Impact AQUA-34: Effects of Conservation Hatcheries on Longfin Smelt (CM18)

CM18 Conservation Hatcheries would establish new and expand existing captive conservation propagation programs for delta and longfin smelt. Two programs would be supported. One, a conservation hatchery to house a delta smelt refugial population and to provide a source of delta smelt and longfin smelt for experimentation, supplementation or reintroduction if deemed necessary by wildlife agencies. Two, expansion of the refugial population of delta smelt and establishment of an experimental population of longfin smelt at the University of California Davis Fish Conservation and Culture Laboratory in Byron. There is no evidence that capturing wild longfin smelt for experimental purposes would be harmful at the population level.

NEPA Effects: If longfin smelt abundance continues to decline then this experimental population would be beneficial for longfin smelt.

CEQA Conclusion: *CM18 Conservation Hatcheries* would establish new and expand existing captive conservation propagation programs for longfin smelt. Two programs include a conservation hatchery for refugial longfin smelt (as well as to provide a population for experimentation) and to establish an experimental population at the Byron facility. There is no evidence that capturing wild longfin smelt for experimental purposes would be harmful at the population level. If longfin smelt abundance continues to decline then this experimental population would be beneficial for longfin smelt. Consequently, no mitigation would be required.

Impact AQUA-35: Effects of Urban Stormwater Treatment on Longfin Smelt (CM19)

The effects of urban stormwater treatment (CM19) would reduce contaminants associated with urban areas because it provides for the treatment of stormwater discharges. As discussed in Chapter 8, *Water Quality*, and previously under Impact AQUA-8 in the section titled *Pyrethroids, Organophosphate Pesticides, and Organochlorine Pesticides,* stormwater treatment would reduce urban loadings of pesticides (including pyrethroids), phosphorous, trace metals and other contaminants. These reductions would contribute to improved water quality in the Delta.

NEPA Effects: Based on the improved overall water quality conditions and reduced pesticides the effect would be beneficial.

CEQA Conclusion: Urban stormwater treatment (CM19) would reduce contaminants associated with urban areas because it would provide for the treatment of stormwater discharges. As discussed in Chapter 8, *Water Quality*, and previously under Impact AQUA-8 in the section titled *Pyrethroids, Organophosphate Pesticides, and Organochlorine Pesticides,* stormwater treatment would reduce urban loadings of pesticides(including pyrethroids), phosphorous, trace metals and other water contaminants. These reductions would contribute to improved water quality in the Delta. Therefore the impacts of urban stormwater treatment would be beneficial because it would have a beneficial effect both directly and through habitat modifications on longfin smelt. Consequently, no mitigation would be required.

Impact AQUA-36: Effects of Removal/Relocation of Nonproject Diversions on Longfin Smelt (CM21)

The BDCP may affect entrainment at other diversions by altering Delta hydrodynamics and transport of larvae. As described for delta smelt, the cumulative effect of multiple agricultural diversions operating over a large proportion of the year may result in losses of longfin smelt, with more substantial effects on larvae. However, these losses may be low relative to those of delta smelt because longfin smelt generally exit the Delta earlier than delta smelt, thereby avoiding exposure to agricultural diversions when they are operating at capacity.

Entrainment of particles representing longfin smelt larvae at Delta agricultural diversions ranged from approximately 0 to over 10%. In nearly all PTM runs, there was lower entrainment under Alternative 1A scenarios than baseline scenarios. The average decrease in entrainment under Alternative 1A scenarios compared to baseline scenarios ranged from 2.3 to 3.5%, whereas the average increase under Alternative 1A scenarios was much less (0.0–0.1%). This reduction is uncertain because particle tracking is not necessarily an accurate representation of smelt larval behavior in relation to agricultural intakes.

There is no evidence of substantial entrainment of covered fish species at agricultural diversions in the Plan Area, but some entrainment likely is occurring. Whatever entrainment is occurring would be reduced by decommissioning agricultural diversions in the BDCP ROAs. PTM modeling and extrapolations to a hypothetical number of diversions to be removed from the ROAs (i.e., approximately 4–12% of diversions) gave estimates of up to a 1% reduction in overall loss of longfin smelt larvae because of such decommissioning. Due to the earlier exit of longfin smelt from the Delta, compared to delta smelt, similar reductions would be a conservative estimate for longfin smelt. This reduction is uncertain because particle tracking is not necessarily an accurate representation of smelt larval behavior in relation to agricultural intakes.

NEPA Effects: It is concluded based on the results above that the effect of removal/relocation of nonproject diversions is not adverse and may be beneficial.

CEQA Conclusion: There is no evidence of substantial entrainment of covered fish species at agricultural diversions in the Plan Area, but some entrainment likely is occurring. Whatever entrainment is occurring would be reduced by decommissioning agricultural diversions in the ROAs. PTM modeling and extrapolations to a hypothetical number of diversions to be removed from the ROAs (i.e., approximately 4–12% of diversions) gave estimates of up to a 1% reduction in overall loss of longfin smelt larvae because of such decommissioning. Due to the earlier exit of longfin smelt from the Delta, compared to delta smelt, similar reductions would be a conservative estimate for longfin smelt. This reduction is uncertain because particle tracking is not necessarily an accurate representation of smelt larval behavior in relation to agricultural intakes. Therefore, removal/relocation of nonproject diversions would be considered a beneficial impact because it would reduce entrainment which would have a positive impact on longfin smelt numbers. Consequently, no mitigation would be required.

Chinook Salmon

As noted in *Environmental Setting/Affected Environment*, four races of Chinook salmon can occur in the vicinity of in-water work for the intakes: Sacramento winter, spring, fall, and late fall–run ESUs (see Table 11-4). The area of the Sacramento River affected by construction of the intakes is primarily a migratory corridor for adult salmon returning to upriver spawning habitat and juvenile salmon outmigrating from upriver habitats to the ocean. Each of these Chinook salmon races uses the Delta as migratory and rearing habitat during the migrant adult and juvenile periods of their respective life histories, implying that they would be subject to a similar range of effects from project construction. However, the duration, extent, and timing of occurrence in the lower Sacramento River and the Delta varies between these races, meaning that they would be subject to different stressor exposure and therefore would be subject to a different range of potential effects. Appendix 11A, *Covered Fish Species* details the temporal and spatial distribution of various life history stages for the Chinook salmon ESUs.

Adult and juvenile migrations past the intake locations in the lower Sacramento River occur as follows.

- Winter-run
  - Adults – December through June, with peak in March
  - Juveniles – November through May, with peak November through January
- Spring-run
  - Adults –February through September, with peak in April and May
  - Juveniles – November through May, with peak November through January
- Fall-run
  - Adults – June through December, with peak in September through November
  - Juveniles – November through September, with peak in February through May

- Late fall–run
  - Adults – October through April, with peak in December through February
  - Juveniles – May through February, with peak in October through February

Timing restrictions for in-water construction activities (typically restricted to the June through October period) would avoid the peak migration periods for all Chinook salmon life history types, with the exception of fall-run adult migrants, which would be likely to occur in areas proposed for construction in September or October. There is also some potential overlap in construction timing with early (late fall–run) or late (spring-run) upriver migrants, and with late emigrating juveniles from any of these population types as well. In general, the numbers of Chinook salmon potentially migrating past the site of the intakes during the expected in-water construction window would generally be small in comparison to the overall size of the migratory population.

Ongoing construction activities at tunnel shaft locations in the Delta will require routine barge trips, resulting in noise, disturbance and water quality impacts associated with vessel operations. These activities will take place year-round. Juvenile Chinook salmon and occasionally adult Chinook salmon also may be present near the barge landings during the in-water construction of barge landing sites, and are likely to be present in areas and at times where routine barge traffic would occur. The likelihood of exposure to construction-related effects would be minimized by adherence to the in-water work window, for in-water construction activities. In addition, the noise levels generated by barge and non-pile driving construction activities would not be expected to reach levels that would adversely affect Chinook salmon.

The three ESUs of Chinook salmon are treated for the purposes of this analysis as distinct species.

Winter-Run Chinook Salmon

Construction and Maintenance of CM1

Impact AQUA-37: Effects of Construction of Water Conveyance Facilities on Chinook Salmon (Winter-Run ESU)

Temporary Increases in Turbidity

Construction of Alternative 1A would unavoidably result in the generation and release of suspended sediments to the water column. Increased suspended sediments will temporarily increase water column turbidity, altering habitat conditions for Chinook salmon and other fish species. Small portion of the migratory adult and migrating and rearing juvenile Chinook salmon life history stages would be exposed to construction-related turbidity effects, as these stages would occur within the area affected by implementation of Alternative 1A.

As discussed previously, turbidity is a measure of the scattering of light penetration by dissolved and particulate organic and inorganic matter in the water column, including, but not limited to suspended sediments. However, the term is commonly used to describe suspended sediment effects associated with construction and is applied accordingly here.

The effects of turbidity on salmonids can vary significantly depending on a number of factors, including the magnitude of the effect relative to baseline turbidity conditions, and species- and life stage-specific sensitivity. Low levels of turbidity can actually be beneficial to salmonids by providing cover from predation during foraging activities (DeRobertis et al. 2003). As turbidity levels increase however, vision becomes sufficiently obscured that foraging success and predator avoidance can decrease, resulting in behavioral avoidance and stress. Higher turbidity levels can clog gill tissues, interfering with respiration and increasing physiological stress. Very high turbidity levels can directly damage gill tissues, resulting in overt physical injury and even death.

The construction activities that could result in temporary increases in turbidity are discussed above in Impact AQUA-1 for delta smelt, and in Chapter 8, *Water Quality*. These activities would occur during the expected in-water construction window (typically June 1 and October 31) to minimize the potential effects on Chinook salmon. This timing avoids the peak timing of most juvenile and adult Chinook salmon migrations. However, there is some overlap between construction timing at the Sacramento River intake locations and the late downstream migration of juveniles in June, and some variable overlap in the upstream migrations of winter-, spring-, and fall-run Chinook salmon adults. Low numbers of juvenile Chinook salmon could also be present in the Delta during construction of the tunnel shafts and barge landings, and are likely to be present during the year-round barge operations during construction.

This indicates that some level of Chinook salmon exposure to construction-related turbidity is likely to occur. However, this exposure is not expected to be of sufficient intensity and duration to result in adverse effects on either juvenile or adult Chinook. Timing restrictions will avoid exposure to the majority of turbidity-related effects, and the extent of these effects would also be avoided and minimized by implementing the environmental commitments *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan* (see Appendix 3B, *Environmental Commitments* and Impact AQUA-1 for delta smelt for details of these plans).

Accidental Spills

Construction-related activities may affect water quality due to accidental spills of contaminants, including cement, oil, fuel, hydraulic fluids, paint, and other construction-related materials. Depending on the type and magnitude of an accidental spill, contaminants can directly affect growth and survival of Chinook salmon. Effects on Chinook salmon from accidental spills during construction would be similar to those described for delta smelt (see Impact AQUA-1). Effects would be minimized by implementing the environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*), specifically the *Spill Prevention, Containment, and Countermeasure Plan*.

Disturbance of Contaminated Sediments

Toxic contaminants are present in both water and sediment in the Delta aquatic environment, as described in Chapter 8, *Water Quality*. In-water construction activities would suspend sediments that may contain toxic contaminants (see discussion under Impact AQUA-1 for delta smelt). Potential effects on Chinook salmon from disturbance of contaminated sediments during construction are similar to those described for delta smelt (Impact AQUA-1). Effects would be minimized by implementation of environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management*

Plan; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*).

Underwater Noise

Underwater sound generated by impact pile driving in or near surface waters can potentially harm fish, including Chinook salmon (see Impact AQUA-1). Table 11-4 illustrates the species and life stages of Chinook salmon present in the north, east, and south Delta during the in-water construction window (expected to be June 1–October 31). Winter-run, spring-run, fall-run and late fall–run Chinook salmon eggs and fry would not experience underwater sound because the locations of the intakes and barge landings are not considered suitable habitat for these two life stages of this species, and they would not be present during the expected in-water construction period (June to October). Therefore, these life history stages would not be affected.

Adult winter- and spring-run Chinook salmon could be present near the construction areas of the intakes during a portion of the in-water work window (June and July) toward the end of their upstream migration period. However, adult fall-run Chinook salmon could occur during a much larger portion of the work window (July through October). Most juvenile Chinook salmon would likely occur in low abundance during in-water construction periods in the north Delta.

Table 11-8 illustrates the estimated area where the cumulative SEL injury threshold would be exceeded if impact pile driving is required during construction. All juveniles exposed to underwater noise would be expected to be larger than the 2-gram size threshold, based on the typical length at age and the length to weight relationship observed for Chinook salmon occurring in the Delta (Myers et al. 1998; Kimmerer et al. 2005). On this basis, juveniles exposed to underwater noise in excess of the effects threshold of 187 dB $SEL_{cumulative}$ would be expected to experience injury-level adverse effects. These effects would be avoided and minimized through implementation of Mitigation Measures AQUA-1a and/or AQUA-1b.

Fish Stranding

Adult Chinook salmon and juvenile winter-run Chinook salmon in the Plan area would not be expected to occur in the vicinity of cofferdam placement when these activities take place. The risk of fish entrapment and subsequent handling stress during removal would be minimized by limiting cofferdam construction and other in-water work to the expected in-water work window (June 1 through October 31). Adverse effects would also be minimized through the implementation of environmental commitment *Fish Rescue and Salvage Plan* (see Impact AQUA-1 and Appendix 3B, *Environmental Commitments*).

In-Water Work Activities

As discussed for delta smelt (see Impact AQUA-1), in-water work activities have the potential to adversely affect fish through physical injury from direct exposure to excavation, materials placement, vessel grounding, or other construction related effects, or behavioral alteration associated with these disturbances. Behavioral disturbances could temporarily alter or delay migration behavior during construction activities. Any such delays would be limited in frequency, short in duration, and would take place during periods when few Chinook salmon are expected to be present. Therefore, while adverse effects cannot be entirely discounted, these temporary and intermittent effects would apply to individual fish, but would be unlikely to affect the population as a whole, or reduce the viability of the population in the long-term. affected will be limited.

Furthermore, effects would be minimized by implementation of environmental commitments described in Appendix 3B, *Environmental Commitments*, including *Erosion and Sediment Control Plan*; *Dispose of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Loss of Spawning, Rearing, or Migration Habitat

As noted in Impact AQUA-1 for delta smelt, in-water construction would temporarily or permanently alter the condition of migratory and rearing habitats in the vicinity of the construction activities. The mainstem Sacramento River is designated as critical habitat for all runs of Chinook salmon, providing migration and rearing habitat. Approximately 28.7 acres of in-water habitat and 22,700 linear feet of shoreline habitat would be temporarily inaccessible during in-water work (see Table 11-5). No suitable Chinook salmon spawning habitat is found in the vicinity of the proposed in-water work; therefore, construction would not affect Chinook salmon spawning habitat. Construction of the approach canal and Byron Tract Forebay would not affect fish-accessible waterways and therefore would not affect Chinook salmon. Nevertheless, potential effects would be minimized by implementation of environmental commitments described in Appendix 3B, *Environmental Commitments*, including *Erosion and Sediment Control Plan*; *Dispose of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Predation

As discussed under Impact AQUA-1 for delta smelt, temporary in-water pilings and over-water structures and local temporary increases in turbidity associated with the construction of Alternative 1A may create conditions that could have a localized effect on predation rates of juvenile Chinook salmon. Specifically, temporary overwater and in-water structures would temporarily increase the amount of cover and/or perching areas available for predators. These effects would be most pronounced at the tunnel shaft sites (the vertical wall cofferdams constructed at the intakes would not be expected to provide effective cover for predatory fish). This could theoretically lead to a localized increase in predator density sufficient to affect predation rates on juvenile Chinook salmon. However, a measurable effect on predation rates is unlikely to occur for the following reasons.

- The increase in over-water and in-water structure area is incrementally small in comparison to the NAA, meaning that any localized effect on predation rate would be difficult to measure.
- Predator concentration and predation effectiveness would be constrained to a certain extent by the ongoing disturbance associated with construction activity.

Project construction is also expected to result in periodic short-term turbidity pulses during in-water construction. This could have a variable and offsetting effect on predation rates, depending on the intensity and duration of the turbidity pulse. Low levels of turbidity may actually reduce predation rates on juvenile Chinook salmon by providing visual cover. In contrast, predation exposure could increase if turbidity reaches levels sufficient to induce behavioral avoidance, forcing juveniles to abandon habitats that provide cover from predation. The net effect of anticipated turbidity levels on predation rates is difficult to predict. However, because turbidity levels would be carefully managed to avoid direct adverse effects on juvenile Chinook salmon, the likelihood of biologically significant indirect effects on predation rates is expected to be negligible.

Summary

Construction of Alternative 1A involves several elements with the potential to cause adverse effects on Chinook salmon. However, these effects will be effectively avoided, minimized and/or mitigation in most cases through implementation of appropriate environmental commitments, conservation measures, and mitigation measures. Construction-related turbidity and underwater noise associated with impact pile driving are the most geographically extensive potential effects, with underwater noise having the greatest potential for adverse effects on Chinook salmon.

The majority of potential construction-related adverse effects will be avoided and minimized by construction timing. The in-water work window will minimize Chinook salmon exposure to water quality and disturbance related stressors by limiting in-water construction activities to a time period when Chinook salmon are least likely to be present in the vicinity. In addition, several environmental commitments will be implemented that will avoid and minimize adverse effects by controlling the duration and magnitude of construction related impacts (see Appendix 3B, *Environmental Commitments*). These include *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material;* and development and implementation of a barge operations plan designed to avoid turbidity generation and shoreline erosion from propeller wash and vessel wakes (see Appendix 3B *Environmental Commitments*: *Barge Operations Plan*). Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt. These timing restrictions and environmental commitments are expected to avoid adverse effects on Chinook salmon from construction-related turbidity, accidental spills, and re-suspension and redistribution of potentially contaminated sediments.

Underwater noise associated with pile driving has the greatest potential for adverse effects on Chinook salmon. In general, timing restrictions would limit pile driving to periods when Chinook salmon are least likely to be present in the vicinity of planned activities. Adult winter-, spring-, and fall-run Chinook salmon could occur in the area during the in-water work window, and have a reasonable probability of exposure to underwater noise effects, although their occurrence during this time period is expected to be limited. Adult Chinook would also likely be migrating rapidly through the Delta and the Sacramento River when pile driving activities could be taking place, meaning that the opportunity for cumulative SEL exposure would be limited and exceedances of the cumulative exposure criterion are unlikely. They may experience short delays in migration past the intakes when pile driving is occurring; however, pile driving would occur only intermittently through a portion of the day, and minor migration delays would be unlikely affect their ability to successfully reach spawning grounds. These adverse effects would be further avoided and minimized by restricting impact pile driving to the minimum amount required for construction, and through implementation of the avoidance and minimization measures included in Mitigation Measures AQUA-1a and AQUA-1b. Chinook salmon migratory behavior (seasonal and daily timing) would also be expected to limit the likelihood of adverse effects. While adverse effects may occur to individual fish, there is no indication that the effects would adversely affect the overall population or the long-term viability of the population.

The likelihood of juvenile winter-run Chinook salmon being in the vicinity when impact driving could take place is low. In addition to their timing in the Delta, the habitat at the intake and barge landing locations is considered poor because of relatively steep rip rap banks and deep channels with little refuge, which may further limit the overall abundance of juvenile Chinook salmon.

Therefore, the potential for juvenile winter-run Chinook salmon to experience an adverse effect (e.g., injury or mortality, or migratory disturbance) would be low because of their low temporal and spatial migration distribution around the intake and barge facility construction areas, and the intermittent nature of potential exposure above the threshold criterion. While underwater noise from impact pile driving could affect individual Chinook salmon, the effect would be unlikely to adversely affect Chinook salmon populations. Therefore, the effect would not be adverse.

Implementation of environmental commitments *Fish Rescue and Salvage Plan* and *Barge Operations Plan* (as described in Appendix 3B) would also offset potential effects of construction activities on Chinook salmon. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt. Construction of the approach canal and Byron Tract Forebay would not affect fish-accessible waterways and therefore would not affect Chinook salmon. As a result, these construction activities would not be expected to result in adverse effects on Chinook salmon.

The construction of the intakes and barge landings will temporarily affect rearing and migration habitat, and the intakes screens will permanently alter habitat in the Sacramento River. Despite the relatively poor quality of the current habitat, it is designated critical habitat for Chinook salmon. However, implementation of *CM6 Channel Margin Enhancement* would enhance channel margin habitat along 20 miles of the Sacramento River, including the vicinity of the intake structures, and would be designed to result in a net improvement in channel margin habitat function. Therefore, the temporary and permanent effects on rearing and migration habitat would not be expected to adversely affect Chinook salmon populations.

NEPA Effects: Overall, the effect would not be expected to be adverse for winter-run Chinook salmon.

CEQA Conclusion: The potential impact on Chinook salmon from construction activities would be considered less than significant due to implementation of the environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*, such as *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*. These measures would be expected to protect Chinook salmon from any adverse water quality effect (turbidity, hazardous spills) resulting from project construction. Construction would not be expected to increase predation rates relative to Existing Conditions. Construction associated with Alternative 1A will result in both temporary and permanent alteration of rearing and migratory habitats used by Chinook salmon. However, these effects are not expected to be significant because the loss of habitat is not substantial compared to the amount of habitat currently available in combination with the amount of new habitat that would result from restoration. The direct effects of underwater construction noise on Chinook salmon would be a significant impact because of the high likelihood that it would cause injury or death to most impacted fish in the immediate vicinity of the activity. However, implementation of Mitigation Measures AQUA-1a and AQUA-1b would minimize the potential effects from underwater noise and would reduce the severity of impacts to a less-than-significant level.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 for delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 for delta smelt.

Impact AQUA-38: Effects of Maintenance of Water Conveyance Facilities on Chinook Salmon (Winter-Run ESU)

Temporary Increases in Turbidity

As discussed for construction-related effects of turbidity on salmonids (Impact AQUA-37), increased turbidity could result in a decreased ability to forage or physical injury to the gills. However, increased turbidity can also decrease predation rates by sight predators, potentially increasing survival rates. In-water maintenance activities would typically occur between June 1 and October 31 when winter-run Chinook salmon are minimally present in the Sacramento River. In-water activities would be limited in duration and infrequent. Effects would also be minimized by implementing the environmental commitments described in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*). Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Accidental Spills

The potential effects of maintenance activities would be similar to those discussed for construction-related effects (see Impact AQUA-1 for delta smelt). Effects would be minimized by implementing the environmental commitments in Appendix 3B, *Environmental Commitments*. These environmental commitments include *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Underwater Noise

As discussed for delta smelt (see Impact AQUA-2 for delta smelt), underwater noise levels produced by in-water maintenance activities are not expected to reach a level that would harm juvenile or adult fishes. NMFS has found that underwater sound pressure levels less than the 150 dB RMS behavioral effects threshold may result in temporary altered behavior of fishes indicative of stress but would not result in permanent harm or injury (National Marine Fisheries Service 2001).

Maintenance-Related Disturbance

The potential effects of in-water maintenance activities would be similar to those discussed for construction-related effects (see Impact AQUA-2 for delta smelt). Effects would be minimized by implementing environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*, and by limiting the use of these habitats to during the expected in-water construction window. These environmental commitments include *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous*

Materials Management Plan; *Spill Prevention, Containment, and Countermeasure Plan;* and *Barge Operations Plan*. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Loss of Spawning, Rearing, or Migration Habitat

Two maintenance activities, dredging and riprap placement, would reduce habitat values in the area around the intakes. Removal of sediment would decrease the number of macroinvertebrates around the intakes. This could cause a temporary loss of prey resources of juvenile Chinook salmon, and a temporary reduction in migration habitat. However available rearing and migration habitat of similar quantity and quality would be readily accessible to Chinook salmon in adjacent areas. These maintenance activities would also occur when few Chinook would occur in the area, and the habitat would recover relatively quickly. In addition, no Chinook salmon spawning habitat occurs in these areas. Furthermore, potential effects would be minimized by implementation of environmental commitments described in Appendix 3B, *Environmental Commitments*. These environmental commitments include *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan;* and *Dispose of Spoils, Reusable Tunnel Material, and Dredged Material*. Pertinent details of these plans are provided under Impact AQUA-1.

Predation

Maintenance activities would be unlikely to have any measurable effect on winter-run Chinook predation rates. These activities may include the use of barges and other watercraft that could theoretically provide cover, shelter, and perching areas for winter-run Chinook predators. However, the limited duration of maintenance activities and the associated noise and disturbance would be expected to dissuade predators from concentrating at sufficient density to measurably affect predation rates on winter-run Chinook.

Summary

In-water maintenance activities would be scheduled to occur when the least numbers of Chinook salmon would be present in or near the maintenance areas. Such activities would include maintenance dredging at the intake sites, and installation or repair of riprap bank armoring. Implementing the environmental commitments described in Appendix 3B, *Environmental Commitments*, would further minimize or eliminate effects on Chinook salmon by reducing the amount of turbidity and guiding the rapid and effective response in the case of inadvertent spills of hazardous materials. These environmental commitments include *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Implementation of these environmental commitments, along with the low numbers of Chinook salmon expected to occur in the maintenance areas during the expected in-water work windows and the limited frequency and duration of in-water maintenance activities, would result in a very low potential for adverse effects on Chinook salmon. In addition, no spawning habitat occurs in the areas potentially affected by maintenance activities, and ample rearing, and migration habitat of the same quality is readily accessible in the area, and this habitat would not be affected by maintenance activities.

NEPA Effects: The short-term maintenance activities would not adversely affect Chinook salmon populations.

CEQA Conclusion: In addition to the limited frequency and duration of in-water maintenance activities, implementation of the commitments identified above and described in detail in Appendix 3B, *Environmental Commitments*, would minimize the potential for maintenance activities to affect Chinook salmon populations by reducing the amount of turbidity and guiding the rapid and effective response to inadvertent spills of hazardous materials. These environmental commitments, described in greater detail under Impact AQUA-1 for delta smelt, include *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*. Potential changes to rearing and migratory habitat would also be limited and temporary. Therefore, the potential impact of maintenance activities is considered less than significant because it would not substantially reduce Chinook salmon habitat, restrict its range, or interfere with its movement. Consequently, no mitigation would be required.

Water Operations of CM1

Impact AQUA-39: Effects of Water Operations on Entrainment of Chinook Salmon (Winter-Run ESU)

Water Exports from SWP/CVP South Delta Facilities

An entrainment index of winter-run Chinook salmon at the South Delta facilities was estimated using the salvage-density method and normalized by measures of annual adult population abundance in the year of entrainment (as detailed in *BDCP Effects Analysis - Appendix 5.B, Section 5.B.4*, *herein incorporated by reference*). Under NAA, losses of juvenile winter-run Chinook salmon begin in December, peak in March at both facilities, and sharply decline in April.

The average entrainment index under Alternative 1A would be reduced by 60% across all water years compared to NAA (Table 11-1A-9). Entrainment would be substantially reduced in wet, above-normal, and below-normal water year types (50-87% less than NAA) and would be slightly reduced in dry and critical water year types (7-8% less than NAA). Pre-screen predation losses at the south Delta facilities would also decrease commensurate with the reductions in entrainment described above.

To put this into context, the relative magnitude of entrainment loss, as estimated by salvage density, can be compared with a general index of juvenile population abundance (as detailed in *BDCP Effects Analysis – Appendix 5.B, Section 5B.5.4.4, herein incorporated by reference)*. For winter-run Chinook salmon, NMFS calculates a juvenile production estimate of juveniles passing Red Bluff Diversion Dam (mean value 1994 to 2009 about 1 million fish) and assumes 50% mortality during downstream migration. The general index of winter-run juvenile abundance reaching the Delta is 500,000 fish. Proportional losses averaged across all years were 1.4% under NAA and decreased to 0.5–0.6% under Alternative 1A scenarios.

Table 11-1A-9. Juvenile Winter-Run Chinook Salmon Annual Entrainment Index[a] at the SWP and CVP Salvage Facilities—Differences between Model Scenarios for Alternative 1A

	Absolute Difference (Percent Difference)	
Water Year	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Wet	-9,862 (-87%)	-10,282 (-87%)
Above Normal	-5,115 (-77%)	-5,239 (-78%)
Below Normal	-3,827 (-53%)	-3,403 (-50%)
Dry	-569 (-15%)	-262 (-8%)
Critical	-213 (-17%)	-74 (-7%)
All Years	-4,129 (-61%)	-4,069 (-60%)

Shading indicates >10% increased entrainment.

Note: Estimated annual index of fish lost, based on normalized salvage densities.

Water Exports from SWP/CVP North Delta Intake Facilities

Entrainment of winter-run Chinook salmon at the north Delta intakes would occur only under the action alternatives, including Alternative 1A, because there are no north Delta intakes operational under NAA conditions. The north Delta intakes would be screened to exclude juvenile fish, including juvenile winter-run Chinook salmon. The state-of-the-art, positive barrier screens would be designed and built to specifications developed to reduce the risk of entrainment and impingement, and are expected to be effective at excluding all life stages of winter-run Chinook salmon that would occur in the vicinity including juveniles outmigrating during December-April (as evaluated in *BDCP Effects Analysis – Appendix 5B, Entrainment, Section B.6.2.1, hereby incorporated by reference)*. The timing of occurrence would be similar to that discussed above for the south Delta facilities, typically December-April, and peaking in March. The project's adaptive management plan includes monitoring of the new screens to determine their effectiveness. If the screens are not meeting expectations, additional measures may be implemented to improve screen performance, such as modifications to the screens or other structural components at the intakes, or changes in water diversion operations to reduce entrainment or impingement rates of juvenile winter-run Chinook salmon.

Water Exports with a Dual Conveyance for the SWP North Bay Aqueduct

Entrainment of winter-run Chinook salmon (juveniles and smolts) at the North Bay Aqueduct has not been explicitly analyzed. However, the Barker Slough Pumping Plant is screened for fish >25mm and the alternative intake would presumably have screens of 1.75-m mesh. Based on the north Delta intake analysis (*BDCP Effects Analysis – Appendix 5B Entrainment, Section B.5.9 Entrainment and Impingement (SWP/CVP North Delta Intakes), hereby incorporated by reference*), it would be expected to be 100% screened for salmon based on typical fish size and mesh size.

Monitoring would occur to ensure that fish are indeed being excluded according to the design specifications. If monitoring indicates that screen effectiveness is not meeting expectations, the BDCP-proposed Real-Time Response Team would implement additional measures to reduce entrainment or impingement, such as modifications to the screens or intakes, or changes in water diversion operations. Based on the aforementioned analysis and assumptions, additional measures to reduce entrainment would not be necessary.

NEPA Effects: Alternative 1A would reduce entrainment of juvenile winter-run Chinook salmon at the South Delta facilities by approximately 60% compared to NAA. Operations at the proposed north Delta intake facilities and the NBA Alternative Intake would potentially entrain juveniles, but this would be minimized by installation of state-of-the-art fish screens and operations with an adaptive management program. There would not be an adverse effect, and the overall effect is expected to be beneficial.

CEQA Conclusion: As described above, operational activities associated with reduced water exports from SWP/CVP south Delta facilities under Alternative 1A would result in an overall decrease in entrainment for juvenile winter-run Chinook salmon (on average 61% decrease compared to Existing Conditions). At the same time, operational activities associated with water exports from SWP/CVP north Delta intake facilities would result in an increase in entrainment or a loss of individuals for salmon at that location. However, because the intakes would be equipped with state of the art screens, compared to the south Delta facilities, entrainment is expected to be reduced as a whole. The potential impacts of Alternative 1A water operations on entrainment of winter-run Chinook salmon would be beneficial. Consequently, no mitigation would be required.

Impact AQUA-40: Effects of Water Operations on Spawning and Egg Incubation Habitat for Chinook Salmon (Winter-Run ESU)

In general, Alternative 1A would reduce the quantity and quality of spawning and egg incubation habitat for winter-run Chinook salmon relative to NAA.

Flows in the Sacramento River between Keswick and upstream of Red Bluff Diversion Dam were examined during the May through September winter-run spawning period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Lower flows can reduce the instream area available for spawning and egg incubation. Flows under A1A_LLT during May, June, and July would generally be similar to or greater than flows under NAA. Flows under A1A_LLT during August and September would generally be lower than flows under NAA by up to 45%. These results indicate that there would be intermittent negligible to small flow-related effects of Alternative 1A on spawning and egg incubation habitat.

Shasta Reservoir storage volume at the end of May influences flow rates below the dam during the May through September winter-run spawning and egg incubation period. May Shasta storage volume under A1A_LLT would be similar to or up to 8% lower than storage under NAA for all water year types (Table 11-1A-10).

Table 11-1A-10. Difference and Percent Difference in May Water Storage Volume (thousand acre-feet) in Shasta Reservoir for Alternative 1A Model Scenarios

Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Wet	-85 (-2%)	-51 (-1%)
Above Normal	-169 (-4%)	-82 (-2%)
Below Normal	-518 (-13%)	-320 (-8%)
Dry	-647 (-17%)	-202 (-6%)
Critical	-618 (-25%)	-35 (-2%)

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the May through September winter-run spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period at either location.

The number of days on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month (May through September) and year of the 82-year modeling period (Table 11-1A-11). The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern", as defined in Table 11-1A-12. Levels of concern were used to examine variation in temperature results and were not meant to be biologically meaningful. Differences between baselines and Alternative 1A in the highest level of concern across all months and all 82 modeled years are presented in Table 11-1A-13. There would be no difference in levels of concern between NAA and Alternative 1A.

Table 11-1A-11. Maximum Water Temperature Criteria for Covered Salmonids and Sturgeon Provided by NMFS and Used in the BDCP Effects Analysis

Location	Period	Maximum Water Temperature (°F)	Purpose
Upper Sacramento River			
Bend Bridge	May–Sep	56	Winter- and spring-run spawning and egg incubation
		63	Green sturgeon spawning and egg incubation
Red Bluff	Oct–Apr	56	Spring-, fall-, and late fall–run spawning and egg incubation
Hamilton City	Mar–Jun	61 (optimal), 68 (lethal)	White sturgeon spawning and egg incubation
Feather River			
Robinson Riffle (RM 61.6)	Sep–Apr	56	Spring-run and steelhead spawning and incubation
	May–Aug	63	Spring-run and steelhead rearing
Gridley Bridge	Oct–Apr	56	Fall- and late fall–run spawning and steelhead rearing
	May–Sep	64	Green sturgeon spawning, incubation, and rearing
American River			
Watt Avenue Bridge	May–Oct	65	Juvenile steelhead rearing

Table 11-1A-12. Number of Days per Month Required to Trigger Each Level of Concern for Water Temperature Exceedances in the Sacramento River for Covered Salmonids and Sturgeon Provided by NMFS and Used in the BDCP Effects Analysis

Exceedance above Water Temperature Threshold (°F)	Level of Concern			
	None	Yellow	Orange	Red
1	0-9 days	10-14 days	15-19 days	≥20 days
2	0-4 days	5-9 days	10-14 days	≥15 days
3	0 days	1-4 days	5-9 days	≥10 days

Table 11-1A-13. Differences between Baseline and Alternative 1A Scenarios in the Number of Years in Which Water Temperature Exceedances above 56°F Are within Each Level of Concern, Sacramento River at Bend Bridge, May through September

Level of Concern[a]	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Red	33 (67%)	0 (0%)
Orange	-15 (-100%)	0 (NA)
Yellow	-15 (-100%)	0 (NA)
None	-3 (-100%)	0 (NA)

NA = could not be calculated because the denominator was 0.
[a] For definitions of levels of concern, see Table 11-1A-12.

Total degree-days exceeding 56°F at Bend Bridge were summed by month and water year type during May through September (Table 11-1A-14). Total degree-days under Alternative 1A would be up to 15% lower than under NAA during May and June and up to 20% higher during July through September.

Table 11-1A-14. Differences between Baseline and Alternative 1A Scenarios in Total Degree-Days (°F-Days) by Month and Water Year Type for Water Temperature Exceedances above 56°F in the Sacramento River at Bend Bridge, May through September

Month	Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
May	Wet	953 (253%)	-249 (-16%)
	Above Normal	226 (106%)	-129 (-23%)
	Below Normal	453 (207%)	-10 (-1%)
	Dry	180 (97%)	-234 (-39%)
	Critical	413 (187%)	3 (0%)
	All	2,224 (183%)	-620 (-15%)
June	Wet	321 (84%)	-390 (-36%)
	Above Normal	90 (61%)	-139 (-37%)
	Below Normal	394 (283%)	42 (9%)
	Dry	570 (303%)	36 (5%)
	Critical	597 (149%)	47 (5%)
	All	1,972 (157%)	-404 (-11%)
July	Wet	760 (147%)	154 (14%)
	Above Normal	383 (473%)	113 (32%)
	Below Normal	876 (596%)	420 (70%)
	Dry	1,349 (478%)	421 (35%)
	Critical	1,845 (224%)	59 (2%)
	All	5,213 (281%)	1,167 (20%)
August	Wet	2,217 (318%)	254 (10%)
	Above Normal	933 (229%)	274 (26%)
	Below Normal	1,358 (512%)	323 (25%)
	Dry	2,236 (334%)	626 (27%)
	Critical	2,751 (185%)	132 (3%)
	All	9,494 (269%)	1,607 (14%)
September	Wet	2,398 (325%)	1,689 (117%)
	Above Normal	997 (140%)	597 (54%)
	Below Normal	1,385 (186%)	239 (13%)
	Dry	2,531 (198%)	-65 (-2%)
	Critical	1,867 (90%)	-24 (-1%)
	All	9,182 (165%)	2,437 (20%)

The Reclamation egg mortality model predicts that winter-run Chinook salmon egg mortality in the Sacramento River under A1A_LLT would be similar to mortality under NAA except in above normal, below normal and dry water years (13% 120%, and 9% higher, respectively). The increase in the percent of winter-run population subject to mortality would be less than 2% in all water years. Therefore, the increase in mortality of 9% to 120% from NAA to A1A_LLT, although relatively large, would be negligible at an absolute scale to the winter-run population (Table 11-1A-15). These results indicate that climate change would cause the majority of the increase in winter-run egg mortality.

Table 11-1A-15. Difference and Percent Difference in Percent Mortality of Winter-Run Chinook Salmon Eggs in the Sacramento River (Egg Mortality Model)

Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Wet	1 (264%)	-0.1 (-4%)
Above Normal	2 (413%)	0.3 (13%)
Below Normal	3 (310%)	2 (120%)
Dry	7 (423%)	1 (9%)
Critical	43 (158%)	-2 (-2%)
All	9 (189%)	0.3 (2%)

SacEFT predicts that there would be a 28% decrease in the percentage of years with good spawning availability, measured as weighted usable area, under A1A_LLT relative to NAA (Table 11-1A-16). SacEFT predicts that the percentage of years with good (lower) redd scour risk under A1A_LLT would be similar to the percentage of years under NAA. SacEFT predicts that the percentage of years with good egg incubation conditions under A1A_LLT would be similar to that under NAA. SacEFT predicts that the percentage of years with good (lower) redd dewatering risk under A1A_LLT would be 17% lower compared to NAA. These results indicate that there would be moderate effects of Alternative 1A on spawning habitat.

Table 11-1A-16. Difference and Percent Difference in Percentage of Years with "Good" Conditions for Winter-Run Chinook Salmon Habitat Metrics in the Upper Sacramento River (from SacEFT)

Metric	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Spawning WUA	-35 (-60%)	-9 (-28%)
Redd Scour Risk	0 (0%)	0 (0%)
Egg Incubation	-25 (-26%)	-2 (-3%)
Redd Dewatering Risk	-1 (-4%)	-5 (-17%)
Juvenile Rearing WUA	-8 (-16%)	17 (68%)
Juvenile Stranding Risk	-15 (-75%)	-26 (-84%)

WUA = Weighted Usable Area.

NEPA Effects: Considering the results presented here for winter-run Chinook salmon spawning and egg incubation, this effect would be adverse because it has the potential to substantially reduce suitable spawning habitat and substantially reduce the number of fish as a result of egg mortality. Flows during August and September would be moderately lower under Alternative 1A. In addition, the total degree-days exceeding the 56°F NMFS threshold at Bend Bridge would be 14% to 20% greater than the total under the NEPA baseline during three of the five months examined. Combining these results with those of the SacEFT model, which predicts that the number of years with good winter-run spawning habitat would be reduced by 28% and the number of years with good (low) redd dewatering risk would be 17% lower under Alternative 1A (Table 11-1A-16), the impact is adverse to winter-run Chinook salmon. This effect is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this effect to a level that is not adverse would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this would be an unavoidable adverse effect because there is no feasible mitigation.

CEQA Conclusion: In general, Alternative 1A would reduce the quantity and quality of spawning and egg incubation habitat for winter-run Chinook salmon relative to the Existing Conditions.

CALSIM flows in the Sacramento River between Keswick and upstream of Red Bluff were examined during the May through September winter-run spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would generally be similar to or greater than flows under Existing Conditions during May and June and generally lower by up to 26% during July, August, and September.

Shasta Reservoir storage volume at the end of May under A1A_LLT would be similar to Existing Conditions in wet and above normal water years, but 13% to 25% lower in the other below normal, dry, and critical water years (Table 11-1A-10). This indicates that there would be a small to moderate effect of Alternative 1A on flows during the spawning and egg incubation period.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the May through September winter-run spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 1A during May and June. Mean monthly water temperature would be up to 14% higher under Alternative 1A in July through September depending on month, water year type, and location.

The number of days on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month (May through September) and year of the 82-year modeling period (Table 11-1A-11). The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern", as defined in Table 11-1A-12. The number of years classified as "red" would increase by 67% under Alternative 1A relative to Existing Conditions (Table 11-1A-13).

Total degree-days exceeding 56°F at Bend Bridge were summed by month and water year type during May through September (Table 11-1A-14). Total degree-days under Alternative 1A would be 157% to 281% higher than that under Existing Conditions depending on month throughout the period.

The Reclamation egg mortality model predicts that winter-run Chinook salmon egg mortality in the Sacramento River under A1A_LLT would be 158 to 423% greater than mortality under Existing Conditions depending on water year type (Table 11-1A-15). These increases would only affect the winter-run population during dry and critical years, in which the absolute percent increase of the winter-run population would be 7 and 43%, respectively. These results indicate that Alternative 1A would cause increased winter-run Chinook salmon mortality in the Sacramento River.

SacEFT predicts that there would be a 60% decrease in the percentage of years with good spawning availability, measured as weighted usable area, under A1A_LLT relative to Existing Conditions (Table 11-1A-16). SacEFT predicts that the percentage of years with good (lower) redd scour risk under A1A_LLT would be similar to the percentage of years under Existing Conditions. SacEFT predicts that the percentage of years with good egg incubation conditions under A1A_LLT would be 26% lower than under Existing Conditions. SacEFT predicts that the percentage of years with good (lower) redd dewatering risk under A1A_LLT would be 4% lower than the percentage of years under Existing Conditions. These results indicate that Alternative 1A would cause small to moderate reductions in spawning WUA and egg incubation conditions.

Collectively, these results indicate that the impact would be significant because it has the potential to substantially reduce suitable spawning habitat and substantially reduce the number of fish as a result of egg mortality. Egg mortality in drier years, during which winter-run Chinook salmon would already be stressed due to reduced flows and increased temperatures, would be up to 43% greater on an absolute scale due to Alternative 1A compared to the Existing Conditions (Table 11-1A-15). Further, the extent of spawning habitat would be 60% lower due to Alternative 1A compared to the Existing Conditions (Table 11-1A-16), which represents a substantial reduction in spawning habitat and, therefore, in adult spawner and redd carrying capacity. This impact is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this impact to a less-than-significant level would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this impact is significant and unavoidable because there is no feasible mitigation available. Even so, proposed below is mitigation that has the potential to reduce the severity of impact though not necessarily to a less-than-significant level.

Mitigation Measure AQUA-40a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Winter-Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Spawning Habitat

Although analysis conducted as part of the EIR/EIS determined that Alternative 1A would have significant and unavoidable adverse effects on spawning habitat, this conclusion was based on the best available scientific information at the time and may prove to have been over- or understated. Upon the commencement of operations of CM1 and continuing through the life of the permit, the BDCP proponents will monitor effects on spawning habitat in order to determine whether such effects would be as extensive as concluded at the time of preparation of this document and to determine any potentially feasible means of reducing the severity of such effects. This mitigation measure requires a series of actions to accomplish these purposes, consistent with the operational framework for Alternative 1A.

The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 1A operations only. Development of mitigation actions for the incremental impact on spawning habitat attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 1A.

Mitigation Measure AQUA-40b: Conduct Additional Evaluation and Modeling of Impacts on Winter-Run Chinook Salmon Spawning Habitat Following Initial Operations of CM1

Following commencement of initial operations of CM1 and continuing through the life of the permit, the BDCP proponents will conduct additional evaluations to define the extent to which modified operations could reduce impacts to spawning habitat under Alternative 1A. The analysis required under this measure may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6).

Mitigation Measure AQUA-40c: Consult with USFWS and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Winter-Run Chinook Salmon Spawning Habitat Consistent with CM1

In order to determine the feasibility of reducing the effects of CM1 operations on winter-run Chinook salmon habitat, the BDCP proponents will consult with USFWS and the Department of Fish and Wildlife to identify and implement any feasible operational means to minimize effects on spawning habitat. Any such action will be developed in conjunction with the ongoing monitoring and evaluation of habitat conditions required by Mitigation Measure AQUA-40a.

If feasible means are identified to reduce impacts on spawning habitat consistent with the overall operational framework of Alternative 1A without causing new significant adverse impacts on other covered species, such means shall be implemented. If sufficient operational flexibility to reduce effects on winter-run Chinook salmon habitat is not feasible under Alternative 1A operations, achieving further impact reduction pursuant to this mitigation measure would not be feasible under this Alternative, and the impact on winter-run Chinook salmon would remain significant and unavoidable.

Impact AQUA-41: Effects of Water Operations on Rearing Habitat for Chinook Salmon (Winter-Run ESU)

In general, Alternative 1A would reduce the quantity and quality of rearing habitat for fry and juvenile winter-run Chinook salmon relative to NAA.

Sacramento River flows upstream of Red Bluff were examined for the juvenile winter-run Chinook salmon rearing period (August through December) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Lower flows can lead to reduced extent and quality of fry and juvenile rearing habitat. Flows under A1A_LLT would generally be similar to or greater than flows under NAA during October and December, and generally lower during August, September, and November by up to 44%.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the August through December winter-run juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period at either location.

SacEFT predicts that the percentage of years with good juvenile rearing habitat availability, measured as weighted usable area, under A1A_LLT would be 68% greater than the percentage of years under NAA (Table 11-1A-16). In addition, the percentage of years with good (low) juvenile stranding risk under A1A_LLT is predicted to 84% lower than under NAA. This indicates that, while the quantity of juvenile rearing habitat in the Sacramento River would be greater, the quality, measured as stranding risk, would be substantially reduced under A1A_LLT relative to NAA.

SALMOD predicts that winter-run smolt equivalent habitat-related mortality under A1A_LLT would have a negligible difference (<5%) in habitat-related mortality compared with NAA.

NEPA Effects: Collectively, these results indicate that the effect is adverse because it has the potential to substantially reduce the amount of suitable habitat and substantially interfere with the movement of fish. Differences in flows, although small, are consistent among most months and water year types. In addition, effects on juvenile stranding risk are substantially negative (26%

absolute scale, or 84% relative scale reduction). This effect is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this effect to a level that is not adverse would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this would be an unavoidable adverse effect because there is no feasible mitigation available.

CEQA Conclusion: In general, Alternative 1A would reduce the quantity and quality of fry and juvenile rearing habitat for winter-run Chinook salmon relative to the Existing Conditions.

Sacramento River flows upstream of Red Bluff were examined for the juvenile winter-run Chinook salmon rearing period (August through December) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would generally be similar to or greater than flows under Existing Conditions during October and December, but up to 24% lower than Existing Conditions during August, September, and November.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the August through December winter-run rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperature would be up to 14% higher under Alternative 1A in July through October depending on month, water year type, and location. There would be no differences (<5%) between Existing Conditions and Alternative 1A in mean monthly water temperature during November and December at either location.

SacEFT predicts that the percentage of years with good juvenile rearing habitat availability, measured as weighted usable area, under A1A_LLT would be 16% lower than under Existing Conditions (Table 11-1A-16). In addition, the percentage of years with good (low) juvenile stranding risk under A1A_LLT is predicted to be substantially (75%) lower than under Existing Conditions. This indicates that the quantity and quality of juvenile rearing habitat in the Sacramento River would be lower under A1A_LLT relative to Existing Conditions.

SALMOD predicts that winter-run smolt equivalent habitat-related mortality under A1A_LLT would be 10% higher than under Existing Conditions.

These results indicate that the impact would be significant because it has the potential to substantially reduce the amount of suitable habitat and substantially interfere with the movement of fish. Differences in flows are moderately large during the majority of months and water year types. Further, a 16% reduction in rearing habitat quantity and 75% increase in stranding risk would reduce upstream habitat conditions for winter-run fry and juveniles. SALMOD predicts a 10% increase in habitat-related mortality of winter-run smolt equivalents under Alternative 1A. This impact is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this impact to a less-than-significant level would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this impact is significant and unavoidable because there is no feasible mitigation available. Even so, proposed below is mitigation that has the potential to reduce the severity of impact though not necessarily to a less-than-significant level.

Mitigation Measure AQUA-41a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Winter-Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Rearing Habitat

Although analysis conducted as part of the EIR/EIS determined that Alternative 1A would have significant and unavoidable adverse effects on rearing habitat, this conclusion was based on the best available scientific information at the time and may prove to have been over- or understated. Upon the commencement of operations of CM1 and continuing through the life of the permit, the BDCP proponents will monitor effects on rearing habitat in order to determine whether such effects would be as extensive as concluded at the time of preparation of this document and to determine any potentially feasible means of reducing the severity of such effects. This mitigation measure requires a series of actions to accomplish these purposes, consistent with the operational framework for Alternative 1A.

The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 1A operations only. Development of mitigation actions for the incremental impact on rearing habitat attributable to climate change/sea level rise compared to Existing Conditions are not required because these changed conditions would occur with or without implementation of Alternative 1A.

Mitigation Measure AQUA-41b: Conduct Additional Evaluation and Modeling of Impacts on Winter-Run Chinook Salmon Rearing Habitat Following Initial Operations of CM1

Following commencement of initial operations of CM1 and continuing through the life of the permit, the BDCP proponents will conduct additional evaluations to define the extent to which modified operations could reduce impacts to rearing habitat under Alternative 1A. The analysis required under this measure may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6).

Mitigation Measure AQUA-41c: Consult with USFWS and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Winter-Run Chinook Salmon Rearing Habitat Consistent with CM1

In order to determine the feasibility of reducing the effects of CM1 operations on winter-run Chinook salmon habitat, the BDCP proponents will consult with USFWS and the Department of Fish and Wildlife to identify and implement any feasible operational means to minimize effects on rearing habitat. Any such action will be developed in conjunction with the ongoing monitoring and evaluation of habitat conditions required by Mitigation Measure AQUA-41a.

If feasible means are identified to reduce impacts on rearing habitat consistent with the overall operational framework of Alternative 1A without causing new significant adverse impacts on other covered species, such means shall be implemented. If sufficient operational flexibility to reduce effects on winter-run Chinook salmon habitat is not feasible under Alternative 1A operations, achieving further impact reduction pursuant to this mitigation measure would not be feasible under this Alternative, and the impact on winter-run Chinook salmon would remain significant and unavoidable.

Impact AQUA-42: Effects of Water Operations on Migration Conditions for Chinook Salmon (Winter-Run ESU)

In general, Alternative 1A would affect migration conditions for winter-run Chinook salmon relative to NAA.

Upstream of the Delta

Flows in the Sacramento River upstream of Red Bluff were examined for the July through November juvenile emigration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*. A reduction in flow may reduce the ability of juvenile winter-run Chinook salmon to migrate effectively down the Sacramento River. Flows under A1A_LLT would generally be similar or up to 36% greater to flows under NAA in July and October, and generally lower than NAA flows during August, September, and November, in which flows would be up to 44% lower under A1A_LLT.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the July through November winter-run juvenile emigration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period at either location.

Flows in the Sacramento River upstream of Red Bluff were examined during the adult winter-run Chinook salmon upstream migration period (December through August). A reduction in flows may reduce the olfactory cues needed by adult winter-run to return to natal spawning grounds in the upper Sacramento River. Flows under A1A_LLT would generally be similar to or greater than those under NAA except during August, in which flows would be up to 19% lower under A1A_LLT.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the December through August winter-run upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period at either location.

Through-Delta

Juveniles

The effects of Alternative 1A on juvenile winter-run Chinook salmon were evaluated by examining changes in flows downstream of the north Delta diversion, estimated predation losses associated with these intakes, and modeled survival by the Delta Passage Model.

Sacramento River flows

As discussed in the *BDCP Effects Analysis – Appendix 5.C Flow* (*Section 5.5.3.2*), Plan Area flows have considerable importance for downstream migrating juvenile salmonids, as shown by studies in which through-Delta survival of Chinook salmon smolts positively correlated with flow (Newman 2003; Perry et al. 2010), although Zeug and Cavallo (2012) did not find evidence for effects of inflow on the probability of recovery of coded-wire-tagged Chinook salmon in ocean fisheries. Flow-related survival, in terms of the influence of downstream river (net) flow, may be more important in areas with largely unidirectional downstream flow as opposed to strong tidal influence, for tidal influence progressively becomes much greater with movement downstream (see *BDCP Effects Analysis – Appendix 5.C, Flow, Passage, Salinity, and Turbidity, Section 5.C.5.3.1.11.1* for discussion of context of flow changes). The Delta Passage Model (DPM), for example, does not include a net flow-survival relationship in the Sacramento River below Rio Vista because such a relationship is not supported by existing data (*BDCP Effects Analysis – Appendix 5.C, Section 5.C.4.3.2.2*). Dispersal of smaller, fry-sized Chinook salmon that may forage and rear in the Plan Area for longer periods of time is also related to flows upstream and within the Plan Area (Kjelson et al. 1982; Brandes and McLain 2001). Foraging winter-run Chinook salmon spend longer periods of time within the Plan Area and may not be as reliant on Plan Area channel flows for migration.

Juvenile salmonids migrating down the Sacramento River would generally experience lower flows below the north Delta intakes compared to Existing Conditions. Mean monthly flows were simulated by CALSIM-II during the winter-run Chinook emigration period (November to early May). Under Alternative 1A, monthly flows averaged across all water years were approximately 10% to 31% lower compared to baseline conditions. The differences by water year types ranged from fairly similar to baseline conditions (about 5% difference) in December of dry and critical years, to 39% lower in November of above normal years.

It is important to emphasize that *CM1 Water Facilities and Operation* includes bypass flow criteria that will be managed in real time to minimize adverse effects of diversions at the north Delta intakes on downstream-migrating salmonids. Juvenile salmonids migrating down the Sacramento River often do so in pulses that are triggered by increases in flows. CM1 will account for such changes in flows and the associated pulses of fish by monitoring fish presence at locations such as Knights Landing and adjusting to low-level pumping as necessary. Low-level pumping will consist of total north Delta diversions of up to 6% of river flow for flows greater than 5,000 cfs and not more than 300 cfs at any intake. Following the initial pulse flows, schedules of post-pulse flows will be applied depending on flows in the river at the time. Additional detail is provided in Chapter 3 Section 3.6.4.2.

Predation Associated with North Delta Diversion Intakes

The north Delta export facilities would likely attract piscivorous fish around the intake structures. Predation losses were estimated by two methods to bound the hypothetical range of potential mortality: striped bass bioenergetics modeling of salmon predation, and an assumed 5% fixed rate of loss of juvenile salmon migrating past the overall facilities. These two methods provide a hypothetical range of potential mortality at the north Delta diversion, with uncertainties associated with each estimate. Neither method takes into account existing levels of predation along the channelized Sacramento River channel.

The bioenergetics model estimated striped bass annual consumption of migrating juvenile salmon at the north Delta intakes. The methods (based on Loboschefsky and Nobriga 2010, Loboschefsky et al. 2012) are detailed in *BDCP 5F – Biological Stressors (Section 5F.3.1, hereby incorporated by reference).* Consumption estimates were based on water temperature, striped bass size and density, and the density and size of prey encountered. Striped bass densities were based on observations at the Glenn Colusa Irrigation District (GCID) facility on the upper Sacramento River (Vogel_2008). At a median predator density of 0.12 predators per foot (0.39 predators per meter) of intake, estimated predation loss would represent about 2% of the annual production of juvenile winter-run Chinook salmon (Table 11-1A-17). The bioenergetics model likely overestimates predation of juvenile salmon because of simplified model assumptions.

Table 11-1A-17. Chinook Salmon Predation Loss at the Proposed North Delta Intake Facilities (Five Intakes)

Striped Bass Numbers		Estimated Number of Juvenile Salmon Consumed				Percentage of Annual Juvenile Production (%) Consumed			
Per 1,000 ft of Intake	Total Bass	Winter	Spring	Fall	Late Fall	Winter	Spring	Fall	Late Fall
18 (Low)	154	7,815	10,935	167,668	31,724	0.3	0.3	0.3	0.7
119 (Median)	1,017	51,669	72,292	1,108,470	209,734	2.0	1.7	1.8	4.9
219 (High)	1,872	95,087	133,042	2,039,958	385,981	3.7	3.2	3.3	9.0

Source: *BDCP Effects Analysis – Appendix 5.F Biological Stressors, Section 5F.5.3.1.1.*
Note: Based on bioenergetics modeling of consumption by striped bass.

A conservative upper estimate of potential predation assumed a fixed 5% loss per intake due to predation as well as impingement, injury or exhaustion (described in *BDCP Effects Analysis – Appendix 5.F, Biological Stressors on Covered Fish, Section5F.3.2.2)* and habitat loss associated with screened intakes. This 5% loss was applied iteratively for the five successive intakes on the Sacramento River under Alternative 1A. The assumed 5% loss term is based on observations of acoustically tagged hatchery-raised juvenile salmon released at the GCID diversion facilities (Vogel 2008). There is considerable uncertainty in applying this loss term to the north Delta diversions because the design and location of the GCID screen and the north Delta diversion are substantially different. The GCID is located along a relatively narrow oxbow channel (about 10 to 50 meters wide) while the north Delta intakes would be located on the much wider channel of the mainstem lower Sacramento River (about 150 to 180 meters wide). For the purposes of this analysis, it is assumed that all juvenile salmon migrating down the mainstem Sacramento River would come in close proximity to the intakes, although there is high uncertainty with this assumption. However, the estimates of predation loss at GCID are for a single large diversion intake, while Alternative 1A would have five north Delta intakes. Thus, while factors unique to the GCID screen may increase predation loss estimates relative to the north Delta, the cumulative amount of intake structure proposed under the Plan would be much larger than the GCID screen, increasing exposure of juvenile salmon to screen-related impacts.

The 5% loss would apply only to those fish that pass through this reach close to the screens, although the assumption here is that all the fish passing are subject to this 5% loss. Of the Sacramento Basin population of Chinook salmon smolts that reach the Delta, a small proportion would be expected to emigrate through the Yolo Bypass and downstream to Rio Vista, thus bypassing the north Delta intakes entirely (*BDCP Effects Analysis – Appendix 5.C, Flow, Passage, Salinity, and Turbidity*). The average proportion of Chinook salmon smolts modeled by DPM entering the Yolo Bypass was 12.1% for winter-run, 8.8% for spring-run, and 3.4% for fall-run and 3.6% for late fall-run. The remainder of smolts would outmigrate via the mainstem Sacramento River past the proposed north Delta intakes. The proportion of migrating smolts surviving to the north Delta intakes, as estimated by the DPM, would be 93.1% of winter-run salmon smolts, 93.1% of spring-run salmon smolts, 93.2% of Sacramento River basin fall-run salmon smolts, and 93.0% of late fall-run salmon smolts. Under the fixed loss method, the cumulative attrition across the five intakes of the north Delta diversion complex for Alternative 1A would be an estimated 18.5% loss of those smolts that reached the north Delta. However, there are appreciable uncertainties in these analyses, including unknown baseline levels of predation, uncertainty in the bioenergetics model parameters, and the comparability of the GCID intakes.

Habitat Loss Associated with North Delta Diversion Intakes

Juvenile salmon utilize shoreline areas to feed and grow during their out-migration. Shoreline features that include natural cover such as submerged and overhanging large wood, aquatic vegetation, and undercut banks provide greater habitat complexity for foraging, resting, and avoiding predators. As juvenile Chinook salmon grow, they move into deeper water with higher current velocities, but still seek shelter and velocity refugia to minimize energy expenditures. (Healey 1991, Moyle 2002).

While the condition of the habitat at the intake sites has been altered with riprap and has limited in-water or overwater habitat features typically associated with fish rearing and out-migration habitat, it nevertheless provides some level of cover/shade, refuge, and organic input of value to out-migrating salmonids. The in-water components of the intake structures would permanently alter the condition of migratory habitats in the vicinity of the intake locations. The mainstem Sacramento River is designated as critical habitat for all listed runs of Chinook salmon, providing important habitat for migration. Approximately 22 acres of in-water habitat and 11,900 linear feet of shoreline habitat would be permanently modified and/or inaccessible as a result of the intakes. While restoration components of the BDCP (CM4–CM7 in particular) would provide substantial habitat values, the permanent loss of 22 acres under Alternative 1A would adversely affect migratory conditions.

Delta Passage Model

Through-Delta survival to Chipps Island by emigrating winter-run Chinook smolts was modeled by the Delta Passage Model (DPM). The DPM simulates migration and mortality of Chinook salmon smolts entering the Delta from the Sacramento, Mokelumne, and San Joaquin Rivers through a simplified Delta channel network, and provides quantitative estimates of relative Chinook salmon smolt survival through the Delta to Chipps Island (method detailed in *BDCP 5C Flow, Passage, Salinity and Turbidity, Section5C.4.3.2.2 hereby incorporated by reference*). The DPM does not account for habitat restoration.

Average survival under Alternative 1A would be 33% across all years, 45% in wetter years, and 26% in drier years (Table 11-1A-18). Modeled survival would be similar (<5% difference) to baseline conditions (about 1% lower survival compared to NAA, a 1% to 4% relative decrease).

Table 11-1A-18. Through-Delta Survival (%) of Emigrating Juvenile Winter-Run Chinook Salmon under Alternative 1A

	Percentage Survival			Difference in Percentage Survival (Relative Difference)	
Year Types	EXISTING CONDITIONS	NAA	A1A_LLT	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Wetter Years	46.3	46.1	45.5	-0.9 (-2%)	-0.6 (-1%)
Drier Years	28.0	27.1	26.0	-2.0 (-6%)	-1.1 (-4%)
All Years	34.9	34.2	33.3	-1.6 (-5%)	-0.9 (-3%)

Note: Delta Passage Model results for survival to Chipps Island.
Wetter = Wet and above normal water years (6 years).
Drier = Below normal, dry and critical water years (10 years).

Adults

Attraction flows and the importance of olfactory cues to adult Chinook salmon were well-described by Marston et al. (2012): Chinook salmon rely primarily on olfactory cues to successfully migrate through the Delta's maze of waterways to home back to their natal river (Groves et al. 1968; Mesick 2001). Juvenile salmon imprint by acquiring a series of chemical waypoints at every major confluence that enables them to relocate their river of origin (Quinn 1997; Williams 2006).

Marston et al. (2012) used recoveries of coded-wire tags from hatchery-origin Chinook salmon to estimate stray rates of adults. Fish released further upstream in-river had considerably lower straying rates than fish released downstream (including in San Francisco Bay) presumably because the fish released downstream had imprinted on fewer waypoints. For the Sacramento River, the stray rate for fish released upstream of the confluence of the Sacramento and San Joaquin Rivers was very low (average 0.1%, range 0 to 6.7%; Marston et al. 2012)—if this rate is representative of wild populations spawned upstream, then it indicates a very low rate of straying for fish emigrating from natal tributaries in the Sacramento River basin with the existing flows through the Plan Area. As noted by Marston et al. (2012:18), Quinn (1997) suggested that background levels of straying for hatchery-origin salmon are 2% to 5%, although few studies have been conducted on wild-origin Chinook salmon; one such study for wild-origin Mokelumne River Chinook salmon—albeit a population with appreciable hatchery influence—reported a stray rate of over 7% (Williams 2006 as cited in Marston et al. 2006). Therefore, for this analysis of effects, it was assumed with high certainty that Plan Area migration flows for adult winter-run Chinook salmon (incorporating factors such as olfactory cues) are of low importance as an attribute that has been changed from its historical condition, as judged by the low stray rate of Sacramento-origin hatchery fish. The high certainty level reflects the low levels of straying reported for adult Chinook salmon from the Sacramento River region under existing flow conditions.

Sacramento River flows downstream of the proposed north Delta intakes generally will be lower under Alternative 1A operations relative to baseline (NAA), with differences between water-year types because of differences in the relative proportion of water being exported from the north Delta and south Delta facilities (*Appendix 11C)*. The effects of flow reduction in the lower reach of the Sacramento River on the attraction and upstream migration of adult salmonids are uncertain. Flows in the lower Sacramento River are influenced by tidal hydrodynamics (as discussed in *Appendix 5.C,* *Flow, Passage, Salinity, and Turbidity, Section 5.C.5.3.1.11.1 Changes in Tidally Influenced Areas of the Plan Area (Delta Region)*). The influence of the tide may also affect adult attraction and migration.

The average percentage of Sacramento River–origin water at Collinsville, where the Sacramento and San Joaquin Rivers converge in the West Delta subregion, was assessed by DSM2 fingerprinting analysis (detailed in *BDCP 5C.4 Flow, Passage, Salinity and Turbidity, Section 5C.4.3.1 hereby incorporated by reference*). For migrating adult winter-run Chinook (December-February migration period) this proportion would be slightly lower (3% to 6% decrease) under Alternative 1A (averages 63% to 71%) compared to NAA (averages 66% to 75%) (Table 11-1A-19). While the importance of olfactory cues for guiding adult salmonids to upstream spawning habitat is well-recognized (Hasler and Scholz 1983; Quinn 2005; review by Marston et al. 2012), detection and response to flow changes can vary. For example, adult sockeye salmon detected and behaviorally responded to a change in olfactory cues (e.g., dilution of olfactory cues from their natal stream) of greater than approximately 20%, although adults were not discernibly affected by dilution of 10% or less (Fretwell 1989). This may indicate that flow differences estimated for winter-run Chinook salmon under Alternative 1A will not be of considerable importance, although this is uncertain.

Table 11-1A-19. Monthly Average Percentage (%) of Water at Collinsville Originating in the Sacramento River during the December through February Adult Winter-Run Chinook Salmon Migration Period

	Percentage of Water			Difference in Percentage of Water	
Month	EXISTING CONDITIONS	NAA	A1A_LLT	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
December	67	66	63	-4	-3
January	76	75	71	-5	-4
February	75	73	67	-8	-6

Source: DSM2-QUAL fingerprinting analysis (monthly time step, October 1976-September 1991). *BDCP Effects Analysis – Appendix 5.5, Section 5C.5.3. Passage, Movement, and Migration Results.*

NEPA Effects: Overall, the results indicate that the effect of Alternative 1A is adverse because it has the potential to substantially decrease winter-run Chinook salmon migration habitat conditions in the Sacramento River. In addition, this alternative is adverse due to the cumulative effects associated with five north Delta intake facilities, including mortality related to near-field effects (e.g. impingement and predation) and far-field effects (reduced survival due to reduced flows downstream of the intakes) associated with the five NDD intakes.

Upstream of the Delta in the Sacramento River, flows would be up to 44% lower during the majority of the juvenile migration period. These reductions in flow may impact the condition and survival of juvenile winter-run Chinook salmon as they migrate downstream. There would be no effect of Alternative 1A on upstream flows during the adult migration period or on temperatures during either migration period.

Adult attraction flows in the Delta under Alternative 1A would be lower than those under NAA, but adult attraction flows are expected to be adequate to provide olfactory cues for migrating adults.

Near-field effects of Alternative 1A NDD on winter-run Chinook salmon related to impingement and predation associated with five new intakes could result in substantial effects on juvenile migrating winter-run Chinook salmon, although there is high uncertainty regarding the potential effects.

Estimates within the effects analysis range from very low levels of effects (<2% mortality) to very significant effects (~ 19% mortality above current baseline levels). CM15 would be implemented with the intent of providing localized and temporary reductions in predation pressure at the NDD. Additionally, several pre-construction surveys to better understand how to minimize losses associated with the five new intake structures will be implemented as part of the final NDD screen design effort. Alternative 1A also includes an Adaptive Management Program and Real-Time Operational Decision-Making Process to evaluate and make limited adjustments intended to provide adequate migration conditions for winter-run Chinook salmon. However, at this time, due to the absence of comparable facilities anywhere in the lower Sacramento River/Delta, the degree of mortality expected from near-field effects at the NDD remains highly uncertain.

Two recent studies (Newman 2003 and Perry 2010) indicate that far-field effects associated with the new intakes could cause a reduction in smolt survival in the Sacramento River downstream of the NDD intakes due to reduced flows in this area. The analyses of other elements of Alternative 1A predict improvements in smolt condition and survival associated with increased access to the Yolo Bypass, reduced interior Delta entry, and reduced south Delta entrainment. The overall magnitude of each of these factors and how they might interact and/or offset each other in affecting salmonid survival through the plan area is uncertain, and remains an area of active investigation for the BDCP.

The DPM is a flow-based model being developed for BDCP which attempts to combine the effects of all of these elements of BDCP operations and conservation measures to predict smolt migration survival throughout the entire Plan Area. The current draft of this model predicts that smolt migration survival under Alternative 1A would be similar to survival rates estimated for NAA. Further refinement and testing of the DPM, along with several ongoing and planned studies related to salmonid survival at and downstream of the NDD are expected to be completed in the foreseeable future. These efforts are expected to improve our understanding of the relationships and interactions among the various factors affecting salmonid survival, and reduce the uncertainty around the potential effects of BDCP implementation on migration conditions for Chinook salmon. Until these efforts are completed and their results are fully analyzed, the overall effect of Alternative 1A on winter-run Chinook salmon through-Delta survival remains uncertain.

Therefore, primarily as a result of reduced upstream migration habitat conditions for winter-run Chinook salmon due to reduced flows along with unacceptable levels of uncertainty regarding the cumulative impacts of near-field and far-field effects associated with the presence and operation of the five intakes on winter-run Chinook salmon, this effect is adverse. While implementation of the conservation and mitigation measures listed below would address these impacts, these are not anticipated to reduce the impacts to a level considered not adverse.

CEQA Conclusion:

Upstream of the Delta

In general, Alternative 1A would affect migration conditions for winter-run Chinook salmon relative to the Existing Conditions.

Flows in the Sacramento River upstream of Red Bluff were examined during the July through November juvenile emigration period. Flows under A1A_LLT for juvenile migrants would generally be lower than flows under Existing Conditions (by up to 24%), except during October, in which flows would be up to 36% higher (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the July through November winter-run juvenile emigration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperature would be up to 14% higher under Alternative 1A in July through October depending on month, water year type, and location. There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 1A during November.

Flows under A1A_LLT in the Sacramento River upstream of Red Bluff during December through August would generally be similar or greater to flows under Existing Conditions, except during July and August, in which flows under A1A_LLT would be up to 24% lower.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the December through August winter-run upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 1A during December through June. Mean monthly water temperature would be up to 14% higher under Alternative 1A in July and August depending on month, water year type, and location.

Through-Delta

Juveniles

As described above, the five NDD intakes would impact migrating juveniles due to predation at the intakes (estimated 2% to 18.5% loss of smolts entering the Delta) and lost or modified aquatic and shoreline habitat. Flows below the NDD would be reduced during juvenile and adult migration periods. Juvenile survival through the Delta, estimated by DPM, would be 33% across all years, 45% in wetter years, and 26% in drier years (Table 11-1A-18). Modeled survival would decrease slightly compared to Existing Conditions (1% to 2% lower survival, a 2% to 7% relative decrease).

Adults

The proportion of Sacramento River water in the Delta would decline by 4% to 8% compared to Existing Conditions during the adult migration period (Table 11-1A-19), but this reduction would not be expected to significantly affect olfactory cues. Sacramento River flow at Rio Vista would generally decline during the adult migration period (*Appendix 11C*).

Summary of CEQA Conclusion

Overall, upstream of the Delta, Alternative 1A would significantly affect the migration conditions for winter-run Chinook salmon, relative to the Existing Conditions. Flows in the upper Sacramento River under Alternative 1A would be substantially lower than under Existing Conditions during the majority of the juvenile winter-run Chinook salmon migration period, although flows would generally be similar to or higher than flow under Existing Conditions during the majority of the adult migration period. In addition, water temperatures are predicted to be up to 14% greater under Alternative 1A relative to Existing Conditions during the majority of the juvenile migration period, although temperatures would not be affected during the majority of the adult migration period. Modeled juvenile survival through the Delta is expected to be similar or slightly lower in all water year types, but estimated predation losses past the five intakes could hypothetically range from 2%

to 19% which is significant. Additionally, habitat losses associated with five NDD structures would be significant. As a result of these changes in migration conditions, this impact is significant.

With respect to the NDD intakes, implementation of CM6 and CM15 would address these impacts, but are not anticipated to reduce them to a level considered less than significant. Although implementation of *CM6 Channel Margin Enhancement* would provide habitat similar to that which would be lost, it would not necessarily be located near the intakes and therefore would not fully compensate for the lost habitat. Additionally, implementation of this measure would not fully address predation losses. *CM15 Localized Reduction of Predatory Fishes (Predator Control)* has substantial uncertainties associated with its effectiveness such that it is considered to have no demonstrable effect. Conservation measures that address habitat and predation losses, therefore, would potentially minimize impacts to some extent but not to a less than significant level. Consequently, as a result of these changes in migration conditions, this impact is significant and unavoidable.

Applicable conservation measures are briefly described below and full descriptions are found in Chapter 3, Section 3.6.2.5 Channel Margin Enhancement (CM6) and Section 3.6.3.4 Localized Reduction of Predatory Fishes (Predator Control) (CM15).

CM6 Channel Margin Enhancement. CM6 would entail restoration of 20 linear miles of channel margin by improving channel geometry and restoring riparian, marsh, and mudflat habitats on the waterside side of levees along channels that provide rearing and outmigration habitat for juvenile salmonids. Linear miles of enhancement would be measured along one side or the other of a given channel segment (e.g., if both sides of a channel are enhanced for a length of 1 mile, this would account for a total of 2 miles of channel margin enhancement). At least 10 linear miles would be enhanced by year 10 of Plan implementation; enhancement would then be phased in 5-mile increments at years 20 and 30, for a total of 20 miles at year 30. Channel margin enhancement would be performed only along channels that provide rearing and outmigration habitat for juvenile salmonids. These include channels that are protected by federal project levees—including the Sacramento River between Freeport and Walnut Grove among several others.

CM15 Localized Reduction of Predatory Fishes (Predator Control). CM15 would seek to reduce populations of predatory fishes at specific locations or modify holding habitat at selected locations of high predation risk (i.e., predation "hotspots"). This conservation measure seeks to benefit covered salmonids by reducing mortality rates of juvenile migratory life stages that are particularly vulnerable to predatory fishes. Predators are a natural part of the Delta ecosystem. Therefore, this conservation measure is not intended to entirely remove predators at any location, or substantially alter the abundance of predators at the scale of the Delta system. This conservation measure would also not remove piscivorous birds. Because of uncertainties regarding treatment methods and efficacy, implementation of CM15 would involve discrete pilot projects and research actions coupled with an adaptive management and monitoring program to evaluate effectiveness. Effects would be temporary, as new individuals would be expected to occupy vacated areas; therefore, removal activities would need to be continuous during periods of concern. CM15 also recognizes that the NDD intakes would create new predation hotspots.

This impact is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this impact to a less-than-significant level would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this impact is significant and unavoidable because there is no feasible mitigation available. Even so, proposed below is mitigation that has the potential to reduce the severity of the impact though not necessarily to a less-than-significant level.

Mitigation Measure AQUA-42a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Winter-Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Migration Conditions

Although analysis conducted as part of the EIR/EIS determined that Alternative 1A would have significant and unavoidable adverse effects on migration habitat, this conclusion was based on the best available scientific information at the time and may prove to have been over- or understated. Upon the commencement of operations of CM1 and continuing through the life of the permit, the BDCP proponents will monitor effects on migration habitat in order to determine whether such effects would be as extensive as concluded at the time of preparation of this document and to determine any potentially feasible means of reducing the severity of such effects. This mitigation measure requires a series of actions to accomplish these purposes, consistent with the operational framework for Alternative 1A.

The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 1A operations only. Development of mitigation actions for the incremental impact on migration habitat attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 1A.

Mitigation Measure AQUA-42b: Conduct Additional Evaluation and Modeling of Impacts on Winter-Run Chinook Salmon Migration Conditions Following Initial Operations of CM1

Following commencement of initial operations of CM1 and continuing through the life of the permit, the BDCP proponents will conduct additional evaluations to define the extent to which modified operations could reduce impacts to migration habitat under Alternative 1A. The analysis required under this measure may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6).

Mitigation Measure AQUA-42c: Consult with USFWS, and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Winter-Run Chinook Salmon Migration Conditions Consistent with CM1

In order to determine the feasibility of reducing the effects of CM1 operations on winter-run Chinook salmon habitat, the BDCP proponents will consult with FWS and the Department of Fish and Wildlife to identify and implement any feasible operational means to minimize effects on migration habitat. Any such action will be developed in conjunction with the ongoing monitoring and evaluation of habitat conditions required by Mitigation Measure AQUA-42a.

If feasible means are identified to reduce impacts on migration habitat consistent with the overall operational framework of Alternative 1A without causing new significant adverse impacts on other covered species, such means shall be implemented. If sufficient operational flexibility to reduce effects on winter-run Chinook salmon habitat is not feasible under Alternative 1A operations, achieving further impact reduction pursuant to this mitigation measure would not be feasible under this Alternative, and the impact on winter-run Chinook salmon would remain significant and unavoidable.

Restoration Measures (CM2, CM4–7, and CM10)

Impact AQUA-43: Effects of Construction of Restoration Measures on Chinook Salmon (Winter-Run ESU)

Restoration activities are described above under delta smelt (Impact AQUA-7). Potential effects of construction activities during habitat restoration actions on Chinook salmon would be similar to those discussed above for construction and maintenance actions on Chinook salmon (see Impact AQUA-37 and Impact AQUA-38 for winter-run Chinook salmon). Because these activities would be of relatively short duration, the effects would be temporary; in addition, the activities would occur in isolated areas.

Temporary Increases in Turbidity

Restoration construction activities such as riprap removal, shoreline excavation and recontouring, and planting riparian vegetation have the potential to result in temporary increases in turbidity conditions in adjacent waterways. However, implementing the environmental commitments described in Appendix 3B, *Environmental Commitments,* would minimize the potential for turbidity to affect Chinook salmon. These environmental commitments include *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Increased Exposure to Methylmercury

As discussed above for delta smelt (Impact AQUA-8), the implementation of *CM12 Methylmercury Management* would minimize potential effects of methylmercury mobilization from restoration sites, on Chinook salmon. As a result, restoration activities are not expected to substantially increase the bioavailability and toxicity of methylmercury on Chinook salmon.

Accidental Spills

As discussed above for construction and maintenance activities (see Impact AQUA-37 and Impact AQUA-38 for winter-run Chinook salmon), implementation of environmental commitments described in Appendix 3B, *Environmental Commitments,* would minimize the potential for introduction of contaminants to surface waters and provide for effective containment and cleanup should accidental spills occur. These environmental commitments are *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; and *Spill Prevention, Containment, and Countermeasure Plan*. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Disturbance of Contaminated Sediments

Potential effects of restoration activities on the disturbance of contaminated sediments would be similar to those discussed for delta smelt (see Impact AQUA-7). The potential impacts of toxics on Chinook salmon would be minimized to the extent possible by timing construction activities so that vulnerable juveniles are not present, and implementation of environmental commitments (see Appendix 3B, *Environmental Commitments*). These environmental commitments are *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Disposal of Spoils,* *Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

In-Water Work Activities

Potential effects of in-water restoration activities are similar to those described above for delta smelt (see Impact AQUA-7). Such activities are not expected to elevate underwater noise above the threshold sound pressure levels established for fish, and any changes in noise and light levels would be minor and temporary, and any Chinook salmon in the area would likely avoid areas where the restoration activities are occurring. Potential effects of in-water activity would be minimized by implementing the environmental commitments described under Impact AQUA-1 and in Appendix 3B, *Environmental Commitments*, including *Erosion and Sediment Control Plan*; *Dispose of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*.

Predation

Restoration activities would be unlikely to have any measurable effect on Chinook salmon predation rates. Much of the restoration would occur on dry land (e.g., recontouring, removing levees) which would have no in-water effects including on predators. In-water activities may include the use of barges and other watercraft that could theoretically provide cover, shelter, and perching areas for Chinook salmon predators. However, the limited duration of these activities and the associated noise and disturbance would be expected to dissuade predators from concentrating at sufficient density to measurably affect predation rates on Chinook salmon.

Summary

Restoration activities are described above under delta smelt (Impact AQUA-7). Potential effects of these activities would be similar to those discussed above for construction and maintenance actions on Chinook salmon (see Impact AQUA-37 and Impact AQUA-38 for winter-run Chinook salmon). Because these activities would be of relatively short duration, the effects would be temporary; in addition, the activities would occur in isolated areas. Implementation of the environmental commitments described in Appendix 3B, *Environmental Commitments,* that would minimize or eliminate effects on winter-run Chinook salmon include *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt. As a result, the effects of short-term restoration construction activities are not adverse to Chinook salmon.

While implementation of these environmental commitments would minimize or eliminate short-term effects occurring during restoration construction, long-term effects could also occur. For example, removing or breaching levees would result in the expansion of floodplain habitat, although more frequent inundation these areas could promote conversion of mercury to methylated mercury, and runoff containing agricultural-related toxins such as copper and organochlorine pesticides. However, the overall effect of increased bioavailability of methylmercury and other pollutants on Chinook salmon is likely to be of low magnitude, periodic and localized because they would occur primarily in relation to specific actions at specific locations and would dissipate after the initial influx. In addition, *CM12 Methylmercury Management* provides for site-specific assessment of restoration areas, integration of design measures to minimize methylmercury production, and site monitoring and reporting.

NEPA Effects: With implementation of *CM12 Methylmercury Management*, the overall long-term effects of habitat restoration are expected to be beneficial to winter-run Chinook salmon and other covered fish species by providing additional or improved habitat.

CEQA Conclusion: Habitat restoration activities could result in short-term adverse effects on Chinook salmon, primarily as a result of increased turbidity and potential for contaminated sediments to enter the water column. In addition to in-water work window restrictions, the limited frequency, duration, and spatial extent of restoration construction activities would minimize these potential effects on winter-run Chinook salmon. In contrast, habitat restoration is expected to result in a significant net-benefit for Chinook salmon by substantially increasing the quality and quantity of key habitats required by this species. Implementation of environmental commitments identified above and described in detail under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*), along with *CM12 Methylmercury Management* to minimize methylmercury production would also reduce the frequency, duration, and spatial extent of any impacts. Therefore, this impact is considered less than significant for Chinook salmon because it would not substantially reduce habitat, restrict its range or interfere with its movement. Additionally, there would be additional beneficial long-term net benefits of habitat restoration. Consequently, no mitigation would be required.

Impact AQUA-44: Effects of Contaminants Associated with Restoration Measures on Chinook Salmon (Winter-Run ESU)

Alternative 1A habitat restoration actions (particularly *CM2, Yolo Bypass Fisheries Enhancement; CM4, Tidal Natural Communities Restoration; CM5, Seasonally Inundated Floodplain Restoration; CM6 Channel Margin Enhancement; and CM7 Riparian Natural Community Restoration*) could result in the disturbance or mobilization of upland and aquatic contaminants that could affect Chinook salmon (e.g., by causing embryonic deformities or bioaccumulation). As previously mentioned, a complete analysis can be found in the *BDCP Effects Analysis – Appendix 5D*, *Contaminants (hereby incorporated by reference)*. Potential impacts on winter-run Chinook salmon from effects of methylmercury, selenium, copper, ammonia, and pesticides associated with habitat restoration activities would be similar to those discussed for delta smelt (see Impact AQUA-8). The Yolo Bypass, a notable rearing area for juvenile Chinook salmon, is an area expected to be among the highest for potential methylmercury production. While juvenile Chinook salmon show high spatial variability in the bioaccumulation of methylmercury (Henery et al. 2010), it has not been demonstrated that these accumulations impair small fishes. Future exposure levels in restored habitats that are similar to current levels may not affect the species' viability, though they may be of concern for passing mercury up the food web to birds and humans. As described in *BDCP Effects Analysis – Appendix D*, *Contaminants, Section 5D.4.1 Mercury (hereby incorporated by reference)*, the amounts of methylmercury mobilized and resultant effects on covered fish species are not currently quantifiable.

It is anticipated that any potential effects of methylmercury on Chinook salmon will be addressed through implementation of CM12. CM12 is intended to minimize methylmercury exposure associated with restoration measures for juvenile Chinook salmon. Additional analysis and tools may be developed to further reduce methylmercury exposure as the habitat restoration conservation measures are refined and analyzed in site-specific documents. The site-specific analysis is the appropriate place to assess the potential for risk of methylmercury exposure for Chinook salmon once site specific sampling and other information can be developed.

NEPA Effects: The effect of restoration measures on chemical contaminants is not adverse to Chinook salmon with respect to selenium, copper, ammonia and pesticides. The effects of methylmercury on Chinook salmon are uncertain.

CEQA Conclusion: Alternative 1A restoration actions associated with CM2, CM4–CM7, and CM10, are likely to result in increased production, mobilization, and bioavailability of methylmercury, However, implementation of *CM12 Methylmercury Management* would help to minimize the increased mobilization of methylmercury at restoration areas. Therefore, the impact of contaminants is considered less than significant because it would not substantially affect Chinook salmon either directly or through habitat modifications and, with restoration, would be beneficial in the long-term. Consequently, no mitigation would be required.

Impact AQUA-45: Effects of Restored Habitat Conditions on Chinook Salmon (Winter-Run ESU)

The expected effects of restored habitat conditions on Chinook salmon would be similar to those discussed under Impact AQUA-9, for delta smelt, which were determined to be generally beneficial.

CM2 Yolo Bypass Fisheries Enhancement

As discussed under Impact AQUA-9, Yolo Bypass fisheries enhancement modifications are designed to increase the frequency, duration and magnitude of seasonal floodplain inundation in the Yolo Bypass. These actions would improve passage and habitat for Chinook salmon. Increased frequency of inundation will enhance the existing connectivity between the Sacramento River and the Yolo Bypass floodplain habitat, result in the increased mobilization of organic material and primary and secondary aquatic productivity, and provide additional shallow water rearing habitat for juvenile Chinook salmon. The increased inundation would also improve and expand the available migration habitat for juvenile Chinook salmon, likely with fewer predators than the mainstem river, as well as for adult Chinook salmon. These modifications, which include fish passage improvements and flow management, would reduce migratory delays and loss of adult salmon. They would also enhance rearing habitat for Sacramento River basin salmonids.

CM4 Tidal Natural Communities Restoration

The potential effects of *CM4 Tidal Natural Communities Restoration* activities on Chinook salmon, would be similar to those discussed under Impact AQUA-9. Habitat Suitability Analysis indicates that tidal wetland restoration provides substantial increases in available habitat suitable for juvenile foraging salmon as compared to Existing Conditions, therefore this effect is not adverse. Increases in HUs for juvenile salmon are approximately 5,000 HUs each in the Cache Slough and Suisun Marsh ROAs, 2,000 HUs in the West Delta ROA, and negligible in the South Delta and Cosumnes-Mokelumne ROAs.

CM5 Seasonally Inundated Floodplain Restoration

The potential effects of CM5 Seasonally Inundated Floodplain Restoration on Chinook salmon, would be similar to those discussed above for CM2 Yolo Bypass Fisheries Enhancement, as well as under Impact AQUA-9 Habitat conditions during juvenile rearing, including access to low- velocity, shallow- water habitat with few predators and abundant food supplies, are important for juvenile growth and survival. CM5 is intended to contribute to an increase in suitable rearing habitat for juvenile salmonids within the south Delta subregion of the Plan Area, and particularly along key migration routes, which is intended to increase through-Delta survival. Seasonally inundated floodplain is expected to provide suitable rearing conditions (i.e., suitable water depths, cover from predators, food), as well as improve migration corridors.

CM6 Channel Margin Enhancement

Proposed channel margin enhancement activities will include 20 miles of channel margin habitat to provide rearing and outmigration habitat for juvenile salmonids. These channels include the Sacramento River between Freeport and Walnut Grove, and Steamboat and Sutter Sloughs. The affinity of Chinook salmon fry for channel margins is particularly high, and such enhancements will provide important refuge from high flows, and overhead and instream cover for protection from predators. Expanded nearshore habitat with improved inputs of terrestrial organic matter, insects, and woody material, as well as riparian shade and underwater cover, also will increase the quality of Chinook salmon rearing habitat in the Plan Area. Enhanced channel margins in the vicinity of the proposed north Delta intakes (upstream, between the intakes, and downstream) would provide resting spots and refuge for Chinook salmon moving through this area.

Channel margin enhancement will increase the habitat along important juvenile salmonid migration routes; consequently, the measure will improve connectivity between patches of higher value habitats and would be considered beneficial. This is particularly necessary for reaches that have very low existing habitat quality and are heavily used by salmonids—for example, the Sacramento River between Freeport and Georgiana Slough. The efficacy of the measure may depend on the lengths of enhanced channel margin habitat and the distance between enhanced areas—that is, there may be a tradeoff between enhancing multiple shorter reaches that have less distance between them and enhancing relatively few longer channel margin habitats with greater distances between them.

In addition to the multiple benefits identified above for enhancing channel margin habitat, there is also the potential for some negative effects. Any increase in the amount of time that Chinook salmon occupy these restored habitats, may increase exposure to any toxins sequestered in shallow-water sediments. However, the potential for effects are expected to be minimal because of the relatively short period of their life history spent in these areas. Channel margin enhancements also have the potential to provide habitat for nonnative predator species, which could increase the predation rates on Chinook salmon. Monitoring of bank protection projects and other future studies will inform site designs to limit the potential increase in such nonnative predator fish species. Overall, the effect of channel margin enhancement is expected to be beneficial for Chinook salmon.

CM7 Riparian Natural Community Restoration

Habitat Complexity from Riparian Restoration (CM7) in the Plan Area

CM7 Riparian Natural Community Restoration is intended to restore riparian habitat within the context of flood control objectives and managed upstream hydrology to provide direct and indirect benefits to aquatic and terrestrial species along important migration corridors. Riparian restoration will increase instream cover through contributions of woody material derived from the riparian forest. Downed wood provides structural complexity important for resting and refuge sites used by Chinook salmon, and will contribute to creation of shaded refugia. The overall benefits of these positive effects would depend on the extent to which restored riparian areas are allowed to undergo natural processes such as bank erosion, which would facilitate formation of undercut banks and introduction of complex structure into water bodies.

Chinook salmon would also benefit from contributions of the riparian community to the aquatic foodweb, in the form of terrestrial insects and leaf litter that enter the water, thereby increasing production of zooplankton and macroinvertebrates that provide food for Chinook salmon. Riparian vegetation also supports the formation of steep, undercut banks that provide cover for Chinook salmon. The increased habitat complexity provided by riparian restorations is expected to be beneficial to Chinook salmon.

CM10 Nontidal Marsh Restoration

CM10 Nontidal Marsh Restoration will have minor indirect beneficial effects on Chinook salmon in the main river systems and Delta. These upland wetlands provide hydrologic and water quality functions such as storing water during floods and filtering contaminants. These sites would also provide some additional food resources such as insects, zooplankton, phytoplankton and dissolved organic carbon. These materials would be exported during flood stages when the upland might be connected to the river system. Although the contribution from 400 acres would be small, it would be beneficial.

NEPA Effects: The effects of floodplain, tidal, channel margin and riparian habitat restoration activities on winter-run Chinook salmon are expected to be beneficial, providing increased amounts and quality of available habitat, increasing habitat diversity, increasing overall productivity and reducing predation. In addition, besides providing increased habitat, Yolo Bypass enhancements would also reduce migratory delays and loss of adult salmon and improve overall passage conditions.

Despite the improvements in habitat and habitat functions in the Delta from floodplain, tidal, channel margin and riparian habitat restoration activities, habitat quality is expected to decline in the LLT primarily because of climate change. The overall effect of restoration activities is expected to remain beneficial for winter-run Chinook salmon.

However, it is important to note that benefits would not be derived in all years, and that an adaptive management plan would be needed to determine an operational protocol that optimizes benefits both locally and in adjacent habitats.

CEQA Conclusion: The overall effects of floodplain, tidal, channel margin and riparian habitat restoration activities are expected to be beneficial for winter-run Chinook salmon, providing increased amounts and quality of available habitat, increasing habitat diversity, increasing overall productivity and reducing predation. In addition, besides providing increased habitat, Yolo Bypass enhancements would reduce migratory delays and loss of adult salmon and improve passage conditions. Despite the improvements in habitat and habitat functions in the Delta from floodplain, tidal, channel margin and riparian habitat restoration activities, habitat quality is expected to decline in the LLT primarily because of climate change. However, the overall impact of restoration activities is expected to remain beneficial for Chinook salmon because they increase habitat. Consequently, no mitigation would be required.

Other Conservation Measures (CM12–CM19 and CM21)

Impact AQUA-46: Effects of Methylmercury Management on Chinook Salmon (Winter-Run ESU) (CM12)

Refer to Impact AQUA-10 under delta smelt for a discussion of the expected effects of methylmercury management on winter-run Chinook salmon.

Impact AQUA-47: Effects of Invasive Aquatic Vegetation Management on Chinook Salmon (Winter-Run ESU) (CM13)

Potential impacts on Chinook salmon from long-term IAV control are similar to those discussed for delta smelt (see Impact AQUA-11), although greater beneficial effects are likely to occur with Chinook salmon, as they occupy habitat near aquatic vegetation to a greater extent than delta smelt. The control of SAV is expected to reduce predation mortality for Chinook salmon, as predation on juvenile salmon in the migration corridor can be significant. Removing SAV is expected to reduce predator habitat and potentially reduce the population of nonnative predatory fish. IAV control is also expected to increase rearing habitat for Chinook salmon and result in an increase in available food resources.

NEPA Effects: The overall effect of IAV removal and control is expected to be beneficial to Chinook salmon.

CEQA Conclusion: The control of IAV should provide a modest net benefit to Chinook salmon during operations through chemical and mechanical treatment and should reduce predation mortality, increase food availability and increase the amount of suitable rearing habitat for juvenile salmonids. This impact is expected to be beneficial, so no mitigation would be required.

Impact AQUA-48: Effects of Dissolved Oxygen Level Management on Chinook Salmon (Winter-Run ESU) (CM14)

As discussed in Chapter 8, *Water Quality*, dissolved oxygen levels would be very similar to Existing Conditions in the areas upstream of the Delta, in the Delta, and in the SWP/CVP export service areas (see discussion of Impacts WQ-10 and WQ-11). As noted there, however, *CM14 Stockton Deepwater Ship Channel Dissolved Oxygen Levels* management would increase the dissolved oxygen levels in the Stockton Deep Water Ship Channel. Winter-run Chinook salmon do not occupy the channel, and would not be affected.

NEPA Effects: Implementation of *CM14 Stockton Deepwater Ship Channel Dissolved Oxygen Levels* would not affect habitat conditions for winter-run Chinook.

CEQA Conclusion: *CM14 Stockton Deepwater Ship Channel Dissolved Oxygen Levels* would increase dissolved oxygen levels in the Stockton Deepwater Ship Channel. Winter-run Chinook salmon do not occupy the channel. Consequently, implementation of *CM14 Stockton Deepwater Ship Channel Dissolved Oxygen Levels* would have no impact on habitat conditions for winter-run Chinook and no mitigation would be required.

Impact AQUA-49: Effects of Localized Reduction of Predatory Fish on Chinook Salmon (Winter-Run ESU) (CM15)

NEPA Effects: To the extent that localized predator control efforts of *CM15 Localized Reduction of Predatory Fish* reduce the local abundance of fish predators in the Delta occupied by juvenile Chinook salmon (predation on adult Chinook salmon is minimal), it is possible, but not assured that there would be some reduction in losses to predation (see Impact AQUA-13). Due to these uncertainties, there would be no demonstrable effect of this conservation measure on Chinook salmon.

CEQA Conclusion: Due to the uncertainties associated with this CM, there would be no demonstrable effect on Chinook salmon. Consequently, no mitigation would be required.

Impact AQUA-50: Effects of Nonphysical Fish Barriers on Chinook Salmon (Winter-Run ESU) (CM16)

NPBs are designed to guide juvenile salmonid fish away from migration routes with low survival and high predation risk, such as the head of Old River and Georgiana Slough. Tools such as the Delta Passage Model can be used to assess reach-specific mortality rates. This model incorporates studies of tagged juvenile smolts to estimate mortality in different reaches, presumably by predation losses as described in *BDCP Effects Analysis – Appendix 5C, Flow, Passage, Salinity, and Turbidity, Section 5C.4.3.2.2 Juvenile Chinook Salmon through-Delta Survival (Delta Passage Model), hereby incorporated by reference*). Perry et al. (2010) observed higher juvenile salmon survival in the mainstem Sacramento River compared to routes through the central Delta via the DCC and Georgiana Slough. Brandes and McLain (2001) found that smolts traveling through the mainstem San Joaquin River had twice the survival as tagged fish released on the upper Old River, where they presumably passed through the central Delta. These results indicate that effective NPBs may reduce predation losses of outmigrating smolts.

The physical structures of the NPB may attract piscivorous fish to the area and increase localized predation risks. Studies on the NPB at the head of Old River indicate that the barrier is very effective at deterring salmon smolts from entering the Old River. However, many predators were attracted to a nearby deep scour hole immediately downstream on the San Joaquin River and establishment of a large in-water structure. In fact, while the NPB deterrence rate was 81%, the predation rate was so high that the juvenile salmon survival rate was not statistically different whether the barrier was on or off (Bowen et al. 2010).

NEPA Effects: The effects of NPBs would not be adverse.

CEQA Conclusion NPBs are designed to guide juvenile salmonid fish away from migration routes with low survival and high predation risk, such as the head of Old River and Georgiana Slough. The Delta Passage Model incorporates studies of tagged juvenile salmonids to estimate mortality presumably by predation losses as described in *BDCP Effects Analysis – Appendix 5C, Flow, Passage, Salinity, and Turbidity, Section 5C.4.3.2.2 Juvenile Chinook Salmon through-Delta Survival (Delta Passage Model), hereby incorporated by reference*). Studies have shown higher survival rates in both the Sacramento River (Perry et al. 2010) and the San Joaquin River (Brandes and McLain 2001) indicating that effective NPBs may reduce predation losses of outmigrating smolts. On the other hand at the NPB at the head of Old River high predation rates were observed (Bowen et al. 2010). Overall, however, the impacts of *CM15 Localized Reduction of Predatory Fish* are expected to be less than significant to slightly beneficial because they would reduce Chinook salmon entrainment which would potentially increase their numbers. Consequently, no mitigation would be required.

Impact AQUA-51: Effects of Illegal Harvest Reduction on Chinook Salmon (Winter-Run ESU) (CM17)

NEPA Effects: *CM17 Illegal Harvest Reduction* would be applied to benefit native sport fish (i.e., Chinook salmon, Central Valley steelhead, green sturgeon and white sturgeon and are expected to have positive effects on these species because it would reduce the number of illegally harvested fish which would increase their number. Therefore, the impacts on winter-run Chinook salmon would be beneficial.

CEQA Conclusion: *CM17 Illegal Harvest Reduction* would be applied to benefit native sport fish (i.e., Chinook salmon, Central Valley steelhead, green sturgeon and white sturgeon) and are expected to have positive effects on these species. The impacts on winter-run Chinook salmon would be beneficial because it would reduce the number of illegally harvested fish which would increase their number. Consequently, no mitigation would be required.

Impact AQUA-52: Effects of Conservation Hatcheries on Chinook Salmon (Winter-Run ESU) (CM18)

NEPA Effects: *CM18 Conservation Hatcheries* would establish new and expand existing conservation propagation programs for delta and longfin smelt. This conservation measure would have no effect on winter-run Chinook salmon.

CEQA Conclusion: *CM18 Conservation Hatcheries* would establish new and expand existing conservation propagation programs for delta and longfin smelt. This conservation measure would have no impact on winter-run Chinook salmon. Consequently, no mitigation would be required.

Impact AQUA-53: Effects of Urban Stormwater Treatment on Chinook Salmon (Winter-Run ESU) (CM19)

The effects of urban stormwater treatment (CM19) would reduce contaminants associated with urban areas because it provides for the treatment of stormwater discharges. As discussed in Chapter 8, *Water Quality*, and previously under Impact AQUA-8 in the section titled *Pyrethroids, Organophosphate Pesticides, and Organochlorine Pesticides,* stormwater treatment would reduce urban loadings of pesticides (including pyrethroids), phosphorous, trace metals and other contaminants. These reductions would contribute to improved water quality in the Delta.

NEPA Effects: Based on the improved overall water quality conditions and reduced pesticides the effect would be beneficial.

CEQA Conclusion: Urban stormwater treatment (CM19) would reduce contaminants associated with urban areas because it would provide for the treatment of stormwater discharges. As discussed in Chapter 8, *Water Quality*, and previously under Impact AQUA-8 in the section titled *Pyrethroids, Organophosphate Pesticides, and Organochlorine Pesticides,* stormwater treatment would reduce urban loadings of pesticides(including pyrethroids), phosphorous, trace metals and other water contaminants. These reductions would contribute to improved water quality in the Delta. Therefore, the impacts of urban stormwater treatment would have a beneficial effect both directly and through habitat modifications on Chinook salmon. Consequently, no mitigation would be required.

Impact AQUA-54: Effects of Removal/Relocation of Nonproject Diversions on Chinook Salmon (Winter-Run ESU) (CM21)

There is no evidence of substantial entrainment of covered fish species at agricultural diversions in the Plan Area, but some entrainment likely is occurring. Whatever entrainment is occurring would be reduced by decommissioning agricultural diversions in the ROAs. PTM runs and extrapolations to a hypothetical number of diversions to be removed from the ROAs (i.e., approximately 4–12% of diversions) estimated slight reductions in entrainment for delta smelt and longfin smelt.

NEPA Effects: While the amount of reduced entrainment for Chinook salmon might be lower, the effects would be beneficial.

CEQA Conclusion: There is no evidence of substantial entrainment of covered fish species at agricultural diversions in the Plan Area, but some entrainment likely is occurring. Whatever entrainment is occurring would be reduced by decommissioning agricultural diversions in the ROAs. PTM runs and extrapolations to a hypothetical number of diversions to be removed from the ROAs (i.e., approximately 4–12% of diversions) estimated slight reductions in entrainment for delta smelt and longfin smelt. While the amount of reduced entrainment for Chinook salmon might be lower the impacts would be beneficial because it would reduce entrainment which would have a positive impact on Chinook salmon numbers. Consequently, no mitigation would be required.

Spring-Run Chinook Salmon

Construction and Maintenance of CM1

Impact AQUA-55: Effects of Construction of Water Conveyance Facilities on Chinook Salmon (Spring-Run ESU)

Temporary Increases in Turbidity

Effects on spring-run Chinook salmon from temporary increases in turbidity during construction would be similar to those described for winter-run Chinook salmon (see Impact AQUA-37). Effects would be avoided and minimized through timing restrictions and by implementing the environmental commitments *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan* (see Appendix 3B, *Environmental Commitments* and Impact AQUA-1 for delta smelt for details of these plans).

Accidental Spills

Effects on spring-run Chinook salmon from accidental spills during construction would be similar to those described for winter-run Chinook salmon (see Impact AQUA-37 for winter-run Chinook salmon). Effects would be minimized by implementing the environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments,* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*), specifically the *Spill Prevention, Containment, and Countermeasure Plan*.

Disturbance of Contaminated Sediments

Potential effects on spring-run Chinook salmon from disturbance of contaminated sediments during construction are similar to those described for winter-run Chinook salmon (see Impact AQUA-37 for winter-run Chinook salmon). Effects would be minimized by implementing the environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*).

Underwater Noise

Underwater sound generated by impact pile driving in or near surface waters can potentially harm fish, including Chinook salmon (see Impact AQUA-1 for delta smelt). Table 11-4 illustrates the species and life stages of Chinook salmon expected to be present in the north, east, and south Delta during the expected in-water construction window (June 1–October 31). Spring-run Chinook salmon eggs and fry would not experience underwater sound because the locations of the intakes and barge landings are not considered suitable habitat for these two life stages of this species, and they would not be present during the in-water construction period (typically June to October). Therefore, these life history stages would not be affected.

Adult spring-run Chinook salmon would have a moderate potential to be in the north Delta in June and a low potential to be in the north Delta in July during intake construction activities. Juvenile spring-run Chinook salmon would not occur near the intakes or barge landings during the in-water construction period (typically June to October).

Table 11-8 illustrates the estimated area where the cumulative SEL threshold would be exceeded if impact pile driving is required during construction. All juveniles exposed to underwater noise would be expected to be larger than the 2-gram size threshold, based on the typical length at age and the length to weight relationship observed for Chinook salmon occurring in the Delta (Myers et al. 1998; Kimmerer et al. 2005). On this basis, juveniles exposed to underwater noise in excess of 187 dB $SEL_{cumulative}$ would be expected to experience injury-level adverse effects. These effects would be avoided and minimized through implementation of Mitigation Measures AQUA-1a and/or AQUA-1b.

Fish Stranding

Effects on spring-run Chinook salmon from fish stranding during construction would be similar to those described for winter-run Chinook salmon (see Impact AQUA-37 for winter-run Chinook salmon). Adverse effects would be minimized by limiting in-water work to approved in-water work windows and implementing the *Fish Rescue and Salvage Plan* environmental commitment (see Impact AQUA-1 and Appendix 3B, *Environmental Commitments*).

In-Water Work Activities

Effects on spring-run Chinook salmon from in-water work activities during construction would be similar to those described for winter-run Chinook salmon (see Impact AQUA-37 for winter-run Chinook salmon). Effects would be minimized by implementing of environmental commitments described in Appendix 3B, *Environmental Commitments*, including *Erosion and Sediment Control Plan*; *Dispose of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Loss of Spawning, Rearing, or Migration Habitat

Effects on spring-run Chinook salmon from loss of spawning, rearing or migration habitat during construction would be similar to those described for winter-run Chinook salmon (see Impact AQUA-37 for winter-run Chinook salmon). Effects would be minimized by implementation of environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*, including *Erosion and Sediment Control Plan*; *Dispose of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*. Pertinent details of these plans are provided under Impact AQUA-1.

Predation

Effects on spring-run Chinook salmon from predation during construction would be similar to those described for winter-run Chinook salmon (see Impact AQUA-37 for winter-run Chinook salmon).

NEPA Effects: Potential effects of construction of the water conveyance facilities on spring-run Chinook salmon would be similar to those discussed for winter-run Chinook salmon (see Impact AQUA-37 for winter run Chinook salmon). Construction of Alternative 1A involves several elements with the potential to cause adverse effects on spring-run Chinook salmon. However, these turbidity and hazardous material spill effects will be effectively avoided and/or minimized in most cases through implementation of environmental commitments (see Impact AQUA-1 and Appendix 3B, *Environmental Commitments*: *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*); conservation measures; and through implementation of the avoidance and minimization measures included in Mitigation Measures AQUA-1a and AQUA-1b. The effects would unlikely be adverse for spring-run Chinook salmon.

CEQA Conclusion: The potential impact on spring-run Chinook salmon from construction activities would be considered less than significant due to implementation of the environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*, such as *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*. These measures would be expected to protect Chinook salmon from any adverse water quality effect (turbidity, spills of hazardous materials) resulting from project construction. Construction would not be expected to increase predation rates relative to NAA. Construction associated with Alternative 1A will result in both temporary and permanent alteration of rearing and migratory habitats used by Chinook salmon. However, these effects are not expected to be significant because the loss of habitat is not substantial compared to the amount of habitat currently available in combination with the amount of new habitat that would result from restoration. The direct effects of underwater construction noise on Chinook salmon would be a significant impact because of the high likelihood that it would cause injury or death to most impacted fish in the immediate vicinity of the activity. However, implementation of Mitigation Measures AQUA-1a and AQUA-1b would minimize the potential effects from underwater noise and would reduce the severity of impacts to a less-than-significant level.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 for delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 for delta smelt.

Impact AQUA-56: Effects of Maintenance of Water Conveyance Facilities on Chinook Salmon (Spring-Run ESU)

Temporary Increases in Turbidity

Effects on spring-run Chinook salmon from temporary increases in turbidity during construction would be similar to those described for winter-run Chinook salmon (see Impact AQUA-38 for winter-run Chinook salmon). Effects would be avoided and minimized through timing restrictions and by implementing the environmental commitments *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan* (see Appendix 3B, *Environmental Commitments* and Impact AQUA-1 for delta smelt for details of these plans).

Accidental Spills

Effects on spring-run Chinook salmon from accidental spills would be similar to those described for winter-run Chinook salmon (see Impact AQUA-38 for winter-run Chinook salmon). Effects would also be avoided and minimized by implementing the environmental commitments *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan* (see Appendix 3B, *Environmental Commitments* and Impact AQUA-1 for delta smelt for details of these plans).

Underwater Noise

Effects on spring-run Chinook salmon from underwater noise would be similar to those described for winter-run Chinook salmon (see Impact AQUA-38 for winter-run Chinook salmon).

Maintenance-Related Disturbance

Effects on spring-run Chinook salmon from in-water work activities would be similar to those described for winter-run Chinook salmon (see Impact AQUA-38 for winter-run Chinook salmon). Effects would be minimized by implementation of environmental commitments including *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan;* and *Barge Operations Plan*, described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*.

Loss of Spawning, Rearing, or Migration Habitat

Effects on spring-run Chinook salmon from loss of spawning, rearing or migration habitat would be similar to those described for winter-run Chinook salmon (see Impact AQUA-38 for winter-run Chinook salmon). Effects would be minimized by implementation of environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*.

Predation

Effects on spring-run Chinook salmon from predation during maintenance would be similar to those described for winter-run Chinook salmon (see Impact AQUA-38 for winter-run Chinook salmon).

Summary

In-water maintenance activities would be scheduled to occur when the least numbers of Chinook salmon would be present in or near the maintenance areas. Such activities would include maintenance dredging at the intake sites, and installation or repair of riprap bank armoring. Implementation of the environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*, would further minimize or eliminate turbidity and hazardous spill effects on Chinook salmon. These environmental commitments include *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Implementation of these environmental commitments, along with the low numbers of Chinook salmon expected to occur in the maintenance areas during the expected in-water work windows and the limited frequency and duration of in-water maintenance activities, would result in a low potential for adverse effects on Chinook salmon. In addition, no spawning habitat occurs in the areas potentially affected by maintenance activities, and ample rearing, and migration habitat of the same quality is readily accessible in the area, and this habitat would not be substantially affected by maintenance activities.

NEPA Effects: The short-term maintenance activities would not adversely affect Chinook salmon.

CEQA Conclusion: In addition to the limited frequency and duration of in-water maintenance activities, implementation of the environmental commitments identified above and described in detail under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*, would minimize the potential for turbidity and hazardous spills from maintenance activities to affect Chinook salmon by reducing the amount of turbidity and guiding the rapid and effective response to inadvertent spills of hazardous materials. These environmental commitments described in greater detail under Impact AQUA-1 for delta smelt, include *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*. Potential changes to rearing and migratory habitat would also be limited and temporary. Therefore, the potential impact of maintenance activities is considered less than significant because it would not substantially reduce Chinook salmon habitat, restrict its range, or interfere with its movement. Consequently no mitigation would be required.

Water Operations of CM1

Impact AQUA-57: Effects of Water Operations on Entrainment of Chinook Salmon (Spring-Run ESU)

Water Exports from SWP/CVP South Delta Facilities

Entrainment of spring-run Chinook salmon at the south Delta export facilities, as estimated by the salvage density method, would be 14% lower under Alternative 1A compared to NAA when averaged across all water years (Table 11-1A-20). This was driven by 65% reduced entrainment in wet years. However, entrainment would be greater in drier years, ranging from 11% more in critical years to 51% more in below normal years. Pre-screen predation losses at the south Delta facilities would change commensurate with the changes in entrainment described above, increasing in drier years and decreasing in wet years. Increased entrainment during drier years may have a population-level impact on spring-run Chinook salmon since recruitment levels are lower during these years.

Table 11-1A-20. Juvenile Spring-Run Chinook Salmon Annual Entrainment Index[a] at the SWP and CVP Salvage Facilities—Differences between Model Scenarios for Alternative 1A

	Absolute Difference (Percent Difference)	
Water Year	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Wet	-56,160 (-63%)	-59,788 (-65%)
Above Normal	2,331 (9%)	-737 (-2%)
Below Normal	4,446 (70%)	3,651 (51%)
Dry	9,770 (59%)	8,576 (49%)
Critical	-527 (-4%)	1,094 (11%)
All Years	-3,778 (-10%)	-5,389 (-14%)

Shading indicates >5% increased entrainment.

Note: Estimated annual index of fish lost, based on normalized salvage densities.

The proportion of the annual spring-run population entrained would decrease under Alternative 1A across all years compared to NAA conditions (*BDCP Effects Analysis – Appendix 5.B Entrainment, Section 5B.5.4.4, herein incorporated by reference*). Under the assumption that the annual number of juvenile spring-run Chinook salmon juveniles approaching the Delta was 750,000 fish, the percentage of the population lost to entrainment across all years averaged would be 4.5-5.0% under Alternative 1A, similar to NAA (5.0–5.3%).

These percentages are probably an overestimate because the length-based classification method may classify fall-run Chinook salmon as spring-run.

Water Exports from SWP/CVP North Delta Intake Facilities

As described for winter-run Chinook salmon (Impact AQUA-39), potential entrainment of spring-run Chinook salmon at the north Delta intakes occurs only under the action alternatives, including Alternative 1A. The effects would be minimal because the north Delta intakes would be screened to exclude juvenile fish, including juvenile spring-run Chinook salmon.

Water Exports with a Dual Conveyance for the SWP North Bay Aqueduct

The effects would be similar to those described for Impact AQUA-39. Entrainment and impingement effects for spring-run Chinook salmon would be minimal because intakes would have state-of-the-art screens installed.

NEPA Effects: Under Alternative 1A, entrainment of juvenile spring-run Chinook salmon at the south Delta facilities would decrease 14% on average, but would increase 11% to 51% in drier years. The north Delta intakes would be screened to exclude juvenile fish, and monitored to ensure fish screen performance consistent with design specifications. As a result of increased south Delta entrainment in drier years, this effect is adverse.

CEQA Conclusion: As described above, operational activities associated with water exports from SWP/CVP south Delta facilities would decrease in entrainment of spring-run Chinook salmon in wet years, but would increase entrainment in above normal (9% increase), below normal (70% increase) and dry (59% increase) water years. There is also entrainment risk at the proposed north Delta facilities, although screening would avoid this. The overall impact of Alternative 1A on entrainment of spring-run Chinook salmon would be significant due to increased south Delta entrainment.

Impact AQUA-58: Effects of Water Operations on Spawning and Egg Incubation Habitat for Chinook Salmon (Spring-Run ESU)

In general, Alternative 1A would reduce spawning and egg incubation habitat for spring-run Chinook salmon relative to NAA.

Sacramento River

Flows in the Sacramento River upstream of Red Bluff were examined during the spring-run Chinook salmon spawning and incubation period (September through January) type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would generally be similar to or up to 33% greater than flows under NAA, except during September and November, in which flows would be up to 44% lower.

Shasta Reservoir storage volume at the end of September influences flows downstream of the dam during the spring-run spawning and egg incubation period (September through January). Storage under A1A_LLT would be greater than storage under NAA in wet (8% higher) and above normal (5% higher) water years, 9% lower than storage under NAA in below water years, and similar to storage under NAA in dry and critical water years (Table 11-1A-21).

Table 11-1A-21. Difference and Percent Difference in September Water Storage Volume (thousand acre-feet) in Shasta Reservoir for Alternative 1A Model Scenarios

Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Wet	-290 (-9%)	221 (8%)
Above Normal	-483 (-15%)	132 (5%)
Below Normal	-568 (-20%)	-214 (-9%)
Dry	-555 (-23%)	-44 (-2%)
Critical	-387 (-33%)	-3 (-0.4%)

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the September through January spring-run Chinook salmon spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period at either location.

The number of days on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month (May through September At Bend Bridge and October through April at Red Bluff) and year of the 82-year modeling period (Table 11-1A-11). The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern", as defined in Table 11-1A-12. Differences between baselines and Alternative 1A in the highest level of concern across all months and all 82 modeled years are presented in Table 11-1A-13 for Bend Bridge and in Table 11-1A-22 for Red Bluff. There would be no difference in levels of concern between NAA and Alternative 1A at Bend Bridge. At Red Bluff, there would be 6 (14%) and 4 (50%) fewer years with a "red" and "yellow" level of concern, respectively, under Alternative 1A.

Table 11-1A-22. Differences between Baseline and Alternative 1A Scenarios in the Number of Years in Which Water Temperature Exceedances above 56°F Are within Each Level of Concern, Sacramento River at Red Bluff, October through April

Level of Concern[a]	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Red	30 (250%)	-6 (-14%)
Orange	12 (200%)	5 (28%)
Yellow	-5 (-38%)	-4 (-50%)
None	-37 (-73%)	5 (36%)

[a] For definitions of levels of concern, see Table 11-1A-12.

Total degree-days exceeding 56°F were summed by month and water year type at Bend Bridge during May through September and at Red Bluff during October through April. At Bend Bridge, total degree-days under Alternative 1A would be up to 15% lower than those under NAA during May and June and up to 20% higher during July through September (Table 11-1A-14). At Red Bluff, total degree-days under Alternative 1A would be 17% higher than those under NAA during November, 13% lower during April, and similar during remaining months (Table 11-1A-23).

Table 11-1A-23. Differences between Baseline and Alternative 1A Scenarios in Total Degree-Days (°F-Days) by Month and Water Year Type for Water Temperature Exceedances above 56°F in the Sacramento River at Red Bluff, October through April

Month	Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
October	Wet	1,087 (423%)	-82 (-6%)
	Above Normal	439 (169%)	-38 (-5%)
	Below Normal	823 (394%)	117 (13%)
	Dry	1,067 (217%)	-4 (0%)
	Critical	880 (147%)	-43 (-3%)
	All	4,296 (236%)	-50 (-1%)
November	Wet	91 (9,100%)	1 (1%)
	Above Normal	69 (NA)	8 (13%)
	Below Normal	107 (NA)	59 (123%)
	Dry	166 (2,075%)	15 (9%)
	Critical	107 (2,675%)	-3 (-3%)
	All	540 (4,154%)	80 (17%)
December	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
January	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
February	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
March	Wet	9 (NA)	0 (0%)
	Above Normal	6 (NA)	2 (50%)
	Below Normal	30 (333%)	9 (30%)
	Dry	59 (421%)	-5 (-6%)
	Critical	25 (2,500%)	-2 (-7%)
	All	129 (538%)	4 (3%)
April	Wet	253 (220%)	-8 (-2%)
	Above Normal	197 (141%)	-32 (-9%)
	Below Normal	226 (286%)	-4 (-1%)
	Dry	154 (83%)	-166 (-33%)
	Critical	135 (1,125%)	-16 (-10%)
	All	965 (181%)	-226 (-13%)

NA = could not be calculated because the denominator was 0.

The Reclamation egg mortality model predicts that spring-run Chinook salmon egg mortality in the Sacramento River under A1A_LLT would be similar to mortality under NAA in dry and critical years, but greater in wet (40% greater), above normal (24% greater), and below normal (30% greater) water years (Table 11-1A-24).

Table 11-1A-24. Difference and Percent Difference in Percent Mortality of Spring-Run Chinook Salmon Eggs in the Sacramento River (Egg Mortality Model)

Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Wet	25 (244%)	10 (40%)
Above Normal	30 (229%)	8 (24%)
Below Normal	42 (350%)	12 (30%)
Dry	56 (282%)	-1 (-2%)
Critical	22 (30%)	-0.2 (-0.2%)
All	35 (156%)	6 (12%)

SacEFT predicts that there would be a substantial increase (57%) in the percentage of years with good spawning availability, measured as weighted useable area, between A1A_LLT and NAA (Table 11-1A-25). SacEFT predicts that there would be no difference in the percentage of years with good (lower) redd scour risk under A1A_LLT relative to NAA (Table 11-1A-25). SacEFT predicts that there would be a 32% decrease in the percentage of years with good (lower) egg incubation conditions under A1A_LLT relative to NAA. SacEFT predicts that there would be a 26% increase in the percentage of years with good (lower) redd dewatering risk under A1A_LLT relative to NAA.

Table 11-1A-25. Difference and Percent Difference in Percentage of Years with "Good" Conditions for Spring-Run Chinook Salmon Habitat Metrics in the Upper Sacramento River (from SacEFT)

Metric	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Spawning WUA	7 (10%)	28 (57%)
Redd Scour Risk	0 (0%)	0 (0%)
Egg Incubation	-63 (-73%)	-11 (-32%)
Redd Dewatering Risk	-6 (-12%)	9 (26%)
Juvenile Rearing WUA	0 (0%)	0 (0%)
Juvenile Stranding Risk	-5 (-26%)	0 (0%)

WUA = Weighted Usable Area.

Clear Creek

Flows under A1A_LLT would be similar to flows under NAA throughout the September through January spring-run spawning and egg incubation period for all water year types, except in critical years during September (13% reduction) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

The potential risk of spring-run Chinook salmon redd dewatering in Clear Creek was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in September when spawning is assumed to occur. The greatest reduction in flows under

A1A_LLT during September through January would be the same as that under NAA in all water year types (Table 11-1A-26).

Water temperatures were not modeled in Clear Creek.

Table 11-1A-26. Difference and Percent Difference in Greatest Monthly Reduction (Percent Change) in Instream Flow in Clear Creek below Whiskeytown Reservoir during the September through January Spawning and Egg Incubation Period[a]

Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Wet	0 (NA)	0 (NA)
Above Normal	-27 (NA)	0 (0%)
Below Normal	53 (100%)	0 (NA)
Dry	-67 (NA)	0 (0%)
Critical	-33 (-50%)	0 (0%)

NA = could not be calculated because the denominator was 0.

[a] Redd dewatering risk not applicable for months when flows during the egg incubation period were at or greater than flows in September, when spawning is assumed to occur. A negative value indicates that the greatest monthly reduction would be of greater magnitude (worse) under the alternative than under the baseline.

Feather River

Flows were examined in the Feather River low-flow channel (upstream of Thermalito Afterbay) where spring-run Chinook primarily spawn and eggs incubate during September through January (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would not differ from NAA because minimum Feather River flows are included in the FERC settlement agreement and would be met for all model scenarios (California Department of Water Resources 2006).

Oroville Reservoir storage volume at the end of September influence flows downstream of the dam during the spring-run spawning and egg incubation period. Storage volume at the end of September under A1A_LLT would be 18% to 31% greater than storage under NAA depending on water year type (Table 11-1A-27).

Table 11-1A-27. Difference and Percent Difference in September Water Storage Volume (thousand acre-feet) in Oroville Reservoir for Model Scenarios

Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Wet	-467 (-16%)	547 (29%)
Above Normal	-504 (-21%)	287 (18%)
Below Normal	-340 (-17%)	270 (19%)
Dry	-42 (-3%)	311 (31%)
Critical	-20 (-2%)	168 (21%)

The potential risk of redd dewatering in the Feather River low-flow channel was evaluated by comparing the magnitude of flow reduction each month over the egg incubation period compared to the flow in September when spawning is assumed to occur. Minimum flows in the low-flow channel during October through January were identical among A1A_LLT and NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Therefore, there would be no effect of Alternative 1A on redd dewatering in the Feather River low-flow channel.

Mean monthly water temperatures were examined in the Feather River low-flow channel (upstream of Thermalito Afterbay) during September through January (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

The percent of months exceeding the 56°F temperature threshold in the Feather River above Thermalito Afterbay (low-flow channel) was evaluated during September through January (Table 11-1A-28). The percent of months exceeding the threshold under Alternative 1A would generally be lower (up to 32% lower on an absolute scale) than the percent under NAA during October and November and similar during other months, except for the >5.0 degree category during September (5% absolute scale increase).

Table 11-1A-28. Differences between Baseline and Alternative 1A Scenarios in Percent of Months during the 82-Year CALSIM Modeling Period during Which Water Temperatures in the Feather River above Thermalito Afterbay Exceed the 56°F Threshold, September through January

	Degrees Above Threshold				
Month	>1.0	>2.0	>3.0	>4.0	>5.0
EXISTING CONDITIONS vs. A1A_LLT					
September	0 (0%)	1 (1%)	9 (9%)	23 (32%)	47 (115%)
October	32 (144%)	36 (483%)	25 (400%)	26 (1,050%)	20 (800%)
November	33 (1,350%)	28 (2,300%)	21 (1,700%)	12 (NA)	7 (NA)
December	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
NAA vs. A1A_LLT					
September	0 (0%)	0 (0%)	1 (1%)	0 (0%)	5 (6%)
October	-32 (-37%)	-22 (-34%)	-25 (-44%)	-21 (-43%)	-17 (-44%)
November	-31 (-46%)	-30 (-50%)	-27 (-55%)	-20 (-62%)	-17 (-70%)
December	-4 (-100%)	-1 (-100%)	-1 (-100%)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.

Total degree-days exceeding 56°F were summed by month and water year type above Thermalito Afterbay (low-flow channel) during September through January (Table 11-1A-29). Total degree-months would be similar between NAA and Alternative 1A during September, December, and January, and 37% and 45% lower during October and November.

Table 11-1A-29. Differences between Baseline and Alternative 1A Scenarios in Total Degree-Months (°F-Months) by Month and Water Year Type for Water Temperature Exceedances above 56°F in the Feather River above Thermalito Afterbay, September through January

Month	Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
September	Wet	60 (56%)	35 (26%)
	Above Normal	23 (53%)	13 (25%)
	Below Normal	35 (58%)	4 (4%)
	Dry	47 (68%)	-41 (-26%)
	Critical	43 (66%)	-19 (-15%)
	All	208 (60%)	-8 (-1%)
October	Wet	39 (780%)	-57 (-56%)
	Above Normal	20 (200%)	-15 (-33%)
	Below Normal	39 (557%)	-15 (-25%)
	Dry	52 (743%)	-28 (-32%)
	Critical	28 (350%)	-13 (-27%)
	All	178 (481%)	-128 (-37%)
November	Wet	21 (NA)	-35 (-63%)
	Above Normal	14 (467%)	-11 (-39%)
	Below Normal	16 (1,600%)	-18 (-51%)
	Dry	30 (NA)	-21 (-41%)
	Critical	23 (NA)	-5 (-18%)
	All	104 (2,600%)	-90 (-45%)
December	Wet	0 (NA)	-1 (-100%)
	Above Normal	1 (NA)	0 (0%)
	Below Normal	0 (NA)	-3 (-100%)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	1 (NA)	-4 (-80%)
January	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.

NEPA Effects: In conclusion, the effect is adverse because habitat would be substantially reduced. Spawning habitat conditions in the Sacramento River are predicted by SacEFT to improve, although egg incubation conditions would be degraded. In addition, the Reclamation egg mortality model predicts that there would be an 8% to 12% increase in egg mortality in wet, above normal, and below normal years. There would be no flow- or temperature-related effects on spring-run Chinook salmon spawning and egg incubation in Clear Creek or the Feather River. This effect is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this effect to a level that is not adverse would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this would be an unavoidable adverse effect because there is no feasible mitigation.

CEQA Conclusion: In general, Alternative 1A would reduce spawning and egg incubation habitat for spring-run Chinook salmon relative to Existing Conditions.

Sacramento River

Flows in the Sacramento River upstream of Red Bluff were examined during the spring-run Chinook salmon spawning and incubation period (September through January) type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would generally be similar to or up to 36% greater than flows under Existing Conditions, except during September and November, in which flows would be up to 24% lower.

Shasta Reservoir storage volume at the end of September influences flows downstream of the dam during the spring-run spawning and egg incubation period (September through January). September storage under A1A_LLT would be lower by 9% to 33% than storage under Existing Conditions in all water year types (Table 11-1A-21).

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the September through January spring-run Chinook salmon spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). At Keswick, temperatures under Alternative 1A during September and October would be 7% and 6% greater, respectively, than those under Existing Conditions, but not different in other months during the period. At Red Bluff, temperatures under Alternative 1A during September and October would be 7% and 5% greater, respectively, than those under Existing Conditions, but not different in other months during the period.

The number of days on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month (May through September At Bend Bridge and October through April at Red Bluff) and year of the 82-year modeling period (Table 11-1A-11). The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern", as defined in Table 11-1A-12. Differences between baselines and Alternative 1A in the highest level of concern across all months and all 82 modeled years are presented in Table 11-1A-13 for Bend Bridge and in Table 11-1A-22 for Red Bluff. At Bend Bridge, there would be a 103% increase in the number of years with a "red" level of concern under Alternative 1A relative to Existing Conditions. At Red Bluff, there would be 250% and 200% increases in the number of years with "red" and "orange" levels of concern under Alternative 1A relative to Existing Conditions.

Total degree-days exceeding 56°F were summed by month and water year type at Bend Bridge during May through September and at Red Bluff during October through April. At Bend Bridge, total degree-days under Alternative 1A would be up to 157% to 281% higher than those under Existing Conditions depending on the month (Table 11-1A-14). At Red Bluff, total degree-days under Alternative 1A would be 181% to 4154% higher than those under Existing Conditions during October, November, March, and April, and similar during December through February (Table 11-1A-23).

The Reclamation egg mortality model predicts that spring-run Chinook salmon egg mortality in the Sacramento River under A1A_LLT would be 30% to 350% higher than mortality under Existing Conditions depending on water year type (Table 11-1A-24).

SacEFT predicts that there would be a 10% increase in the percentage of years with good spawning availability, measured as weighted useable area, between A1A_LLT and Existing Conditions (Table 11-1A-25). SacEFT predicts that there would be no difference in the percentage of years with good (lower) redd scour risk under A1A_LLT relative to Existing Conditions (Table 11-1A-25). SacEFT predicts that there would be a 73% decrease in the percentage of years with good (lower) egg incubation conditions under A1A_LLT relative to Existing Conditions. SacEFT predicts that there would be a 12% decrease in the percentage of years with good (lower) redd dewatering risk under A1A_LLT relative to Existing Conditions.

Clear Creek

Flows under A1A_LLT would be similar to flows under Existing Conditions throughout the September through January spring-run spawning and egg incubation period for all water year types, except in critical years during September (37% reduction) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

The potential risk of spring-run Chinook salmon redd dewatering in Clear Creek was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in September when spawning is assumed to occur. The greatest reduction in flows under A1A_LLT during September through January would be the same or lower than the reduction under Existing Conditions in wet and below normal water year types and greater by 27%, 67%, and 33% then Existing Conditions in above normal, dry, and critical water years, respectively (Table 11-1A-26).

Water temperatures were not modeled in Clear Creek.

Feather River

Flows were examined in the Feather River low-flow channel (upstream of Thermalito Afterbay) where spring-run Chinook primarily spawn during September through January (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would not differ from Existing Conditions because minimum Feather River flows are included in the FERC settlement agreement and would be met for all model scenarios (California Department of Water Resources 2006).

Oroville Reservoir storage volume at the end of September influence flows downstream of the dam during the spring-run spawning and egg incubation period. Storage volume at the end of September under A1A_LLT would be similar to storage under Existing Conditions in dry and critical water years, but 16% to 21% in wet, above normal, and below normal water years (Table 11-1A-27).

The potential risk of redd dewatering in the Feather River low-flow channel was evaluated by comparing the magnitude of flow reduction each month over the egg incubation period compared to the flow in September when spawning is assumed to occur. Minimum flows in the low-flow channel during October through January were identical among A1A_LLT and Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Therefore, there would be no effect of Alternative 1A on redd dewatering in the Feather River low-flow channel.

Mean monthly water temperatures were examined in the Feather River low-flow channel (upstream of Thermalito Afterbay) during September through January (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

Temperatures under Alternative 1A would be 7% to 10% greater than those under Existing Conditions in all months during the period except September.

The percent of months exceeding the 56°F temperature threshold in the Feather River above Thermalito Afterbay (low-flow channel) was evaluated during September through January (Table 11-1A-28). The percent of months exceeding the threshold under Alternative 1A would be similar to or up to 47% higher (absolute scale) than under Existing Conditions during September through November. There would be no difference in the percent of months exceeding the threshold between Existing Conditions and alternative 1A during December and January.

Total degree-days exceeding 56°F were summed by month and water year type above Thermalito Afterbay (low-flow channel) during September through January (Table 11-1A-29). Total degree-months exceeding the threshold under Alternative 1A would be 60% to 2600% greater than those under Existing Conditions during September through November. There would be no difference in total degree-months between Existing Conditions and Alternative 1A during December and January.

Summary of CEQA Conclusion

Collectively, the results indicate that the difference between the CEQA baseline and Alternative 1A is significant because the alternative could substantially reduce the number of fish as a result of degraded spawning habitat conditions and egg mortality in the Sacramento and Feather Rivers and in Clear Creek. Shasta reservoir storage would be substantially reduced at the end of September under Alternative 1A relative to Existing Conditions, which would alter flows and increase water temperatures in the Sacramento River to above NMFS thresholds substantially more frequently. This would lead to degraded egg incubation conditions, as predicted by SacEFT, and increased egg mortality, as predicted by the Reclamation egg mortality model. Flows would generally not differ in the Feather and Clear Creek between Existing Conditions and Alternative 1A although water temperatures and the exceedance of NMFS temperature thresholds would increase under Alternative 1A in the Feather River during the majority of months evaluated. This impact is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this impact to a less-than-significant level would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this impact is significant and unavoidable because there is no feasible mitigation available. Even so, proposed below is mitigation that has the potential to reduce the severity of impact though not necessarily to a less-than-significant level.

Mitigation Measure AQUA-58a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Spring-Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Spawning Habitat

Although analysis conducted as part of the EIR/EIS determined that Alternative 1A would have significant and unavoidable adverse effects on spawning habitat, this conclusion was based on the best available scientific information at the time and may prove to have been over- or understated. Upon the commencement of operations of CM1 and continuing through the life of the permit, the BDCP proponents will monitor effects on spawning habitat in order to determine whether such effects would be as extensive as concluded at the time of preparation of this document and to determine any potentially feasible means of reducing the severity of such effects. This mitigation measure requires a series of actions to accomplish these purposes, consistent with the operational framework for Alternative 1A.

The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 1A operations only. Development of mitigation actions for the incremental impact on spawning habitat attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 1A.

Mitigation Measure AQUA-58b: Conduct Additional Evaluation and Modeling of Impacts on Spring-Run Chinook Salmon Spawning Habitat Following Initial Operations of CM1

Following commencement of initial operations of CM1 and continuing through the life of the permit, the BDCP proponents will conduct additional evaluations to define the extent to which modified operations could reduce impacts to spawning habitat under Alternative 1A. The analysis required under this measure may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6).

Mitigation Measure AQUA-58c: Consult with USFWS and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Spring-Run Chinook Salmon Spawning Habitat Consistent with CM1

In order to determine the feasibility of reducing the effects of CM1 operations on spring-run Chinook salmon habitat, the BDCP proponents will consult with USFWS and the Department of Fish and Wildlife to identify and implement any feasible operational means to minimize effects on spawning habitat. Any such action will be developed in conjunction with the ongoing monitoring and evaluation of habitat conditions required by Mitigation Measure AQUA-40a.

If feasible means are identified to reduce impacts on spawning habitat consistent with the overall operational framework of Alternative 1A without causing new significant adverse impacts on other covered species, such means shall be implemented. If sufficient operational flexibility to reduce effects on spring-run Chinook salmon habitat is not feasible under Alternative 1A operations, achieving further impact reduction pursuant to this mitigation measure would not be feasible under this Alternative, and the impact on spring-run Chinook salmon would remain significant and unavoidable.

Impact AQUA-59: Effects of Water Operations on Rearing Habitat for Chinook Salmon (Spring-Run ESU)

In general, Alternative 1A would not affect the quantity and quality of rearing habitat for fry and juvenile spring-run Chinook salmon relative to NAA.

Sacramento River

Flows were evaluated during the November through March larval and juvenile spring-run Chinook salmon rearing period in the Sacramento River between Keswick Dam and just upstream of Red Bluff (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows between December and July under A1A_LLT would generally be similar to or greater than those under NAA. Flows during November would be lower (by up to 30%) under A1A_LLT than under NAA.

As reported for Alternative 1A (Impact AQUA-40 for spring-run Chinook salmon), May Shasta storage volume under A1A_LLT would be similar to or up to 8% lower than storage under NAA for all water year types (Table 11-1A-10).

As reported in Impact AQUA-58, September Shasta storage volume would be greater than storage under NAA in wet (8% higher) and above normal (5% higher) water years, 9% lower than storage under NAA in below water years, and similar to storage under NAA in dry and critical water years (Table 11-1A-21).

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the year-round spring-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period at either location.

SacEFT predicts that the percentage of years with good juvenile rearing WUA conditions and juvenile stranding risk under A1A_LLT would be similar to that under NAA (Table 11-1A-25).

SALMOD predicts that spring-run smolt equivalent habitat-related mortality would be 7% lower under A1A_LLT than NAA.

Clear Creek

Flows in Clear Creek during the November through March rearing period under A1A_LLT would generally be similar to or greater than flows under NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Water temperatures were not modeled in Clear Creek.

Feather River

Flows in the Feather River both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) during November through June were reviewed to determine flow-related effects on larval and juvenile spring-run rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Relatively constant flows in the low flow channel throughout this period under A1A_LLT would not differ from those under NAA. In the high flow channel, flows under A1A_LLT would be mostly greater by up to 110% than flows under NAA during November through June with few exceptions during which flows would be similar to, or up to 15% lower, than under NAA.

May Oroville storage under A1A_LLT would be similar to storage under NAA, except for dry years (5% higher) (Table 11-1A-30).

As reported for Alternative 1A (Impact AQUA-58 for spring-run Chinook salmon), September Oroville storage volume would be 18% to 31% greater than under NAA depending on water year type (Table 11-1A-27).

Table 11-1A-30. Difference and Percent Difference in May Water Storage Volume (thousand acre-feet) in Oroville Reservoir for Model Scenarios

Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Wet	-91 (-3%)	-45 (-1%)
Above Normal	-237 (-7%)	-81 (-2%)
Below Normal	-379 (-12%)	-26 (-1%)
Dry	-410 (-15%)	110 (5%)
Critical	-260 (-14%)	57 (4%)

Mean monthly water temperatures in the Feather River both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were evaluated during November through June (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period at either location.

The percent of months exceeding the 63°F temperature threshold in the Feather River above Thermalito Afterbay (low-flow channel) was evaluated during May through August (Table 11-1A-31). The percent of months exceeding the threshold under Alternative 1A would generally be similar to or lower (up to 19% lower on an absolute scale) than the percent under NAA.

Table 11-1A-31. Differences between Baseline and Alternative 1A Scenarios in Percent of Months during the 82-Year CALSIM Modeling Period during Which Water Temperatures in the Feather River above Thermalito Afterbay Exceed the 63°F Threshold, May through August

	Degrees Above Threshold				
Month	>1.0	>2.0	>3.0	>4.0	>5.0
EXISTING CONDITIONS vs. A1A_LLT					
May	2 (NA)	2 (NA)	0 (NA)	0 (NA)	0 (NA)
June	27 (49%)	32 (118%)	30 (600%)	12 (NA)	2 (NA)
July	0 (0%)	0 (0%)	1 (1%)	25 (34%)	49 (125%)
August	0 (0%)	12 (14%)	35 (60%)	49 (174%)	42 (425%)
NAA vs. A1A_LLT					
May	-4 (-60%)	0 (0%)	-1 (-100%)	0 (NA)	0 (NA)
June	-6 (-7%)	-19 (-24%)	-12 (-26%)	-9 (-41%)	-2 (-50%)
July	0 (0%)	0 (0%)	0 (0%)	-1 (-1%)	-5 (-5%)
August	0 (0%)	0 (0%)	-6 (-6%)	-4 (-5%)	-5 (-9%)

NA = could not be calculated because the denominator was 0.

Total degree-days exceeding 63°F were summed by month and water year type above Thermalito Afterbay (low-flow channel) during May through August (Table 11-1A-32). Total degree-months under Alternative 1A would be similar to or lower than those under NAA depending on the month.

Table 11-1A-32. Differences between Baseline and Alternative 1A Scenarios in Total Degree-Months (°F-Months) by Month and Water Year Type for Water Temperature Exceedances above 63°F in the Feather River above Thermalito Afterbay, May through August

Month	Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
May	Wet	1 (NA)	0 (0%)
	Above Normal	1 (NA)	0 (0%)
	Below Normal	0 (NA)	0 (NA)
	Dry	2 (NA)	0 (0%)
	Critical	3 (NA)	-1 (-25%)
	All	7 (NA)	-1 (-13%)
June	Wet	27 (180%)	-2 (-5%)
	Above Normal	14 (100%)	-3 (-10%)
	Below Normal	19 (146%)	-3 (-9%)
	Dry	31 (135%)	-2 (-4%)
	Critical	22 (367%)	-3 (-10%)
	All	113 (159%)	-13 (-7%)
July	Wet	46 (38%)	5 (3%)
	Above Normal	22 (50%)	2 (3%)
	Below Normal	30 (51%)	2 (2%)
	Dry	43 (61%)	7 (7%)
	Critical	37 (71%)	5 (6%)
	All	178 (51%)	21 (4%)
August	Wet	43 (48%)	10 (8%)
	Above Normal	21 (84%)	3 (7%)
	Below Normal	33 (87%)	4 (6%)
	Dry	44 (110%)	-9 (-10%)
	Critical	36 (86%)	-4 (-5%)
	All	177 (76%)	4 (1%)

NA = could not be calculated because the denominator was 0.

NEPA Effects: Collectively, these results indicate that the effect is not adverse because habitat would not be substantially reduced. There would be no flow- or temperature-related effects in the Sacramento and Feather Rivers and Clear Creek under Alternative 1A relative to NAA.

CEQA Conclusion: In general, under Alternative 1A water operations, the quantity and quality of rearing habitat for fry and juvenile spring-run Chinook salmon would not be affected relative to the CEQA baseline.

Sacramento River

Flows were evaluated during the November through March larval and juvenile spring-run Chinook salmon rearing period in the Sacramento River between Keswick Dam and just upstream of Red Bluff (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows during November would be lower by up to 21% under A1A_LLT than under Existing Conditions. Flows under A1A_LLT during the remaining 4 months of the period would be generally similar to or up to 13% greater than those under Existing Conditions.

Shasta Reservoir storage volume at the end of May would be similar to Existing Conditions in wet and, above normal, and below normal water years (up to -4%), but up to 25% lower in the other by 6% to 9% in dry and critical water years, with an overall average of -9% for all years, respectively (Table 11-1A-10). This indicates that there would be a small to moderate effect of Alternative 1A on flows during the spawning and egg incubation period.

Shasta Reservoir storage volume at the end of September under A1A_LLT would be 9% to 33% lower relative to Existing Conditions (Table 11-1A-21).

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the November through March spring-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). At both locations, there would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 1A in most months.

SacEFT predicts that the percentage of years with good juvenile rearing WUA conditions under A1A_LLT would be similar to Existing Conditions (Table 11-1A-25). The percentage of years with good (lower) juvenile stranding risk conditions under A1A_LLT would be 26% lower than under Existing Conditions.

SALMOD predicts that spring-run smolt equivalent habitat-related mortality under A1A_LLT would be 37% lower than under Existing Conditions.

Clear Creek

Flows in Clear Creek during the November through March period under A1A_LLT would generally be similar to or greater than flows under Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Water temperatures were not modeled in Clear Creek.

Feather River

Relatively constant flows in the low flow channel throughout the November through June period under A1A_LLT would not differ from those under Existing Conditions. In the high flow channel, flows under A1A_LLT would be similar to or greater than flows under Existing Conditions from November through June with few exceptions during which flows would be up to 40% lower under A1A_LLT.

May Oroville storage volume under A1A_LLT would be lower than Existing Conditions by 7% to 15% depending on water year type, except in wet years, in which storage would be similar to Existing Conditions (Table 11-1A-30).

Oroville Reservoir storage volume at the end of September would be similar under A1A_LLT relative to Existing Conditions during dry and critical water years, but moderately lower (up to 21% lower) for other water year types (Table 11-1A-27).

Mean monthly water temperatures in the Feather River both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were evaluated during the November through June juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Water temperature under Alternative 1A would be 5% to 10% greater than those under Existing Conditions during November through March, but similar (<5% difference) during April through June.

The percent of months exceeding the 63°F temperature threshold in the Feather River above Thermalito Afterbay (low-flow channel) was evaluated during May through August (Table 11-1A-31). The percent of months exceeding the threshold under Alternative 1A would be similar to those under Existing Conditions during May, but up to 49% greater during June through August.

Total degree-days exceeding 63°F were summed by month and water year type above Thermalito Afterbay (low-flow channel) during May through August (Table 11-1A-32). Total degree-months under Alternative 1A would be similar to those under Existing Conditions during May, but 51% to 159% higher during June through August.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-59 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 1A could be significant because, under the CEQA baseline, the alternative could substantially reduce rearing habitat, contrary to the NEPA conclusion set forth above. Flows in the Sacramento and Feather Rivers and in Clear Creek would be similar under Alternative 1A relative to the CEQA baseline, although temperatures and the exceedances above the temperature thresholds in the Feather River would be substantially higher under Alternative 1A. SacEFT predicts increased juvenile stranding risk and SALMOD predicts increased habitat-related mortality in the Sacramento River.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 1A does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 1A indicates that flows and reservoir storage in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 1A. This indicates that the differences between Existing Conditions and Alternative 1A found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 1A, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on rearing habitat for spring-run Chinook salmon. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-60: Effects of Water Operations on Migration Conditions for Chinook Salmon (Spring-Run ESU)

Upstream of the Delta

In general, Alternative 1A would reduce migration conditions for spring-run Chinook salmon relative to NAA.

Sacramento River

Flows in the Sacramento River upstream of Red Bluff were evaluated during the December through May juvenile Chinook salmon spring-run migration period. Flows under A1A_LLT during December through May would always be similar to or greater (up to 16%) than flows under NAA, except for January in critical years (11% lower)(Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the December through May juvenile Chinook salmon spring-run emigration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

Flows in the Sacramento River upstream of Red Bluff were evaluated during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT in April through June would generally be similar to or greater (up to 14%) than flows under NAA. During July, flows under A1A_LLT would generally be similar to flows under NAA. During August, flows under A1A_LLT would be lower (up to 19% lower) than flows under NAA.

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

Clear Creek

Flows in Clear Creek during the November through May juvenile Chinook salmon spring-run migration period under A1A_LLT would be similar to or greater than flows under NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flows in Clear Creek during the April through August adult spring-run Chinook salmon upstream migration period under A1A_LLT would generally be similar to or greater than flows under NAA with the exception of critical water years during June in which there would be an 8% reduction in flows (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Water temperatures were not modeled in Clear Creek.

Feather River

Flows in the Feather River at the confluence with the Sacramento River were examined during the November through May juvenile spring-run Chinook salmon migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be similar to or greater than flows under NAA in all months and water years except during November in above normal years (7% lower) and January in critical years (7% lower).

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the November through May juvenile spring-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

Flows in the Feather River at the confluence with the Sacramento River were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT during April through June would generally be greater by up to 44% than flows under NAA, except in critical years during June (8% lower). Flows under A1A_LLT during July and August would generally be lower than flows under NAA by up to 49%.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

Through-Delta

Juveniles

As discussed for winter-run Chinook above (Impact AQUA-42), Plan Area flows have considerable importance for downstream migrating juvenile salmonids and would be affected by the north Delta diversions. Under Alternative 1A, Sacramento River flows below the NDD during the juvenile spring-run migration period (November-May) would be reduced compared to Existing Conditions (Appendix 11C). Mean monthly flows under Alternative 1A averaged across years would be lower (up to 31% lower) compared to NAA. Flows would be up to 39% lower in November of above normal years. However, *CM1 Water Facilities and Operation* includes bypass flow criteria that will be managed in real time to minimize adverse effects of diversions at the north Delta intakes on downstream-migrating salmonids.

Potential predation losses at the north Delta intakes, as estimated by the bioenergetics model, would be minimal (less than 2% of annual production) (Table 11-1A-17). An assumption of 5% loss per intake would yield a cumulative loss of 19.2% of spring-run Chinook juveniles that reach the Delta. This assumption is uncertain and represents an upper bound estimate. In addition, the five intake structures would permanently displace approximately 22 acres of in-water habitat.

Through-Delta survival of migrating juvenile spring-run Chinook salmon, as estimated by DPM, averaged 29% across all years, 38% in wetter years, and 24% in drier years under Alternative 1A (Table 11-1A-33). This is similar (<5% difference) to results under baseline conditions (about 1% lower survival compared to NAA, a 3% relative decrease).

Table 11-1A-33. Through-Delta Survival (%) of Emigrating Juvenile Spring-Run Chinook Salmon under Alternative 1A

	Percentage Survival			Difference in Percentage Survival (Relative Difference)	
Year Type	EXISTING CONDITIONS	NAA	A1A_LLT	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Wetter Years	42.1	40.4	38.1	-4.0 (-10%)	-2.3 (-6%)
Drier Years	24.8	24.3	24.1	-0.7 (-2%)	-0.2 (0%)
All Years	31.3	30.3	29.3	-1.9 (-5%)	-1.0 (-2%)

Note: Delta Passage Model results for survival to Chipps Island.
Wetter = Wet and above normal water years (6 years).
Drier = Below normal, dry and critical water years (10 years).

Adults

Adult salmonids migrating through the delta use flow and olfactory cues for navigation to their natal streams (Marston et al. 2012), as discussed above for winter-run Chinook (Impact AQUA-42). The importance of flow changes to currently affect these cues is rated as low but with low certainty. Sacramento River flows downstream of the proposed north Delta intakes generally will be lower under Alternative 1A operations relative to NAA, with differences between water-year types because of differences in the relative proportion of water being exported from the north Delta and south Delta facilities (*Appendix 11C)*. During the adult spring-run Chinook salmon upstream migration from March to June, the proportion of Sacramento River water in the Delta would decrease 5% to 11% under Alternative 1A compared to NAA (Table 11-1A-34). Adult salmonid attraction due to olfactory cues could be adversely affected by dilution greater than 20%, but has not been discernibly affected by dilution of 10% or less (Fretwell 1989). Olfactory cues for adult spring-run Chinook salmon from the Sacramento River would not substantially affected by flow operations under Alternative 1A.

Table 11-1A-34. Monthly Average Percentage (%) of Water at Collinsville Originating in the Sacramento River during the March through June Adult Spring-Run Chinook Salmon Migration Period

Month	EXISTING CONDITIONS	NAA	A1A_LLT	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
March	78	76	67	-11	-9
April	77	75	67	-10	-8
May	69	65	61	-8	-4
June	64	62	59	-5	-3

Shading indicates 10% or greater absolute difference.

Source: DSM2-QUAL fingerprinting analysis (monthly time step, October 1976-September 1991). *BDCP Effects Analysis – Appendix 5.C, Section 5C.5.3. Passage, Movement, and Migration Results.*

NEPA Effects: Overall, the results indicate that the effect of Alternative 1A is adverse due to the cumulative effects associated with five north Delta intake facilities, including mortality related to near-field effects (e.g. impingement and predation) and far-field effects (reduced survival due to reduced flows downstream of the intakes) associated with the five NDD intakes.

Upstream of the Delta migration conditions for spring-run Chinook salmon under Alternative 1A would not be adverse because flow and temperature conditions would generally be similar to those under the NEPA baseline.

Adult attraction flows under Alternative 1A would be lower than those under NAA, but adult attraction flows are expected to be adequate to provide olfactory cues for migrating adults.

Near-field effects of Alternative 1A NDD on spring-run Chinook salmon related to impingement and predation associated with five new intakes could result in substantial effects on juvenile migrating spring-run Chinook salmon, although there is high uncertainty regarding the potential effects. Estimates within the effects analysis range from very low levels of effects (~2% mortality) to very significant effects (~ 19% mortality above current baseline levels). CM15 would be implemented with the intent of providing localized and temporary reductions in predation pressure at the NDD. Additionally, several pre-construction surveys to better understand how to minimize losses associated with the five new intake structures will be implemented as part of the final NDD screen design effort. Alternative 1A also includes an Adaptive Management Program and Real-Time Operational Decision-Making Process to evaluate and make limited adjustments intended to provide adequate migration conditions for spring-run Chinook salmon. However, at this time, due to the absence of comparable facilities anywhere in the lower Sacramento River/Delta, the degree of mortality expected from near-field effects at the NDD remains highly uncertain.

Two recent studies (Newman 2003 and Perry 2010) indicate that far-field effects associated with the new intakes could cause a reduction in smolt survival in the Sacramento River downstream of the NDD intakes due to reduced flows in this area. The analyses of other elements of Alternative 1A predict improvements in smolt condition and survival associated with increased access to the Yolo Bypass, reduced interior Delta entry, and reduced south Delta entrainment. The overall magnitude of each of these factors and how they might interact and/or offset each other in affecting salmonid survival through the plan area is uncertain, and remains an area of active investigation for the BDCP.

The DPM is a flow-based model being developed for BDCP which attempts to combine the effects of all of these elements of BDCP operations and conservation measures to predict smolt migration survival throughout the entire Plan Area. The current draft of this model predicts that smolt migration survival under Alternative 1A would be similar to survival rates estimated for NAA. Further refinement and testing of the DPM, along with several ongoing and planned studies related to salmonid survival at and downstream of the NDD are expected to be completed in the foreseeable future. These efforts are expected to improve our understanding of the relationships and interactions among the various factors affecting salmonid survival, and reduce the uncertainty around the potential effects of BDCP implementation on migration conditions for Chinook salmon. Until these efforts are completed and their results are fully analyzed, the overall effect of Alternative 1A on spring-run Chinook salmon through-Delta survival remains uncertain.

Therefore, primarily as a result of reduced upstream migration habitat conditions for spring-run Chinook salmon due to unacceptable levels of uncertainty regarding the cumulative impacts of near-field and far-field effects associated with the presence and operation of the five intakes on spring-run Chinook salmon, this effect is adverse. While implementation of the conservation and mitigation measures listed below would address these impacts, these are not anticipated to reduce the impacts to a level considered not adverse.

CEQA Conclusion: In general, Alternative 1A would reduce migration conditions for spring-run Chinook salmon relative to the Existing Conditions.

Upstream of the Delta

Sacramento River

Flows in the Sacramento River upstream of Red Bluff during December through May juvenile spring-run Chinook salmon migration period under A1A_LLT would generally be similar to or greater than flows under Existing Conditions except in wet water years during May (14% decrease) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the December through May juvenile Chinook salmon spring-run emigration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 1A in any month or water year type throughout the period.

Flows in the Sacramento River upstream of Red Bluff during the April through August adult spring-run Chinook salmon upstream migration period under A1A_LLT would generally be similar to flows under Existing Conditions during April and June, greater than flows under Existing Conditions during May, and lower than Existing Conditions during July and August.

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 1A during April through July. Mean monthly water temperatures under Alternative 1A would be 7% greater relative to Existing Conditions during August.

Clear Creek

Flows in Clear Creek during the November through May juvenile Chinook salmon spring-run migration period under A1A_LLT would be similar to or greater than flows under Existing Conditions, with the greatest increases occurring in January, February, and March of wet years (17% to 54% increases) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flows in Clear Creek during the April through August adult spring-run Chinook salmon upstream migration period under A1A_LLT would generally be similar to or greater than flows under Existing Conditions with exceptions during August of critical water years (17% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Water temperatures were not modeled in Clear Creek.

Feather River

Flows were examined for the Feather River at the confluence with the Sacramento River during the November through May juvenile Chinook salmon spring-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would generally be greater (up to 37% greater) or similar to those under Existing Conditions, except for below normal years in November, January and March (11% to 12% lower), and wet years in November and May (13% and 23% lower, respectively).

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the November through May juvenile spring-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Water temperatures under Alterative 1A would be 5% greater than those under Existing Conditions in November and December, but similar during January through May.

Flows were examined for the Feather River at the confluence with the Sacramento River during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows during April through May under A1A_LLT would generally be similar to or greater than flows under Existing Conditions, except in wet years during May (23% lower). Flows during June, July, and August under A1A_LLT would generally be up to 60% lower than flows under Existing Conditions.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Water temperatures under Alternative 1A would be 6% higher than those under Existing Conditions during July and August, and similar during April through June.

Through-Delta

Juveniles

As discussed for winter-run Chinook above (Impact AQUA-42), Plan Area flows have considerable importance for downstream migrating juvenile salmonids and would be affected by the north Delta diversions. Under Alternative 1A, Sacramento River flows below the NDD during the main juvenile spring-run migration period (November-January) would be reduced compared to Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under Alternative 1A averaged across years would be lower (up to 32% lower) compared to Existing Conditions. Flows would be up to 37% lower in March of above normal and April of below normal years. Note that *CM1 Water Facilities and Operation* includes bypass flow criteria that will be managed in real time to minimize adverse effects of diversions at the north Delta intakes on downstream-migrating salmonids.

Potential predation losses at the five north Delta intakes would range from less than 2% (bioenergetics modeling) to 19% (an upper bound based on 5% loss per intake) of the annual production that reaches the north Delta. In addition, the five intake structures would permanently displace approximately 22 acres of in-water habitat.

Through-Delta survival of migrating juveniles, as estimated by DPM, averaged 29% across all years, with greater survival in wetter years (38%) than in drier years (24%) under Alternative 1A. Compared to Existing Conditions, average juvenile survival would decrease 4% (10% relative decrease) in wetter years and would be similar to Existing Conditions in drier (3% relative decrease) and all years combined (6% relative decrease) (Table 11-1A-33).

Adults

During the adult spring-run Chinook salmon migration period (March-June), Sacramento River flows downstream of the proposed north Delta intakes generally will be lower under Alternative 1A operations compared to Existing Conditions, with differences between water-year types because of differences in the relative proportion of water being exported from the north Delta and south Delta facilities (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*. The proportion of Sacramento River water in the Delta would decline 5% to 11% compared to Existing Conditions (Table 11-1A-34); this change in olfactory cues is not expected to appreciably affect migrating adults.

Summary of CEQA Conclusion

Overall, the results indicate that the effect of Alternative 1A is significant because it has the potential to substantially decrease spring-run Chinook salmon migration habitat conditions. Upstream of the Delta, migration conditions would generally be similar to those under Existing Conditions, except in the Feather River, in which flows would be up to 60% lower during the majority of the adult upstream migration period. Survival of juveniles migrating through the Delta is expected to be similar or slightly lower in wetter years compared to Existing Conditions, but estimated predation losses past the five NDD intakes could hypothetically range from 2% to 19%. In general, the impact on emigrating juveniles would be significant due to the impacts associated with predation and habitat loss from the five intakes (similar to the previous description under Impact AQUA-42). Implementation of CM6 and CM15 would address these impacts, but are not anticipated to reduce them to a level considered less than significant. Although implementation of *CM6 Channel Margin Enhancement* would provide habitat similar to that which would be lost, it would not necessarily be located near the intakes and therefore would not fully compensate for the lost habitat. Additionally, implementation of this measure would not fully address predation losses. *CM15 Localized Reduction of Predatory Fishes (Predator Control)* has substantial uncertainties associated with its effectiveness such that it is considered to have no demonstrable effect. Conservation measures that address habitat and predation losses, therefore, would potentially minimize impacts to some extent but not to a less than significant level. Consequently, as a result of these changes in migration conditions, this impact is significant and unavoidable.

Applicable conservation measures are briefly described below and full descriptions are found in Chapter 3, Section 3.6.2.5 Channel Margin Enhancement (CM6) and Section 3.6.3.4 Localized Reduction of Predatory Fishes (Predator Control) (CM15).

CM6 Channel Margin Enhancement. CM6 would entail restoration of 20 linear miles of channel margin by improving channel geometry and restoring riparian, marsh, and mudflat habitats on the waterside side of levees along channels that provide rearing and outmigration habitat for juvenile salmonids. Linear miles of enhancement would be measured along one side or the other of a given channel segment (e.g., if both sides of a channel are enhanced for a length of 1 mile, this would account for a total of 2 miles of channel margin enhancement). At least 10 linear miles would be enhanced by year 10 of Plan implementation; enhancement would then be phased in 5-mile increments at years 20 and 30, for a total of 20 miles at year 30. Channel margin enhancement would be performed only along channels that provide rearing and outmigration habitat for juvenile salmonids. These include channels that are protected by federal project levees—including the Sacramento River between Freeport and Walnut Grove among several others.

CM15 Localized Reduction of Predatory Fishes (Predator Control). CM15 would seek to reduce populations of predatory fishes at specific locations or modify holding habitat at selected locations of high predation risk (i.e., predation "hotspots"). This conservation measure seeks to benefit covered salmonids by reducing mortality rates of juvenile migratory life stages that are particularly vulnerable to predatory fishes. Predators are a natural part of the Delta ecosystem. Therefore, this conservation measure is not intended to entirely remove predators at any location, or substantially alter the abundance of predators at the scale of the Delta system. This conservation measure would also not remove piscivorous birds. Because of uncertainties regarding treatment methods and efficacy, implementation of CM15 would involve discrete pilot projects and research actions coupled with an adaptive management and monitoring program to evaluate effectiveness. Effects would be temporary, as new individuals would be expected to occupy vacated areas; therefore, removal activities would need to be continuous during periods of concern. CM15 also recognizes that the NDD intakes would create new predation hotspots.

This impact is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this impact to a less-than-significant level would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this impact is significant and unavoidable because there is no feasible mitigation available. Even so, proposed below is mitigation that has the potential to reduce the severity of the impact though not necessarily to a less-than-significant level.

Mitigation Measure AQUA-60a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Spring-Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Migration Conditions

Although analysis conducted as part of the EIR/EIS determined that Alternative 1A would have significant and unavoidable adverse effects on migration habitat, this conclusion was based on the best available scientific information at the time and may prove to have been over- or understated. Upon the commencement of operations of CM1 and continuing through the life of the permit, the BDCP proponents will monitor effects on migration habitat in order to determine whether such effects would be as extensive as concluded at the time of preparation of this document and to determine any potentially feasible means of reducing the severity of such effects. This mitigation measure requires a series of actions to accomplish these purposes, consistent with the operational framework for Alternative 1A.

The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 1A operations only. Development of mitigation actions for the incremental impact on migration habitat attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 1A.

Mitigation Measure AQUA-60b: Conduct Additional Evaluation and Modeling of Impacts on Spring-Run Chinook Salmon Migration Conditions Following Initial Operations of CM1

Following commencement of initial operations of CM1 and continuing through the life of the permit, the BDCP proponents will conduct additional evaluations to define the extent to which modified operations could reduce impacts to migration habitat under Alternative 1A. The analysis required under this measure may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6).

Mitigation Measure AQUA-60c: Consult with USFWS, and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Spring-Run Chinook Salmon Migration Conditions Consistent with CM1

In order to determine the feasibility of reducing the effects of CM1 operations on spring-run Chinook salmon habitat, the BDCP proponents will consult with FWS and the Department of Fish and Wildlife to identify and implement any feasible operational means to minimize effects on migration habitat. Any such action will be developed in conjunction with the ongoing monitoring and evaluation of habitat conditions required by Mitigation Measure AQUA-60a.

If feasible means are identified to reduce impacts on migration habitat consistent with the overall operational framework of Alternative 1A without causing new significant adverse impacts on other covered species, such means shall be implemented. If sufficient operational flexibility to reduce effects on spring-run Chinook salmon habitat is not feasible under Alternative 1A operations, achieving further impact reduction pursuant to this mitigation measure would not be feasible under this Alternative, and the impact on spring-run Chinook salmon would remain significant and unavoidable.

Restoration Measures (CM2, CM4–CM7, and CM10)

Impact AQUA-61: Effects of Construction of Restoration Measures on Chinook Salmon (Spring-Run ESU)

Please refer to Impact AQUA-43 for winter-run Chinook salmon.

Impact AQUA-62: Effects of Contaminants Associated with Restoration Measures on Chinook Salmon (Spring-Run ESU)

Please refer to Impact AQUA-44 for winter-run Chinook salmon.

Impact AQUA-63: Effects of Restored Habitat Conditions on Chinook Salmon (Spring-Run ESU)

Please refer to Impact AQUA-45 for winter-run Chinook salmon.

Other Conservation Measures (CM12–CM19 and CM21)

Impact AQUA-64: Effects of Methylmercury Management on Chinook Salmon (Spring-Run ESU) (CM12)

Please refer to Impact AQUA-46 for winter-run Chinook salmon.

Impact AQUA-65: Effects of Invasive Aquatic Vegetation Management on Chinook Salmon (Spring-Run ESU) (CM13)

Please refer to Impact AQUA-47 for winter-run Chinook salmon.

Impact AQUA-66: Effects of Dissolved Oxygen Level Management on Chinook Salmon (Spring-Run ESU) (CM14)

NEPA Effects*:* As discussed in Chapter 8, *Water Quality*, dissolved oxygen levels would be very similar to Existing Conditions in the areas upstream of the Delta, in the Delta, and in the SWP/CVP export service areas (see discussion of Impacts WQ-10 and WQ-11). As noted there, however, *CM14*

Stockton Deepwater Ship Channel Dissolved Oxygen Levels management would increase the dissolved oxygen levels in the Stockton Deep Water Ship Channel. Spring-run Chinook salmon occupy the channel for periods of time. The effect would be beneficial.

CEQA Conclusion: *CM14 Stockton Deepwater Ship Channel Dissolved Oxygen Levels* would increase dissolved oxygen levels in the Stockton Deepwater Ship Channel. Spring-run Chinook salmon occupy the channel for periods of time. Implementation of *CM14 Stockton Deepwater Ship Channel Dissolved Oxygen Levels* would improve the habitat conditions for spring-run Chinook during the periods they occupy the channel. The impact would be beneficial because it would improve habitat conditions. Consequently, no mitigation would be required.

Impact AQUA-67: Effects of Localized Reduction of Predatory Fish on Chinook Salmon (Spring-Run ESU) (CM15)

Please refer to Impact AQUA-49 for winter-run Chinook salmon.

Impact AQUA-68: Effects of Nonphysical Fish Barriers on Chinook Salmon (Spring-Run ESU) (CM16)

Please refer to Impact AQUA-50 for winter-run Chinook salmon.

Impact AQUA-69: Effects of Illegal Harvest Reduction on Chinook Salmon (Spring-Run ESU) (CM17)

Please refer to Impact AQUA-51 for winter-run Chinook salmon.

Impact AQUA-70: Effects of Conservation Hatcheries on Chinook Salmon (Spring-Run ESU) (CM18)

Please refer to Impact AQUA-52 for winter-run Chinook salmon.

Impact AQUA-71: Effects of Urban Stormwater Treatment on Chinook Salmon (Spring-Run ESU) (CM19)

Please refer to Impact AQUA-53 for winter-run Chinook salmon.

Impact AQUA-72: Effects of Removal/Relocation of Nonproject Diversions on Chinook Salmon (Spring-Run ESU) (CM21)

Please refer to Impact AQUA-54 for winter-run Chinook salmon.

Fall-/Late Fall–Run Chinook Salmon

Construction and Maintenance of CM1

Impact AQUA-73: Effects of Construction of Water Conveyance Facilities on Chinook Salmon (Fall-/Late Fall–Run ESU)

Temporary Increases in Turbidity

Effects on fall-run and late fall–run Chinook salmon from temporary increases in turbidity during construction would be similar to those described for winter-run Chinook salmon (see Impact AQUA-

37 for winter-run Chinook salmon). Effects would be avoided and minimized through timing restrictions and by implementing the environmental commitments *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan* (see Appendix 3B, *Environmental Commitments* and Impact AQUA-1 for delta smelt for details of these plans).

Accidental Spills

Effects on fall-run and late fall–run Chinook salmon from accidental spills during construction would be similar to those described for winter-run Chinook salmon (see Impact AQUA-37 for winter-run Chinook salmon). Effects would be minimized by implementing the environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*), specifically the *Spill Prevention, Containment, and Countermeasure Plan*.

Disturbance of Contaminated Sediments

Potential effects on fall-run and late fall–run Chinook salmon from disturbance of contaminated sediments during construction are similar to those described for winter-run Chinook salmon (see Impact AQUA-37 for winter-run Chinook salmon).

Underwater Noise

Underwater sound generated by impact pile driving in or near surface waters can potentially harm fish, including Chinook salmon (see Impact AQUA-1). Table 11-4 illustrates the species and life stages of Chinook salmon expected to be present in the north, east, and south Delta during the expected in-water construction window (June 1–October 31). Winter-run, spring-run, fall-run, and late fall–run Chinook salmon eggs and fry would not experience underwater sound because the locations of the intakes and barge landings are not considered suitable habitat for these two life stages of this species, and they would not be present during the in-water construction period (typically June to October). Therefore, these life history stages would not be affected.

Adult fall-run Chinook salmon are expected to be semi-abundant to abundant near the construction areas of the intakes and barge landings in September and October. Juvenile fall-run Chinook salmon have a low to moderate potential to occur near the intakes during pile driving in June through October, and near the barge landings in June to September. Individual fish exposed to sound pressure levels in excess of 187 dB $SEL_{cumulative}$ would be expected to experience the onset of physical injury. The probability of exposure in excess of this threshold is limited by the fact that the amount impact pile driving and the duration of pile driving during any one day will be minimized to the extent practicable. In addition, Sacramento River fall-run Chinook salmon are typified by an ocean-type life history, meaning that they enter freshwater close to maturity and migrate rapidly to spawning habitats (Healy 1991). As such, fall-run Chinook salmon would be expected to migrate through the construction zone quickly, which would limit exposure to cumulative SEL levels.

Adult late fall–run Chinook salmon would not occur near the intakes or barge landings during the in-water construction period. In-water work will take place from June to October. Adult late fall–run Chinook do not commonly enter the lower Sacramento River before November and have completed their upstream migration by May. Juvenile late fall–run Chinook salmon are present in the

Sacramento River and the Delta between June and October, but are typically present at such low abundance that the probability of occurrence in proximity to active construction at the intake and barge landing sites would be limited. However, individuals occurring in proximity to construction would be exposed to underwater noise impacts.

Table 11-8 illustrates the estimated area where the cumulative SEL threshold would be exceeded if impact pile driving is required during construction. All juveniles exposed to underwater noise would be expected to be larger than the 2-gram size threshold, based on the typical length at age and the length to weight relationship observed for Chinook salmon occurring in the Delta (Myers et al. 1998; Kimmerer et al. 2005). On this basis, juveniles exposed to underwater noise in excess of 187 dB $SEL_{cumulative}$ would be expected to experience injury-level adverse effects. These effects would be avoided and minimized through implementation of Mitigation Measures AQUA-1a and/or AQUA-1b.

Fish Stranding

Juvenile fall-run Chinook salmon could be present in the vicinity of intake construction on the Sacramento River during the period when cofferdams are installed to isolate work areas. This presents the potential for entrapment within the isolated work areas and the subsequent exposure to injury or mortality from capture stranding stress during removal, or incidental stranding during work area dewatering. The risk of fish entrapment and subsequent handling stress during removal would be minimized by limiting cofferdam construction and other in-water work to the CDFW- and NMFS- approved in-water work windows (expected to be June 1 through October 31). Adverse effects would also be minimized through the implementation of environmental commitment *Fish Rescue and Salvage Plan* (see Impact AQUA-1 for delta smelt and Appendix 3B, *Environmental Commitments*). However, the potential for individual juvenile fall-run Chinook salmon to experience adverse effects from incidental entrapment cannot be discounted, such effects are not expected to adversely affect the overall population.

In-Water Work Activities

Effects on fall-run and late-fall-run Chinook salmon from in-water work activities during construction would be similar to those described for winter-run Chinook salmon (see Impact AQUA-37 for winter-run Chinook salmon).

Loss of Spawning, Rearing, or Migration Habitat

Effects on fall-run and late-fall-run Chinook salmon from loss of spawning, rearing or migration habitat during construction would be similar to those described for winter-run Chinook salmon (see Impact AQUA-37 for winter-run Chinook salmon).

Predation

Effects on fall-run and late-fall-run Chinook salmon from predation during construction would be similar to those described for winter-run Chinook salmon (see Impact AQUA-37 for winter-run Chinook salmon).

Summary

Construction of Alternative 1A involves several elements with the potential to cause adverse effects on individual fall-run and late-fall-run Chinook salmon. However, these effects will be avoided and/or minimized in most cases through implementation of environmental commitments and conservation measures, such that adverse population effects would not be expected to occur. Construction-related turbidity and underwater noise associated with impact pile driving are the most geographically extensive potential effects, with underwater noise having the greatest potential for adverse effects on Chinook salmon.

The majority of potential construction-related adverse effects will be avoided and minimized by construction timing. Adhering to the in-water work window will minimize Chinook salmon exposure to water quality and disturbance related stressors by limiting in-water construction activities to a time period when Chinook salmon are least likely to be present in the vicinity. In addition, several environmental commitments will be implemented that will avoid and minimize adverse effects by controlling the duration and magnitude of construction related impacts (see Impact AQUA-1 for delta smelt and Appendix 3B, *Environmental Commitments*). These include *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material;* and development and implementation of a barge operations plan (see *Barge Operations Plan*) designed to avoid turbidity generation and shoreline erosion from propeller wash and vessel wakes. These timing restrictions and environmental commitments are expected to avoid adverse effects on Chinook salmon from construction-related turbidity, accidental spills, and re-suspension and redistribution of potentially contaminated sediments.

Underwater noise associated with pile driving has the greatest potential for adverse effects on Chinook salmon, with adult fall-run Chinook having the greatest likelihood of exposure. However, the migration timing of spring- and winter-run Chinook salmon also overlaps a portion of the expected in-water work window, and could be affected by pile driving activities. In general, timing restrictions would limit pile driving to periods when Chinook salmon are least likely to be present in the vicinity of planned activities. Adult Chinook would also be migrating rapidly through the Delta and the Sacramento River when pile driving activities could be taking place, meaning that the opportunity for cumulative SEL exposure would be limited and exceedances of the cumulative exposure criterion are unlikely. They may experience short delays in migration past the intakes when pile driving is occurring; however, pile driving would occur only intermittently through a portion of the day, and minor migration delays would be unlikely affect their ability to successfully reach spawning grounds. These adverse effects would be further avoided and minimized by restricting impact pile driving to the minimum amount required for construction, and through implementation of the avoidance and minimization measures included in Mitigation Measures AQUA-1a and AQUA-1b. Chinook salmon migratory behavior would also be expected to limit the likelihood of adverse effects, as upstream migrants are likely to be moving quickly through the Delta and lower Sacramento River, thereby reducing the number of fish occurring in the construction area during pile driving periods. This migration behavior would also reduce the effects of cumulative exposure associated with multiple pile strikes.

Therefore, the potential for Chinook salmon to experience an adverse effect (e.g., injury or mortality, or migratory disturbance) would be low because of the potentially low to moderate temporal and spatial migration distribution around the intake and barge facility construction areas during the in-water construction window.

The likelihood of juvenile fall- and late fall–run Chinook salmon being in the vicinity when impact driving could take place is low. In addition to their timing in the Delta, the habitat at the intake and barge landing locations is considered poor because of relatively steep rip rap banks and deep channels with little refuge, which may further limit the overall abundance of juvenile Chinook salmon. Therefore, the potential for juvenile fall- and late fall–run Chinook salmon to experience an adverse effect (e.g., injury or mortality, or migratory disturbance) would be low because of their low temporal and spatial migration distribution around the intake and barge facility construction areas, and the intermittent nature of potential exposure above the threshold criterion. While underwater noise from impact pile driving could affect individual Chinook salmon, the effect would not adversely affect Chinook salmon populations. Thus, the effect would not be adverse.

Implementation of environmental commitments *Fish Rescue and Salvage Plan* and *Barge Operations Plan* (as described under Impact AQUA-1 for delta smelt and in Appendix 3B) would also offset potential effects of construction activities on Chinook salmon. Construction of the approach canal and Byron Tract Forebay would not affect fish-accessible waterways and therefore would not affect Chinook salmon. As a result, these construction activities would not result in adverse effects on Chinook salmon populations.

The construction of the intakes and barge landings will temporarily affect rearing and migration habitat, and the intakes screens will permanently alter habitat in the Sacramento River. Despite the relatively poor quality of the current habitat, it is designated critical habitat for Chinook salmon. However, implementation of *CM6 Channel Margin Enhancement* would enhance channel margin habitat along 20 miles of the Sacramento River, including the vicinity of the intake structures, and would be designed to result in a net improvement in channel margin habitat function. Therefore, the temporary and permanent effects on rearing and migration habitat would not adversely affect Chinook salmon populations.

NEPA Effects: The effects would not be adverse for fall-run/late fall-run Chinook salmon.

CEQA Conclusion: The potential impact on Chinook salmon from construction activities would be considered less than significant due to implementation of the environmental commitments described in Appendix 3B, *Environmental Commitments*; these are *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt. These measures would be expected to protect Chinook salmon from any adverse water quality effect (turbidity and spills of hazardous materials) resulting from project construction. Construction would not be expected to increase predation rates relative to Existing Conditions. Construction associated with Alternative 1A will result in both temporary and permanent alteration of rearing and migratory habitats used by Chinook salmon. However, these impacts are not expected to be significant because the loss of habitat is not substantial compared to the amount of habitat currently available in combination with the amount of new habitat that would result from restoration. The direct effects of underwater construction noise on Chinook salmon would be a significant impact because of the high likelihood that it would cause injury or death to most impacted fish in the immediate vicinity of the activity. However, implementation of Mitigation Measures AQUA-1a and AQUA-1b would minimize the potential effects from underwater noise and would reduce the severity of impacts to a less-than-significant level.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 for delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 for delta smelt.

Impact AQUA-74: Effects of Maintenance of Water Conveyance Facilities on Chinook Salmon (Fall-/Late Fall–Run ESU)

Temporary Increases in Turbidity

Effects on fall-run and late-fall-run Chinook salmon from temporary increases in turbidity during construction would be similar to those described for winter-run Chinook salmon (see Impact AQUA-38 for winter-run Chinook salmon). Effects would also be minimized by implementing the environmental commitments described in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*). Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Accidental Spills

Effects on fall-run and late-fall-run Chinook salmon from accidental spills would be similar to those described for winter-run Chinook salmon (see Impact AQUA-38 for winter-run Chinook salmon). Effects would be minimized by implementing the environmental commitments in Appendix 3B, *Environmental Commitments*. These environmental commitments include *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Underwater Noise

Effects on fall-run and late-fall-run Chinook salmon from underwater noise would be similar to those described for winter-run Chinook salmon (see Impact AQUA-38 for winter-run Chinook salmon).

Maintenance-Related Disturbance

Effects on fall-run and late-fall-run Chinook salmon from in-water work activities would be similar to those described for winter-run Chinook salmon (see Impact AQUA-38 for winter-run Chinook salmon). Effects would be minimized through timing restrictions and by implementing environmental commitments including *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan;* and *Barge Operations Plan*, described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*.

Loss of Spawning, Rearing, or Migration Habitat

Effects on fall-run and late-fall-run Chinook salmon from loss of spawning, rearing or migration habitat would be similar to those described for winter-run Chinook salmon (see Impact AQUA-38 for winter-run Chinook salmon). Potential effects would be minimized by implementation of environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*.

Predation

Effects on fall-run and late-fall Chinook salmon from predation during construction would be similar to those described for winter-run Chinook salmon (see Impact AQUA-38 for winter-run Chinook salmon).

Summary

In-water maintenance activities would be scheduled to occur when the least numbers of Chinook salmon would be present in or near the maintenance areas. Such activities would include maintenance dredging at the intake sites, and installation or repair of riprap bank armoring. Implementation of the environmental commitments described in Appendix 3B, Environmental Commitments, would further minimize or eliminate effects on Chinook salmon. These environmental commitments include Environmental Training; Stormwater Pollution Prevention Plan; Erosion and Sediment Control Plan; Hazardous Materials Management Plan; Spill Prevention, Containment, and Countermeasure Plan; and Disposal of Spoils, Reusable Tunnel Material, and Dredged Material. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Implementation of these environmental commitments, along with the low numbers of Chinook salmon expected to occur in the maintenance areas during the approved in-water work windows and the limited frequency and duration of in-water maintenance activities, would result in a very low potential for adverse effects on Chinook salmon from increased turbidity or spills of hazardous materials. In addition, no spawning habitat occurs in the areas potentially affected by maintenance activities, and ample rearing, and migration habitat of the same quality is readily accessible in the area, and this habitat would not be affected by maintenance activities.

NEPA Effects: As a result, the short-term maintenance activities would not adversely affect Chinook salmon populations.

CEQA Conclusion: In addition to the limited frequency and duration of in-water maintenance activities, implementation of the environmental commitments identified above and described in detail under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*, would minimize the potential for maintenance activities to affect Chinook salmon increased turbidity or spills of hazardous materials. These environmental commitments described in greater detail under Impact AQUA-1 for delta smelt, include *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*. Potential changes to rearing and migratory habitat would also be limited and temporary. Therefore, the potential impact of maintenance activities is considered less than significant because it would not substantially reduce Chinook salmon habitat, restrict its range, or interfere with its movement. Consequently, no mitigation would be required.

Water Operations of CM1

Impact AQUA-75: Effects of Water Operations on Entrainment of Chinook Salmon (Fall-/Late Fall–Run ESU))

Water Exports from SWP/CVP South Delta Facilities

As noted above for spring-run Chinook salmon juveniles (Impact AQUA-57), the seasonal entrainment pattern is the best index of entrainment—as opposed to the actual numbers of fish salvaged —because of the overlap between fall-run and spring-run juvenile Chinook salmon and the length-at-date criteria used to characterize race. Entrainment loss of fall-run Chinook salmon peaks in May at both the SWP and CVP facilities, with a second almost as large peak in February at the CVP facility.

Under Alternative 1A, average entrainment, as estimated by the salvage density method across all years, would decrease 27% for fall-run and decrease 37% for late fall–run Chinook salmon compared to NAA (Table 11-1A-35). When examining individual water year types, fall-run entrainment would decrease in wet (70% lower) and above normal (17% lower) years, but increase in below normal (7% increase) and dry years (30% increase). The reduction was driven largely by a shift in export pumping to the north Delta intakes in wet years. Since recruitment levels may be lower in drier years, increases in entrainment during these periods may be an important stressor on the population. Entrainment of late fall-run Chinook salmon would decrease under Alternative 1A for all water year types except dry years, when entrainment would increase 6%.

Under the assumption that the annual number of juvenile fall-run Chinook salmon juveniles approaching the Delta was 23 million fish, the percentage of the population lost to entrainment across all years averaged 0.24% under baseline and decreased slightly to 0.17–0.20% under Alternative 1A. However, increased entrainment during drier years may have a population-level impact since recruitment levels are lower during these years.

Table 11-1A-35. Juvenile Fall-Run and Late Fall-Run Chinook Salmon Annual Entrainment Index[a] at the SWP and CVP Salvage Facilities—Differences between Model Scenarios for Alternative 1A

	Absolute Difference (Percent Difference)	
Water Year	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Fall-Run Chinook Salmon		
Wet	-89,431 (-70%)	-89,608 (-70%)
Above Normal	-5,259 (-16%)	-5,733 (-17%)
Below Normal	1,313 (10%)	953 (7%)
Dry	7,992 (41%)	6,345 (30%)
Critical	-8,458 (-21%)	-3,280 (-9%)
All Years	-14,988 (-27%)	-15,044 (-27%)
Late Fall-Run Chinook Salmon		
Wet	-3,809 (-64%)	-3,722 (-63%)
Above Normal	-221 (-38%)	-207 (-37%)
Below Normal	-14 (-25%)	-11 (-20%)
Dry	-9 (-7%)	7 (6%)
Critical	-44 (-27%)	-31 (-20%)
All Years	-773 (-40%)	-692 (-37%)
	Shading indicates 10% or greater increased entrainment.	
Note: Estimated annual index of fish lost, based on normalized salvage data.		

Water Exports from SWP/CVP North Delta Intake Facilities

Potential entrainment at the north Delta intakes occurs only under the action alternatives, including Alternative 1A, because there are no north Delta intakes operational under NAA. The north Delta intakes would be screened to exclude juvenile fish, including fall-run and late fall–run Chinook salmon, and are expected to be effective at excluding fish greater than 15mm long. The effects would be minimal, the same as described for Impact AQUA-39 for Alternative 1A.

Water Exports with a Dual Conveyance for the SWP North Bay Aqueduct

The effects would be the same as described for Impact AQUA-39 for Alternative 1A. Entrainment and impingement effects on fall-run and late fall–run Chinook salmon juveniles would be minimal because intakes would have state-of-the-art screens installed.

NEPA Effects: In conclusion, Alternative 1A would reduce overall entrainment at the south Delta facilities, and would have minimal entrainment effects at other diversions due to screens. Therefore, the effects would not be adverse for fall-run or late fall–run Chinook salmon.

CEQA Conclusion: Entrainment at the south Delta facilities would decrease under Alternative 1A across all years for fall-run Chinook salmon (27% decrease) and late fall–run Chinook salmon (40% decrease) compared to Existing Conditions. Relative reduction in entrainment was greatest in wet years (64% to 70% decreased entrainment), when more export pumping shifts to the north Delta intakes. Entrainment of fall-run Chinook salmon increased, however, in below normal (10% increase) and dry (41% increase) water years. However, increased entrainment during drier years may have a population-level impact on fall-run Chinook salmon since recruitment levels are lower during these years. In general, potential impacts of Alternative 1A water operations on entrainment of juvenile Chinook salmon (fall-/late fall–run ESU) would be beneficial due to an overall reduction in entrainment which is beneficial to the population. As with fall-run Chinook, increased entrainment during drier years may have a population-level impact on late fall-run Chinook salmon since recruitment levels are lower during these years.

Impact AQUA-76: Effects of Water Operations on Spawning and Egg Incubation Habitat for Chinook Salmon (Fall-/Late Fall–Run ESU)

In general, Alternative 1A would not affect the quantity and quality of spawning and egg incubation habitat for fall-/late fall–run Chinook salmon relative to NAA.

Sacramento River

Fall-Run

Sacramento River flows upstream of Red Bluff were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be similar to flows under NAA during December and January with the exception of January of critical years (11% lower). Flows under A1A_LLT during October would be 12% to 33% greater than flows under NAA, and flows under A1A_LLT during November would be 9% to 30% lower than flows under NAA.

Shasta Reservoir storage at the end of September would affect flows during the fall-run spawning and egg incubation period. End of September Shasta Reservoir storage would be greater than storage under NAA in wet (8% higher) and above normal (5% higher) water years, 9% lower than storage under NAA in below water years, and similar to storage under NAA in dry and critical water years (Table 11-1A-21).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

The number of days at Red Bluff on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month during October through April and year of the 82-year modeling period (Table 11-1A-11). The combination of number of days and degrees above the 56°F threshold were further assigned a “level of concern”, as defined in Table 11-1A-12. Differences between baselines and Alternative 1A in the highest level of concern across all months and all 82 modeled years are presented in Table 11-1A-22. There would be 6 (14%) and 4 (50%) fewer years with a “red” and “yellow” level of concern, respectively, under Alternative 1A. The level of concern in these years would be reduced to an “orange” level (from “red”) or no (from “yellow”) level.

Total degree-days exceeding 56°F were summed by month and water year type at Red Bluff during October through April. Total degree-days under Alternative 1A would be 17% higher than those under NAA during November, 13% lower during April, and similar during remaining months (Table 11-1A-23).

The Reclamation egg mortality model predicts that fall-run Chinook salmon egg mortality in the Sacramento River under A1A_LLT would be lower than or similar to mortality under NAA in all water year types, including above normal (5% greater relative to NAA, but absolute increase of 1%

of fall-run population) and below normal years (19% greater relative to NAA, but absolute increase of 4% of fall-run population) (Table 11-1A-36). These results indicate that climate change would increase fall-run Chinook salmon egg mortality, but Alternative 1A would have negligible effects.

Table 11-1A-36. Difference and Percent Difference in Percent Mortality of Fall-Run Chinook Salmon Eggs in the Sacramento River (Egg Mortality Model)

Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Wet	10 (105%)	0.6 (3%)
Above Normal	12 (111%)	1 (5%)
Below Normal	15 (144%)	4 (19%)
Dry	18 (120%)	0.8 (3%)
Critical	9 (30%)	-0.8 (-2%)
All	13 (92%)	1 (4%)

SacEFT predicts that there would be a 23% increase in the percentage of years with good spawning availability for fall-run Chinook salmon, measured as weighted usable area, under A1A_LLT relative to NAA (Table 11-1A-37). SacEFT predicts that there would be a 4% increase in the percentage of years with good (lower) redd scour risk under A1A_LLT relative to NAA. SacEFT predicts that there would be a 1% decrease in the percentage of years with good (lower) egg incubation conditions between A1A_LLT and NAA. SacEFT predicts that there would be a 7% increase in the percentage of years with good (lower) redd dewatering risk under A1A_LLT relative to NAA.

Table 11-1A-37. Difference and Percent Difference in Percentage of Years with "Good" Conditions for Fall-Run Chinook Salmon Habitat Metrics in the Upper Sacramento River (from SacEFT)

Metric	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Spawning WUA	-5 (-10%)	8 (23%)
Redd Scour Risk	8 (13%)	3 (4%)
Egg Incubation	-26 (-28%)	-1 (-1%)
Redd Dewatering Risk	2 (7%)	2 (7%)
Juvenile Rearing WUA	1 (3%)	-6 (-15%)
Juvenile Stranding Risk	-3 (-10%)	8 (40%)

WUA = Weighted Usable Area.

Late Fall-Run

Sacramento River flows upstream of Red Bluff were examined for the February through May late fall–run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be similar to or up to 14% greater than flows under NAA throughout the period.

Shasta Reservoir storage at the end of September would affect flows during the late fall–run spawning and egg incubation period. End of September Shasta Reservoir storage would be greater than storage under NAA in wet (8% higher) and above normal (5% higher) water years, 9% lower than storage under NAA in below water years, and similar to storage under NAA in dry and critical water years (Table 11-1A-21). The Reclamation egg mortality model predicts that late fall-run

Chinook salmon egg mortality in the Sacramento River under A1A_LLT would be similar to or less than the mortality under NAA in all water years, although there would be up to a 21% relative decrease (in dry years), the absolute decrease would be 2% of the late fall-run population (Table 11-1A-38).

Table 11-1A-38. Difference and Percent Difference in Percent Mortality of Late Fall–Run Chinook Salmon Eggs in the Sacramento River (Egg Mortality Model)

Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Wet	3 (167%)	-1 (-13%)
Above Normal	4 (154%)	-1 (-11%)
Below Normal	5 (328%)	1 (15%)
Dry	3 (124%)	-2 (-21%)
Critical	3 (129%)	-0.3 (-6%)
All	4 (168%)	-1 (-10%)

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the February through May late fall–run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

The number of days at Red Bluff on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month during October through April and year of the 82-year modeling period (Table 11-1A-11). The combination of number of days and degrees above the 56°F threshold were further assigned a “level of concern”, as defined in Table 11-1A-12. Differences between baselines and Alternative 1A in the highest level of concern across all months and all 82 modeled years are presented in Table 11-1A-22. There would be 6 (14%) and 4 (50%) fewer years with a “red” and “yellow” level of concern, respectively, under Alternative 1A. The level of concern in these years would be reduced to an “orange” level (from “red”) or no (from “yellow”) level.

Total degree-days exceeding 56°F were summed by month and water year type at Red Bluff during October through April. Total degree-days under Alternative 1A would be 17% higher than those under NAA during November, 13% lower during April, and similar during remaining months (Table 11-1A-23).

SacEFT predicts that there would be a 10% decrease in the percentage of years with good spawning availability for late fall–run Chinook salmon, measured as weighted usable area, under A1A_LLT relative to NAA (Table 11-1A-39). On an absolute scale (5% reduction), this effect is considered small. SacEFT predicts that there would be a negligible (<5%) difference in the percentage of years with good (lower) redd scour risk, egg incubation conditions and redd dewatering risk between A1A_LLT and NAA.

Table 11-1A-39. Difference and Percent Difference in Percentage of Years with "Good" Conditions for Late Fall–Run Chinook Salmon Habitat Metrics in the Upper Sacramento River (from SacEFT)

Metric	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Spawning WUA	-9 (-17%)	-5 (-10%)
Redd Scour Risk	-5 (-6%)	1 (1%)
Egg Incubation	-2 (-2%)	-2 (-2%)
Redd Dewatering Risk	-7 (-11%)	-2 (-4%)
Juvenile Rearing WUA	-8 (-18%)	-26 (-41%)
Juvenile Stranding Risk	-26 (-36%)	0 (0%)

WUA = Weighted Usable Area.

Clear Creek

No water temperature modeling was conducted in Clear Creek.

Fall-Run

Clear Creek flows below Whiskeytown Reservoir were examined for the September through February fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be similar to or greater than flows under NAA in all water year types.

The potential risk of redd dewatering in Clear Creek was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in September when spawning is assumed to occur. The greatest monthly reduction in Clear Creek flows during September through February under A1A_LLT would be the same as the reduction under NAA for all water year types (Table 11-1A-40).

Table 11-1A-40. Difference and Percent Difference in Greatest Monthly Reduction (Percent Change) in Instream Flow in Clear Creek below Whiskeytown Reservoir during the September through February Spawning and Egg Incubation Period[a]

Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Wet	0 (NA)	0 (NA)
Above Normal	-27 (NA)	0 (0%)
Below Normal	53 (100%)	0 (NA)
Dry	-67 (NA)	0 (0%)
Critical	-33 (-50%)	0 (0%)

NA = could not be calculated because the denominator was 0.

[a] Redd dewatering risk not applicable for months when flows during the egg incubation period were at or greater than flows in September, when spawning is assumed to occur. A negative value indicates that the greatest monthly reduction would be of greater magnitude (worse) under the alternative than under the baseline.

Feather River

Fall-Run

Flows in the Feather River in the low flow and high flow channels were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in the low-flow channel under A1A_LLT would be identical to those under NAA. Flows in the high-flow channel under A1A_LLT generally be similar to or greater than those under NAA, except in above normal years during November and in critical years during January (10% to 15% lower, respectively).

The potential risk of redd dewatering in the Feather River low-flow channel was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in October when spawning is assumed to occur. Minimum flows in the low-flow channel during November through January were identical between A1A_LLT and NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Therefore, there would be no effect of Alternative 1A on redd dewatering in the Feather River low-flow channel.

Mean monthly water temperatures in the Feather River above Thermalito Afterbay (low-flow channel) and below Thermalito Afterbay (high-flow channel) were examined during the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period at either location.

The percent of months exceeding the 56°F temperature threshold in the Feather River at Gridley was evaluated during October through April (Table 11-1A-41). The percent of months exceeding the threshold under Alternative 1A would similar to or up to 20% lower (absolute scale) than the percent under NAA.

Table 11-1A-41. Differences between Baseline and Alternative 1A Scenarios in Percent of Months during the 82-Year CALSIM Modeling Period during Which Water Temperatures in the Feather River at Gridley Exceed the 56°F Threshold, October through April

	Degrees Above Threshold				
Month	>1.0	>2.0	>3.0	>4.0	>5.0
EXISTING CONDITIONS vs. A1A_LLT					
October	2 (3%)	12 (14%)	19 (25%)	37 (91%)	47 (253%)
November	38 (1,033%)	22 (1,800%)	12 (NA)	6 (NA)	4 (NA)
December	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	1 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
March	25 (333%)	16 (433%)	7 (600%)	4 (NA)	2 (NA)
April	12 (18%)	19 (33%)	33 (108%)	37 (214%)	20 (178%)
NAA vs. A1A_LLT					
October	0 (0%)	-1 (-1%)	-5 (-5%)	-11 (-13%)	-12 (-16%)
November	-20 (-32%)	-17 (-42%)	-20 (-62%)	-12 (-67%)	-2 (-40%)
December	-1 (-100%)	-1 (-100%)	0 (NA)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	-2 (-67%)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
March	-12 (-28%)	-9 (-30%)	-2 (-22%)	-4 (-50%)	-1 (-33%)
April	-7 (-8%)	-5 (-6%)	-9 (-12%)	-5 (-8%)	-7 (-19%)

NA = could not be calculated because the denominator was 0.

Total degree-months exceeding 56°F were summed by month and water year type at Gridley during October through April (Table 11-1A-42). Total degree-months would be similar between NAA and Alternative 1A for all months except October, November, and March, in which degree-months would be 5% to 33% lower under Alternative 1A.

Table 11-1A-42. Differences between Baseline and Alternative 1A Scenarios in Total Degree-Months (°F-Months) by Month and Water Year Type for Water Temperature Exceedances above 56°F in the Feather River at Gridley, October through April

Month	Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
October	Wet	75 (103%)	-27 (-15%)
	Above Normal	27 (61%)	-9 (-11%)
	Below Normal	41 (75%)	-8 (-8%)
	Dry	56 (106%)	-15 (-12%)
	Critical	42 (102%)	-2 (-2%)
	All	241 (91%)	-61 (-11%)
November	Wet	19 (NA)	-18 (-49%)
	Above Normal	13 (650%)	-6 (-29%)
	Below Normal	14 (1,400%)	-7 (-32%)
	Dry	19 (NA)	-12 (-39%)
	Critical	18 (1,800%)	0 (0%)
	All	83 (2,075%)	-43 (-33%)
December	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	-2 (-100%)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	-2 (-100%)
January	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
February	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	-1 (-100%)
	Dry	1 (NA)	1 (NA)
	Critical	2 (NA)	0 (0%)
	All	2 (NA)	-1 (-33%)
March	Wet	5 (NA)	0 (0%)
	Above Normal	-1 (-100%)	-3 (-100%)
	Below Normal	17 (1,700%)	-4 (-18%)
	Dry	24 (600%)	1 (4%)
	Critical	17 (425%)	0 (0%)
	All	63 (630%)	-5 (-6%)
April	Wet	38 (271%)	0 (0%)
	Above Normal	26 (113%)	-1 (-2%)
	Below Normal	24 (60%)	-1 (-2%)
	Dry	37 (76%)	-4 (-4%)
	Critical	31 (107%)	0 (0%)
	All	156 (101%)	-6 (-2%)

NA = could not be calculated because the denominator was 0.

The Reclamation egg mortality model predicts that fall-run Chinook salmon egg mortality in the Feather River under A1A_LLT would be similar to or up to 68% lower than mortality under NAA in all water years (Table 11-1A-43).

Table 11-1A-43. Difference and Percent Difference in Percent Mortality of Fall-Run Chinook Salmon Eggs in the Feather River (Egg Mortality Model)

Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Wet	5 (379%)	-14 (-68%)
Above Normal	6 (553%)	-6 (-45%)
Below Normal	12 (654%)	-2 (-10%)
Dry	13 (599%)	-6 (-27%)
Critical	21 (428%)	-3 (-9%)
All	11 (499%)	-7 (-36%)

American River

Fall-Run

Flows in the American River at the confluence with the Sacramento River were examined during the October through January fall-run spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT during November through January would generally be similar to flows under NAA, except for above normal water years during November (18% lower) and below normal water years during December (7% higher). Flows under A1A_LLT during October would be 13% to 42% greater than flows under NAA.

Mean monthly water temperatures in the American River at the Watt Avenue Bridge were examined during the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

The percent of months exceeding the 56°F temperature threshold in the American River at the Watt Avenue Bridge was evaluated during November through April (Table 11-1A-44). The percent of months exceeding the threshold under Alternative 1A would similar to or up to 12% lower (absolute scale) than the percent under NAA.

Table 11-1A-44. Differences between Baseline and Alternative 1A Scenarios in Percent of Months during the 82-Year CALSIM Modeling Period during Which Water Temperatures in the American River at the Watt Avenue Bridge Exceed the 56°F Threshold, November through April

	Degrees Above Threshold				
Month	>1.0	>2.0	>3.0	>4.0	>5.0
EXISTING CONDITIONS vs. A1A_LLT					
November	43 (95%)	49 (182%)	49 (364%)	40 (1,600%)	32 (2,600%)
December	2 (NA)	1 (NA)	0 (NA)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	1 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
March	25 (200%)	14 (183%)	12 (500%)	10 (800%)	5 (NA)
April	25 (35%)	25 (40%)	27 (59%)	30 (92%)	22 (82%)
NAA vs. A1A_LLT					
November	-4 (-4%)	-9 (-10%)	-11 (-15%)	-15 (-26%)	-7 (-18%)
December	1 (100%)	0 (0%)	0 (NA)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	-2 (-67%)	-1 (-100%)	0 (NA)	0 (NA)	0 (NA)
March	-12 (-25%)	-11 (-35%)	-1 (-8%)	-1 (-10%)	0 (0%)
April	-1 (-1%)	-6 (-7%)	-7 (-9%)	-10 (-14%)	-7 (-13%)

NA = could not be calculated because the denominator was 0.

Total degree-months exceeding 56°F were summed by month and water year type at the Watt Avenue Bridge during November through April (Table 11-1A-45). Total degree-months would be similar between NAA and Alternative 1A for all months.

Table 11-1A-45. Differences between Baseline and Alternative 1A Scenarios in Total Degree-Months (°F-Months) by Month and Water Year Type for Water Temperature Exceedances above 56°F in the American River at the Watt Avenue Bridge, November through April

Month	Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
November	Wet	79 (316%)	-3 (-3%)
	Above Normal	31 (282%)	-5 (-11%)
	Below Normal	45 (563%)	2 (4%)
	Dry	46 (354%)	-5 (-8%)
	Critical	35 (219%)	-3 (-6%)
	All	236 (323%)	-14 (-4%)
December	Wet	1 (NA)	1 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	2 (NA)	0 (0%)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	4 (NA)	2 (100%)
January	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
February	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	3 (NA)	-1 (-25%)
	All	3 (NA)	-1 (-25%)
March	Wet	10 (500%)	-2 (-14%)
	Above Normal	9 (NA)	0 (0%)
	Below Normal	10 (333%)	-1 (-7%)
	Dry	24 (600%)	-1 (-3%)
	Critical	20 (200%)	0 (0%)
	All	73 (384%)	-4 (-4%)
April	Wet	58 (207%)	0 (0%)
	Above Normal	33 (150%)	-1 (-2%)
	Below Normal	38 (106%)	-3 (-4%)
	Dry	41 (54%)	-4 (-3%)
	Critical	33 (56%)	-2 (-2%)
	All	203 (92%)	-10 (-2%)

NA = could not be calculated because the denominator was 0.

The potential risk of redd dewatering in the American River at Nimbus Dam was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in October when spawning is assumed to occur. The greatest monthly reduction in American

River flows during November through January under A1A_LLT be 16% to 53% greater in magnitude than under NAA (Table 11-1A-46).

Table 11-1A-46. Difference and Percent Difference in Greatest Monthly Reduction (Percent Change) in Instream Flow in the American River at Nimbus Dam during the October through January Spawning and Egg Incubation Period[a]

Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Wet	-32 (-150%)	-8 (-17%)
Above Normal	-16 (-54%)	-6 (-16%)
Below Normal	-44 (-227%)	-16 (-35%)
Dry	-17 (-37%)	-20 (-44%)
Critical	-9 (-18%)	-21 (-53%)

NA = could not be calculated because the denominator was 0.

[a] Redd dewatering risk not applicable for months when flows during the egg incubation period were at or greater than flows in October, when spawning is assumed to occur. A negative value indicates that the greatest monthly reduction would be of greater magnitude (worse) under the alternative than under the baseline.

The Reclamation egg mortality model predicts that fall-run Chinook salmon egg mortality in the American River under A1A_LLT would be similar to mortality under NAA in all water years (Table 11-1A-47).

Table 11-1A-47. Difference and Percent Difference in Percent Mortality of Fall-Run Chinook Salmon Eggs in the American River (Egg Mortality Model)

Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Wet	25 (165%)	1 (3%)
Above Normal	21 (204%)	-1 (-3%)
Below Normal	20 (165%)	-2 (-5%)
Dry	17 (102%)	0.3 (1%)
Critical	9 (44%)	-1 (-2%)
All	20 (129%)	-0.1 (-0.2%)

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be similar to flows under NAA throughout the period.

Water temperatures throughout the Stanislaus River would be similar under NAA and Alternative 1A throughout the October through January period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

San Joaquin River

Flows in the San Joaquin River at Vernalis were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be similar to flows under NAA throughout the period.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Flows in the Mokelumne River at the Delta were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be similar to flows under NAA throughout the period.

Water temperature modeling was not conducted in the Mokelumne River.

NEPA Effects: Collectively, it is concluded that the effect is not adverse because habitat conditions are not substantially reduced. There would be no reductions in flows or increases in temperatures under Alternative 1A that would translate into adverse biological effects on fall-run Chinook salmon in any river examined and there would be beneficial temperature-related effects of Alternative 1A in the Feather River.

CEQA Conclusion:

In general, Alternative 1A would not affect the quantity and quality of spawning and egg incubation habitat for fall-/late fall–run Chinook salmon relative to the Existing Conditions.

Sacramento River

Fall-Run

Flows in the Sacramento River upstream of Red Bluff were examined during the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would generally be greater than or similar to Existing Conditions during October, December, and January. During November however, flows under A1A_LLT would be up to 21% lower than under Existing Conditions depending on water year type.

Shasta Reservoir storage volume at the end of September would be 9% to 33% lower under A1A_LLT relative to Existing Conditions (Table 11-1A-21).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 1A during the period, except during October, in which temperatures would be 5% higher under Alternative 1A.

The number of days at Red Bluff on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month during October through April and year of the 82-year modeling period (Table 11-1A-11). The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern", as defined in Table 11-1A-12. Differences between baselines and Alternative 1A in the highest level of concern across all months and all 82 modeled years are presented in Table 11-1A-22. There would be 250% and 200% increases in the number of years with "red" and "orange" levels of concern under Alternative 1A relative to Existing Conditions.

Total degree-days exceeding 56°F were summed by month and water year type at Red Bluff during October through April. Total degree-days under Alternative 1A would be 181% to 4154% higher than those under Existing Conditions during October, November, March, and April, and similar during December through February (Table 11-1A-23).

The Reclamation egg mortality model predicts that fall-run Chinook salmon egg mortality in the Sacramento River under A1A_LLT would be 30% to 144% greater than mortality under Existing Conditions, which is a 9% to 18% increase on an absolute scale (Table 11-1A-36).

SacEFT predicts that there would be a 10% decrease in the percentage of years with good spawning availability, measured as weighted usable area, under A1A_LLT relative to Existing Conditions (Table 11-1A-37). SacEFT predicts that there would be a 13% increase in the percentage of years with good (lower) redd scour risk under A1A_LLT relative to Existing Conditions. SacEFT predicts that there would be a 28% decrease in the percentage of years with good (lower) egg incubation conditions under A1A_LLT relative to Existing Conditions. SacEFT predicts that there would be a 7% increase in the percentage of years with good (lower) redd dewatering risk under A1A_LLT relative to Existing Conditions.

Late Fall–Run

Flows in the Sacramento River upstream of Red Bluff were examined during the February through May late fall–run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would generally be greater than or similar to flows under Existing Conditions, except in wet years during May (14% lower).

Shasta Reservoir storage volume at the end of September would be 9% to 33% lower under A1A_LLT relative to Existing Conditions (Table 11-1A-21).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the February through May late fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 1A in any month or water year type throughout the period.

The number of days at Red Bluff on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month during October through April and year of the 82-year modeling period (Table 11-1A-11). The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern", as defined in Table 11-1A-12. Differences between baselines and Alternative 1A in the highest level of concern across all months and all 82 modeled years are presented in Table 11-1A-22. There would be 250% and 200% increases in the number of years with "red" and "orange" levels of concern under Alternative 1A relative to Existing Conditions.

Total degree-days exceeding 56°F were summed by month and water year type at Red Bluff during October through April. Total degree-days under Alternative 1A would be 181% to 4154% higher than those under Existing Conditions during October, November, March, and April, and similar during December through February (Table 11-1A-23).

The Reclamation egg mortality model predicts that late fall–run Chinook salmon egg mortality in the Sacramento River under A1A_LLT would be 124% to 329% greater than mortality under Existing Conditions (Table 11-1A-38). However, absolute differences in the percent of the late-fall population subject to mortality would be minimal in all but below normal years, in which there is a 5% increase.

SacEFT predicts that there would be a 17% decrease in the percentage of years with good spawning availability, measured as weighted usable area, under A1A_LLT relative to Existing Conditions (Table 11-1A-39). SacEFT predicts that there would be a 6% decrease in the percentage of years with good (lower) redd scour risk under A1A_LLT relative to Existing Conditions. SacEFT predicts that there would be no difference in the percentage of years with good (lower) egg incubation conditions under A1A_LLT relative to Existing Conditions. SacEFT predicts that there would be an 11% decrease in the percentage of years with good (lower) redd dewatering risk under A1A_LLT relative to Existing Conditions.

Clear Creek

No water temperature modeling was conducted in Clear Creek.

Fall-Run

Flows in Clear Creek below Whiskeytown Reservoir under A1A_LLT during the September through February fall-run spawning and egg incubation period would be similar to or greater than flows under Existing Conditions.

The potential risk of redd dewatering in Clear Creek was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in September when spawning occurred. The greatest monthly reduction in Clear Creek flows during September through February under A1A_LLT would be similar to or lower magnitude than those under Existing Conditions in wet and below normal water years, but the reduction would be 27%, 67%, and 33% greater (absolute, not relative, differences) under A1A_LLT in above normal, dry, and critical water years, respectively (Table 11-1A-40).

Feather River

Fall-Run

Flows in the low-flow channel during October through January under A1A_LLT would be identical to those under Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in the high-flow channel under A1A_LLT would generally be similar to or greater by up to 51% than flows under Existing Conditions.

The potential risk of redd dewatering in the Feather River low-flow channel was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in October when spawning is assumed to occur. Minimum flows in the low-flow channel were identical between A1A_LLT and Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized* *in the Fish Analysis*). Therefore, there would be no effect of Alternative 1A on redd dewatering in the Feather River low-flow channel.

The Reclamation egg mortality model predicts that fall-run Chinook salmon egg mortality in the Feather River under A1A_LLT would be 379% to 599% greater than mortality under Existing Conditions (Table 11-1A-43).

Mean monthly water temperatures in the Feather River above Thermalito Afterbay (low-flow channel) and below Thermalito Afterbay (high-flow channel) were examined during the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures would be under Alternative 1A relative to Existing Conditions by 7% to 10% higher in the low-flow channel and 6% to 8% higher in the high-flow channel depending on month.

The percent of months exceeding the 56°F temperature threshold in the Feather River at Gridley was evaluated during October through April (Table 11-1A-41). The percent of months exceeding the threshold under Alternative 1A would similar to or up to 47% higher (absolute scale) than the percent under Existing Conditions during all months except December through February, during which there would be no difference in the percent of months exceeding the threshold.

Total degree-months exceeding 56°F were summed by month and water year type at Gridley during October through April (Table 11-1A-42). Total degree-months under Alternative 1A would be 91% to 2075% higher than total degree-months under Existing Conditions, except during December through February, in which there would be no difference between Existing Conditions and Alternative 1A in total degree-months exceeding the 56°F threshold.

American River

Fall-Run

Flows in the American River at the confluence with the Sacramento River were examined during the October through January fall-run spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be greater than flows under Existing Conditions during October, but generally lower by up to 38% than flows under Existing Conditions during November through January.

Mean monthly water temperatures in the American River at the Watt Avenue Bridge were examined during the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly temperatures under Alternative 1A would be 5% to 12% greater than those under Existing Conditions depending on month.

The percent of months exceeding the 56°F temperature threshold in the American River at the Watt Avenue Bridge was evaluated during November through April (Table 11-1A-44). The percent of months exceeding the threshold under Alternative 1A would be up to 49% greater (absolute scale) than the percent under Existing Conditions during November, March, and April and similar to the percent under Existing Conditions during December through February.

Total degree-months exceeding 56°F were summed by month and water year type at the Watt Avenue Bridge during November through April (Table 11-1A-45). Total degree-months under

Alternative 1A would be 92% to 323% greater than total degree-months under Existing Conditions during November, March and April and similar to total degree months under Existing Conditions during December through February.

The potential risk of redd dewatering in the American River at Nimbus Dam was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in October when spawning is assumed to occur. The greatest monthly reduction in American River flows during November through January under A1A_LLT would be 18% to 227% greater magnitude than those under Existing Conditions, depending on water year type (Table 11-1A-46). The Reclamation egg mortality model predicts that fall-run Chinook salmon egg mortality in the American River under A1A_LLT would be 44% to 204% greater than mortality under Existing Conditions (Table 11-1A-47).

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the October through January fall-run spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would generally be up to 18% lower than those under Existing Conditions throughout the period.

Water temperatures in the Stanislaus River at the confluence with the San Joaquin River were examined during the October through January fall-run spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under Alternative 1A would not be different from those under Existing Conditions during October, but 6% higher during November through January.

San Joaquin River

Flows in the San Joaquin River at Vernalis were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be up to 8% lower than Existing Conditions in most water years during October, similar to Existing Conditions in November and December (each month with one water year greater than 5% lower), and up to 6% higher than Existing Conditions during January.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Flows in the Mokelumne River at the Delta were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be up to 14% lower than flows under Existing Conditions during October and November, up to 15% greater than flows under Existing Conditions during December, and similar to flows under Existing Conditions during January.

Water temperature modeling was not conducted in the Mokelumne River.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-76 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 1A could be significant because, under the CEQA baseline, the alternative could substantially reduce the amount of suitable spawning and egg incubation habitat, contrary to the NEPA conclusion set forth above. There would be flow reductions or temperature increases in the Sacramento, Feather, and American Rivers that would have biologically meaningful effects on fall-/late fall-run Chinook salmon spawning and egg incubation habitat.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 1A does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 1A indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 1A. This indicates that the differences between Existing Conditions and Alternative 1A found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 1A, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on spawning and egg incubation habitat for fall-run Chinook salmon. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-77: Effects of Water Operations on Rearing Habitat for Chinook Salmon (Fall-/Late Fall–Run ESU)

In general, Alternative 1A would not affect the quantity and quality of larval and juvenile rearing habitat for fall- and late fall–run Chinook salmon relative to NAA.

Sacramento River

Fall-Run

Sacramento River flows upstream of Red Bluff were examined for the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be greater than or similar to flows under NAA throughout the period, except for January in critical water years, when flows are estimated to be about 11% lower.

Shasta Reservoir storage at the end of September would affect flows during the fall-run larval and juvenile rearing period. Storage under A1A_LLT would be greater than storage under NAA in wet (8% higher) and above normal (5% higher) water years, 9% lower than storage under NAA in below normal water years, and similar to storage under NAA in dry and critical water years (Table 11-1A-21).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento*

River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

SacEFT predicts that there would be a 15% decrease in the percentage of years with good juvenile rearing availability for fall-run Chinook salmon, measured as weighted usable area, under A1A_LLT relative to NAA (Table 11-1A-37). SacEFT predicts that there would be a 40% increase in the percentage of years with "good" (lower) juvenile stranding risk under A1A_LLT relative to NAA.

SALMOD predicts that fall-run smolt equivalent habitat-related mortality under A1A_LLT would be 5% lower than mortality under NAA.

Late Fall-Run

Sacramento River flows upstream of Red Bluff were examined for the March through July late fall–run Chinook salmon juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows throughout the period A1A_LLT were generally similar to or greater than those under NAA.

Shasta Reservoir storage at the end of September and May would affect flows during the late fall–run larval and juvenile rearing period. Storage under A1A_LLT would be greater than storage under NAA in wet (8% higher) and above normal (5% higher) water years, 9% lower than storage under NAA in below water years, and similar to storage under NAA in dry and critical water years (Table 11-1A-21). May Shasta storage volume under A1A_LLT would be similar to or up to 8% lower than storage under NAA for all water year types (Table 11-1A-10).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the March through July late fall–run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

SacEFT predicts that there would be a 41% decrease in the percentage of years with good juvenile rearing availability for late fall–run Chinook salmon, measured as weighted usable area, under A1A_LLT relative to NAA (Table 11-1A-39). SacEFT predicts that there would be no difference in the percentage of years with "good" (lower) juvenile stranding risk under A1A_LLT relative to NAA.

SALMOD predicts that late fall–run smolt equivalent habitat-related mortality under A1A_LLT would be similar to mortality under NAA.

Clear Creek

No water temperature modeling was conducted in Clear Creek.

Fall-Run

Flows in Clear Creek below Whiskeytown Reservoir were examined the January through May fall-run Chinook salmon rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be similar to flows under NAA throughout the period.

Feather River

Fall-Run

Flows in the Feather River both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) during December through June were reviewed to determine flow-related effects on larval and juvenile fall-run rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Relatively constant flows in the low flow channel throughout this period under A1A_LLT would not differ from those under NAA. In the high flow channel, flows under A1A_LLT would be up to 110% greater than flows under NAA throughout the period, except for January during critical water years, during which flows would be up to 15% lower.

May Oroville storage under A1A_LLT would be similar to storage under NAA, except for dry years (5% higher) (Table 11-1A-30).

Oroville storage volume at the end of September under A1A_LLT would be 18% to 31% greater than storage under NAA depending on water year type (Table 11-1A-27).

Mean monthly water temperatures in the Feather River in both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were examined during the December through June fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis).* There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period at either location.

American River

Fall-Run

Flows in the American River at the confluence with the Sacramento River were examined for the January through May fall-run larval and juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would generally be similar to or greater than flows under NAA except in dry and critical years during March (9% lower in both water year types).

Mean monthly water temperatures in the American River at the Watt Avenue Bridge were examined during the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River for Alternative 1A are not different from those under NAA, for the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures throughout the Stanislaus River would be similar between NAA and Alternative 1A throughout the January through May fall-run rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

San Joaquin River

Flows in the San Joaquin River at Vernalis for Alternative 1A are not different from those under NAA, for the January through May fall-run larval and juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Flows in the Mokelumne River at the Delta for Alternative 1A are not different from those under NAA, for the January through May fall-run larval and juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Water temperature modeling was not conducted in the Mokelumne River.

NEPA Effects: Taken together, these results indicate that the effect is not adverse because it does not have the potential to substantially reduce the amount of suitable habitat of fish. Fall-run Chinook salmon would experience beneficial effects of Alternative 1A in the Sacramento River and would not be affected in any upstream waterway. SacEFT predicts that there would be a 41% decrease in the percentage of years with good juvenile rearing availability for late fall-run, although modeled flow outputs predict that flows, which drive rearing habitat availability, would increase during the rearing period. In addition, the number of years with good juvenile stranding risk for late fall-run Chinook salmon as predicted by SacEFT would not differ between Alternative 1A and the NEPA baseline, nor would smolt equivalent habitat-related mortality as predicted by SALMOD. There are no effects of Alternative 1A on fall-run or late-fall-run in other waterways that would rise to the level of adverse.

CEQA Conclusion: In general, Alternative 1A would not affect the quantity and quality of larval and juvenile rearing habitat for fall-/late fall–run Chinook salmon relative to the Existing Conditions.

Sacramento River

Fall-Run

Sacramento River flows upstream of Red Bluff were examined for the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would generally be greater than or similar to flows under Existing Conditions, except in wet years during May (14% lower).

End of September Shasta Reservoir storage under A1A_LLT would be greater than storage under NAA in wet (8% higher) and above normal (5% higher) water years, 9% lower than storage under NAA in below water years, and similar to storage under NAA in dry and critical water years (Table 11-1A-21).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 1A in any month or water year type throughout the period. SacEFT predicts that there would be a 3% increase in the percentage of years with good juvenile rearing availability for fall-run Chinook salmon, measured as weighted usable area, under A1A_LLT relative to Existing Conditions (Table 11-1A-37). SacEFT predicts that there would be a 10% reduction in the percentage of years with "good" (lower) juvenile stranding risk under A1A_LLT relative to Existing Conditions.

SALMOD predicts that fall-run smolt equivalent habitat-related mortality under A1A_LLT would be 12% lower than mortality under Existing Conditions.

Late Fall–Run

Sacramento River flows upstream of Red Bluff were examined for the March through July late fall–run Chinook salmon juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows during the period would generally be similar to or greater than those under Existing Conditions, except in wet water years during May (14% lower).

Sacramento River flows upstream of Red Bluff were examined for the March through July late fall–run Chinook salmon juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows during July, under A1A_LLT were generally lower by up to 10% than those under Existing Conditions for most water year types. Flows during other months were generally similar to or greater than those under Existing Conditions, except in wet water years during May (14% lower).

End of September Shasta Reservoir storage would be 9% to 33% lower under A1A_LLT relative to Existing Conditions depending on water year type (Table 11-1A-21).

End of May Shasta storage under A1A_LLT would be similar to Existing Conditions in wet and above normal water years, but lower by 13% to 25% in below normal, dry, and critical water years (Table 11-1A-10).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the March through July late fall–run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 1A in any month or water year type throughout the period.

SacEFT predicts that there would be an 18% reduction in the percentage of years with good juvenile rearing availability for late fall–run Chinook salmon, measured as weighted usable area, under A1A_LLT relative to Existing Conditions (Table 11-1A-39). SacEFT predicts that there would be a 36% reduction in the percentage of years with "good" (lower) juvenile stranding risk under A1A_LLT relative to Existing Conditions.

SALMOD predicts that late fall–run smolt equivalent habitat-related mortality under A1A_LLT would be 7% higher than mortality under Existing Conditions.

Clear Creek

No temperature modeling was conducted in Clear Creek.

Fall-Run

Flows in Clear Creek below Whiskeytown Reservoir were examined the January through May fall-run Chinook salmon rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish*

Analysis). Flows under A1A_LLT would be similar to or greater (by up to 54%) than flows under Existing Conditions for the entire period.

Feather River

Fall-Run

Flows in the Feather River both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) during December through June were reviewed to determine flow-related effects on larval and juvenile fall-run rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Relatively constant flows in the low flow channel throughout the period under A1A_LLT would not differ from those under Existing Conditions. In the high flow channel, flows under A1A_LLT would be mostly greater than flows under Existing Conditions by up to 204% with few exceptions.

May Oroville storage volume under A1A_LLT would be lower than Existing Conditions by 7% to 15% depending on water year type, except in wet years, in which storage would be similar to Existing Conditions (Table 11-1A-30).

Oroville Reservoir storage volume at the end of September would be similar under A1A_LLT relative to Existing Conditions during dry and critical water years, but moderately lower (up to 21% lower) for other water year types (Table 11-1A-27).

Mean monthly water temperatures in the Feather River both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were examined during the December through June fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). In the low-flow channel, mean monthly water temperatures under Alternative 1A would be 5% to 10% higher than those under Existing Conditions during December through March, but not different from those under Existing Conditions during April through June. In the high-flow channel, mean monthly water temperatures under Alternative 1A would be 5% to 8% higher than those under Existing Conditions during December through February, but not different from those under Existing Conditions during March through June.

American River

Fall-Run

Flows in the American River at the confluence with the Sacramento River were examined for the January through May fall-run larval and juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would generally be similar to or up to 29% greater than flows under Existing Conditions for most water year types, except during January and May, when flows would be up to 27% lower depending on water year type. Mean monthly water temperatures in the American River at the Watt Avenue Bridge were examined during the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under Alternative 1A would be 5% to 7% higher than those under Existing Conditions during January through March, but not different during April and May.

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River for Alternative 1A would be up to 36% lower than Existing Conditions in January through May fall-run larval and juvenile rearing period in most water year types (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were examined during the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under Alternative 1A would be 6% higher than those under Existing Conditions in all months during the period.

San Joaquin River

Flows in the San Joaquin River at Vernalis were examined for the January through May fall-run Chinook salmon larval and juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would generally be similar to flows under Existing Conditions during January and February and lower by up to 15% during March through May.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Flows in the Mokelumne River at the Delta were examined for January through May fall-run Chinook salmon larval and juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be similar to flows under Existing Conditions during January through March and lower by up to 18% than flows under Existing Conditions during April and May.

Water temperature modeling was not conducted in the Mokelumne River.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-77 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 1A could be significant because, under the CEQA baseline, the alternative could substantially reduce the fall-/late fall-run Chinook salmon rearing habitat, contrary to the NEPA conclusion set forth above. SacEFT and SALMOD predict negative effects of Alternative 1A on fall-run and late fall-run Chinook salmon rearing conditions in the Sacramento River. There would be small reductions in mean monthly water temperatures under Alternative 1A in the Feather River. There would be consistent moderate flow reductions under Alternative 1A in the Stanislaus River and small reductions in the San Joaquin and Mokelumne Rivers. There would, however, be beneficial effects of Alternative 1A to fall-run Chinook salmon in the Feather River.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 1A does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in

the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 1A indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 1A. This indicates that the differences between Existing Conditions and Alternative 1A found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 1A, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on rearing incubation habitat for fall-/late fall-run Chinook salmon. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-78: Effects of Water Operations on Migration Conditions for Chinook Salmon (Fall-/Late Fall–Run ESU)

Upstream of the Delta

In general, Alternative 1A would reduce migration conditions for fall-/late fall–run Chinook salmon relative to NAA.

Sacramento River

Fall-Run

Flows in the Sacramento River upstream of Red Bluff for juvenile fall-run migrants under A1A_LLT would be similar to or up to 14% greater than flows under NAA throughout the February through May juvenile fall-run Chinook salmon migration period in all water year types (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

Flows in the Sacramento River upstream of Red Bluff were examined during the adult fall-run Chinook salmon upstream migration period (September through October) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). During September, flows under A1A_LLT would generally be lower by up to 44% than those under NAA. During October, flows under A1A_LLT would be 12% to 33% higher than those under NAA

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the September through October adult fall-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

Late Fall-Run

Flows in the Sacramento River upstream of Red Bluff for juvenile late fall-run Chinook salmon migrants (January through March) under A1A_LLT would generally be similar to flows under NAA with some small exceptions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the January through March juvenile late fall-run Chinook salmon emigration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

Flows in the Sacramento River upstream of Red Bluff during the adult late fall-run Chinook salmon upstream migration period (December through February) under A1A_LLT would be generally be similar to flows under NAA with some small exceptions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the December through February adult late fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

Clear Creek

Water temperature modeling was not conducted in Clear Creek.

Fall-Run

Flows in the Clear Creek below Whiskeytown Reservoir were examined for juvenile fall-run migrants during February through May. Flows under A1A_LLT would be similar to flows under NAA during all water year types (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flows in Clear Creek below Whiskeytown Reservoir during the adult fall-run Chinook salmon upstream migration period (September through October) under A1A_LLT would be similar to those under NAA throughout the period, except for critical years during September (13% lower) and October (5% greater) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Feather River

Fall-Run

Flows in the Feather River at the confluence with the Sacramento River during the juvenile fall-run Chinook salmon emigration period (February through May) under A1A_LLT would generally be up to 110% greater than flows under NAA with few exceptions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

Flows in the Feather River at the confluence with the Sacramento River were examined during the September through October fall-run Chinook salmon adult migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would generally be lower by up to 69% than flows under NAA during September, but greater by up to 55% than flows under NAA during October.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the September through October fall-run Chinook salmon adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

American River

Fall-Run

Flows in the American River at the confluence with the Sacramento River were examined during the February through May juvenile Chinook salmon fall-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be greater than flows under NAA during May and generally similar to flows under NAA with some small exceptions).

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

Flows in the American River at the confluence with the Sacramento River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be lower by up to 50% than those under NAA during September), but greater by up to 42% during October.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

Stanislaus River

Fall-Run

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be similar to those under NAA in all months and water year types throughout the period.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be similar to those under NAA in all months and water year types throughout the period.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

San Joaquin River

Fall-Run

Flows in the San Joaquin River at Vernalis were examined during the February through May juvenile Chinook salmon fall-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be similar to those under NAA in all months and water year types throughout the period.

Flows in the San Joaquin River at Vernalis were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be similar to those under NAA in all months and water year types throughout the period.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Fall-Run

Flows in the Mokelumne River at the Delta were examined during the February through May juvenile Chinook salmon fall-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be similar to those under NAA in all months and water year types throughout the period.

Flows in the Mokelumne River at the Delta were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be similar to those under NAA in all months and water year types throughout the period.

Water temperature modeling was not conducted in the Mokelumne River.

Through-Delta

Sacramento River

Fall-Run

Juveniles

Plan Area flows have considerable importance for downstream migrating juvenile salmonids and would be affected by the north Delta diversions, as discussed above for winter-run Chinook above (Impact AQUA-42 for Alternative 1A). During the juvenile fall-run Chinook salmon migration period (February through May), mean monthly flows in the Sacramento River below the NDD would be reduced compared to NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows during this period were lower (up to 23% lower) under Alternative 1A compared to baseline conditions (NAA) when averaged across all water years, with flows reduced up to 32% in April of above normal years. As discussed in Impact AQUA-42, *CM1 Water Facilities and Operation* includes bypass flow criteria that will be managed in real time to minimize adverse effects of diversions at the north Delta intakes on downstream-migrating salmonids.

Through-Delta survival of migrating fall-run Chinook salmon smolts from the Sacramento River, as estimated by DPM under Alternative 1A, averaged 24% across all years, 22% in drier years, and 29% in wetter years (Table 11-1A-48). Compared to baseline conditions (NAA), average survival would be 2% lower (7% relative decrease) in wetter years, and similar in drier years and across all years.

Table 11-1A-48. Through-Delta Survival (%) of Emigrating Juvenile Fall-Run Chinook Salmon under Alternative 1A

	Percentage Survival			Difference in Percentage Survival (Relative Difference)	
Year Type	EXISTING CONDITIONS	NAA	A1A_LLT	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Sacramento River					
Wetter Years	34.5	31.1	28.8	-5.7 (-16%)	-2.3 (-7%)
Drier Years	20.6	20.8	21.7	1.1 (5%)	0.9 (4%)
All Years	25.8	24.7	24.4	-1.4 (-6%)	-0.3 (-1%)
Mokelumne River					
Wetter Years	17.2	15.7	15.4	-1.7 (-10%)	-0.3 (-2%)
Drier Years	15.6	15.9	15.6	-0.1 (<1%)	-0.4 (-2%)
All Years	16.2	15.9	15.5	-0.7 (-4%)	-0.4 (-2%)
San Joaquin River					
Wetter Years	19.3	20.3	18.0	-1.4 (-7%)	-2.3 (-11%)
Drier Years	10.0	9.5	10.6	0.6 (6%)	1.1 (11%)
All Years	13.5	13.6	13.4	-0.1 (-1%)	-0.2 (-2%)

Note: Delta Passage Model results for survival to Chipps Island.
Wetter = Wet and above normal water years (6 years).
Drier = Below normal, dry and critical water years (10 years).

Potential predation at the north Delta intakes could occur if predatory fish aggregated along the screens as has been observed at other long screens in the Central Valley (Vogel 2008). Baseline levels of predation are uncertain, however. Analysis by a bioenergetics model (Appendix 5.F, *Biological Stressors on Covered Fish,* Section 5.F.3.2.1) indicates a predation loss of annual production from the Sacramento River basin of 1.8% for fall-run Chinook salmon and 4.9% for late fall-run Chinook salmon (Table 11-1A-17). A more conservative estimate of predation (5% loss per intake) would yield a cumulative loss of about 20% of the annual production of fall-run and late fall-run Chinook salmon that reach the north Delta. The five intake structures would also permanently displace approximately 22 acres of in-water habitat along the migration route. However, there are appreciable uncertainties in these analyses, including unknown baseline levels of predation, uncertainty in the bioenergetics model parameters, and the comparability of the GCID intakes for estimating loss rates.

Adults

Adult salmonids migrating through the Delta use flow and olfactory cues for navigation to their natal streams (Marston et al. 2012), as discussed above for winter-run Chinook (Impact AQUA-42 for Alternative 1A). Sacramento River flows downstream of the proposed north Delta intakes generally will be lower under Alternative 1A operations relative to NAA, with differences between water-year types because of differences in the relative proportion of water being exported from the north Delta and south Delta facilities (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*.

During the adult fall-run Chinook salmon upstream migration from September to December, the proportion of Sacramento River water in the Delta would decrease 5% to 12% under Alternative 1A compared to NAA (Table 11-1A-49). Adult salmonid attraction due to olfactory cues could be adversely affected by dilution greater than 20%, but has not been discernibly affected by dilution of 10% or less (Fretwell 1989).

Table 11-1A-49. Percentage (%) of Water at Collinsville Originating in the Sacramento River during the Adult Fall-Run and Late Fall-Run Chinook Salmon Migration Period for Alternative 1A

	Scenario			Percentage Difference	
Month	EXISTING CONDITIONS	NAA	A1A_LLT	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Fall-Run—Sacramento River					
September	60	65	53	-7	-12
October	60	68	64	4	-4
November	60	66	61	1	-5
December	67	66	63	-4	-3
Fall-Run—San Joaquin River					
September	0.3	0.1	1.1	0.8	1
October	0.2	0.3	1.8	1.6	1.5
November	0.4	1.0	3.1	2.7	2.1
December	0.9	1.0	1.5	0.6	0.5
Late Fall-Run—Sacramento River					
December	67	66	63	-4	-3
January	76	75	71	-5	-4
February	75	72	67	-8	-5
March	78	76	67	-11	-9

Shading indicates 10% or greater absolute difference.

Late Fall-Run

Juveniles

During the juvenile late fall-run Chinook salmon emigration period (October-February), mean monthly flows in the Sacramento River below the north Delta intakes under Alternative 1A averaged across years would increase 15% in October and decrease (10%-31%) from November-February compared to NAA. Flows would be up to 39% lower in November of above normal years. Through-Delta survival rates under Alternative 1A would average 23% across all years, 27% in wetter years, and 20% in drier years, which is similar to NAA (Table 11-1A-50).

Estimates of potential predation losses at the north Delta intakes range from 4.9% (bioenergetics model, Table 11-1A-17) up to 20.3% (fixed 5% loss per intake) of annual production of late fall-run salmon reaching the Delta. The five intake structures would displace approximately 22 acres of in-water habitat. Uncertainties exist regarding baseline levels of predation, bioenergetics model parameters, and comparability of the 5% loss based on GCID intakes.

Table 11-1A-50. Through-Delta Survival (%) of Emigrating Juvenile Late Fall-Run Chinook Salmon under Alternative 1A

	Percentage Survival			Difference in Percentage Survival (Relative Difference)	
Year Type	EXISTING CONDITIONS	NAA	A1A_LLT	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Wetter Years	28.8	27.3	27.3	-1.4 (-5%)	0 (0%)
Drier Years	18.8	20.2	20.4	1.7 (9%)	0.2 (1%)
All Years	22.5	22.9	23.0	0.5 (2%)	0.1 (1%)

Note: Delta Passage Model results for survival to Chipps Island.
Wetter = Wet and above normal water years (6 years).
Drier = Below normal, dry and critical water years (10 years).

Adults

During the adult late fall-run Chinook salmon upstream migration from September to December, the proportion of Sacramento River water in the Delta would be 63% to 71%, which would be 3% to 9% decrease compared to NAA (Table 11-1A-49). Adult salmonid attraction due to olfactory cues could be adversely affected by dilution greater than 20%, but has not been discernibly affected by dilution of 10% or less (Fretwell 1989).

Mokelumne River

Fall-Run

Juveniles

Through-Delta survival of migrating fall-run Chinook salmon smolts from the Mokelumne River, as estimated by DPM under Alternative 1A, averaged 15.4-15.6% and was similar for wetter, drier, and all years (Table 11-1A-48). Compared to baseline conditions (NAA), average survival would be less than 0.5% lower (2% relative decrease).

San Joaquin River

Fall-Run

Juveniles

Through-Delta survival of migrating fall-run Chinook salmon smolts from the San Joaquin River, as estimated by DPM under Alternative 1A, averaged 13% across all years, 18% in wetter years, and 11% in drier years (Table 11-1A-48). Compared to baseline conditions (NAA), average survival would be 2% lower (11% relative decrease) in wetter years and 1% greater (11% relative increase) in drier years.

Adults

The percentage of water at Collinsville that originated from the San Joaquin River is small (no more than 1% under NAA) during the fall-run migration period (September to December) (Table 11-1A-49). Alternative 1A operations conditions would incrementally increase olfactory cues associated with the San Joaquin River, which would benefit adult fall-run Chinook salmon migrating to the San Joaquin River.

Predation Associated with Entrainment

The effects would be the same as described for predation in Impact AQUA-57. While the estimated number of spring-run Chinook salmon juveniles predicted to be consumed by striped bass predators would be substantial (up to tens of thousands), the population level effect would be minimal (less than 1%) when compared to the annual production estimated for the Sacramento Valley (*BDCP Effects Analysis – Appendix 5F, Biological Stressor*s, *Section F.5.3 Potential Effects: Benefits and Risks, hereby incorporated by reference*).

NEPA Effects*:* Overall, the results indicate that the effect of Alternative 1A is adverse because it has the potential to substantially decrease fall- and late fall-run Chinook salmon migration habitat conditions upstream of the Delta. In addition, this alternative is adverse due to the cumulative effects associated with five north Delta intake facilities, including mortality related to near-field effects (e.g. impingement and predation) and far-field effects (reduced survival due to reduced flows downstream of the intakes) associated with the five NDD intakes.

Upstream of the Delta, flows in the Sacramento, Feather, and American rivers would be up to 69% lower during one of the two months of the fall-run Chinook salmon adult migration period. These reductions in flow may impact the ability of adult fall-run Chinook salmon to migrate upstream successfully. There would be no other effects of Alternative 1A on upstream flows or water temperatures during the juvenile or adult migration periods for fall- and late fall-run Chinook salmon.

Adult attraction flows in the Delta under Alternative 1A would be lower than those under NAA, but adult attraction flows are expected to be adequate to provide olfactory cues for migrating adults.

Near-field effects of Alternative 1A NDD on fall- and late fall-run Chinook salmon related to impingement and predation associated with five new intakes could result in substantial effects on juvenile migrating fall- and late fall-run Chinook salmon, although there is high uncertainty regarding the potential effects. Estimates within the effects analysis range from very low levels of effects (<2% mortality) to very significant effects (~ 20% mortality above current baseline levels). CM15 would be implemented with the intent of providing localized and temporary reductions in predation pressure at the NDD. Additionally, several pre-construction surveys to better understand how to minimize losses associated with the five new intake structures will be implemented as part of the final NDD screen design effort. Alternative 1A also includes an Adaptive Management Program and Real-Time Operational Decision-Making Process to evaluate and make limited adjustments intended to provide adequate migration conditions for fall- and late fall-run Chinook salmon. However, at this time, due to the absence of comparable facilities anywhere in the lower Sacramento River/Delta, the degree of mortality expected from near-field effects at the NDD remains highly uncertain.

Two recent studies (Newman 2003 and Perry 2010) indicate that far-field effects associated with the new intakes could cause a reduction in smolt survival in the Sacramento River downstream of the NDD intakes due to reduced flows in this area. The analyses of other elements of Alternative 1A predict improvements in smolt condition and survival associated with increased access to the Yolo Bypass, reduced interior Delta entry, and reduced south Delta entrainment. The overall magnitude of each of these factors and how they might interact and/or offset each other in affecting salmonid survival through the plan area is uncertain, and remains an area of active investigation for the BDCP.

The DPM is a flow-based model being developed for BDCP which attempts to combine the effects of all of these elements of BDCP operations and conservation measures to predict smolt migration survival throughout the entire Plan Area. The current draft of this model predicts that smolt migration survival under Alternative 1A would be similar to survival rates estimated for NAA. Further refinement and testing of the DPM, along with several ongoing and planned studies related to salmonid survival at and downstream of the NDD are expected to be completed in the foreseeable future. These efforts are expected to improve our understanding of the relationships and interactions among the various factors affecting salmonid survival, and reduce the uncertainty around the potential effects of BDCP implementation on migration conditions for Chinook salmon. Until these efforts are completed and their results are fully analyzed, the overall effect of Alternative 1A on fall- and late fall-run Chinook salmon through-Delta survival remains uncertain.

Therefore, primarily as a result of reduced upstream migration habitat conditions for fall- and late fall-run Chinook salmon due to reduced flows along with unacceptable levels of uncertainty regarding the cumulative impacts of near-field and far-field effects associated with the presence and operation of the five intakes on fall- and late fall-run Chinook salmon, this effect is adverse.

While the implementation of the conservation and mitigation measures described below would address these impacts, these measures are not anticipated to reduce the impact to a level considered not adverse.

CEQA Conclusion: In general, Alternative 1A would reduce migration conditions for fall-/late fall–run Chinook salmon relative to the Existing Conditions.

Upstream of the Delta

Sacramento River

Fall-Run

Flows in the Sacramento River upstream of Red Bluff for juvenile fall-run migrants during February through May under A1A_LLT would generally be similar to or greater than those under Existing Conditions, except in wet water years during May (14% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 1A in any month or water year type throughout the period.

Flows in the Sacramento River upstream of Red Bluff were examined during the adult fall-run Chinook salmon upstream migration period (September through October). Flows under A1A_LLT would generally be or lower than those under Existing Conditions during September (up to 24% lower), except for above normal years (6% greater) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in October would be 15% to 36% greater than Existing Conditions.

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the September through October adult fall-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under Alternative 1A would be 7% and 5% greater than those under Existing Conditions during September and October, respectively.

Late Fall-Run

Flows in the Sacramento River upstream of Red Bluff for juvenile late fall-run Chinook salmon migrants (January through March) under A1A_LLT would be similar to or greater than flows under Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the January through March juvenile late fall-run Chinook salmon emigration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 1A in any month or water year type throughout the period.

Flows in the Sacramento River upstream of Red Bluff during the adult late fall-run Chinook salmon upstream migration period (December through February) under A1A_LLT would also be similar to or greater than those under Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the December through February adult late fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 1A in any month or water year type throughout the period.

Clear Creek

Fall-Run

Flows in Clear Creek below Whiskeytown Reservoir during the juvenile fall-run Chinook salmon upstream migration period (February through May) under A1A_LLT would be similar to or greater than those under Existing Conditions throughout the period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flows in Clear Creek below Whiskeytown Reservoir during the adult fall-run Chinook salmon upstream migration period (September through October) under A1A_LLT would generally be similar to or greater than those under Existing Conditions except in critical years (37% lower during September) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Water temperature modeling was not conducted in Clear Creek.

Feather River

Fall-Run

Flows in the Feather River at the confluence with the Sacramento River during the juvenile fall-run Chinook salmon migration period (February through May) under A1A_LLT would generally be similar to or greater than flows under Existing Conditions, except in below normal years during

March (11% lower) and in wet years during May (23% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 1A in any month or water year type throughout the period.

Flows in the Feather River at the confluence with the Sacramento River were examined during the September through October fall-run Chinook salmon adult migration period. Flows under A1A_LLT would generally be lower (up to 27% lower) during September, except in critical years (13% greater than Existing Conditions). During October, flows under A1A_LLT would generally be greater (up to 35% greater) than flows under Existing Conditions.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the September through October fall-run Chinook salmon adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 1A in any month or water year type throughout the period.

American River

Fall-Run

Flows in the American River at the confluence with the Sacramento River were examined during the February through May juvenile Chinook salmon fall-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT during February, March, and April would generally be similar to or greater than flows under Existing Conditions, except for critical years during February and March (13% and 12% lower, respectively) and above normal years during April (8% lower). Flows under A1A_LLT during May would be mostly lower by up to 27% than flows under Existing Conditions.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under Alternative 1A would be 5% to 7% higher than under Existing Conditions in all month except April, in which there would be no difference.

Flows in the American River at the confluence with the Sacramento River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT during September would be 44% to 58% lower than flows under Existing Conditions. Flows under A1A_LLT during October would be 5% and 45% greater than those under Existing Conditions.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation*

Temperature Model Results utilized in the Fish Analysis). Mean monthly water temperatures under Alternative 1A would be 6% and 11% higher than those under Existing Conditions during September and October, respectively.

Stanislaus River

Fall-Run

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT throughout this period would generally be lower than Existing Conditions (up to 36% lower), except for March in wet water years (7% greater).

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under Alternative 1A would be 6% higher than those under Existing Conditions in every month of the period.

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would generally be similar to flows under Existing Conditions during September, except in wet and above normal years (17% and 6% lower, respectively). During October, flows would be 6% to 11% lower depending on water year type.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under Alternative 1A would be 6% higher than those under Existing Conditions during September but there would be no difference in mean monthly water temperatures between Alternative 1A and Existing Conditions during October.

San Joaquin River

Fall-Run

Flows in the San Joaquin River at Vernalis were examined during the February through May juvenile Chinook salmon fall-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be similar to Existing Conditions but with lower flows in two water years during February, and would be lower than Existing Conditions by up to 15% during March, April and May.

Flows in the San Joaquin River at Vernalis were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be lower than Existing Conditions by up to 11% during both months.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Fall-Run

Flows in the Mokelumne River at the Delta were examined during the February through May juvenile Chinook salmon fall-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be similar to those under Existing Conditions during February and March, but up to 18% lower than flows under Existing Conditions during April and May.

Flows in the Mokelumne River at the Delta were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be up to 29% lower than those under Existing Conditions depending on water year type.

Water temperature modeling was not conducted in the Mokelumne River.

Through-Delta

Sacramento River

Fall-Run

Juvenile fall-run Chinook salmon migrating down the Sacramento River during February through May would generally experience lower flows below the north Delta intakes compared to Existing Conditions. During the juvenile fall-run Chinook salmon emigration period (November to early May), mean monthly flows in the Sacramento River below the north Delta intakes under Alternative 1A averaged across years would be lower (up to 29% lower) compared to Existing Conditions. Flows would be up to 32% lower in March of above normal and April of below normal years. Through-Delta survival of migrating fall-run Chinook salmon smolts from the Sacramento River under Alternative 1A was fairly similar to Existing Conditions in drier and all years averaged, and lower in wetter years (5.7% lower survival, a 16% relative decrease) (Table 11-1A-48).

During the adult fall-run Chinook salmon upstream migration from September to December, the proportion of Sacramento River water in the Delta under Alternative 1A would be 53% to 64%. Compared to Existing Conditions, it would decrease in September (7% decrease) and December (4% decrease), and would be increase 4% in October (Table 11-1A-49).

Late Fall-Run

Under Alternative 1A during the juvenile migration period for late fall-run Chinook salmon, average monthly flows in the Sacramento River below the north Delta intakes averaged across all years would be 10%-31% lower from November to February, and 15% higher in October compared to Existing Conditions. Flows would decrease up to 37% in November of above normal years. Through-Delta survival rates under Alternative 1A would average 23% across all years, 27% in wetter years, and 20% in drier years (Table 11-1A-50). This would be similar to Existing Conditions averaged across years, and slightly lower in wetter years and higher in drier years (a 5-9% relative difference).

During the adult migration period (December to March), the percentage of water at Collinsville originating from the Sacramento River under Alternative 1A (63% to 71%) would decrease 4% to 11% compared to Existing Conditions (Table 11-1A-49).

Mokelumne River

Fall-Run

Through-Delta survival of migrating juvenile fall-run Chinook salmon from the Mokelumne River under Alternative 1A was fairly similar in drier and all years averaged, and lower in wetter years (1.7% lower survival, a 10% relative decrease) compared to Existing Conditions (Table 11-1A-48).

San Joaquin River

Fall-Run

Juveniles

Through-Delta survival rates under Alternative 1A would average 23% across all years, 27% in wetter years, and 20% in drier years (Table 11-1A-48). This would be similar to NAA averaged across years, and slightly lower in wetter years and higher in drier years (a 6-7% relative difference).

Adults

The percentage of water at Collinsville originating from the San Joaquin River is small (no more than 1% under NAA) during the fall-run migration period (September to December). Olfactory cues for fall-run Chinook migrating to the San Joaquin River under Alternative 1A (0.6 to 2.7%) would be increased compared to Existing Conditions (Table 11-1A-49).

Summary of CEQA Conclusion

Overall, the results indicate that the effect of Alternative 1A is adverse because it has the potential to substantially decrease fall- and late fall-run Chinook salmon migration habitat conditions upstream of the Delta. In addition, this alternative is adverse due to the cumulative effects associated with five north Delta intake facilities, including mortality related to near-field effects (e.g. impingement and predation) and far-field effects (reduced survival due to reduced flows downstream of the intakes) associated with the five NDD intakes.

Upstream of the Delta, flows in the American, Stanislaus, San Joaquin, and Mokelumne rivers would be lower and water temperatures in the American and Stanislaus rivers would be elevated during substantial portions of the fall-/late fall-run Chinook salmon migration periods. In the Delta, the impact on emigrating juveniles would be significant due to the impacts associated with predation and habitat loss from the five intakes under this alternative (similar to the previous description under Impact AQUA-42). Implementation of CM6 and CM15 would address these impacts, but are not anticipated to reduce them to a level considered less than significant. Although implementation of *CM6 Channel Margin Enhancement* would provide habitat similar to that which would be lost, it would not necessarily be located near the intakes and therefore would not fully compensate for the lost habitat. Additionally, implementation of this measure would not fully address predation losses. *CM15 Localized Reduction of Predatory Fishes (Predator Control)* has substantial uncertainties associated with its effectiveness such that it is considered to have no demonstrable effect. Conservation measures that address habitat and predation losses, therefore, would potentially minimize impacts to some extent but not to a less than significant level. Consequently, as a result of these changes in migration conditions, this impact is significant and unavoidable.

Applicable conservation measures are briefly described below and full descriptions are found in Chapter 3, Section 3.6.2.5 Channel Margin Enhancement (CM6) and Section 3.6.3.4 Localized Reduction of Predatory Fishes (Predator Control) (CM15).

CM6 Channel Margin Enhancement. CM6 would entail restoration of 20 linear miles of channel margin by improving channel geometry and restoring riparian, marsh, and mudflat habitats on the waterside side of levees along channels that provide rearing and outmigration habitat for juvenile salmonids. Linear miles of enhancement would be measured along one side or the other of a given channel segment (e.g., if both sides of a channel are enhanced for a length of 1 mile, this would account for a total of 2 miles of channel margin enhancement). At least 10 linear miles would be enhanced by year 10 of Plan implementation; enhancement would then be phased in 5-mile increments at years 20 and 30, for a total of 20 miles at year 30. Channel margin enhancement would be performed only along channels that provide rearing and outmigration habitat for juvenile salmonids. These include channels that are protected by federal project levees—including the Sacramento River between Freeport and Walnut Grove among several others.

CM15 Localized Reduction of Predatory Fishes (Predator Control). CM15 would seek to reduce populations of predatory fishes at specific locations or modify holding habitat at selected locations of high predation risk (i.e., predation "hotspots"). This conservation measure seeks to benefit covered salmonids by reducing mortality rates of juvenile migratory life stages that are particularly vulnerable to predatory fishes. Predators are a natural part of the Delta ecosystem. Therefore, this conservation measure is not intended to entirely remove predators at any location, or substantially alter the abundance of predators at the scale of the Delta system. This conservation measure would also not remove piscivorous birds. Because of uncertainties regarding treatment methods and efficacy, implementation of CM15 would involve discrete pilot projects and research actions coupled with an adaptive management and monitoring program to evaluate effectiveness. Effects would be temporary, as new individuals would be expected to occupy vacated areas; therefore, removal activities would need to be continuous during periods of concern. CM15 also recognizes that the NDD intakes would create new predation hotspots.

This impact is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this impact to a less-than-significant level would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this impact is significant and unavoidable because there is no feasible mitigation available. Even so, proposed below is mitigation that has the potential to reduce the severity of impact though not necessarily to a less-than-significant level.

Mitigation Measure AQUA-78a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Fall-/Late Fall–Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Migration Conditions

Although analysis conducted as part of the EIR/EIS determined that Alternative 1A would have significant and unavoidable adverse effects on migration habitat, this conclusion was based on the best available scientific information at the time and may prove to have been over- or understated. Upon the commencement of operations of CM1 and continuing through the life of the permit, the BDCP proponents will monitor effects on migration habitat in order to determine whether such effects would be as extensive as concluded at the time of preparation of this document and to determine any potentially feasible means of reducing the severity of such effects. This mitigation measure requires a series of actions to accomplish these purposes, consistent with the operational framework for Alternative 1A.

The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 1A operations only. Development of mitigation actions for the incremental impact on migration habitat attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 1A.

Mitigation Measure AQUA-78b: Conduct Additional Evaluation and Modeling of Impacts on Fall-/Late Fall–Run Chinook Salmon Migration Conditions Following Initial Operations of CM1

Following commencement of initial operations of CM1 and continuing through the life of the permit, the BDCP proponents will conduct additional evaluations to define the extent to which modified operations could reduce impacts to migration habitat under Alternative 1A. The analysis required under this measure may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6).

Mitigation Measure AQUA-78c: Consult with USFWS and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Fall-/Late Fall–Run Chinook Salmon Migration Conditions Consistent with CM1

In order to determine the feasibility of reducing the effects of CM1 operations on fall-run/late fall-run Chinook salmon habitat, the BDCP proponents will consult with USFWS and the Department of Fish and Wildlife to identify and implement any feasible operational means to either effects on migration habitat. Any such action will be developed in conjunction with the ongoing monitoring and evaluation of habitat conditions required by Mitigation Measure AQUA-78a.

If feasible means are identified to reduce impacts on migration habitat consistent with the overall operational framework of Alternative 1A without causing new significant adverse impacts on other covered species, such means shall be implemented. If sufficient operational flexibility to reduce effects on fall-run/late fall-run Chinook salmon habitat is not feasible under Alternative 1A operations, achieving further impact reduction pursuant to this mitigation measure would not be feasible under this Alternative, and the impact on fall-run/late fall-run Chinook salmon would remain significant and unavoidable.

Restoration Measures (CM2, CM4–CM7, and CM10)

Impact AQUA-79: Effects of Construction of Restoration Measures on Chinook Salmon (Fall-/Late Fall–Run ESU)

Please refer to Impact AQUA-43 for winter-run Chinook salmon.

Impact AQUA-80: Effects of Contaminants Associated with Restoration Measures on Chinook Salmon (Fall-/Late Fall–Run ESU)

Please refer to Impact AQUA-44 for winter-run Chinook salmon.

Impact AQUA-81: Effects of Restored Habitat Conditions on Chinook Salmon (Fall-/Late Fall–Run ESU)

Please refer to Impact AQUA-45 for winter-run Chinook salmon.

Other Conservation Measures (CM12–CM19 and CM21)

Impact AQUA-82: Effects of Methylmercury Management on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM12)

Please refer to Impact AQUA-46 for winter-run Chinook salmon.

Impact AQUA-83: Effects of Invasive Aquatic Vegetation Management on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM13)

Please refer to Impact AQUA-47 for winter-run Chinook salmon.

Impact AQUA-84: Effects of Dissolved Oxygen Level Management on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM14)

Please refer to Impact AQUA-66 for spring-run Chinook salmon.

Impact AQUA-85: Effects of Localized Reduction of Predatory Fish on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM15)

Please refer to Impact AQUA-49 for winter-run Chinook salmon.

Impact AQUA-86: Effects of Nonphysical Fish Barriers on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM16)

Please refer to Impact AQUA-50 for winter-run Chinook salmon.

Impact AQUA-87: Effects of Illegal Harvest Reduction on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM17)

Please refer to Impact AQUA-51 for winter-run Chinook salmon.

Impact AQUA-88: Effects of Conservation Hatcheries on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM18)

Please refer to Impact AQUA-52 for winter-run Chinook salmon.

Impact AQUA-89: Effects of Urban Stormwater Treatment on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM19)

Please refer to Impact AQUA-53 for winter-run Chinook salmon.

Impact AQUA-90: Effects of Removal/Relocation of Nonproject Diversions on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM21)

Please refer to Impact AQUA-54 for winter-run Chinook salmon.

Steelhead

Construction and Maintenance of CM1

Impact AQUA-91: Effects of Construction of Water Conveyance Facilities on Steelhead

Steelhead could be present in the vicinity of the intake and barge landings during in-water construction. The potential for exposure of steelhead to construction-related activities is expected to be low and would be limited to two construction seasons (one for installation of cofferdams and barge landings, and one for removal of cofferdams and barge landings). Adult steelhead could be present at the intake sites at the beginning of the upstream migration period in September and October (see Table 11-4). Late-migrating juveniles could also be in the vicinity of the intake locations in June. Juvenile steelhead may be in the vicinity of the barge landings during construction. Appendix 11A, *Covered Fish Species* details the temporal and spatial distribution of various life history stages for steelhead.

Temporary Increases in Turbidity

Low numbers of steelhead may be exposed to increased levels of turbidity during in-water construction at the intakes and barge landings (see Table 11-4). Potential effects on steelhead from temporary increases in turbidity are similar to those described for Chinook salmon (see Impact AQUA-37).The extent of adverse effects would be avoided and minimized by implementing the environmental commitments *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*. Pertinent measures included in these plans are discussed under Impact AQUA-1 for delta smelt.

Accidental Spills

Potential effects on steelhead from accidental spills are similar to those described for delta smelt (see Impact AQUA-1). Depending on the type and magnitude of an accidental spill, contaminants can directly affect the growth and survival of steelhead. Implementation of the environmental commitments discussed for delta smelt (see Impact AQUA-1) and contained in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*), specifically the *Spill Prevention, Containment, and Countermeasure Plan*, would minimize the potential for introduction of contaminants to surface waters and provide for effective containment and cleanup should accidental spills occur. Pertinent measures included in these plans are discussed under Impact AQUA-1 for delta smelt.

Disturbance of Contaminated Sediments

Toxic contaminants are present in both water and sediment in the Delta aquatic environment, as described in Chapter 8*, Water Quality*. In-water construction activities would suspend sediments that may contain toxic contaminants (see discussion under Impact AQUA-1 for delta smelt). Potential effects on steelhead from disturbance of contaminated sediments during construction are similar to those described for delta smelt (Impact AQUA-1). Effects would be minimized by implementation of environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution*

Prevention Plan; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*).

Underwater Noise

Underwater sound generated by impact pile driving in or near surface waters can potentially harm steelhead. It is important to note that the impact would be realized only where piles must be impact driven; underwater sound generated by vibratory pile installation methods are not sufficiently loud to injure fish.

Potential effects on steelhead from impact pile driving are similar to those described for Chinook salmon (see Impact AQUA-37). Table 11-4 illustrates the life stages of steelhead expected to be present in the north, east, and south Delta during the in-water construction window (expected to be June 1–October 31). Central Valley steelhead eggs and fry would not experience underwater sound from pile driving because the locations of the intakes and barge landings are not considered suitable habitat for these two life stages of this species; therefore, effects would not occur.

Adult Central Valley steelhead could be present near the construction areas of the intakes and barge landings during June and July. Adults use the Sacramento and San Joaquin Rivers on their migration to upriver spawning areas during spring and summer. However, densities of the adults would be very low, as June and July do not overlap with peak migration periods. Steelhead could be moderately abundant near the construction areas for intakes in October. Adult steelhead are large and are able to avoid injurious exposure to underwater noise from pile driving. They may experience short delays in migration past the intakes when pile driving is occurring; however, pile driving would occur only intermittently through a portion of the day, and minor migration delays would not affect their ability to successfully reach spawning grounds. Therefore, the potential for adult Central Valley steelhead to experience an adverse effect (e.g., injury or mortality, or migratory disturbance) would be low because of their size, ability to move away from the underwater sound, and their potentially low to moderate temporal and spatial migration distribution around the construction areas.

Juvenile steelhead that have migrated downriver could be moderately abundant in the vicinity of the intakes and barge landings during June and July. The habitat in these areas is considered poor because of relatively steep rip rap banks and deep channels with little refuge, which may limit their overall abundance in these areas. Although it is not possible to predict the number of steelhead that would be exposed to underwater sound at the construction locations, underwater noise could exceed the criteria for approximately 8 to 12 hours a day for those days that impact pile driving occur.

If an individual juvenile steelhead were present in an area affected by underwater sound from impact pile driving above the 187-dB $SEL_{cumulative}$ level, and proximate to an impact-driven pile, it could experience an adverse effect, such as injury or mortality. However, because of the overall low densities of juvenile steelhead expected in all pile driving locations, the relatively low incidence of impact pile driving expected, and implementation of the avoidance and minimization measures included in Mitigation Measures AQUA-1a and AQUA-1b, the potential for juvenile steelhead to experience an adverse effect from impact pile driving (e.g., injury or mortality) would be very low. Therefore, underwater noise from impact pile driving would not adversely affect steelhead population levels.

Fish Stranding

The risk of fish entrapment and subsequent handling stress during removal would be minimized by limiting cofferdam construction and other in-water work to the CDFW- and NMFS- approved in-water work windows (expected to be June 1 through October 31). In addition, implementation of environmental commitment *Fish Rescue and Salvage Plan*, would also minimize impacts (see Impact AQUA-1 and Appendix 3B, *Environmental Commitments*). The typical size and swimming ability of steelhead smolts would also minimize the chances of stranding or entrapment inside of the cofferdam structures. Therefore, stranding would not be expected to adversely affect steelhead.

In-Water Work Activities

As discussed for delta smelt (see Impact AQUA-1), although fish would likely avoid the noise and activity of pile installation and placement of riprap protection, these activities have the potential to result in direct injury or mortality. Although low numbers of steelhead would likely be present during in-water construction activities, it is unknown how many juvenile steelhead could be affected. Effects would be minimized by implementation of environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*, including *Erosion and Sediment Control Plan*; *Dispose of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*.

Loss of Spawning, Rearing, or Migration Habitat

There is no suitable spawning habitat for steelhead in the vicinity of the proposed in-water work; therefore steelhead spawning habitat would not be affected by construction activities. Construction would temporarily and permanently affect designated critical rearing and migration habitat for steelhead. The existing rearing habitat is of low quality, consisting of armored levees with limited riparian vegetation (see Impact AQUA-1).

The mainstem Sacramento River is designated as steelhead critical habitat, providing migration and rearing habitat. This includes up to about 28.7 acres temporarily lost during in-water work, and a total of approximately 22,700 linear feet of river bank affected (see Table 11-5). Construction of the approach canal and Byron Tract Forebay would not affect fish-accessible waterways and therefore would not affect steelhead. The work would be conducted in stages, with dredging at Intake 1 in June; dredging at Intakes 2, 3, and 5 in July; and dredging at Intake 4 in August of the first in-water construction year. The armored levee bank habitat that would be permanently lost would be replaced by the intake screen structures (alteration of up to 8,300 linear feet of channel margin). Some riparian trees and shrubs that currently grow on the levee banks would be lost, slightly reducing cover and shade, and the input of leaves and insects falling into the river from overhanging vegetation. However, bank armoring and lack of physical structure currently limit the quality of this habitat. Potential effects would be minimized by implementation of environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*.

Predation

Impacts on steelhead from predation would be similar to those described for Chinook salmon (see Impact AQUA-37).

Summary

Potential effects of construction activities on steelhead would be similar to those discussed for Chinook salmon (Impact AQUA-37). Implementation of the environmental commitments described for Chinook salmon and in Appendix 3B, *Environmental Commitments*, would minimize effects of construction activities on steelhead from turbidity increases and inadvertent spills of hazardous materials. These environmental commitments are *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt. As a result, these effects would not likely be adverse to steelhead.

The low numbers of steelhead would also minimize the potential for effects during in-water construction activities (including impact pile driving). The relatively low incidence of impact pile driving expected, and implementation of the avoidance and minimization measures included in Mitigation Measures AQUA-1a and AQUA-1b, would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality).

Locally increased predator habitat and predation from the temporary construction structures (cofferdams and barge landing docks) would not have population level effects. Therefore, predation effects on steelhead from construction activities would not be adverse.

Although construction of the intakes and barge landings will temporarily or permanently affect critical steelhead rearing and migration habitat, the relatively poor quality of the current habitat and implementation of *CM6 Channel Margin Enhancement* would result in a net improvement in channel margin habitat function.

NEPA Effects: Overall, construction activities are not expected to adversely affect steelhead or their habitat.

CEQA Conclusion: The potential impact on steelhead from construction activities is considered less than significant due to implementation of the measures described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*. These include *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*. These measures would be expected to protect steelhead from any adverse water quality effect (turbidity increases or spills of hazardous materials) resulting from project construction. Construction would not be expected to increase predation rates relative to NAA. Construction associated with Alternative 1A will result in both temporary and permanent alteration of rearing and migratory habitats used by steelhead. However, these impacts are not expected to be significant because the loss of habitat is not substantial compared to the amount of habitat currently available in combination with the amount of new habitat that would result from restoration.

Locally increased predator habitat and predation from the temporary construction structures (cofferdams and barge landing docks) would not have population level effects. Implementation of *CM6 Channel Margin Enhancement* would result in a net improvement in channel margin habitat function after construction. The direct effects of underwater construction noise on steelhead would be a significant impact because of the high likelihood that it would cause injury or death to most impacted fish in the immediate vicinity of the activity. However, implementation of Mitigation

Measures AQUA-1a and AQUA-1b would minimize the potential effects from underwater noise and would minimize the severity of impacts to a less-than-significant level.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 for delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 for delta smelt.

For these reasons, the impacts of construction activities on steelhead would be less than significant, and no additional mitigation would be required.

Impact AQUA-92: Effects of Maintenance of Water Conveyance Facilities on Steelhead

Temporary Increases in Turbidity

As discussed for construction-related effects of turbidity on Chinook salmon (Impact AQUA-37), increased turbidity could result in a decreased ability to forage, a decreased ability to avoid predators, or physical injury to the gills. In-water maintenance activities would occur between typically June 1 and October 31 when steelhead are minimally present in the Sacramento River. In-water activities would be limited in duration and infrequent. Turbidity effects would be minimized by implementing the environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*. These environmental commitments are *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Accidental Spills

The potential effects of maintenance activities would be similar to those discussed for construction-related effects on Chinook salmon (see Impact AQUA-37). Effects would be minimized by implementation of environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; and *Spill Prevention, Containment, and Countermeasure Plan*). Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Underwater Noise

As discussed for delta smelt (see Impact AQUA-2), underwater noise levels produced by in-water maintenance activities are not expected to reach a level that would harm juvenile or adult fishes. This effect would not be adverse because potential noise from in-water maintenance activities would not exceed the threshold sound pressure level and would be temporary. In addition, the in-water work would be conducted when the least number of steelhead are likely to be present.

Maintenance-Related Disturbance

Effects on steelhead from use of in-water equipment (boats, barges, and dredging equipment) during maintenance would be the same as those discussed for delta smelt (see Impact AQUA-2). Direct injury and mortality of steelhead are most likely to occur during dredging activities around the new intakes. Suction dredging and mechanical excavation can capture or crush fish, causing injury or mortality. In-water dredging would occur during months when steelhead are minimally present in the Sacramento River, and dredging would be of short duration. Furthermore, effects would be minimized by implementation of environmental commitments including *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan;* and *Barge Operations Plan*, described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*.

Loss of Spawning, Rearing, or Migration Habitat

Steelhead habitat near the intake structures would be limited to rearing and migration. A small area of rearing habitat could be affected due to periodic dredging or placement of riprap. Migration habitat would be available farther out in the channel and would be unaffected by dredging and riprap placement. Available rearing and migration habitat of similar quantity and quality would be readily accessible to steelhead in the immediate vicinity of maintenance activities. Potential effects would be minimized by implementation of environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*.

Predation

Effects on steelhead from predation during construction would be similar to those described for winter-run Chinook salmon (see Impact AQUA-37 for winter-run Chinook salmon).

Summary

In-water maintenance activities would be scheduled to occur when the least numbers of steelhead would be present in or near the maintenance areas. Such activities would include maintenance dredging at the intake sites, and installation or repair of riprap bank armoring. Implementation of the environmental commitments described in Appendix 3B, *Environmental Commitments*, would further minimize or eliminate effects on Chinook salmon. These include *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Implementation of these environmental commitments, along with the low numbers of steelhead expected to occur in the maintenance areas during the approved in-water work windows and the limited frequency and duration of in-water maintenance activities, would result in a very low potential for adverse effects on steelhead from turbidity increases or spills of hazardous materials. In addition, no spawning habitat occurs in the areas potentially affected by maintenance activities, and ample rearing, and migration habitat of the same quality is readily accessible in the area, and this habitat would not be affected by maintenance activities.

NEPA Effects: The short-term maintenance activities would not adversely affect steelhead.

CEQA Conclusion: In addition to the limited frequency and duration of in-water maintenance activities, implementation of environmental commitments identified above and described in detail in Appendix 3B, *Environmental Commitments*, would minimize the potential for maintenance activities to affect steelhead through increases in turbidity or spills of hazardous materials. These environmental commitments, described under Impact AQUA-1 for delta smelt and in Appendix 3B, Environmental Commitments, include *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*. Potential changes to rearing and migratory habitat would also be limited and temporary. Therefore, the potential impact of maintenance activities is considered less than significant because it would not substantially interfere with its movement. Consequently, no mitigation would be required.

Water Operations of CM1

Numerous methods were used to estimate entrainment losses under Alternative 1A compared to NAA (refer to *Methods for Analysis* in this chapter). A complete analysis can be found in the *BDCP Effects Analysis – Appendix 5B*, *Entrainment (hereby incorporated by reference)*. In general and using a variety of methods, the difference between NAA and Alternative 1A varies across water-year types and species.

Impact AQUA-93: Effects of Water Operations on Entrainment of Steelhead

Water Exports from SWP/CVP South Delta Facilities

An entrainment index of winter-run Chinook salmon at the South Delta facilities was estimated using the salvage-density method (as detailed in *BDCP Effects Analysis - Appendix 5.B, Section 5.B.4*, *herein incorporated by reference*). Under NAA, entrainment peaks in February at both SWP and CVP facilities and is also relatively high in January and March. Estimated losses for juvenile steelhead were approximately four times greater at the SWP export facilities compared to the CVP export facilities, with losses at both facilities generally from 1,000 to 10,000 fish per year. Losses were greatest in above-normal and below-normal years, and least in critical water years.

Annual entrainment loss of juvenile steelhead across all years decreased 56% under Alternative 1A compared to baseline (Table 11-1A-51). Entrainment would decrease most in wet (85% decrease), above-normal (66% decrease), and below-normal years (56% decrease). Entrainment of juvenile steelhead in dry and critical years generally would be similar under Alternative 1A to NAA.

Table 11-1A-51. Juvenile Steelhead Annual Entrainment at the SWP and CVP Salvage Facilities—Differences between Model Scenarios for Alternative 1

	Absolute Difference (Percent Difference)	
Water Year	Existing Conditions vs. A1A_LLT	NAA vs. A1A_LLT
Wet	-5,259 (-84%)	-5,352 (-85%)
Above Normal	-8,883 (-68%)	-9,227 (-69%)
Below Normal	-6,393 (-54%)	-5,662 (-51%)
Dry	-699 (-9%)	-108 (-2%)
Critical	-212 (-4%)	139 (3%)
All Years	-6,569 (-59%)	-6,381 (-58%)
	Shading indicates 10% or greater increased entrainment.	
Note: Estimated annual number of fish lost, based on normalized data.		

Water Exports from SWP/CVP North Delta Intake Facilities

Potential entrainment of juvenile steelhead at the north Delta intakes occurs only under the action alternatives, including Alternative 1A, because there are no north Delta intakes operational under NAA. The north Delta intakes would be screened to exclude juvenile fish and are expected to be effective at excluding juvenile steelhead. The screens will be designed and built to specifications that are developed to reduce the risk of entrainment and impingement. Steelhead juveniles are larger than Chinook juveniles and would be less vulnerable to entrainment. The project's adaptive management plan includes monitoring of the new screens to determine their effectiveness. If the screens are not meeting expectations additional measures may be implemented to improve screen performance such as modifications to the screens or other structural components at the intakes, or changes in water diversion operations to reduce entrainment or impingement rates of juvenile steelhead.

Water Exports with a Dual Conveyance for the SWP North Bay Aqueduct

Entrainment of juvenile steelhead at the North Bay Aqueduct has not been explicitly analyzed. However, changes at the NBA Barker Slough Pumping Plant would have minimal effect because steelhead are not present in this area and therefore have minimal risk of entrainment under Existing Conditions. Entrainment at the proposed NBA alternative intake would be expected to be minimal because the intake would be 100% screened based on typical fish size and mesh size. Monitoring would occur to ensure that fish are indeed being excluded according to the design specifications. If monitoring indicates that screen effectiveness is not meeting expectations, the BDCP-proposed Real-Time Response Team would implement additional measures to reduce entrainment or impingement, such as modifications to the screens or intakes, or changes in water diversion operations.

NEPA Effects: Juvenile steelhead entrainment would decrease substantially overall (greater than 50% decrease Juvenile steelhead entrainment at the south Delta facilities would decrease substantially (56% decrease across all water years) compared to NAA. Entrainment risk at the north Delta intakes and North Bay Aqueduct would be minimized due to screening. Therefore this effect is expected to be generally beneficial to the species.

CEQA Conclusion: As described above, operational activities associated with water exports from SWP/CVP south Delta facilities would result in an overall decrease in entrainment for juvenile steelhead. At the same time, operational activities associated with water exports from SWP/CVP north Delta intake facilities would result in an increase in entrainment or a loss of individuals at that location. However, because the intakes would be equipped with state-of-the-art screens, entrainment is expected to be reduced as a whole. Potential impacts of Alternative 1A water operations on entrainment of steelhead would be beneficial due to an overall reduction in entrainment which is beneficial to the population. Consequently, no mitigation would be required.

Impact AQUA-94: Effects of Water Operations on Spawning and Egg Incubation Habitat for Steelhead

In general, Alternative 1A would not affect steelhead spawning and egg incubation habitat relative to NAA.

Sacramento River

Flows in the Sacramento River between Keswick and upstream of Red Bluff Diversion Dam, where the majority of steelhead spawning occurs, were examined during the primary steelhead spawning and egg incubation period of January through April (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Lower flows can reduce the instream area available for spawning and egg incubation, and rapid reductions in flow can expose redds, leading to mortality. Flows under A1A_LLT throughout the period would be similar to or greater than flows under NAA during this period, except in critical water years during January (11% lower).

Mean monthly water temperatures in the Sacramento River at Keswick and Red Bluff were examined during the January through April primary steelhead spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period at either location

SacEFT predicts that there would be a 6% decrease in the percentage of years with good spawning availability, measured as weighted usable area, under A1A_LLT relative to NAA (Table 11-1A-52). SacEFT predicts that there would be a negligible (<5%) difference in the percentage of years with good (lower) redd scour risk, and no (0%) differences in the percentage of years with good (lower) egg incubation conditions, under A1A_LLT relative to NAA. SacEFT predicts that there would be a 13% increase in the risk of redd dewatering attributable to the project.

Table 11-1A-52. Difference and Percent Difference in Percentage of Years with "Good" Conditions for Steelhead Habitat Metrics in the Upper Sacramento River (from SacEFT)

Metric	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Spawning WUA	0 (0%)	-3 (-6%)
Redd Scour Risk	-6 (-7%)	-3 (-4%)
Egg Incubation	0 (0%)	0 (0%)
Redd Dewatering Risk	4 (7%)	7 (13%)
Juvenile Rearing WUA	-4 (-10%)	-8 (-18%)
Juvenile Stranding Risk	-19 (-56%)	-5 (-25%)

WUA = Weighted Usable Area.

Clear Creek

Flows in Clear Creek were examined during the steelhead spawning and egg incubation period (January through April). Flows under A1A_LLT would generally be similar to flows under NAA throughout the period, (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Results of the flow analyses for the risk of redd dewatering for Clear Creek indicate that the greatest monthly flow reduction would be identical between NAA and A1A_LLT for all water year types (Table 11-1A-53).

Table 11-1A-53. Comparisons of Greatest Monthly Reduction (Percent Change) in Instream Flow under Model Scenarios in Clear Creek during the January–April Steelhead Spawning and Egg Incubation Period[a]

Water Year Type	A1A_LLT vs. EXISTING CONDITIONS	A1A_LLT vs. NAA
Wet	-25 (-38%)	0 (0%)
Above Normal	0 (NA)	0 (NA)
Below Normal	0 (NA)	0 (NA)
Dry	0 (NA)	0 (NA)
Critical	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.

[a] Redd dewatering risk not applicable for months when flows during the egg incubation period were at or greater than flows in the month when spawning is assumed to occur. A negative value indicates that the greatest monthly reduction would be of greater magnitude (worse) under the alternative than under the baseline.

No water temperature modeling was conducted in Clear Creek.

Feather River

Flows were examined in the Feather River low-flow channel (upstream of Thermalito Afterbay) and high-flow channel (at Thermalito Afterbay) during the steelhead spawning and egg incubation period (January through April) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in the low-flow channel under A1A_LLT would not differ from NAA because minimum Feather River flows are included in the FERC settlement agreement and would be met for all model scenarios (California Department of Water Resources 2006). Flows under A1A_LLT at Thermalito

Afterbay would generally be greater by up to 82% than flows under NAA, except in critical years during January (15% lower).

Oroville Reservoir storage volume at the end of September and end of May influences flows downstream of the dam during the steelhead spawning and egg incubation period. Storage volume at the end of September under A1A_LLT would be 18% to 31% greater than storage under NAA depending on water year type (Table 11-2A-27). May Oroville storage under A1A_LLT would be similar to storage under NAA in all water years except dry, in which flows would be 5% greater than storage under NAA (Table 11-2A-30).

Mean monthly water temperatures in the Feather River low-flow channel (upstream of Thermalito Afterbay) and high-flow channel (at Thermalito Afterbay) were examined during the January through April steelhead spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period at either location.

The percent of months exceeding the 56°F temperature threshold in the Feather River above Thermalito Afterbay (low-flow channel) was evaluated during January through April (Table 11-1A-54). The percent of months exceeding the threshold under Alternative 1A would generally be similar to or lower (up to 12% lower on an absolute scale) than the percent under NAA depending on month and degrees above the threshold.

Table 11-1A-54. Differences between Baseline and Alternative 1A Scenarios in Percent of Months during the 82-Year CALSIM Modeling Period during Which Water Temperatures in the Feather River above Thermalito Afterbay Exceed the 56°F Threshold, January through April

	Degrees Above Threshold				
Month	>1.0	>2.0	>3.0	>4.0	>5.0
EXISTING CONDITIONS vs. A1A_LLT					
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
March	5 (400%)	2 (NA)	1 (NA)	1 (NA)	0 (NA)
April	35 (400%)	15 (300%)	12 (NA)	4 (NA)	0 (NA)
NAA vs. A1A_LLT					
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
March	-4 (-38%)	0 (0%)	0 (0%)	0 (0%)	-1 (-100%)
April	-10 (-19%)	-12 (-38%)	-5 (-29%)	-2 (-40%)	-1 (-100%)

NA = could not be calculated because the denominator was 0.

Total degree-months exceeding 56°F were summed by month and water year type above Thermalito Afterbay (low-flow channel) during January through April (Table 11-1A-55). Total degree-months would be similar between NAA and Alternative 1A in all months.

Table 11-1A-55. Differences between Baseline and Alternative 1A Scenarios in Total Degree-Months (°F-Months) by Month and Water Year Type for Water Temperature Exceedances above 56°F in the Feather River above Thermalito Afterbay, January through April

Month	Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
January	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
February	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
March	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	2 (NA)	0 (0%)
	Dry	3 (NA)	1 (50%)
	Critical	9 (900%)	1 (11%)
	All	14 (1,400%)	2 (15%)
April	Wet	5 (NA)	2 (67%)
	Above Normal	12 (600%)	1 (8%)
	Below Normal	14 (350%)	-2 (-10%)
	Dry	22 (440%)	-4 (-13%)
	Critical	21 (NA)	-2 (-9%)
	All	74 (673%)	-5 (-6%)

NA = could not be calculated because the denominator was 0.

American River

Flows in the American River at the confluence with the Sacramento River were examined for the January through April steelhead spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Lower flows can reduce the instream area available for spawning and egg incubation, and rapid reductions in flow can expose redds leading to mortality. Flows under A1A_LLT would generally be similar to flows under NAA during the period except in dry and critical years during March (9% lower in both years) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*.

Mean monthly water temperatures in the American River at the Watt Avenue Bridge were evaluated during the January through April steelhead spawning and egg incubation period ((Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

The percent of months exceeding the 56°F temperature threshold in the American River at the Watt Avenue Bridge was evaluated during November through April (Table 11-1A-44). Steelhead spawn and eggs incubate in the American River between January and April. During this period, the percent of months exceeding the threshold under Alternative 1A would similar to or up to 12% lower (absolute scale) than the percent under NAA.

Total degree-months exceeding 56°F were summed by month and water year type at the Watt Avenue Bridge during November through April (Table 11-1A-45). During the January through April steelhead spawning and egg incubation period, total degree-months would be similar between NAA and Alternative 1A.

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the January through April steelhead spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT throughout this period would generally be identical to flows under NAA.

Water temperatures throughout the Stanislaus River would be similar under NAA and Alternative 1A throughout the January through April steelhead spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

San Joaquin River

The mainstem San Joaquin River does not provide habitat for steelhead spawning or egg incubation.

Mokelumne River

Flows in the Mokelumne River at the Delta were examined during the January through April steelhead spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT throughout this period would generally be identical to flows under NAA.

Water temperature modeling was not conducted in the Mokelumne River.

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because it would not substantially reduce suitable spawning habitat or substantially reduce the number of fish as a result of egg mortality. There would be very few reductions in flows under Alternative 1A during the period examined in each waterway. Flows would improve in the Feather River and the exceedance of NMFS temperature thresholds would be reduced under Alternative 1A.

CEQA Conclusion:

In general, Alternative 1A would not affect the quantity and quality of steelhead spawning habitat relative to the Existing Conditions due to substantial increased exposure to elevated water temperatures in the Feather and American Rivers and reductions in mean monthly flows in the Stanislaus River.

Sacramento River

Flows in the Sacramento River between Keswick and upstream of Red Bluff Diversion Dam, where the majority of steelhead spawning occurs, were examined during the primary steelhead spawning and egg incubation period of January through April (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Lower flows can reduce the instream area available for spawning and egg incubation, and rapid reductions in flow can expose redds, leading to mortality. At Keswick, flows under A1A_LLT would generally be similar to flows under Existing Conditions during January, March, and April, and up to 16% higher than flows under Existing Conditions during February with some exceptions. Upstream of Red Bluff Diversion Dam, flows under A1A_LLT would generally be similar to flows under Existing Conditions during February through April and higher by up to 13% than flows under Existing Conditions during January.

Mean monthly water temperatures in the Sacramento River at Keswick and Red Bluff were examined during the January through April primary steelhead spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 1A in any month or water year type throughout the period at either location.

SacEFT predicts no changes (0% difference) in spawning habitat and egg incubation conditions for Alternative 1A compared to Existing Conditions (Table 11-1A-16). SacEFT predicts that there would be a small (7%) reduction in the percent of years with good (lower) redd scour risk under A1A_LLT relative to Existing Conditions. SacEFT predicts that there would be a 7% increase in the risk of redd dewatering under A1A_LLT relative to Existing Conditions.

Clear Creek

Flows in Clear Creek were examined during the steelhead spawning and egg incubation period (January through April). Flows under A1A_LLT would be similar to or greater than flows under Existing Conditions throughout the period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Results of the flow analyses for the risk of redd dewatering for Clear Creek indicate that the greatest monthly flow reduction would be identical between Existing Conditions and A1A_LLT for all water year types except wet, in which the greatest reduction would be 38% lower (worse) under A1A_LLT than under Existing Conditions (Table 11-1A-53).

No water temperature modeling was conducted in Clear Creek.

Feather River

Flows were examined in the Feather River low-flow channel (upstream of Thermalito Afterbay) and high-flow channel (at Thermalito Afterbay) during the steelhead spawning and egg incubation period (January through April) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in the low-flow channel under A1A_LLT would not differ from Existing Conditions because minimum Feather River flows are included in the FERC settlement agreement and would be met for all model scenarios (California Department of Water Resources 2006). Flows under A1A_LLT at Thermalito Afterbay would generally be similar to or greater than flows under Existing Conditions, except in above and below normal water years during January (37 and 40% lower, respectively), below normal years during February (16% lower), and below normal water years during March (31% lower, respectively).

Oroville Reservoir storage volume at the end of September and end of May influences flows downstream of the dam during the steelhead spawning and egg incubation period. Oroville

Reservoir storage volume at the end of September would be up to 21% lower under A1A_LLT relative to Existing Conditions depending on water year type except in dry and critical years, in which storage would be similar to Existing Conditions (Table 11-1A-27). May Oroville storage volume under A1A_LLT would be lower than Existing Conditions by 7% to 15% depending on water year type, except in wet years, in which storage would be similar to Existing Conditions (Table 11-1A-30).

Mean monthly water temperatures in the Feather River low-flow channel (upstream of Thermalito Afterbay) and high-flow channel (at Thermalito Afterbay) were examined during the January through April steelhead spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). In the low-flow channel, mean monthly water temperatures under Alternative 1A would be 5% to 7% greater than those under Existing Conditions during January through March and similar to temperatures under Existing Conditions during April. In the high-flow channel, mean monthly water temperatures under Alternative 1A would be 6% greater than those under Existing Conditions during January and February and similar to temperatures under Existing Conditions during March and April.

The percent of months exceeding the 56°F temperature threshold in the Feather River above Thermalito Afterbay (low-flow channel) was evaluated during January through April (Table 11-1A-54). The percent of months exceeding the threshold under Alternative 1A would generally be similar to the percent under Existing Conditions during January and February and similar to or up to 35% greater (absolute scale) than the percent under NAA depending on month and degrees above the threshold.

Total degree-months exceeding 56°F were summed by month and water year type above Thermalito Afterbay (low-flow channel) during January through April (Table 11-1A-55). Total degree-months would be similar between Existing Conditions and Alternative 1A during January and February and 673% to 1400% higher under Alternative 1A compared to Existing Conditions during March and April.

American River

Flows in the American River at the confluence with the Sacramento River were examined for the January through April steelhead spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would generally be lower by up to 27% than flows under Existing Conditions during January, greater by up to 29% than flows under Existing Conditions during February and March, and similar to flows under Existing Conditions during April with few exceptions.

Mean monthly water temperatures in the American River at the Watt Avenue Bridge were evaluated during the January through April steelhead spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperature under Alternative 1A would be 5% to 7% higher than those under Existing Conditions during January through March, and temperatures would not differ between Alternative 1A and Existing Conditions during April.

The percent of months exceeding the 56°F temperature threshold in the American River at the Watt Avenue Bridge was evaluated during November through April (Table 11-1A-44). Steelhead spawn and eggs incubate in the American River between January and April. During January and February, the percent of month exceeding the threshold under Existing Conditions and Alternative 1A would be identical. During March and April, the percent of months exceeding the threshold under Alternative 1A would be up to 30% greater (absolute scale) than the percent under Existing Conditions.

Total degree-months exceeding 56°F were summed by month and water year type at the Watt Avenue Bridge during November through April (Table 11-1A-45). During the January and February, there would be no difference in total degree-months above the threshold between Existing Conditions and Alternative 1A. During March and April, total degree-months under Alternative 1A would be 384% and 92% greater than those under Existing Conditions, respectively.

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the January through April steelhead spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT throughout this period would be up to 36% lower flows under Existing Conditions in all months with few exceptions.

Water temperatures in the Stanislaus River at the confluence with the San Joaquin River was evaluated during the January through April steelhead spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under Alternative 1A would be 6% higher than those under Existing Conditions in all months.

San Joaquin River

The mainstem San Joaquin River does not provide habitat for steelhead spawning or egg incubation.

Mokelumne River

Flows in the Mokelumne River at the Delta were examined during the January through April steelhead spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would generally be similar to flows under Existing Conditions during January through March and up to 14% lower during April.

Water temperature modeling was not conducted in the Mokelumne River.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-94 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 1A could be significant because, under the CEQA baseline, the alternative could substantially reduce suitable spawning habitat or substantially reduce the number of fish as a result of egg mortality, contrary to the NEPA conclusion set forth above. Temperatures in the Feather and American Rivers would increase such that the extent of exceeding NMFS thresholds would increase substantially. In addition, flows in the Stanislaus River would be lower under Alternative 1A throughout the steelhead spawning and egg incubation period. There would generally be negligible effects of Alternative 1A on steelhead spawning and egg incubation in the Sacramento River.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 1A does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 1A indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 1A. This indicates that the differences between Existing Conditions and Alternative 1A found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 1A, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on spawning and egg incubation habitat for steelhead. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-95: Effects of Water Operations on Rearing Habitat for Steelhead

In general, Alternative 1A would not affect the quantity or quality of steelhead rearing habitat relative to NAA.

Sacramento River

Juvenile steelhead rear within the Sacramento River for 1 to 2 years before migrating downstream to the ocean. Lower flows can reduce the instream area available for rearing and rapid reductions in flow can strand fry or juveniles leading to mortality. Year-round Sacramento River flows within the reach where the majority of steelhead spawning and juvenile rearing occurs (Keswick Dam to upstream of RBDD) were evaluated (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows during October and between December and July under A1A_LLT would generally be similar to or greater than those under NAA. Flows during August, September, and November would generally be lower (by up to 45%) under A1A_LLT than under NAA.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the year-round steelhead juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period at either location.

SacEFT predicts that the percentage of years with good juvenile steelhead rearing WUA conditions under A1A_LLT would be 18% lower than that under NAA (Table 11-1A-52). Also, the percentage of years with good (lower) juvenile stranding risk conditions under A1A_LLT would be 25% lower than under NAA. These results indicate that Alternative 1A would cause a moderate decrease in rearing habitat conditions and increase in juvenile mortality risk resulting from stranding in the Sacramento River.

Clear Creek

Flows in Clear Creek below Whiskeytown during the year-round steelhead rearing period under A1A_LLT would generally be similar to or greater than flows under NAA, except in critical years during June and September, in which flows would be 8% and 13% lower, respectively (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Water temperatures were not modeled in Clear Creek.

It was assumed that habitat for juvenile steelhead rearing would be constrained by the month having the lowest instream flows. Juvenile rearing habitat is assumed to increase in Clear Creek as instream flows increase, and therefore the use of the lowest monthly instream flow as an index of habitat constraints for juvenile rearing was selected for use in this analysis. Results of the analysis of minimum monthly instream flows affecting juvenile rearing habitat are shown in Table 11-1A-56.

Results predict that Alternative 1A would generally have no effect on juvenile rearing habitat, based on minimum instream flows, compared to NAA with the exception of increases in below normal (86%) and dry (575%) water years, which would have beneficial effects.

Table 11-1A-56. Minimum Monthly Instream Flow (cfs) for Alternative 1A Model Scenarios in Clear Creek during the Year-Round Juvenile Steelhead Rearing Period

Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Wet	0 (0%)	0 (0%)
Above Normal	0 (0%)	0 (0%)
Below Normal	15 (21%)	39 (86%)
Dry	0 (0%)	43 (575%)
Critical	-50 (-100%)	0 (NA)

Note: Minimum flows occurred between October and March.
NA = could not be calculated because the denominator was 0.

Denton (1986) developed flow recommendations for steelhead in Clear Creek using IFIM (Figure 11-1A-4). The current Clear Creek management regime uses flows slightly lower than those recommended by Denton. Results from a new IFIM study on Clear Creek are currently being analyzed. Depending on results of this study the flow regime could be adjusted in the future. We expect that the modeled flows will be suitable for the existing steelhead populations in Clear Creek. No change in effect on steelhead in Clear Creek is anticipated.

Feather River

Year-round flows in the Feather River both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were reviewed to determine flow-related effects on steelhead juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). The low-flow channel is the primary reach of the Feather River utilized by steelhead spawning and rearing (Cavallo et al. 2003). Relatively constant flows in the low-flow channel throughout the year under A1A_LLT would not differ from those under NAA. In the high-flow channel, flows under A1A_LLT would be mostly greater by up to 110% than flows under NAA during November through June with few exceptions during which flows would be similar to, or up to 15% lower, than under NAA.

May Oroville storage under A1A_LLT would be similar to storage under NAA, except for dry years (5% higher) (Table 11-1A-30).

As reported for Alternative 1A (Impact AQUA-58 for spring-run Chinook salmon), September Oroville storage volume would be 18% to 31% greater than under NAA depending on water year type (Table 11-1A-27).

Mean monthly water temperatures in the Feather River in both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were examined during the year-round steelhead juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis).* There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period at either location.

An additional analysis evaluated the percent of months exceeding a 63°F temperature threshold in the Feather River above Thermalito Afterbay (low-flow channel) (May through August) and exceeding a 56°F threshold at Gridley (October through April) for each model scenario. In the low-flow channel, the percent of months exceeding the threshold under Alternative 1A would generally be similar to or lower (up to 19% lower on an absolute scale) than the percent under NAA (Table 11-1A-31). At Gridley, the percent of months exceeding the threshold under Alternative 1A would similar to or up to 20% lower (absolute scale) than the percent under NAA (Table 11-1A-41).

Total degree-months exceeding 56°F were summed by month and water year type in the Feather River above Thermalito Afterbay (low-flow channel) and at Gridley during November through April. In the low-flow channel, total degree-months under Alternative 1A would be similar to or lower than those under NAA depending on the month (Table 11-1A-32). At Gridley, total degree-months would be similar between NAA and Alternative 1A for all months except October, November, and March, in which degree-months would be 5% to 33% lower under Alternative 1A (Table 11-1A-42).

American River

Flows in the American River at the confluence with the Sacramento River were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would generally be similar to flows under NAA during January through April and November through December, greater than flows under NAA during May, June, and October, and lower than flows under NAA during July through September.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River and the Watt Avenue Bridge were examined during the year-round steelhead rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

The percent of months exceeding a 65°F temperature threshold in the American River at the Watt Avenue Bridge was evaluated during May through October (Table 11-1A-57). During May, June, and October, the percent of months exceeding the threshold under Alternative 1A would similar to or up to 23% lower (absolute scale) than the percent under NAA. During July through September, the percent of months exceeding the threshold would mostly be similar between NAA and Alternative 1A with one or two degree categories in which there would be increases of up to 10% on an absolute scale in percent of months exceeding the threshold under Alternative 1A.

Table 11-1A-57. Differences between Baseline and Alternative 1A Scenarios in Percent of Months during the 82-Year CALSIM Modeling Period during Which Water Temperatures in the American River at the Watt Avenue Bridge Exceed the 65°F Threshold, May through October

	Degrees Above Threshold				
Month	>1.0	>2.0	>3.0	>4.0	>5.0
EXISTING CONDITIONS vs. A1A_LLT					
May	33 (169%)	26 (175%)	15 (133%)	11 (180%)	4 (75%)
June	33 (52%)	31 (58%)	17 (42%)	14 (44%)	9 (41%)
July	0 (0%)	1 (1%)	31 (49%)	44 (124%)	41 (236%)
August	0 (0%)	2 (3%)	19 (23%)	52 (108%)	67 (216%)
September	15 (17%)	47 (88%)	63 (196%)	68 (423%)	57 (767%)
October	68 (1,375%)	48 (1,950%)	33 (NA)	16 (NA)	9 (NA)
NAA vs. A1A_LLT					
May	-11 (-17%)	-9 (-18%)	-14 (-34%)	-15 (-46%)	-9 (-50%)
June	-1 (-1%)	-7 (-8%)	-23 (-29%)	-21 (-32%)	-19 (-38%)
July	0 (0%)	0 (0%)	-4 (-4%)	9 (12%)	2 (4%)
August	0 (0%)	0 (0%)	0 (0%)	4 (4%)	7 (8%)
September	0 (0%)	2 (3%)	10 (12%)	10 (13%)	4 (6%)
October	-7 (-9%)	-15 (-23%)	-12 (-27%)	-14 (-46%)	-2 (-22%)

NA = could not be calculated because the denominator was 0.

Total degree-months exceeding 65°F were summed by month and water year type at the Watt Avenue Bridge during May through October (Table 11-1A-58). During May, June, and October, total degree-months would be similar between NAA and Alternative 1A or up to 16% lower under Alternative 1A. During July through September, there would be 5% to 13% increases in total degree-months exceeding the threshold.

Table 11-1A-58. Differences between Baseline and Alternative 1A Scenarios in Total Degree-Months (°F-Months) by Month and Water Year Type for Water Temperature Exceedances above 65°F in the American River at the Watt Avenue Bridge, May through October

Month	Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
May	Wet	19 (317%)	-2 (-7%)
	Above Normal	21 (NA)	-6 (-22%)
	Below Normal	16 (533%)	-7 (-27%)
	Dry	20 (91%)	-14 (-25%)
	Critical	33 (174%)	1 (2%)
	All	108 (216%)	-29 (-16%)
June	Wet	45 (265%)	-23 (-27%)
	Above Normal	18 (75%)	-14 (-25%)
	Below Normal	21 (72%)	-17 (-25%)
	Dry	41 (60%)	1 (1%)
	Critical	44 (88%)	-6 (-6%)
	All	168 (89%)	-60 (-14%)
July	Wet	57 (73%)	8 (6%)
	Above Normal	16 (59%)	10 (30%)
	Below Normal	35 (103%)	14 (25%)
	Dry	77 (124%)	26 (23%)
	Critical	50 (62%)	4 (3%)
	All	234 (83%)	61 (13%)
August	Wet	102 (129%)	-6 (-3%)
	Above Normal	37 (90%)	4 (5%)
	Below Normal	56 (100%)	19 (20%)
	Dry	93 (137%)	12 (8%)
	Critical	69 (87%)	5 (3%)
	All	356 (110%)	33 (5%)
September	Wet	108 (450%)	34 (35%)
	Above Normal	47 (294%)	11 (21%)
	Below Normal	50 (179%)	3 (4%)
	Dry	85 (202%)	-1 (-1%)
	Critical	54 (110%)	1 (1%)
	All	344 (216%)	48 (11%)
October	Wet	47 (4,700%)	-7 (-13%)
	Above Normal	29 (NA)	3 (12%)
	Below Normal	32 (NA)	-7 (-18%)
	Dry	35 (NA)	-2 (-5%)
	Critical	27 (540%)	-3 (-9%)
	All	169 (2,817%)	-17 (-9%)

NA = could not be calculated because the denominator was 0.

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be similar to flows under NAA throughout the period.

Mean monthly water temperatures throughout the Stanislaus River would be similar under NAA and Alternative 1A throughout the year-round period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

San Joaquin River

Flows in the San Joaquin River at Vernalis were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be similar to flows under NAA throughout the period.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Flows in the Mokelumne River at the Delta were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be similar to flows under NAA throughout the period.

Water temperature modeling was not conducted in the Mokelumne River.

NEPA Effects: Collectively, it is concluded that the effect of Alternative 1A is not adverse because it does not have the potential to substantially reduce rearing habitat or substantially reduce the number of fish. Flows reductions under Alternative 1A would cause a moderate reduction in rearing habitat availability and moderate increase in juvenile stranding risk in the Sacramento River. However, there would generally be beneficial temperature-related effects of Alternative 1A in the Feather and American Rivers. There would generally be no effects in the other rivers examined.

CEQA Conclusion: In general, Alternative 1A would not affect the quantity or quality of steelhead rearing habitat relative to the Existing Conditions.

Sacramento River

Year-round Sacramento River flows within the reach where the majority of steelhead spawning and juvenile rearing occurs (Keswick Dam to upstream of RBDD) were evaluated (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows during October and between December and July under A1A_LLT would generally be similar to or up to 40% greater than those under Existing Conditions. Flows under A1A_LLT during August, September and November would generally be lower by up to 33% than under Existing Conditions.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the year-round steelhead juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). At both locations, mean monthly water temperatures under Alternative 1A would generally be similar to those under Existing Conditions, except during August through December, in which there would be 5% to 7% higher temperatures under Alternative 1A.

SacEFT predicts that there would be a 10% decrease in the percentage of years with good rearing habitat availability, measured as weighted usable area, under A1A_LLT relative to Existing Conditions (Table 11-1A-52). SacEFT predicts that there would be a substantial reduction (-56%) in the number of years with good (lower) juvenile stranding risk under A1A_LLT relative Existing Conditions.

Clear Creek

Flows in Clear Creek during the year-round rearing period under A1A_LLT would generally be similar to or greater than flows under Existing Conditions, except for critical years in February and August and September, in which flows would be 17% to 37% lower, respectively (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

No water temperature modeling was conducted in Clear Creek.

Juvenile rearing habitat is assumed to increase in Clear Creek as instream flows increase, and therefore the use of the lowest monthly instream flow as an index of habitat constraints for juvenile rearing was selected for use in this analysis. Results of the analysis of minimum monthly instream flows affecting juvenile rearing habitat are shown in Table 11-1A-56. Results indicate that Alternative 1A would have no effect on juvenile rearing habitat, based on minimum instream flows, compared to Existing Conditions with the exception of a 21% increase in the minimum flow in below normal years, and a 100% decrease in the minimum flow during critical flow years.

Denton (1986) developed flow recommendations for steelhead in Clear Creek using IFIM (Figure 11-1A-4). The current Clear Creek management regime uses flows slightly lower than those recommended by Denton. Results from a new IFIM study on Clear Creek are currently being analyzed. Depending on results of this study the flow regime could be adjusted in the future. We expect that the modeled flows will be suitable for the existing steelhead populations in Clear Creek. No change in effect on steelhead in Clear Creek is anticipated.

Feather River

The low-flow channel is the primary reach of the Feather River utilized by steelhead spawning and rearing (Cavallo et al. 2003). There would be no change in flows for Alternative 1A relative to Existing Conditions in the low-flow channel during the year-round steelhead juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). In the high flow channel (at Thermalito Afterbay), flows under A1A_LLT would be mostly lower (up to 56%) during July through September and mostly similar to or greater than flows under Existing Conditions from October through June with few exceptions during which flows would be up to 48% lower under A1A_LLT.

May Oroville storage volume under A1A_LLT would be lower than Existing Conditions by 7% to 15% depending on water year type, except in wet years, in which storage would be similar to Existing Conditions (Table 11-1A-30).

Oroville Reservoir storage volume at the end of September would be similar under A1A_LLT relative to Existing Conditions during dry and critical water years, but moderately lower (up to 21% lower) for other water year types (Table 11-1A-27).

Mean monthly water temperatures in the Feather River in both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were examined during the year-round steelhead juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature*

Model Results utilized in the Fish Analysis). In the low-flow channel, mean monthly water temperatures under Alternative 1A would be similar to those under Existing Conditions between April and September, but would be 5% to 10% higher between October and March. In the high-flow channel, mean monthly water temperatures under Alternative 1A would be similar to those under Existing Conditions between March through July and in September, but would be 5% to 8% in the remaining six months.

An additional analysis evaluated the percent of months exceeding a 63°F temperature threshold in the Feather River above Thermalito Afterbay (low-flow channel) (May through August) and exceeding a 56°F threshold at Gridley (October through April) for each model scenario. In the low-flow channel, the percent of months exceeding the threshold under Alternative 1A would generally be similar to the percent under Existing Conditions during May, and similar or up to 49% (absolute scale) higher than the percent under Existing Conditions during June through August (Table 11-1A-31). At Gridley, the percent of months exceeding the threshold under Alternative 1A would similar to the percent under Existing Conditions during December through February, but similar to or up to 47% greater (absolute scale) than the percent under Existing Conditions in the remaining 4 months (Table 11-1A-41).

Total degree-months exceeding 56°F were summed by month and water year type in the Feather River above Thermalito Afterbay (low-flow channel) (May through August) at Gridley during October through April. In the low-flow channel, total degree-months under Alternative 1A would be similar to those under Existing Conditions during May and 51% to 159% higher during June through August (Table 11-1A-32). At Gridley, total degree-months under Alternative 1A would be similar to those under Existing Conditions during December through and February and 91% to 2075% greater than those under Existing Conditions in the remaining months of the period (Table 11-1A-42).

American River

Flows in the American River at the confluence with the Sacramento River were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be up to 45% greater than to flows under Existing Conditions during February, March, and October, similar to flows under Existing Conditions during April and June, and up to 58% lower than flows under Existing Conditions during the remaining seven months of the year.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River and the Watt Avenue Bridge were examined during the year-round steelhead rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 1A during April, June and July but higher mean monthly water temperatures in the other months and most water year types throughout the period.

The percent of months exceeding a 65°F temperature threshold in the American River at the Watt Avenue Bridge was evaluated during May through October (Table 11-1A-57). Under A1A_LLT compared to Existing Conditions virtually all months in all years exceed the threshold by 15% to 68% (absolute scale) except for July and August for the 1 degree and 2 degree categories.

Total degree-months exceeding 65°F were summed by month and water year type at the Watt Avenue Bridge during May through October (Table 11-1A-58). During all months and water year types the total degree-months would be higher between Existing Conditions and Alternative 1A by 59% to 4500%.

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be similar to flows under Existing Conditions during August, September, and November and up to 26% lower than flows under Existing Conditions during the remaining 9 months.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were evaluated during the year-round juvenile steelhead rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under Alternatives 1A would be 6% greater than those under Existing Conditions during January through May, August, September, November, and December and would be similar to those under Existing Conditions in the remaining 3 months.

San Joaquin River

Flows in the San Joaquin River at Vernalis were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be up to 6% higher than Existing Conditions during January, generally similar to Existing Conditions during February except for being lower in two water years, lower in most water years than Existing Conditions during March through October (up to 38% lower), and similar to Existing Conditions during November and December.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Flows in the Mokelumne River at the Delta were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be similar to flows under Existing Conditions during January through March, up to 15% greater than flows under Existing Conditions during December, and up to 52% lower than flows under Existing Conditions during the remaining 8 months.

Water temperature modeling was not conducted in the Mokelumne River.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-95 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 1A could be significant because, under the CEQA baseline, the alternative could substantially reduce suitable rearing habitat, contrary to the NEPA conclusion set forth above. SacEFT predicts that there would be a small reduction in the number of years with good rearing habitat availability, and a substantial reduction in the number of years with good juvenile stranding risk. Flows in the Feather River high-flow channel would be mostly lower during summer months (July through September) but there would be no difference in flows in the low-flow channel. Flows would be lower during the majority of months in the American, Stanislaus, and Mokelumne Rivers. NMFS temperature thresholds would be exceeded more often and at a higher magnitude under Alternative 1A in the Feather and American Rivers.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 1A does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 1A indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 1A. This indicates that the differences between Existing Conditions and Alternative 1A found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 1A, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on steelhead rearing habitat. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-96: Effects of Water Operations on Migration Conditions for Steelhead

Upstream of the Delta

In general, Alternative 1A would reduce migration conditions for steelhead relative to NAA.

Sacramento River

Juveniles

Flows in the Sacramento River upstream of Red Bluff were evaluated during the October through May juvenile steelhead migration period. Flows under A1A_LLT would be 9% to 30% lower than flows under NAA during November depending on water year type and would be up to 33% higher during October, April, and May (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT in the remaining four months of the migration period would be similar to flows under NAA.

Mean monthly water temperatures in the Sacramento River upstream of Red Bluff were evaluated during the October through May juvenile steelhead migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

Adults

Flows in the Sacramento River upstream of Red Bluff were evaluated during the September through March steelhead adult upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would up to 44% lower than flows under NAA during September and November depending on water year type and would be up to 33% higher during

October (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT in the remaining four months of the migration period would be similar to flows under NAA.

Mean monthly water temperatures in the Sacramento River upstream of Red Bluff were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

Kelts

Flows in the Sacramento River upstream of Red Bluff were evaluated during the March and April steelhead kelt (post-spawning adult fish) downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be similar to flows under NAA during March and up to 10% greater than flows under NAA during April.

Mean monthly water temperatures in the Sacramento River upstream of Red Bluff were evaluated during the March through April steelhead kelt downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

Clear Creek

Water temperatures were not modeled in Clear Creek.

Juveniles

Flows in Clear Creek during the October through May juvenile Chinook steelhead migration period under A1A_LLT would be similar to or greater than flows under NAA throughout the period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Adults

Flows in Clear Creek during the September through March adult steelhead migration period under A1A_LLT would generally be similar to flows under NAA except in critical years during June (8% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Kelt

Flows in Clear Creek, throughout the March through April steelhead kelt downstream migration period under A1A_LLT, would be similar to flows under NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Feather River

Juveniles

Flows in the Feather River at the confluence with the Sacramento River were examined during the October through May juvenile steelhead migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be up to 59% greater than flows under NAA with few exceptions.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were evaluated during the October through May juvenile steelhead migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

Adults

Flows in the Feather River at the confluence with the Sacramento River were examined during the September through March adult steelhead upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would generally be similar to or up to 59% greater than flows under NAA, except during September, in which flows would be up to 69% lower than flows under NAA.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

Kelt

Flows in the Feather River at the confluence with the Sacramento River were examined during the March and April steelhead kelt downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would generally be up to 29% greater than flows under NAA.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were evaluated during the March through April steelhead kelt downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

American River

Juveniles

Flows in the American River at the confluence with the Sacramento River were evaluated during the October through May juvenile steelhead migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would generally be similar to flows under NAA except during October and May, in which flows would be up to 42% greater than flows under NAA.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were evaluated during the October through May juvenile steelhead migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

Adults

Flows in the American River at the confluence with the Sacramento River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be up to 50% lower than flows under NAA during September, up to 42% greater than flows under NAA during October, and generally similar to flows under NAA in the remaining five months of the period.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

Kelt

Flows in the American River at the confluence with the Sacramento River were evaluated for the March and April kelt migration period. Flows under A1A_LLT would generally be similar to or greater than flows under NAA except in dry and critical years during March (9% lower in both water year types) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were evaluated during the March through April steelhead kelt downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River for Alternative 1A are not different from flows under NAA for any month. Therefore, there would be no effect of Alternative 1A on juvenile, adult, or kelt migration in the Stanislaus River.

Further, mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River for Alternative 1A are not different from flows under NAA for any month. Therefore, there would be no effect of Alternative 1A on juvenile, adult, or kelt migration in the Stanislaus River.

San Joaquin River

Flows in the San Joaquin River at Vernalis for Alternative 1A are not different from flows under NAA for any month. Therefore, there would be no effect of Alternative 1A on juvenile, adult, or kelt migration in the San Joaquin River.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Flows in the Mokelumne River at the Delta for Alternative 1A are not different from flows under NAA for any month. Therefore, there would be no effect of Alternative 1A on juvenile, adult, or kelt migration in the Mokelumne River.

Water temperature modeling was not conducted in the Mokelumne River.

Through-Delta

The approach for steelhead impact assessment is similar to that for Chinook salmon (see Impact AQUA-42 for Alternative 1A). Although steelhead have a similar life history to salmon, there are a few marked differences: juvenile steelhead spend from 1 to 3 years rearing in upstream habitats and migrate downstream as larger juveniles (usually >200 mm) compared to Chinook salmon, and adults do not necessarily die after spawning but can return to the ocean to grow and reproduce again. Adults can return one to three times before dying. The post-spawned adult life stage is termed a kelt and is unique to steelhead.

Overall, juvenile steelhead can be found in the Delta during most months of the year, but the outmigration spans from October through May with a peak outmigration period in February and March. Adult steelhead can also be found in the Delta almost year round with the adult upstream migration from September through March with a peak December through February. The kelt outmigration follows on the upstream migration and spawning and therefore is January through April. Olfactory cues for upstream migrating adults were assessed using fingerprinting analysis to estimate the percentage of source water from the Sacramento and San Joaquin Rivers.

Sacramento River

Juveniles

Flows in the Sacramento River below the north Delta intakes during the juvenile steelhead migration period (October through May) would increase in October (15% increase), decrease 10-20% December to May, and decrease up to 31% in November. Juvenile steelhead and juvenile winter-run Chinook salmon migrate downstream during the same months and would be exposed to similar conditions. As discussed above in Impact AQUA-42, the five north Delta intakes structures of Alternative 1A would increase potential predation loss of migrating juvenile salmonids and would displace 22 acres of aquatic habitat. Losses of juvenile winter-run Chinook salmon were estimated ranging from 2% up to 18.5% of annual production (Impact AQUA_42). However, juvenile steelhead would be less vulnerable than winter-run Chinook salmon to predation associated with the intake facilities because of their greater size and strong swimming ability.

Adults

For Sacramento River steelhead, straying rates of adult hatchery-origin Chinook salmon that were released upstream of the Delta are low (Marston et al. 2012). Although straying rates for hatchery-origin steelhead apparently have not been examined in detail, for this analysis of effects, it was assumed with high certainty (based on Chinook salmon rates), that Plan Area flows in relation to straying have low importance under Existing Conditions for adult Sacramento River region steelhead.

As assessed by DSM2 fingerprinting analysis, the average percentage of Sacramento River–origin water at Collinsville was always slightly lower under Alternative 1A than for NAA during the September-March steelhead upstream migration period. Based on the proportion of Sacramento River flows, olfactory cues would be similar (<10% difference) to NAA for nearly all months of the year. The proportion of flows would decrease 12% in September.

San Joaquin River

Adults

Little information apparently currently exists as to the importance of Plan Area flows on the straying of adult San Joaquin River region steelhead, in contrast to San Joaquin River fall-run Chinook salmon (Marston et al. 2012). Although information specific to steelhead is not available, for this analysis of effects, it was assumed with moderate certainty that the attribute of Plan Area flows (including olfactory cues associated with such flows) is of high importance to adult San Joaquin River region steelhead adults as well.

The percentage of water at Collinsville that originated from the San Joaquin River during the fall-run migration period (September to December) is small, typically 0.1% to less than 3% under NAA. Alternative 1A operations conditions would incrementally increase olfactory cues associated with the San Joaquin River, which would benefit adult steelhead migrating to the San Joaquin River.

NEPA Effects*:* Overall, the results indicate that the effect of Alternative 1A is adverse due to the cumulative effects associated with five north Delta intake facilities, including mortality related to near-field effects (e.g. impingement and predation) and far-field effects (reduced survival due to reduced flows downstream of the intakes) associated with the five NDD intakes.

Upstream of the Delta, flow and water temperature conditions under Alternative 1A would generally be similar to or better for steelhead than those under Existing Conditions in all rivers examined.

Adult attraction flows in the Delta under Alternative 1A would be lower than those under NAA, but adult attraction flows are expected to be adequate to provide olfactory cues for migrating adults.

Near-field effects of Alternative 1A NDD on steelhead from the Sacramento River and tributaries related to impingement and predation associated with five new intakes could result in substantial effects on juvenile migrating steelhead, although there is high uncertainty regarding the potential effects. Estimates within the effects analysis range from very low levels of effects (~2% mortality) to very significant effects (~ 19% mortality above current baseline levels). CM15 would be implemented with the intent of providing localized and temporary reductions in predation pressure at the NDD. Additionally, several pre-construction surveys to better understand how to minimize losses associated with the five new intake structures will be implemented as part of the final NDD screen design effort. Alternative 1A also includes an Adaptive Management Program and Real-Time Operational Decision-Making Process to evaluate and make limited adjustments intended to provide adequate migration conditions for steelhead. However, at this time, due to the absence of comparable facilities anywhere in the lower Sacramento River/Delta, the degree of mortality expected from near-field effects at the NDD remains highly uncertain.

Two recent studies (Newman 2003 and Perry 2010) indicate that far-field effects associated with the new intakes could cause a reduction in smolt survival in the Sacramento River downstream of the NDD intakes due to reduced flows in this area. The analyses of other elements of Alternative 1A predict improvements in smolt condition and survival associated with increased access to the Yolo

Bypass, reduced interior Delta entry, and reduced south Delta entrainment. The overall magnitude of each of these factors and how they might interact and/or offset each other in affecting salmonid survival through the plan area is uncertain, and remains an area of active investigation for the BDCP.

The DPM is a flow-based model being developed for BDCP which attempts to combine the effects of all of these elements of BDCP operations and conservation measures to predict smolt migration survival throughout the entire Plan Area. The current draft of this model predicts that smolt migration survival under Alternative 1A would be similar to survival rates estimated for NAA. Further refinement and testing of the DPM, along with several ongoing and planned studies related to salmonid survival at and downstream of the NDD are expected to be completed in the foreseeable future. These efforts are expected to improve our understanding of the relationships and interactions among the various factors affecting salmonid survival, and reduce the uncertainty around the potential effects of BDCP implementation on migration conditions for Chinook salmon. Until these efforts are completed and their results are fully analyzed, the overall effect of Alternative 1A on steelhead through-Delta survival remains uncertain.

Therefore, primarily as a result of unacceptable levels of uncertainty regarding the cumulative impacts of near-field and far-field effects associated with the presence and operation of the five intakes on steelhead, this effect is adverse.

While the implementation of the conservation and mitigation measures described below would address these impacts, these measures are not anticipated to reduce the impact to a level considered not adverse.

CEQA Conclusion: In general, Alternative 1A would reduce migration conditions for steelhead relative to the Existing Conditions.

Upstream of the Delta

Sacramento River

Juveniles

Flows in the Sacramento River upstream of Red Bluff were evaluated during the October through May juvenile steelhead migration period. Flows under A1A_LLT would be up to 13% lower than flows under Existing Conditions during November, but would generally be greater than or similar to flows under Existing Conditions in the remaining seven months of the juvenile migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River upstream of Red Bluff were evaluated during the October through May juvenile steelhead migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 1A in all months but October, in which temperatures under Alternative 1A would be 5% greater than those under Existing Conditions.

Adults

Flows in the Sacramento River upstream of Red Bluff were evaluated during the September through March steelhead adult upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be up to 24% lower than flows under Existing

Conditions during September and November but would be similar to or greater than flows under Existing Conditions during the remaining five months of the migration period.

Mean monthly water temperatures in the Sacramento River upstream of Red Bluff were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 1A in all months except September and October, in which temperatures under Alternative 1A would be 5% to 7% greater than those under Existing Conditions.

Kelts

Flows in the Sacramento River upstream of Red Bluff were evaluated during the March and April steelhead kelt downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be similar to or greater than those under Existing Conditions throughout the period.

Mean monthly water temperatures in the Sacramento River upstream of Red Bluff were evaluated during the March through April steelhead kelt downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 1A in any month or water year type throughout the period.

Clear Creek

Water temperatures were not modeled in Clear Creek.

Juveniles

Flows in Clear Creek during the October through May juvenile Chinook steelhead migration period under A1A_LLT would generally be similar to or greater than flows under Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Adults

Flows in Clear Creek during the September through March adult steelhead migration period under A1A_LLT would generally be similar to flows under Existing Conditions except in critical years during September (37% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Kelt

Flows in Clear Creek during the March through April steelhead kelt downstream migration period under A1A_LLT would be similar to or greater than flows under Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Feather River

Juveniles

Flows in the Feather River at the confluence with the Sacramento River were examined during the October through May juvenile steelhead migration period (Appendix 11C, *CALSIM II Model Results* *utilized in the Fish Analysis*). Flows under A1A_LLT would be similar to or up to 37% greater than flows under Existing Conditions throughout the period.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were evaluated during the October through May juvenile steelhead migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 1A in all months except November and December, in which temperatures under Alternative 1A would be 5% greater than temperatures under Existing Conditions.

Adults

Flows in the Feather River at the confluence with the Sacramento River were examined during the September through March adult steelhead upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be up to 27% lower than flows under Existing Conditions during September and similar to or up to 37% greater than flows under Existing Conditions in the remaining six months of the period.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 1A in all months except November and December, in which temperatures under Alternative 1A would be 5% greater than temperatures under Existing Conditions.

Kelt

Flows in the Feather River at the confluence with the Sacramento River were examined during the March and April steelhead kelt downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be up to 29% greater than flows under Existing Conditions.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were evaluated during the March through April steelhead kelt downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 1A in any month or water year type throughout the period.

American River

Juveniles

Flows in the American River at the confluence with the Sacramento River were evaluated during the October through May juvenile steelhead migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would generally be up to 45% greater than flows under Existing Conditions during October, February, and March. Flows under A1A_LLT would generally be up to 38% lower than flows under Existing Conditions during November through

January and May. Flows under A1A_LLT would be similar to those under Existing Conditions during April.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were evaluated during the October through May juvenile steelhead migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under Alternative 1A would be 5% to 11% higher than those under Existing Conditions in all months during the period except December and April, in which there would be no difference in water temperatures between Existing Conditions and Alternative 1A.

Adults

Flows in the American River at the confluence with the Sacramento River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would generally be up to 45% greater than flows under Existing Conditions during October, February, and March. Flows under A1A_LLT would generally be up to 58% lower than flows under Existing Conditions during September and November through January.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under Alternative 1A would be 5% to 11% higher than those under Existing Conditions in all months during the period except December, in which there would be no difference in water temperatures between Existing Conditions and Alternative 1A.

Kelt

Flows in the American River at the confluence with the Sacramento River were evaluated for the March and April kelt migration period. Flows under A1A_LLT would generally be up to 14% greater than flows under Existing Conditions during March and generally similar to flows under Existing Conditions during April (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under Alternative 1A would be 5% higher than those under Existing Conditions in March but temperatures would be similar between Existing Conditions and Alternative 1A during April.

Stanislaus River

Juveniles

Flows in the Stanislaus River at the confluence with the San Joaquin River were evaluated for the October through May steelhead juvenile downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under A1A_LLT would be 6% to 16% lower than flows under Existing Conditions depending on month.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were evaluated during the October through May steelhead juvenile downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under Alternative 1A would be 5% to 6% higher than those under existing in all months during the period except October, in which temperature would be similar between Existing Conditions and Alternative 1A.

Adults

Flows in the Stanislaus River at the confluence with the San Joaquin River were evaluated for the September through March steelhead adult upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under A1A_LLT would be 6% to 16% lower than flows under Existing Conditions depending on month.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under Alternative 1A would be 6% higher than those under Existing Conditions in all months during the period except October, in which temperature would be similar between Existing Conditions and Alternative 1A

Kelt

Flows in the Stanislaus River at the confluence with the San Joaquin River were evaluated for the March and April steelhead kelt downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under A1A_LLT would be 8% to 11% lower than flows under Existing Conditions during March and April, respectively.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were evaluated during the March and April steelhead kelt downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under Alternative 1A would be 6% higher than those under Existing Conditions during March and April.

San Joaquin River

Water temperature modeling was not conducted in the San Joaquin River.

Juveniles

Flows in the San Joaquin River at Vernalis were evaluated for the October through May steelhead juvenile downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under Alternative 1A would be up to 8% lower than Existing Conditions in most water years during October, similar to Existing Conditions in November and December (each month with one water year greater than 5% lower), up to 6% higher than Existing Conditions during January, generally similar to Existing Conditions during February except for being lower in two water years, and up to 16% lower in most water years than Existing Conditions during March through May under Alternative 1A.

Adults

Flows in the San Joaquin River at Vernalis were evaluated for the September through March steelhead adult upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under Alternative 1A would be up to 11% lower than Existing Conditions in most water years during September and October, similar to Existing Conditions in November and December (each month with one water year greater than 5% lower), up to 6% higher than Existing Conditions during January, generally similar to Existing Conditions during February except for being lower in two water years, and up to 16% lower in most water years than Existing Conditions during March.

Kelt

Flows in the San Joaquin River at Vernalis were evaluated for the March and April steelhead kelt downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under Alternative 1A would be lower than flows under Existing Conditions in most water years (up to 16% lower) during both months.

Mokelumne River

Water temperature modeling was not conducted in the Mokelumne River.

Juveniles

Flows in the Mokelumne River at Delta were evaluated for the October through May steelhead juvenile downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under Alternative 1A would be flows under Existing Conditions during October and March, 8% to 12% lower than flows under Existing Conditions during November, April, and May, and 12% to 14% higher than flows under Existing Conditions during December through February.

Adults

Flows in the Mokelumne River at Delta were evaluated for the September through March steelhead adult upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under Alternative 1A would be flows under Existing Conditions during October and March, 9% to 27% lower than flows under Existing Conditions during September and November, and 12% to 14% higher than flows under Existing Conditions during December through February.

Kelt

Flows in the Mokelumne River at Delta were evaluated for the March and April steelhead kelt downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under Alternative 1A would be similar to flows under Existing Conditions during March and 8% lower during April.

Through-Delta

Sacramento River

Juveniles

Flows in the Sacramento River below the north Delta intakes during the juvenile steelhead migration period (October through May) would increase in October (15% increase), decrease 10-20% December to May, and decrease up to 31% in November. Juvenile steelhead and juvenile winter-run Chinook salmon migrate downstream during the same months and are exposed to similar conditions. As discussed above in Impact AQUA-42, the five north Delta intakes structures of Alternative 1A would increase potential predation loss of migrating juvenile winter-run Chinook salmon and would displace 22 acres of aquatic habitat. However, because of their greater size and strong swimming ability, juvenile steelhead would be less vulnerable than winter-run Chinook salmon to predation associated with the intake facilities.

Adults

For Sacramento River steelhead, straying rates of adult hatchery-origin Chinook salmon that were released upstream of the Delta are low (Marston et al. 2012). Although straying rates for hatchery-origin steelhead apparently have not been examined in detail, for this analysis of effects, it was assumed with high certainty (based on Chinook salmon rates), that Plan Area flows in relation to straying have low importance under Existing Conditions for adult Sacramento River region steelhead.

As assessed by DSM2 fingerprinting analysis, the average percentage of Sacramento River–origin water at Collinsville was always slightly lower under Alternative 1A than for Existing Conditions during the September-March steelhead upstream migration period. Based on the proportion of Sacramento River flows, olfactory cues would be similar (<10% difference) to Existing Conditions for nearly all months of the year. The proportion of flows would decrease 11% in March.

San Joaquin River

Adults

Little information apparently currently exists as to the importance of Plan Area flows on the straying of adult San Joaquin River region steelhead, in contrast to San Joaquin River fall-run Chinook salmon (Marston et al. 2012). Although information specific to steelhead is not available, for this analysis of effects, it was assumed with moderate certainty that the attribute of Plan Area flows (including olfactory cues associated with such flows) is of high importance to adult San Joaquin River region steelhead adults as well.

The percentage of water at Collinsville that originated from the San Joaquin River is small (no more than 3% under Existing Conditions) during the steelhead migration period (September to March). Alternative 1A operations conditions would incrementally increase olfactory cues associated with the San Joaquin River, which would benefit adult steelhead migrating to the San Joaquin River.

Summary of CEQA Conclusion

Overall, the results indicate that the effect of Alternative 1A is adverse because it has the potential to substantially decrease steelhead migration habitat conditions upstream of the Delta. In addition, this alternative is adverse due to the cumulative effects associated with five north Delta intake facilities, including mortality related to near-field effects (e.g. impingement and predation) and far-field effects (reduced survival due to reduced flows downstream of the intakes) associated with the five NDD intakes.

Upstream of the Delta, flows would generally be lower and temperatures would generally be higher during substantial portions of the juvenile and adult migration periods in the American River, juvenile, adult, and kelt migration periods in the Stanislaus River, and the kelt period in the San Joaquin River.

In the Delta, the impact on emigrating juveniles would be significant due to the impacts associated with predation and habitat loss from the five intakes under this alternative (similar to the previous description under Impact AQUA-42). Implementation of CM6 and CM15 would address these impacts, but are not anticipated to reduce them to a level considered less than significant. Although implementation of *CM6 Channel Margin Enhancement* would provide habitat similar to that which would be lost, it would not necessarily be located near the intakes and therefore would not fully compensate for the lost habitat. Additionally, implementation of this measure would not fully address predation losses. *CM15 Localized Reduction of Predatory Fishes (Predator Control)* has substantial uncertainties associated with its effectiveness such that it is considered to have no demonstrable effect. Conservation measures that address habitat and predation losses, therefore, would potentially minimize impacts to some extent but not to a less than significant level. Consequently, as a result of these changes in migration conditions, this impact is significant and unavoidable.

Applicable conservation measures are briefly described below and full descriptions are found in Chapter 3, Section 3.6.2.5 Channel Margin Enhancement (CM6) and Section 3.6.3.4 Localized Reduction of Predatory Fishes (Predator Control) (CM15).

CM6 Channel Margin Enhancement. CM6 would entail restoration of 20 linear miles of channel margin by improving channel geometry and restoring riparian, marsh, and mudflat habitats on the waterside side of levees along channels that provide rearing and outmigration habitat for juvenile salmonids. Linear miles of enhancement would be measured along one side or the other of a given channel segment (e.g., if both sides of a channel are enhanced for a length of 1 mile, this would account for a total of 2 miles of channel margin enhancement). At least 10 linear miles would be enhanced by year 10 of Plan implementation; enhancement would then be phased in 5-mile increments at years 20 and 30, for a total of 20 miles at year 30. Channel margin enhancement would be performed only along channels that provide rearing and outmigration habitat for juvenile salmonids. These include channels that are protected by federal project levees—including the Sacramento River between Freeport and Walnut Grove among several others.

CM15 Localized Reduction of Predatory Fishes (Predator Control). CM15 would seek to reduce populations of predatory fishes at specific locations or modify holding habitat at selected locations of high predation risk (i.e., predation "hotspots"). This conservation measure seeks to benefit covered salmonids by reducing mortality rates of juvenile migratory life stages that are particularly vulnerable to predatory fishes. Predators are a natural part of the Delta ecosystem. Therefore, this conservation measure is not intended to entirely remove predators at any location, or substantially alter the abundance of predators at the scale of the Delta system. This conservation measure would also not remove piscivorous birds. Because of uncertainties regarding treatment methods and efficacy, implementation of CM15 would involve discrete pilot projects and research actions coupled with an adaptive management and monitoring program to evaluate effectiveness. Effects would be temporary, as new individuals would be expected to occupy vacated areas; therefore, removal activities would need to be continuous during periods of concern. CM15 also recognizes that the NDD intakes would create new predation hotspots.

This impact is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this impact to a less-than-significant level would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this impact is significant and unavoidable because there is no feasible mitigation available. Even so, proposed below is mitigation that has the potential to reduce the severity of impact though not necessarily to a less-than-significant level.

Mitigation Measure AQUA-96a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Steelhead to Determine Feasibility of Mitigation to Reduce Impacts to Migration Conditions

Although analysis conducted as part of the EIR/EIS determined that Alternative 1A would have significant and unavoidable adverse effects on migration habitat, this conclusion was based on the best available scientific information at the time and may prove to have been over- or understated. Upon the commencement of operations of CM1 and continuing through the life of the permit, the BDCP proponents will monitor effects on migration habitat in order to determine whether such effects would be as extensive as concluded at the time of preparation of this document and to determine any potentially feasible means of reducing the severity of such effects. This mitigation measure requires a series of actions to accomplish these purposes, consistent with the operational framework for Alternative 1A.

The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 1A operations only. Development of mitigation actions for the incremental impact on migration habitat attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 1A.

Mitigation Measure AQUA-96b: Conduct Additional Evaluation and Modeling of Impacts on Steelhead Migration Conditions Following Initial Operations of CM1

Following commencement of initial operations of CM1 and continuing through the life of the permit, the BDCP proponents will conduct additional evaluations to define the extent to which modified operations could reduce impacts to migration habitat under Alternative 1A. The analysis required under this measure may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6).

Mitigation Measure AQUA-96c: Consult with USFWS, and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Steelhead Migration Conditions Consistent with CM1

In order to determine the feasibility of reducing the effects of CM1 operations on steelhead habitat, the BDCP proponents will consult with FWS and the Department of Fish and Wildlife to identify and implement any feasible operational means to minimize effects on migration habitat. Any such action will be developed in conjunction with the ongoing monitoring and evaluation of habitat conditions required by Mitigation Measure AQUA-96a.

If feasible means are identified to reduce impacts on migration habitat consistent with the overall operational framework of Alternative 1A without causing new significant adverse impacts on other covered species, such means shall be implemented. If sufficient operational flexibility to reduce effects on steelhead habitat is not feasible under Alternative 1A operations, achieving further impact reduction pursuant to this mitigation measure would not be feasible under this Alternative, and the impact on steelhead would remain significant and unavoidable.

Restoration Measures (CM2, CM4–CM7, and CM10)

Impact AQUA-97: Effects of Construction of Restoration Measures on Steelhead

Restoration activities are described above under delta smelt (Impact AQUA-7). Potential effects on steelhead from restoration activities would be similar to those discussed above for winter-run Chinook salmon (see Impact AQUA-43). However, juvenile steelhead migrants are typically older and larger than Chinook salmon migrants, making them less susceptible to effects from restoration construction activities. As larger migrants, steelhead pass through the river more quickly, resulting in lower risks of exposure to increased turbidity, methylmercury, accidental spills, disturbed contaminated sediments or predation. Because these restoration activities also would be of relatively short duration, the effects would be temporary; in addition, the activities would occur in isolated areas. Implementation of environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* would also minimize or eliminate effects on steelhead. These environmental commitments include *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

NEPA Effects: With implementation of the environmental commitments, as well as *CM12 Methylmercury Management*, the overall effects of habitat restoration are expected to be beneficial to steelhead by providing additional or improved habitat.

CEQA Conclusion: Steelhead are expected to occur in the restoration construction areas for limited periods of time as they migrate to and from the ocean, minimizing the potential for effects from restoration construction. In addition to in-water work window restrictions, the limited frequency, duration, and spatial extent of restoration construction activities would also minimize potential effects on steelhead. For these reasons, and implementation of the commitments identified above and described in detail under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*), along with *CM12 Methylmercury Management* would reduce the frequency, duration and extent of any impacts. Therefore, this impact is considered less than significant for steelhead because it would not substantially reduce habitat, restrict its range or interfere with its movement. Consequently, no mitigation would be required.

Impact AQUA-98: Effects of Contaminants Associated with Restoration Measures on Steelhead

As described above for delta smelt and winter-run Chinook salmon, habitat restoration actions could result in the disturbance or mobilization of upland and aquatic contaminants which could affect steelhead. As previously mentioned, a complete analysis can be found in the *BDCP Effects Analysis – Appendix D*, *Contaminants (hereby incorporated by reference)*. Potential impacts on steelhead from effects of methylmercury, selenium, copper, ammonia, and pesticides associated with habitat restoration activities would be similar to those discussed for delta smelt (see Impact AQUA-8).

Steelhead migrate through the plan area relatively quickly, rather than rear or grow there, so the impacts from contaminants are likely to be lower than for delta smelt. The Yolo Bypass is an area expected to be among the highest for potential methylmercury production. Future methylmercury exposure levels in restored habitats that are similar to current levels may not affect the species' viability, though they may be of concern for passing mercury up the food web to birds and humans. As described in *BDCP Effects Analysis – Appendix D*, *Contaminants, Section 5D.4.1 Mercury (hereby incorporated by reference)*, the amounts of methylmercury mobilized and resultant effects on covered fish species are not currently quantifiable.

NEPA Effects: It is anticipated that any potential effects of methylmercury on steelhead will be addressed through implementation of CM12. CM12 is intended to minimize methylmercury exposure associated with restoration measures for steelhead. Additional analysis and tools may be developed to further reduce methylmercury exposure as the habitat restoration conservation measures are refined and analyzed in site-specific documents. The site-specific analysis is the appropriate place to assess the potential for risk of methylmercury exposure for steelhead once site specific sampling and other information can be developed. Overall, the effects of contaminants associated with restoration measures would not be adverse for steelhead with respect to selenium, copper, ammonia and pesticides. The effects of methylmercury on steelhead are uncertain.

CEQA Conclusion: Alternative 1A actions are likely to result in increased production, mobilization, and bioavailability of methylmercury, selenium, copper, and pesticides in the aquatic system. However, any such releases would be sporadic, short-term and localized, and would be unlikely to result in measurable increases in the bioaccumulation in steelhead. In addition, implementation of *CM12 Methylmercury Management* would help to minimize the increased mobilization of methylmercury at restoration areas. Therefore, the impact of contaminants is considered less than significant because it would not substantially effect steelhead either directly or through habitat modifications and, with restoration, would be beneficial in the long-term. Consequently no mitigation would be required.

Impact AQUA-99: Effects of Restored Habitat Conditions on Steelhead

The expected effects of restored habitat conditions on steelhead would be similar to those discussed for Chinook salmon under Impact AQUA-45.

CM2 Yolo Bypass Fisheries Enhancement

As discussed under Impact AQUA-9 for delta smelt, Yolo Bypass fisheries enhancement modifications are designed to increase the frequency, duration and magnitude of seasonal floodplain inundation in the Yolo Bypass. These actions may improve passage and habitat for steelhead. These modifications, which include fish passage improvements and flow management, would reduce migratory delays and loss of adult steelhead at Fremont Weir and other structures. They would also enhance rearing habitat for Sacramento River basin steelhead.

CM4 Tidal Natural Communities Restoration

The potential effects of *CM4 Tidal Natural Communities Restoration* activities on steelhead, would be similar to those discussed under Impact AQUA-45 for Chinook salmon, although juvenile steelhead spend less time in the Plan Area. This may explain why they are not as severely affected by the decline in existing habitat quality. However, Habitat Suitability Analysis indicates that tidal wetland restoration provides substantial increases in available habitat suitable for juvenile foraging steelhead as compared to Existing Conditions. Increases in HUs for juvenile salmon are approximately 5,000 HUs each in the Cache Slough and Suisun Marsh ROAs, 2,000 HUs in the West Delta ROA, and negligible in the South Delta and Cosumnes-Mokelumne ROAs.

CM5 Seasonally Inundated Floodplain Restoration

The potential effects of *CM5 Seasonally Inundated Floodplain Restoration* on steelhead, would be similar to those discussed for Chinook salmon under Impact AQUA-45.

CM6 Channel Margin Enhancement

The potential effects of *CM6 Channel Margin Enhancement* on steelhead, would be similar to those discussed for Chinook salmon under Impact AQUA-45.

CM7 Riparian Natural Community Restoration

The potential effects of *CM7Riparian Natural Community Restoration* on steelhead, would be similar to those discussed for Chinook salmon under Impact AQUA-45.

CM10 Nontidal Marsh Restoration

The potential effects of *CM10 Nontidal Marsh Restoration* on steelhead, would be similar to those discussed for Chinook salmon under Impact AQUA-45.

NEPA Effects: The effects of floodplain, tidal, channel margin and riparian habitat restoration activities on Central Valley steelhead are expected to be similar to those discussed for Chinook salmon (see Impact AQUA-45). In general, these effects are expected to be beneficial for steelhead, providing increased amounts and quality of available habitat, increasing habitat diversity, increasing overall productivity and reducing predation. However, steelhead are assumed and/or known to occur within the Plan Area for relatively short periods of time as both juveniles and adults. As noted for other salmonids, the benefits of the restoration in the Plan Area include a substantial increase in tidal, floodplain, channel margin, and riparian habitat, which is anticipated to provide improved habitat for occupancy and appreciably greater food production for juvenile steelhead; however, because most juvenile steelhead are typically migrants passing quite quickly through the Plan Area, the effect of food benefits and habitat change would be limited for rearing.

Despite the improvements in habitat and habitat functions in the Delta from floodplain, tidal, channel margin and riparian habitat restoration activities, habitat quality is expected to decline in the LLT primarily because of climate change. However, the overall effect of restoration activities is expected to remain beneficial for steelhead.

However, it is important to note that benefits would not be derived in all years, and that an adaptive management plan would be needed to determine an operational protocol that optimizes benefits both locally and in adjacent habitats.

CEQA Conclusion: As with Chinook salmon, the overall effects of floodplain, tidal, channel margin and riparian habitat restoration activities are expected to be beneficial for Central Valley steelhead, by providing increased amounts and quality of available habitat, increasing habitat diversity, increasing overall productivity and reducing predation (see Impact AQUA-45). However, steelhead are assumed and/or known to occur within the Plan Area for relatively short periods of time as both juveniles and adults. As noted for other salmonids, the benefits of the restoration in the Plan Area include a substantial increase in tidal, floodplain, channel margin, and riparian habitat, which is anticipated to provide improved habitat for occupancy and appreciably greater food production for juvenile steelhead; however, because most juvenile steelhead are typically migrants passing quite quickly through the Plan Area, the effect of food benefits and habitat change would be limited for rearing. Despite the improvements in habitat and habitat functions in the Delta from these restoration activities, habitat quality is expected to decline in the LLT, primarily because of climate change. However, the overall impact of restoration activities is expected to remain beneficial for steelhead because they increase habitat. Consequently, no mitigation would be required.

Other Conservation Measures (CM12–CM19 and CM21)

Impact AQUA-100: Effects of Methylmercury Management on Steelhead (CM12)

Refer to Impact AQUA-10 under delta smelt for a discussion of the potential effects of methylmercury management on steelhead.

Impact AQUA-101: Effects of Invasive Aquatic Vegetation Management on Steelhead (CM13)

A general analysis of the effects of aquatic vegetation management on covered fish species is described under the effects for delta smelt (see Impact AQUA-11). Potential impacts on steelhead from IAV control during operations also are similar to those described for Chinook salmon (Impact AQUA-47).

The control of SAV is expected to reduce predation mortality for steelhead, as predation on juvenile salmonids in the migration corridor can be significant; for example, it is well-documented that juvenile Chinook experience predation by largemouth bass lurking in SAV. Removing SAV is expected to reduce the population of nonnative predatory fish. IAV control is also expected to increase rearing habitat for steelhead and result in an increase in available food resources.

NEPA Effects: The overall effect of IAV removal and control is expected to be beneficial to steelhead.

CEQA Conclusion: The control of IAV should provide a modest net benefit to steelhead during operations through chemical and mechanical treatment and should reduce predation mortality, and increase food availability and increase the amount of suitable rearing habitat for juvenile steelhead. This impact is expected to be beneficial because it increases habitat. Consequently, no mitigation would be required.

Impact AQUA-102: Effects of Dissolved Oxygen Level Management on Steelhead (CM14)

NEPA Effects: As discussed in Chapter 8, *Water Quality*, dissolved oxygen levels would be very similar to Existing Conditions in the areas upstream of the Delta, in the Delta, and in the SWP/CVP export service areas (see discussion of Impacts WQ-10 and WQ-11). As noted there, however, *CM14 Stockton Deepwater Ship Channel Dissolved Oxygen Levels* management would increase the dissolved oxygen levels and increase the ability of steelhead to migrate through the area during both upstream migration and downstream outmigration. The effect would be beneficial.

CEQA Conclusion: *CM14 Stockton Deepwater Ship Channel Dissolved Oxygen Levels* would increase dissolved oxygen levels and increase the ability of steelhead to migrate through the area during both upstream migration and downstream outmigration. This impact would be beneficial because it would improve habitat conditions. Consequently, no mitigation would be required.

Impact AQUA-103: Effects of Localized Reduction of Predatory Fish on Steelhead (CM15)

NEPA Effects: To the extent that localized predator control efforts of *CM15 Localized Reduction of Predatory Fish* reduce the local abundance of fish predators in the Delta occupied by juvenile steelhead (predation on adult steelhead is minimal), it is possible, but not assured that there would be some reduction in losses to predation (see Impact AQUA-13). Due to the uncertainties noted above, there would be no demonstrable effect of this conservation measure on steelhead.

CEQA Conclusion: Due to the uncertainties associated with this CM, there would be no demonstrable effect on steelhead. Consequently, no mitigation would be required.

Impact AQUA-104: Effects of Nonphysical Fish Barriers on Steelhead (CM16)

NEPA Effects: A general analysis of effects of NPBs on covered fish species is described under the effects for delta smelt (Impact AQUA-14). Potential impacts on steelhead from implementation of NPBs are similar to those for Chinook salmon (Impact AQUA-50). NPBs, consistent with their intended purpose, would reduce entrainment for several types of covered fish species, including juvenile steelhead. Effects are considered not adverse and may be slightly beneficial.

CEQA Conclusion: NPBs are designed to guide juvenile salmonid fish away from migration routes with low survival and high predation risk, such as the head of Old River and Georgiana Slough. The Delta Passage Model incorporates studies of tagged juvenile salmonids to estimate mortality presumably by predation losses as described in *BDCP Effects Analysis – Appendix C, Flow, Passage, Salinity, and Turbidity, Section C.4.3.2.2 Juvenile Chinook Salmon through-Delta Survival (Delta Passage Model), hereby incorporated by reference*). Studies have shown higher survival rates in both the Sacramento River (Perry et al. 2010) and the San Joaquin River (Brandes and McLain 2001) indicating that effective NPBs may reduce predation losses of outmigrating smolts. On the other hand at the NPB at the head of Old River high predation rates were observed (Bowen et al. 2010). Overall, however, the effects of *CM16 Effects on Nonphysical Fish Barriers on Steelhead* are expected to be less than significant to slightly beneficial because they would reduce steelhead entrainment which would potentially increase their numbers. Consequently, no mitigation would be is required.

Impact AQUA-105: Effects of Illegal Harvest Reduction on Steelhead (CM17)

NEPA Effects: *CM17 Illegal Harvest Reduction* would be applied to Chinook salmon, Central Valley steelhead, green sturgeon and white sturgeon and are expected to have positive effects on these species. The effects on steelhead would be beneficial, by reducing the loss of potential spawners.

CEQA Conclusion: *CM17 Illegal Harvest Reduction* would be applied to Chinook salmon, Central Valley steelhead, green sturgeon and white sturgeon and are expected to have positive effects on these species. The effects on steelhead would be beneficial because it would reduce the number of illegally harvested fish, and potentially increasing the number of successful spawners. Consequently, no mitigation would be required.

Impact AQUA-106: Effects of Conservation Hatcheries on Steelhead (CM18)

NEPA Effects: *CM18 Conservation Hatcheries* would establish new and expand existing conservation propagation programs for delta and longfin smelt. This conservation measure would have no effect on steelhead.

CEQA Conclusion: *CM18 Conservation Hatcheries* would establish new and expand existing conservation propagation programs for delta and longfin smelt. This conservation measure would have no impact on steelhead. Consequently, no mitigation would be required

Impact AQUA-107: Effects of Urban Stormwater Treatment on Steelhead (CM19)

NEPA Effects: The effects of Urban stormwater treatment (CM19) would reduce contaminants associated with urban areas because it provides for the treatment of stormwater discharges. As discussed in Chapter 8, *Water Quality*, and previously under Impact AQUA-8 in the section titled *Pyrethroids, Organophosphate Pesticides, and Organochlorine Pesticides,* stormwater treatment would reduce urban loadings of pesticides (including pyrethroids), phosphorous, trace metals and other contaminants. These reductions would contribute to improved water quality in the Delta. Based on the improved overall water quality conditions and reduced pesticides the effect would be beneficial.

CEQA Conclusion: Urban stormwater treatment (CM19) would reduce contaminants associated with urban areas because it would provide for the treatment of stormwater discharges. As discussed in Chapter 8, *Water Quality*, and previously under Impact AQUA-8 in the section titled *Pyrethroids, Organophosphate Pesticides, and Organochlorine Pesticides,* stormwater treatment would reduce urban loadings of pesticides(including pyrethroids), phosphorous, trace metals and other water contaminants. These reductions would contribute to improved water quality in the Delta. Therefore, the impacts of urban stormwater treatment would be beneficial because it would have a beneficial effect both directly and through habitat modifications on steelhead. Consequently, no mitigation would be required.

Impact AQUA-108: Effects of Removal/Relocation of Nonproject Diversions on Steelhead (CM21)

NEPA Effects: There is no evidence of substantial entrainment of covered fish species at agricultural diversions in the Plan Area, but some entrainment likely is occurring. Whatever entrainment is occurring would be reduced by decommissioning agricultural diversions in the ROAs. PTM runs and extrapolations to a hypothetical number of diversions to be removed from the ROAs (i.e., approximately 4–12% of diversions) estimated slight reductions in entrainment for delta smelt and longfin smelt. While the amount of reduced entrainment for steelhead might be lower, the effects would be beneficial.

CEQA Conclusion: There is no evidence of substantial entrainment of covered fish species at agricultural diversions in the Plan Area, but some entrainment likely is occurring. Whatever entrainment is occurring would be reduced by decommissioning agricultural diversions in the ROAs. PTM runs and extrapolations to a hypothetical number of diversions to be removed from the ROAs (i.e., approximately 4–12% of diversions) estimated slight reductions in entrainment for delta smelt and longfin smelt. While the amount of reduced entrainment for steelhead might be lower the impacts would be beneficial because it would reduce entrainment which would have a positive impact on steelhead numbers. Consequently, no mitigation would be required.

Sacramento Splittail

Construction and Maintenance of CM1

Impact AQUA-109: Effects of Construction of Water Conveyance Facilities on Sacramento Splittail

Sacramento splittail eggs, larvae, juvenile young-of-the-year, and adult spawners could occur in the north Delta and east Delta in June and early July (see Table 11-4). Adult non-spawners could occur in the north Delta in October and November. In the south Delta, juveniles (yearlings), and adult non-spawners are present year round. Juvenile (young-of-the-year) fish are present in June to August, and adult spawners could be present in June and July (Wang 1986). Eggs and larvae could be present in June.

Temporary Increases in Turbidity

Sacramento splittail may be present in all of the Delta subregions during intake and barge landing construction. Because they typically inhabit turbid water, they are unlikely to be affected by temporary increases in turbidity. Potential increases in turbidity would also be minimized to the extent possible because of the limited duration of in-water construction activities, and implementing measures described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Spill Prevention, Containment, and Countermeasure Plan; and Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*). Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Accidental Spills

Potential impacts on Sacramento splittail from accidental spills during construction are similar to those discussed for delta smelt (see Impact AQUA-1). This impact would be minimized because of implementation of commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*), which would minimize the potential for introduction of contaminants to surface waters and provide for effective containment and cleanup should accidental spills occur. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Disturbance of Contaminated Sediments

Impact AQUA-1 describes the potential for effects from disturbing contaminated sediments during construction, although turbidity, and in turn suspension of sediments, would be minimized by implementation of environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and*

Dredged Material; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*). Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

As with delta smelt, it is concluded that BDCP restoration activities could generate potential unavoidable adverse effects on Sacramento splittail from selenium exposure relative to the NAA. While localized, short-term increases in copper concentrations are also possible, the removal of agricultural areas through restoration would eliminate some sources of copper, as well as for pesticides. Implementing *CM19 Urban Stormwater Treatment* would also reduce the discharge of pyrethroid pesticides to the Delta. Therefore, it is concluded that BDCP restoration activities will not generate adverse effects on Sacramento splittail from copper or pesticide exposure, relative to the NAA. Similarly, no appreciable addition or mobilization of ammonia to the aquatic system would result from restoration activities.

Underwater Noise

As described under Impact AQUA-1, underwater sound generated by impact pile driving in or near surface waters can potentially harm Sacramento splittail. Small numbers of Sacramento splittail may be present in the vicinity of the pile driving activities. Should impact pile driving be required, the $SEL_{cumulative}$ threshold for injury could be exceeded. It is important to note that the impact would be realized only where piles must be impact driven, and vibratory pile driving would be the primary method used.

Table 11-4 illustrates the life stages of Sacramento splittail expected to be present in the north, east, and south Delta during the in-water construction window (expected to be June 1–October 31). Larval Sacramento splittail could occur in the vicinity of the intakes in June or early July, and juvenile Sacramento splittail could be in the vicinity of these sites in June, July, and possibly August during the in-water construction. The numbers of larval and juvenile Sacramento splittail are not known, but abundance is expected to be very low during these months. Larval and juvenile Sacramento splittail near the construction areas would be expected to be less than 2 grams and would move with the currents. If an individual larval or juvenile Sacramento splittail were present in the area affected by underwater sound from impact pile driving above the 183-dB $SEL_{cumulative}$ level, and proximate to an impact-driven pile, it could experience an adverse effect, such as injury or mortality.

The potential for Sacramento splittail to be exposed to impact pile driving noise would be relatively small, given the location of the intakes in the Sacramento River, the relatively small areas affected by underwater noise in the eastern and southern Delta, and the expected limited use of impact pile driving. Therefore, while individual larval and juvenile Sacramento splittail could experience an adverse effect (e.g., injury or mortality) from impact pile driving, the effect would be low because of their very low temporal and spatial distribution during construction, and because potential exposure above the threshold criterion would be intermittent and limited. In addition, no adverse effects are expected to occur on a population level. Mitigation Measures AQUA-1a and AQUA-1b would serve to further minimize the potential for adverse effects from underwater noise.

Fish Stranding

In-water work activities have the potential to cause take of fish through the process of trapping and rescuing fish from construction areas. Sacramento splittail are found in the north Delta primarily during October through June. Spawning generally takes place upstream of the proposed intake facilities. Primarily larval and juvenile Sacramento splittail would be expected in the vicinity of the intake facilities and barge landings, and typically during only 1 month (June) of the expected in-water work window. Therefore, Sacramento splittail have a low potential to be subjected to stranding and requiring removal from work areas. Should stranding occur, the implementation of a *Fish Rescue and Salvage Plan* (described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*) would minimize effects.

In-Water Work Activities

Although fish would likely avoid the noise and activity of pile installation and placement of riprap protection, these activities have the potential to result in direct impact. Dredging activities outside of the cofferdams to recontour the riverbed adjacent to the intakes would also have the potential to cause take. Because splittail are benthic feeders, they may become entrained in the dredge. Although the number of Sacramento splittail that could be affected by dredging is unknown, dredging activities would take place during months when splittail are rare in the area. Primarily larval and juvenile Sacramento splittail would be expected in the vicinity of the intake facilities and barge landings, and typically during only 1 month (June) of the expected in-water work window. Therefore, Sacramento splittail have a low potential to be subject to take from in-water work activities during construction. Furthermore, potential effects would be minimized by implementation of environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*.

Loss of Spawning, Rearing, or Migration Habitat

There is no suitable spawning habitat for splittail in the vicinity of the proposed in-water work; therefore splittail spawning habitat would not be affected by construction activities. Intake construction and associated channel dredging would result in a permanent loss of up to approximately 8,300 lineal feet of channel margin in low-quality rearing and migration habitat. While this is a loss of rearing habitat, the overall effects would be limited due to the poor quality of the existing habitat. In addition, implementation of *CM6 Channel Margin Enhancement* would enhance channel margin habitat along 20 miles of the Sacramento River, including the vicinity of the intake structures, and would be designed to result in a net improvement in channel margin habitat function.

As described in Impact AQUA-1, at the six barge landings, there would be in-water and over-water structures for several year each while the tunnel is constructed. The barge landings would each occupy approximately 15,000 square feet of shoreline habitat within their respective delta channels. However, development and implementation of a barge operations plan (see Impact AQUA-1 and Appendix 3B, *Environmental Commitments: Barge Operations Plan*), would minimize potential effects of construction and operations of the barge landings on splittail habitat.

Predation

Construction of in-water and over-water structures and local temporary increases in turbidity associated with construction may affect predation on various fish species, including Sacramento splittail. Although there would be a very slight increase in predator refuge during construction, it would not notably increase predator refuge within the Delta. This impact would not be adverse because the areas constructed are relatively small and the level of predation would not have population level effects.

Summary

In-water construction activities would be scheduled to occur when the least numbers of Sacramento splittail would be present in or near the construction areas. Implementation of environmental commitments *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan;* and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material* (see Appendix 3B)—as well as the species' tolerance to turbidity—would minimize effects of construction activities on turbidity, accidental spills, onsite and offsite sediment transport to surface waters, and re-suspension and redistribution of potentially contaminated sediments. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt. As a result, these effects would not be adverse to Sacramento splittail.

The low numbers of splittail that would likely be present during the expected in-water work window would also minimize the potential effects of in-water construction activities (including impact pile driving). The relatively low incidence of impact pile driving expected, and implementation of the avoidance and minimization measures included in Mitigation Measures AQUA-1a and AQUA-1b, would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality). Implementation of environmental commitments, such as a *Fish Rescue and Salvage Plan* and *Barge Operations Plan* (as described under Impact AQUA-1 for delta smelt and in Appendix 3B), would also offset potential effects of construction activities on splittail. Construction of the approach canal and Byron Tract Forebay would not affect fish-accessible waterways and therefore would not affect splittail. As a result, these construction activities would not result in adverse effects on Sacramento splittail.

Locally increased predator habitat and predation from the temporary construction structures (cofferdams and barge landing docks) would not have population level effects, because splittail typically occur offshore and in open water habitat. Therefore, predation effects on splittail from construction activities would not be adverse.

NEPA Effects: The effects would not be adverse for Sacramento splittail.

CEQA Conclusion: Because they typically inhabit turbid water, Sacramento splittail are unlikely to be affected by temporary increases in turbidity. Potential impacts from turbidity, accidental spills, and resuspension of sediments that may contain toxic contaminants would be limited because exposure would minimized through the control of turbidity as described for delta smelt Impact AQUA-1 including implementation of the measures described under Impact AQUA-1 for delta smelt and in Appendix 3B*, Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*), and Sacramento splittail abundance would be low near active in-water construction sites. Consequently, these impacts would be less than significant.

Although only a limited occurrence of splittail is expected in the construction areas the direct effects of underwater construction noise on them would be a significant impact because of the high likelihood that it would cause injury or death to most impacted fish in the immediate vicinity of the activity. However, Mitigation Measures AQUA-1a and AQUA-1b would reduce the potential for effects from underwater noise and would reduce the severity of impacts to a less-than-significant level. Fish stranding is also expected to be limited because of the low potential for Sacramento splittail to be present. Other in-water construction activities also have a limited potential to affect splittail. While construction and channel dredging would temporarily disturb benthic habitat and would result in a permanent rearing habitat loss of up to approximately 8,300 lineal feet of channel margin within splittail rearing habitat, fish passage and migration would not be substantially affected by this temporary or permanent loss of habitat. There would be no impact on splittail spawning habitat.

CM6 Channel Margin Enhancement would enhance channel margin habitat along 20 miles of the Sacramento River, including the vicinity of the intake structures, and would be designed to result in a net improvement in channel margin habitat function. Because of the low quality of the existing habitat and proposed enhancement under *CM6 Channel Margin Enhancement*, and implementation of the commitments identified in Appendix 3B, *Environmental Commitments*, the overall impact of construction activities would be less than significant, and no additional mitigation would be required.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 from delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 for delta smelt.

Impact AQUA-110: Effects of Maintenance of Water Conveyance Facilities on Sacramento Splittail

Temporary Increases in Turbidity

As discussed above for construction effects (Impact AQUA-109), Sacramento splittail inhabit naturally turbid waters, and would not be affected by a short-term increase in turbidity. Turbidity effects would be minimized by implementation of environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*). Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Accidental Spills

Effects on Sacramento splittail from accidental spills during maintenance would be the same as those discussed for delta smelt (see Impact AQUA-2). Effects would be minimized by implementation of environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*). Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Underwater Noise

As discussed for delta smelt (see Impact AQUA-2), underwater noise levels produced by in-water maintenance activities are not expected to reach a level that would harm juvenile or adult fishes. The potential noise from in-water maintenance activities would not exceed the threshold sound pressure level and would be temporary. In addition, the in-water work would be conducted when the least number of Sacramento splittail are likely to be present.

In-Water Work Activities

The potential effects of in-water maintenance activities would be similar to those discussed for construction-related effects on Sacramento splittail (see Impact AQUA-109). Direct injury and mortality of Sacramento splittail are most likely to occur during dredging activities around the new intakes. Suction dredging and mechanical excavation can capture or crush fish, causing injury or mortality. Sacramento splittail may use both main channel areas and nearshore areas during rearing or migration. Because splittail are benthic feeders, they may become entrained in the dredge. Sacramento splittail may be migrating downstream in June in the Sacramento River. Maintenance dredging would occur infrequently and be of short duration. Although the number of Sacramento splittail that could be affected by dredging is unknown, maintenance dredging would take place during months when adult splittail are rare in the area. Potential effects would be minimized by implementation of environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*.

Loss of Spawning, Rearing, or Migration Habitat

Two maintenance activities, dredging and riprap placement, would reduce habitat values in the area around the intakes and levees. Removal of sediment would decrease the number of macroinvertebrates around the intakes. Splittail are benthic feeders, so removal of macroinvertebrates via dredging could affect prey abundance. However, only a small amount of sediment would be dredged compared to the entire area, and other foraging is readily accessible to splittail in the immediate area.

Sacramento splittail habitat near the intake structures is used for rearing and migration. A small area of rearing habitat could be affected due to the placement of riprap. Migration habitat would be available farther out in the channel and would be unaffected by dredging or riprap placement. Available rearing and migration habitat of similar quantity and quality would be readily accessible to Sacramento splittail in the immediate vicinity. Effects would be minimized by implementation of environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*, including *Erosion and Sediment Control Plan*; *Dispose of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*.

Predation

Maintenance activities would be unlikely to have any measurable effect on Sacramento splittail predation rates. These activities may include the use of barges and other watercraft that could theoretically provide cover, shelter, and perching areas for delta smelt predators. However, the limited duration of maintenance activities and the associated noise and disturbance would be expected to dissuade predators from concentrating at sufficient density to measurably affect predation rates on Sacramento splittail.

Summary

In-water maintenance activities would be scheduled to occur when the least numbers of Sacramento splittail would be present in or near the maintenance areas. In addition, Sacramento splittail are tolerant to increases in turbidity, which might occur during maintenance activities. Such activities would include maintenance dredging at the intake sites, and installation or repair of riprap bank armoring. These activities would remove or decrease the number of macroinvertebrates around the intakes, which would reduce prey abundance; however, other foraging habitat is available in the immediate area. Implementation of the environmental commitments described in Appendix 3B, *Environmental Commitments*, would further minimize or eliminate effects on Sacramento splittail by limiting turbidity increases, and by guiding the rapid and effective response in the case of inadvertent spills of hazardous materials. These environmental commitments include *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Implementation of these environmental commitments, along with the low numbers of Sacramento splittail expected to occur in the maintenance areas during the expected in-water work windows, and the limited frequency and duration of in-water maintenance activities would result in a very low potential for adverse effects on Sacramento splittail. In addition, little or no spawning habitat occurs in the areas potentially affected by maintenance activities, and ample rearing, and migration habitat of the same quality is readily accessible in the area, and this habitat would not be affected by maintenance activities.

NEPA Effects: As a result, the short-term maintenance activities would not adversely affect Sacramento splittail.

CEQA Conclusion: As described above, Sacramento splittail inhabit naturally turbid water and are not expected to be affected by temporary increases in turbidity during maintenance activities. In addition to the limited frequency and duration of in-water maintenance activities and implementation of commitments identified above and described in detail under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*, would minimize the potential for maintenance activities to affect Sacramento splittail by limiting turbidity increases, and by guiding the rapid and effective response in the case of inadvertent spills of hazardous materials. These environmental commitments are *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*. Potential changes to habitat would also be limited and temporary. Therefore, the potential impact of maintenance activities is considered less than significant because it would not substantially reduce Sacramento splittail habitat, restrict its range, or interfere with its movement. Consequently, no mitigation would be required.

Water Operations of CM1

Impact AQUA-111: Effects of Water Operations on Entrainment of Sacramento Splittail

Water Exports from SWP/CVP South Delta Facilities

Juvenile splittail are vulnerable to entrainment at the south Delta export facilities primarily from May through July, during their downstream emigration from floodplain rearing and spawning habitats. Salvage of adult splittail often increases abruptly following the first flush during December through March. The level of entrainment is strongly influenced by abundance, which varies greatly from year to year (Sommer et al. 1997). Adult salvage numbers are relatively high during years of high outflow, when exports are high, and likely to be high 1–3 years after years that produced strong year classes of splittail.

Two methods were used to estimate juvenile splittail entrainment, both of which were designed to account for the very large effect of abundance on entrainment (detailed in *BDCP Effects Analysis – Appendix 5B Entrainment, Section B.5.4.5, hereby incorporated by reference*). One method uses February-June Delta inflow as a proxy for splittail abundance, based on the observed correlation between historical inflow and salvage density, while the other uses days of Yolo Bypass inundation as a proxy for abundance, based on the observed correlation between days of inundation and salvage density. The inflow method more closely estimates entrainment rate (i.e., per capita entrainment), while the inundation method more closely estimates total entrainment. Consequently, estimates based on the inflow method are more directly related to the level of exports at the south Delta facilities during May-July. Alternative 1A is expected to have a much greater effect on days of Yolo Bypass inundations, which would be increased due to implementation of *CM2* (see Impact AQUA-112), than on Delta inflow.

Juvenile Sacramento Splittail—Delta Inflow -Estimated Salvage Density

Salvage generally was estimated to decrease under Alternative 1A scenarios relative to NAA, reflecting the general decrease in SWP/CVP south Delta pumping. Across all water years, reductions in estimated salvage under Alternative 1A scenarios compared to NAA at both facilities ranged from just over 40% to approximately 85%. Given that the bulk of salvage occurs in wet years, the results for wet years were very similar to those for all years. In contrast, reductions under Alternative 1A in above-normal years were low at approximately 3–15%, and in one instance, salvage under Alternative 1A increased relative to NAA by 11%. In the remaining water-year types (below-normal, dry, and critical), reductions in salvage under Alternative 1A relative to NAA generally were in the range of 25–60%.

Juvenile Sacramento Splittail—Yolo Bypass Inundation-Estimated Salvage Density

Across all water years, May–July salvage of juvenile Sacramento splittail under Alternative 1A (A1A_LLT) was generally several times higher at the CVP facilities than the SWP facilities, with the differences in salvage estimates between the facilities diminishing with lower Delta inflow. Salvage estimates ranged from averages of hundreds of thousands or millions in wet water years, through tens or hundreds of thousands in above-normal years, thousands to tens of thousands in below normal water years, and thousands in dry water years, to hundreds in critical water years.

In contrast to estimates of salvage from Delta inflow (see above), salvage from days of Yolo Bypass inundation generally was estimated to increase considerably under Alternative 1A scenarios relative to NAA, reflecting the increased inundation of the Yolo Bypass under Alternative 1A scenarios. Across all water years, increases in estimated salvage under Alternative 1A scenarios compared to NAA at both facilities ranged from approximately 150 to 400%. Given that the bulk of salvage occurs in wet years, the results for wet years were very similar to those for all years. Increases in estimated salvage under Alternative 1A were greatest in above-normal years, at approximately 900–1,300% more than NAA. There were generally reductions in salvage under Alternative 1A scenarios compared to NAA in critical water years, ranging from averages of 1 to 60%. In the remaining water-year types (below-normal and dry), average increases in salvage under Alternative 1A relative to NAA ranged from 20 to 630%.

Sacramento Splittail Adults— Salvage Density Method

The main entrainment period for adult Sacramento splittail occurs December to March. General trends in estimated salvage for adult Sacramento splittail include higher salvage at the SWP than the CVP and decreasing salvage as water years become drier. Salvage under the Alternative 1A scenarios was 62-66 % lower than baseline scenarios, but the differences decreased as water years become drier.

Average salvage across all water years found consistent decreases under Alternative 1A (A1A_LLT) of 65% (2,200 fewer adult Sacramento splittail compared to NAA. Adult salvage would decrease under Alternative 1A scenarios compared to NAA for wet years (3,700 fish; 91% less), above-normal years (3,900 fish; 81% less), below-normal years (1,500 fish; 49% less), and dry years (250 fish; 11% less). In critical years, salvage was low. SWP salvage would peak in November and February and be lower in April and May, while CVP salvage would peak in October and November under all model scenarios.

Water Exports from SWP/CVP North Delta Intake Facilities

Potential entrainment at the north Delta intakes occurs only under the action alternatives, including Alternative 1A, because there are no north Delta intakes operational under NAA. The north Delta intakes would be screened, and analysis indicates that splittail larvae less than 10 mm long would be vulnerable to entrainment (*BDCP Effects Analysis – Appendix 5B Entrainment, Section B.6.2.4, hereby incorporated by reference)*. Very little is known of splittail densities in this area, so monitoring will determine their extent. The project's adaptive management plan includes monitoring of the new screens to determine their effectiveness. If the screens are not meeting expectations, additional measures may be implemented to improve screen performance, such as modifications to the screens or other structural components at the intakes, or changes in water diversion operations to reduce entrainment or impingement.

Water Exports with a Dual Conveyance for the SWP North Bay Aqueduct

Entrainment of Sacramento splittail at the North Bay Aqueduct has not been explicitly analyzed. However, the Barker Slough Pumping Plant is screened for fish greater than 25mm long and the alternative intake would presumably have screens of 1.75-m mesh and therefore it would exclude splittail greater than 10mm, based on north Delta intake analysis. Entrainment to the NBA would be similar or reduced compared to NAA once the alternative intake on the Sacramento River is established. Shifting NBA exports away from Barker Slough, which is near important splittail spawning habitat in the Yolo Bypass region, to the lower Sacramento River may reduce entrainment risk of larval splittail.

Predation Associated with Entrainment

Predation can occur in association with the various types of structures such as intakes that may provide cover for predators or affect prey behavior in a way that enhances predation success. For example, the risk of predation mortality within CCF is assumed to be approximately 75% based on mark-recapture studies on other fish species (Gingras 1997; Clark et al. 2009; Castillo et al. 2012), and the risk of predation associated with the CVP trash racks is assumed to be 15% (National Marine Fisheries Service 2009). The reduced per capita entrainment of juvenile Sacramento splittail to the south Delta under Alternative 1A is expected to concomitantly reduce these predation losses, compared to Existing Conditions.

Juvenile Sacramento splittail would be vulnerable to increased predation mortality in the vicinity of the proposed north Delta intake locations during their emigration from upstream spawning habitats on the Sacramento River such as the Sutter Bypass. However, juvenile splittail are strong swimmers and move rapidly through the lower river on their way to the delta. Splittail do not appear to be a substantial part of the diet of striped bass around the Sacramento River reach where the proposed north Delta intakes would be sited. Results of striped bass diet studies conducted by Thomas (1967) showed that no Sacramento splittail were observed in the striped bass sampled. Stevens (1963) also conducted diet studies on striped bass in the reach of the Sacramento River upstream of Rio Vista and found splittail in the diet of striped bass. However, he reported only 1.4% of the striped bass stomachs that contained food had splittail, representing 1% of the diet of striped bass in July. Sacramento splittail were not observed by Stevens in the diet of striped bass in other months of the year. For purposes of this assessment, it is assumed that juvenile splittail would be vulnerable over a 4-month period in the late spring and summer (April–July) when, on average, nearly all juvenile splittail emigrate.

These observations support the conclusion reported in the *BDCP Effects Analysis – Appendix B, Entrainment (hereby incorporated by reference)*. Based on analyses in the BDCP and consultation with the fishery managers it was concluded that the overall effect was a low overall reduction in predation effects on splittail primarily due to the reduction in predation at the South Delta pumps and a possible but negligible increase in predation at the North Delta facility. Further the conclusion of the agencies was that the predation was not a factor currently limiting splittail abundance. Hence the overall conclusion is that Alternative 1A would have no predation effect on splittail.

NEPA Effects: The two different modeling techniques for estimating entrainment (represented by salvage) of Sacramento splittail at the south Delta facilities gave opposite results. The Delta inflow method estimated substantially less salvage under Alternative 1A compared to NAA because of reduced pumping in the south Delta under Alternative 1A. In contrast, the Yolo Bypass days of inundation method estimated substantial increases (several-fold to an order of magnitude or more) in the number of Sacramento splittail entrained in most water-year types. This would occur because of increased accessibility to floodplain habitat for spawning and early rearing, leading to more juvenile splittail occupying the Plan Area. However, the general decrease in export pumping from the south Delta during the main May–July entrainment period for juvenile splittail would result in a lower overall proportion of the splittail population being entrained. Splittail would be exposed to entrainment and predation risk at the north Delta intakes, but this would be offset by the reduction in per capita entrainment and associated predation at the south Delta facilities as well as increased production of juveniles. Consequently, the overall effect of Alternative 1A would not be adverse.

CEQA Conclusion: As described above, operational activities associated with water exports from SWP/CVP south Delta facilities would not result in an overall increase in per capita entrainment for Sacramento splittail, although water exports from SWP/CVP north Delta intake facilities would result in an increase in larval entrainment or a loss of individuals from predation at that location. The overall reductions in entrainment at the south Delta, and the additional production of juvenile splittail from increased inundation of the Yolo Bypass under CM2, would offset the potential losses at the north Delta facilities. Therefore, impacts of Alternative 1A on entrainment are considered less than significant because there would be no substantial reduction in numbers. Consequently, no mitigation would be required.

Impact AQUA-112: Effects of Water Operations on Spawning and Egg Incubation Habitat for Sacramento Splittail

In general, Alternative 1A would have beneficial effects on splittail spawning habitat relative to NAA by increasing the quantity and quality of spawning habitat in the Yolo Bypass. There would be negligible effects on channel margin and side-channel habitats in the Sacramento River at Wilkins Slough and the Feather River, and negligible effects on water temperatures in the Feather River, relative to NAA. There would be beneficial effects on spawning conditions in channel margin and side-channel habitats from increases in mean monthly flow during the spawning period in both the Sacramento River and the Feather River.

Floodplain Habitat

Sacramento splittail spawn in floodplains and channel margins and in side-channel habitat upstream of the Delta, primarily in the Sacramento River and Feather River. Floodplain spawning overwhelmingly dominates production in wet years. During low-flow years when floodplains are not inundated, spawning in side channels and channel margins would be much more critical. Effects of Alternative 1A on floodplain spawning habitat were evaluated for Yolo Bypass. Increased flows into Yolo Bypass may reduce flooding and flooded spawning habitat to some extent in the Sutter Bypass (the upstream counterpart to Yolo Bypass) but this effect was not quantified. Effects in Yolo Bypass were evaluated using a habitat suitability approach based on water depth (2 m threshold) and inundation duration (minimum of 30 days). Effects of flow velocity were ignored because flow velocity was generally very low throughout the modeled area for most conditions, with generally 80 to 90% of the total available area having flow velocities of 0.5 foot per second or less (a reasonable critical velocity for early life stages of splittail; Young and Cech 1996).

The proposed changes to the Fremont weir would increase the frequency and duration of Yolo Bypass inundation events compared to NAA. Only the inundation events lasting more than 30 days are considered biologically beneficial to splittail, so are the focus of the analyses provided here. A1A_LLT compared to NAA for the drier type years (below normal, dry, and critical), results in an increase in the frequency of events greater than 30 days compared to NAA over the 82-year simulation period (Figure 11-1A-5, Table 11-1A-59). These results indicate that overall project-related effects on occurrence of various duration inundation events would be beneficial for splittail spawning by creating better spawning habitat conditions.

Table 11-1A-59. Differences in Frequencies of Inundation Events (for 82-Year Simulations) of Different Durations on the Yolo Bypass under Different Scenarios and Water Year Types, February through June, from 15 2-D and Daily CALSIM II Modeling Runs

Number of Days of Continuous Inundation	Change in Number of Inundation Events for Each Scenario	
	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
30–49 Days		
Wet	-4	-2
Above Normal	0	0
Below Normal	5	5
Dry	2	2
Critical	1	1
50–69 Days		
Wet	-5	-5
Above Normal	-1	-1
Below Normal	2	2
Dry	0	0
Critical	0	0
≥70 Days		
Wet	8	7
Above Normal	3	3
Below Normal	1	1
Dry	0	0
Critical	0	0

In terms of acreage of suitable splittail habitat in Yolo Bypass, there would be increases ranging from 5 to 983 acres. For wet, above normal, and below normal water years there would be project-related increases (A1A_LLT compared to NAA) of 59%, 68%, and 296% for wet, above normal, and below normal water years, respectively (Table 11-1A-60). The project-related increases for dry and critical years (15 and 5 acres, respectively) would establish small areas of suitable spawning habitat during these water year types compared to no suitable habitat under baseline conditions. These results indicate that increases in inundated acreage in each water year type would result in increased habitat and have a beneficial effect on splittail spawning. The largest increases on a percentage basis would be particularly large in drier year types, when, historically, availability of this habitat has been especially low.

Table 11-1A-60. Increase in Splittail Weighted Habitat Area (acres and percent) in Yolo Bypass from Existing Biological Conditions to Alternative 1A by Water Year Type from 15 2-D and Daily CALSIM II Modeling Runs

Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Wet	1,100 (71%)	983 (59%)
Above Normal	766 (67%)	772 (68%)
Below Normal	359 (274%)	366 (296%)
Dry	15 (NA)	15 (NA)
Critical	5 (NA)	5 (NA)

NA = percent differences could not be computed because no splittail weighted habitat occurred in the bypass for NAA and EXISTING CONDITIONS in those years (dividing by 0).

A potential adverse effect of Alternative 1A that is not included in the modeling is reduced inundation of the Sutter Bypass as a result of increased flow diversion at the Fremont Weir. The Fremont Weir notch with gates opened would increase the amount Sacramento River flow diverted from the river into the bypass when the river's flow is greater than about 14,600 cfs (Munévar pers. comm.). As much as about 6,000 cfs more flow would be diverted from the river with the opened notch than without the notch, resulting in a 6,000 cfs decrease in Sacramento River flow at the weir. A decrease of 6,000 cfs in the river, according to rating curves developed for the river at the Fremont Weir, could result in as much as 3 feet of reduction in river stage (Munévar pers. comm.), although understanding of how notch flows would affect river stage is incomplete (Kirkland pers. comm.). In any case, a lower river stage at the Fremont Weir would be expected to result in a lower level of inundation in the lower Sutter Bypass. Because of the uncertainties regarding how drawdown of the river will propagate, the relationship between notch flow and the magnitude of lower Sutter Bypass inundation is poorly known. Despite this uncertainty, it is evident that *CM2 Yolo Bypass Fisheries Enhancement* has the potential to reduce some of the habitat benefits of Yolo Bypass inundation on splittail production due to effects on Sutter Bypass inundation. Splittail use the Sutter Bypass for spawning and rearing as they do the Yolo Bypass.

Channel Margin and Side-Channel Habitat

Splittail spawning and larval and juvenile rearing also occur in channel margin and side-channel habitat upstream of the Delta. These habitats are likely to be especially important during dry years, when flows are too low to inundate the floodplains (Sommer et al. 2007). Side-channel habitats are affected by changes in flow because greater flows cause more flooding, thereby increasing availability of such habitat, and because rapid reductions in flow dewater the habitats, potentially stranding splittail eggs and rearing larvae. Effects of the BDCP on flows in years with low-flows are expected to be most important to the splittail population because in years of high-flows, when most production comes from floodplain habitats, the upstream side-channel habitats contribute relatively little production.

Effects on channel margin and side-channel habitat were evaluated by comparing flow conditions for the Sacramento River at Wilkins Slough and the Feather River at the confluence with the Sacramento River for the time-frame February through June. These are the most important months for splittail spawning and larval rearing (Sommer pers. comm.), and juveniles likely emigrate from the side-channel habitats during May and June if conditions become unfavorable.

Differences between model scenarios for monthly average flows during February through June by water-year type were determined for the Sacramento River at Wilkins Slough and for the Feather River at the confluence (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

For the Sacramento River at Wilkins Slough, flows during February through April under A1A_LLT would be similar to flows under NAA. During May and June, flows under A1A_LLT would be up to 25% greater than flows under NAA, resulting in a beneficial effect on rearing conditions.

For the Feather River at the confluence, flows during February and June under A1A_LLT would be up to 44% greater than flows under NAA, resulting in a beneficial effect on spawning conditions.

Simulated daily and monthly water temperatures in Sacramento River at Hamilton City and Feather River at the confluence with the Sacramento River, respectively were used to investigate the potential effects of Alternative 1A on the suitability of water temperatures for splittail spawning and egg incubation. A range of 45°F to 75°F was selected as the suitable range for splittail spawning and egg incubation.

There would be no biologically meaningful difference (>5% absolute scale) between NAA and Alternative 1A in the frequency of water temperatures in the Sacramento and Feather Rivers being within the suitable 45°F to 75°F regardless of water year type (Table 11-1A-61).

Overall effects of Alternative 1A on flow consist of negligible effects (<5%) attributable to the project or beneficial effects on spawning conditions through increases in mean monthly flow in the Sacramento and Feather rivers and no change in occurrence of critical high or critically low water temperatures in the Feather River.

Table 11-1A-61. Difference (Percent Difference) in Percent of Days or Months[a] during February to June in Which Temperature Would Be below 45°F or above 75°F in the Sacramento River at Hamilton City and Feather River at the Confluence with the Sacramento River[b]

	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Sacramento River at Hamilton City		
Temperatures below 45°F		
Wet	-3 (-61%)	0 (0%)
Above Normal	-3 (-63%)	0.1 (9%)
Below Normal	-3 (-52%)	0 (0%)
Dry	-1 (-45%)	-0.04 (-4%)
Critical	-1 (-51%)	0.1 (13%)
All	-2 (-56%)	0.01 (1%)
Temperatures above 75°F		
Wet	0 (NA)	0 (NA)
Above Normal	0 (NA)	0 (NA)
Below Normal	0 (NA)	0 (NA)
Dry	0 (NA)	0 (NA)
Critical	0 (NA)	0 (NA)
All	0 (NA)	0 (NA)
Feather River at Sacramento River Confluence		
Temperatures below 45°F		
Wet	0 (NA)	0 (NA)
Above Normal	0 (NA)	0 (NA)
Below Normal	0 (NA)	0 (NA)
Dry	0 (NA)	0 (NA)
Critical	0 (NA)	0 (NA)
All	0 (NA)	0 (NA)
Temperatures above 75°F		
Wet	2 (NA)	1 (14%)
Above Normal	2 (NA)	-2 (-20%)
Below Normal	1 (NA)	-4 (-38%)
Dry	6 (125%)	0 (0%)
Critical	5 (300%)	2 (11%)
All	3 (260%)	-0.5 (-4%)

NA = could not be calculated because the denominator was 0.
[a] Days were used in the Sacramento River and months were used in the Feather River.
[b] Based on the modeling period of 1922 to 2003.

Stranding Potential

As indicated above, rapid reductions in flow can dewater channel margin and side-channel habitats, potentially stranding splittail eggs and rearing larvae. Due to a lack of quantitative tools and historical data to evaluate possible stranding effects, the following provides a narrative summary of potential effects. The Yolo Bypass is exceptionally well-drained because of grading for agriculture, which likely helps limit stranding mortality of splittail. Moreover, water stage decreases on the bypass are relatively gradual (Sommer et al. 2001). Stranding of Sacramento splittail in perennial ponds on the Yolo Bypass does not appear to be a problem under Existing Conditions (Feyrer et al. 2004). Yolo Bypass improvements would be designed, in part, to further reduce the risk of stranding by allowing water to inundate certain areas of the bypass to maximize biological benefits, while keeping water away from other areas to reduce stranding in isolated ponds. Actions under Alternative 1A to increase the frequency of Yolo Bypass inundation would increase the frequency of potential stranding events. For splittail, an increase in inundation frequency would also increase the production of Sacramento splittail in the bypass. While total stranding losses may be greater under Alternative 1A than under NAA, the total number of splittail would be expected to be greater under Alternative 1A.

In the Yolo Bypass, Sommer et al. (2005) found these potential losses are offset by the improvement in rearing conditions. Henning et al. (2006) also noted the potential for stranding risk as wetlands desiccate and oxygen concentrations decline, but the seasonal timing of use by juveniles may decrease these risks. Sommer et al. (2005) addressed the question of stranding and concluded the potential improvements in habitat capacity outweighed the potential stranding problems that may exist in some years. Overall, these effects are not adverse.

NEPA Effects: Collectively, these results indicate that the effect is not adverse because it would not substantially reduce suitable spawning habitat or substantially reduce the number of fish as a result of egg mortality. The effects of Alternative 1A on splittail spawning habitat are primarily beneficial. There would be benefits due to increased inundation in the Yolo Bypass that would increase the quantity and quality of spawning habitat there, and benefits to channel margin and side-channel habitat in the Sacramento River and Feather River from increases in mean monthly flow and decreases in high water temperatures during the spawning period.

CEQA Conclusion:

In general, Alternative 1A would have beneficial effects on splittail spawning habitat relative to Existing Conditions by increasing the quantity of spawning habitat in the Yolo Bypass through increased acreage subjected to periodic inundation.

Floodplain Habitat

Comparisons of splittail weighted habitat area for Alternative 1A and Existing Conditions indicate that there would be an increase in shorter events (30-49 days) in drier water year types and longer duration events (≥70 days) in wetter water year types under A1A_LLT relative to Existing Conditions (Table 11-1A-59). There would be a reduction in the number of events under A1A_LLT of short and mid-range durations (30-49 days and 50-69 days) during wet years primarily.

Alternative 1A would result in increased acreage of suitable spawning habitat compared to Existing Conditions (Table 11-1A-60), with increases of between 5 and 1,100 acres of suitable spawning habitat depending on water year type. Increased areas for wet, above normal, and below normal water years are predicted to be 71%, 67%, and 274%, respectively, for Alternative 1A. Comparisons for dry and critical water years indicate project-related increases of 15 and 5 acres of suitable spawning habitat, respectively, compared to 0 acres for Existing Conditions. These results indicate that Alternative 1A would have beneficial effects on splittail habitat through increasing spawning habitats by up to 274%.

Channel Margin and Side-Channel Habitat

Effects on channel margin and side-channel habitat were evaluated by comparing flow conditions for the Sacramento River at Wilkins Slough and the Feather River at the confluence with the Sacramento River for the February through June splittail spawning and early life stage rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT in the Sacramento River at Wilkins Slough would be similar to flows under Existing Conditions during February and March. During April through June, flows under A1A_LLT would generally be greater than flows under Existing Conditions.

In the Feather River at the confluence with the Sacramento River, flows under A1A_LLT would generally be up to 29% greater than flows under existing conditions during February through April, similar to flows under Existing Conditions during May, and up to 19% lower than flows under Existing Conditions during June.

There would generally be no biologically meaningful difference (>5% absolute scale) between Existing Conditions and Alternative 1A in the frequency of water temperatures in the Sacramento and Feather Rivers being within the suitable 45°F to 75°F, except in dry and critical water years (5% to 6% greater) for the 75°F threshold in the Feather River (Table 11-1A-61).

Stranding Potential

Because there would be little difference in flow conditions between Alternative 1A and Existing Conditions, the project would not have biologically meaningful effects on stranding potential.

Summary of CEQA Conclusion

Overall, these results indicate that the impact is less than significant because it would not substantially reduce suitable spawning habitat or substantially reduce the number of fish as a result of egg mortality. This conclusion is largely a result of increasing the quantity of spawning habitat in the Yolo Bypass through increased acreage subjected to periodic inundation. No mitigation is necessary.

Impact AQUA-113: Effects of Water Operations-on Rearing Habitat for Sacramento Splittail

NEPA Effects: In general, Alternative 1A would have beneficial effects on splittail rearing habitat relative to NAA based on an increase in the quantity and quality of rearing habitat in the Yolo Bypass, beneficial effects on rearing conditions in channel margin and side-channel habitats in the Sacramento River and the Feather River, and reductions in the occurrence of critical high water temperatures in the Feather River in wetter water year types.

Sacramento splittail rear in floodplain and main-channel environments; the analyses of splittail weighted habitat area in Yolo Bypass and effects of flow conditions on channel margin and side-channel habitats provided in the previous impact, Impact AQUA-112, apply to rearing as well as spawning habitat for splittail. As concluded above, the effect is not adverse because it would not substantially reduce suitable rearing habitat or substantially reduce the number of fish as a result of juvenile mortality. Effects of Alternative 1A on flow would have beneficial effects on the availability of channel margin and main-channel habitat through increases in mean monthly flow for some months and water year types during the rearing period. Increased flows into Yolo Bypass may reduce flooding and flooded rearing habitat to some extent in the Sutter Bypass but would create habitat in the Yolo Bypass that would have a beneficial effect on rearing conditions.

CEQA Conclusion: In general, Alternative 1A would have beneficial effects on splittail rearing habitat relative to the Existing Conditions by increasing the quantity of rearing habitat in the Yolo Bypass, and increases in mean monthly flow for some months and water year types in the Sacramento River and the Feather River.

Project effects on splittail rearing habitat would be similar to those described for spawning habitat in the previous impact discussion, Impact AQUA-112. As concluded above, the impact is less than significant because it would not substantially reduce suitable rearing habitat or substantially reduce the number of fish as a result of juvenile mortality and no mitigation is necessary. Effects of Alternative 1A on flow would not have negative effects on the availability of channel margin and main-channel habitat, and would have a beneficial effect through increases in mean monthly flow for some months and water year types during the rearing period. Increased flows into Yolo Bypass may reduce flooding and flooded rearing habitat to some extent in the Sutter Bypass but would create habitat in the Yolo Bypass that would have a beneficial effect on rearing conditions.

Impact AQUA-114: Effects of Water Operations on Migration Conditions for Sacramento Splittail

In general, effects of Alternative 1A would not affect splittail migration conditions in the Sacramento River or the Feather River relative to NAA based on negligible or beneficial effects on mean monthly flow during the migration period (February through June) and negligible or beneficial effects on water temperatures in the Feather River.

The effects of Alternative 1A on splittail migration conditions would be the same as described for channel margin and side-channel habitats in the Sacramento River and Feather River for Impact AQUA-112 above. There would be benefits to channel margin and side-channel habitat in both locations from increases in mean monthly flow and decreases in high water temperatures compared to baseline conditions.

NEPA Effects: The effect of Alternative 1A is not adverse because it would not substantially reduce or degrade migration habitat or substantially reduce the number of fish as a result of mortality. Similarly, because OMR flows are overall improved, the effect of Alternative 1A on through-Delta migration conditions for Sacramento splittail would be beneficial.

CEQA Conclusion: In general, effects of Alternative 1A would not affect splittail migration conditions in the Sacramento River during February through June relative to the Existing Conditions, but would reduce the suitability of channel conditions for migration in the Feather River due to increased exposure to critical water temperatures. However, splittail spawning in the Feather River is not as important as in Yolo Bypass, and therefore, net effects from Alternative 1A on migration conditions in the Feather River would be negligible.

Effects of Alternative 1A on splittail migration conditions would be similar to those described for channel margin and side-channel habitats in Impact AQUA-112. As concluded above, the impact is not significant because it would not substantially reduce suitable migration habitat or substantially reduce the number of fish as a result of mortality and no mitigation is necessary. Effects of Alternative 1A on flow would not have negative effects on the availability of channel margin and main-channel habitat, and would have a beneficial effect through increases in mean monthly flow for some months and water year types during the migration period. Benefits to habitat availability in the Yolo Bypass would outweigh negative effects of increased exposures to water temperatures above the upper threshold of 75°F in the Feather River in drier water year types.

Summary of CEQA Conclusion

Overall, Alternative 1A would not affect splittail migration conditions in the Sacramento River relative to the Existing Conditions, the impact is not significant because it would not substantially reduce suitable migration habitat or substantially reduce the number of fish as a result of mortality and no mitigation is necessary. Similarly, Alternative 1A is expected to reduce OMR reverse flows during the period of juvenile splittail migration through the Delta, resulting in greatly improved conditions in June and July compared to baseline conditions across all water years. Therefore the impact on splittail migration survival is less than significant. No mitigation is required.

Restoration Measures (CM2, CM4–CM7, and CM10)

Impact AQUA-115: Effects of Construction of Restoration Measures on Sacramento Splittail

Temporary Increases in Turbidity

Sacramento splittail inhabit naturally turbid water and forage more effectively in turbid water, and are unlikely to be affected by temporary increases in turbidity during restoration construction. Implementing the environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Fish Rescue and Salvage Plan*; and *Barge Operations Plan*)*,* would minimize the potential for turbidity to affect Sacramento splittail.

Increased Exposure to Methylmercury

The potential effects of increased exposure to methylmercury on Sacramento splittail are expected to be similar to those discussed in detail for delta smelt under Impact AQUA-7, although the magnitude of effects would be different. Sacramento splittail spawning and rearing occur in restored shallow water floodplain habitat, where methylmercury concentrations would likely be greater than deeper open water habitat used extensively by delta smelt. As discussed above however, the overall effect of increased bioavailability of methylmercury on covered fish species is likely to be of low magnitude and localized. With implementation of *CM12 Methylmercury Management*, effects of methylmercury mobilization on Sacramento splittail at the tidal wetland restoration sites are expected to be minimized. In addition, the BMPs put in place to reduce turbidity will also minimize suspension of potentially contaminated sediments, although restoration activities will not produce the biogeochemical conditions that would support methylation of mercury; thus increased bioavailability and toxicity as a result of restoration construction activities are not expected.

Accidental Spills

As discussed under Impact AQUA-1 and Impact AQUA-2, adverse effects from accidental spills will be avoided through implementation of appropriate impact avoidance and minimization measures(*Environmental Training; Stormwater Pollution Prevention Plan; Erosion and Sediment Control Plan; Hazardous Materials Management Plan; Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material; and Barge Operations Plan;* see Appendix 3B, *Environmental Commitments* and Impact AQUA-1). Specifically, environmental commitment *Spill Prevention, Containment, and Countermeasure Plan* will be implemented to minimize the risk of spills occurring and to provide for rapid and effective response to contain any accidental spills. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt. Therefore adverse effects from accidental spills would not be likely to occur.

Disturbance of Contaminated Sediments

Runoff and resuspension of contaminants could cause short-term, localized increases in the concentrations of contaminants in and near restoration sites (see discussion for delta smelt under Impact AQUA-7). The potential impacts of toxics on Sacramento splittail would be minimized to the extent possible by timing construction activities so that vulnerable early life stages of fish are not present and implementation of environmental commitments (see Appendix 3B, *Environmental Commitments; Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*). Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

In-Water Work Activities

Restoration construction could temporarily produce noise levels and disturbances that could affect nearby Sacramento splittail. Such activities are not expected to elevate underwater noise above the threshold sound pressure levels established for fish protection(see discussion for delta smelt under Impact AQUA-1). Any changes in noise and light levels would be minor and temporary. In addition, it is likely that fish would avoid areas where shoreline activities increased noise and light. Potential effects of in-water activity would be minimized by implementation of the environmental commitments described under Impact AQUA-1 and in Appendix 3B, *Environmental Commitments*, including *Erosion and Sediment Control Plan*; *Dispose of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*.

Predation

Restoration construction would be unlikely to have any measurable effect on Sacramento splittail predation rates. Much of the restoration construction would occur on dry land (e.g., recontouring, removing levees) which would have no in-water effects including on predators. In-water activities may include the use of barges and other watercraft that could theoretically provide cover, shelter, and perching areas for predators. However, the limited duration of these activities and the associated noise and disturbance would be expected to dissuade predators from concentrating at sufficient density to measurably affect predation rates on Sacramento splittail.

Summary

In-water and shoreline restoration activities would be scheduled to occur when the least numbers of Sacramento splittail would be present in or near the restoration sites. Such activities would include riprap removal and levee breaching, and shoreline excavation and re-contouring. In addition, runoff from upland construction areas would also have the potential to affect aquatic habitats and Sacramento splittail, although splittail are tolerant to increases in turbidity. Implementation of the environmental commitments described in Appendix 3B, *Environmental Commitments*, would minimize or eliminate effects on Sacramento splittail. These environmental commitments are *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt. As a result, the effects of short-term restoration construction activities are not adverse to Sacramento splittail.

As discussed for delta smelt (see Impact AQUA-7) implementation of these environmental commitments would minimize or eliminate short-term effects; however, more frequent inundation of these restored areas could promote conversion of mercury to methylated mercury and runoff containing agricultural-related toxins such as copper and organochlorine pesticides. The overall effect of increased bioavailability of methylmercury and other pollutants on Sacramento splittail is likely to be of low magnitude, periodic and localized. In addition, *CM12 Methylmercury Management* provides for site-specific assessment of restoration areas, integration of design measures to minimize methylmercury production.

NEPA Effects: Overall, the effects of habitat restoration are expected to be beneficial to Sacramento splittail by providing additional or improved habitat. As a result, the effects of short-term restoration activities are not adverse to Sacramento splittail.

CEQA Conclusion: Sacramento splittail inhabit naturally turbid water and are not expected to be affected by temporary increases in turbidity potentially occurring during restoration activities. In addition to in-water work window restrictions, the limited frequency, duration, and spatial extent of restoration construction activities would minimize potential effects on Sacramento splittail. For these reasons, and implementation of the environmental commitments described in detail under Impact AQUA-1 and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*), impacts on Sacramento splittail from restoration construction activities would be less than significant because it would not substantially reduce its habitat, restrict its range or interfere with its movement. Consequently, no mitigation is required.

Impact AQUA-116: Effects of Contaminants Associated with Restoration Measures on Sacramento Splittail

Effects of implementing the habitat restoration conservation measures (CM2, CM4–CM7, and CM10) on Sacramento splittail will depend on the life stage present in the area of elevated toxins and the duration of exposure. Release of toxic constituents from sediments (e.g., in restored areas) is tied to inundation, and so the highest concentrations will occur during seasonal high water and to a lesser extent for short time periods on a tidal cycle in marshes. As previously mentioned, a complete analysis can be found in the *BDCP Effects Analysis – Appendix D*, *Contaminants (hereby incorporated by reference)*. Potential impacts on Sacramento splittail from effects of methylmercury, selenium, copper, ammonia, and pesticides associated with habitat restoration activities would be similar to those discussed in detail for delta smelt (see Impact AQUA-8) except that Sacramento splittail is a benthic forager so the release of sediment borne contaminants may result in greater effects for this species. However, these effects are not expected to adversely affect Sacramento splittail. In addition, the overall effect of restoration measures is generally beneficial to Sacramento splittail.

The large numbers of factors that influence the production of methylmercury in freshwater tidal habitat make it challenging to predict methylmercury conditions, covered species exposures or bioaccumulation. The limited data available from past restoration actions indicate that methylmercury production in wetlands and resulting bioaccumulation is highly variable. It is reasonable to expect that some increases in methylmercury are possible on a local or regional scale. The Delta is currently impaired for methylmercury and a TMDL from the Central Valley Regional Water Quality Control Board is guiding loading reduction for both point and non-point sources to insure that the aquatic life associated beneficial uses are protected. The initial phase of the 2010

TMDL is underway and includes seven years of research on the management of methylmercury associated with Delta wetlands. Sacramento splittail is a benthic forager so released contaminants including mercury and selenium may be more problematic for this species.

Longer water residence times in restoration areas could make selenium more bioavailable to Sacramento splittail but Delta-relevant information is limited to assess this risk. Analysis of the effects of selenium bioaccumulation in fishes is located in Chapter 8 *Water Quality*. Areas of concern for splittail would include the western Delta and Suisun Bay, and the South Delta in areas that receive San Joaquin River water. In these locations, selenium load is bioaccumulated by invasive bivalves, increasing Sacramento splittail's exposure through their diet.

Portions of the San Joaquin River are on the 303(d) list and a TDML has been implemented to reduce loading. Because increases in bioavailable selenium in the habitat restoration areas are uncertain, proposed avoidance and minimization measures would require evaluating risks of selenium exposure at a project level for each restoration area, minimizing to the extent practicable potential risk of additional bioaccumulation, and monitoring selenium levels in fish and/or wildlife to establish whether, or to what extent, additional bioaccumulation is occurring. See Appendix 3B, *Environmental Commitments* for a description of the environmental commitment which are being made with respect to Selenium Management; and BDCP Appendix 3.C – *Avoidance and Minimization Measures, hereby incorporated by reference* for additional detail on this avoidance and minimization measure (AMM27).

NEPA Effects: It is anticipated that any potential effects of methylmercury and selenium on Sacramento splittail will be addressed through implementation of CM12 and AMM27. These measures are intended to minimize methylmercury and selenium exposure associated with restoration measures for Sacramento splittail at all life stages. Further analysis and tools may be developed to further reduce methylmercury and selenium exposure for Sacramento splittail as the habitat restoration conservation measures are refined and analyzed in site-specific documents. The site-specific analysis is the appropriate place to assess the potential for risk of methylmercury and selenium exposure for Sacramento splittail once site specific sampling and other information can be developed. Overall, the effects of contaminants associated with restoration measures would not be adverse for Sacramento splittail with respect to copper, ammonia and pesticides. The effects of methylmercury and selenium on Sacramento splittail are uncertain.

CEQA Conclusion: Alternative 1A actions are likely to result in increased production, mobilization, and bioavailability of methylmercury, selenium, copper, and pesticides in the aquatic system. However, any such releases would be sporadic, short-term and localized, and would be unlikely to result in measurable increases in the bioaccumulation in Sacramento splittail even though it is a benthic forager. In addition, implementation of *CM12 Methylmercury Management* would help to minimize the increased mobilization of methylmercury at restoration areas. Therefore, the impact is considered less than significant because it would not substantially affect Sacramento splittail either directly or through habitat modifications. Consequently, no mitigation would be required.

Impact AQUA-117: Effects of Restored Habitat Conditions on Sacramento Splittail

The potential effects of the proposed conservation measures on Sacramento splittail are expected to be similar to those discussed under Impact AQUA-9 for delta smelt.

CM2 Yolo Bypass Fisheries Enhancement

As discussed under Impact AQUA-9, Yolo Bypass fisheries enhancement modifications are designed to increase the frequency, duration and magnitude of seasonal floodplain inundation in the Yolo Bypass. These actions would improve and enhance spawning and rearing habitat for Sacramento splittail. The Yolo Bypass is an important spawning area for splittail, and increasing the duration of inundation is expected to provide substantial benefits to splittail productivity in the Delta.

CM4 Tidal Natural Communities Restoration

Tidal wetland restoration adds substantially to the shallow water fish habitat in the Plan Area and in the five ROAs (see Impact AQUA-9). Expanded access to seasonal floodplain, tidal wetland, and improved channel margins will expand shallow water, low-velocity habitat with increased food production. Habitat Suitability Analysis indicates that tidal wetland restoration provides substantial increases in available habitat suitable for Sacramento splittail—as compared to Existing Conditions. A substantial extent of restored habitat in the Cache Slough and Suisun Marsh ROAs was modeled for Sacramento splittail, ranging from more than 4,000 HUs to nearly 6,500 HUs. Restored habitat size for splittail was appreciable in the South Delta ROA (more than 7,500 HUs for juveniles and 5,000 HUs for adults). Splittail is not affected by the relatively warm temperature and low turbidity that limit the other species in the south Delta. For further discussion, see Impact AQUA-9.

CM5 Seasonally Inundated Floodplain Restoration

Under CM5, up to 10,000 acres of seasonally inundated floodplain would be restored, mainly in the south Delta, primarily through levee setbacks, removal of riprap, or grading of floodplain. Inundated vegetation on floodplains in the Central Valley is known to provide important spawning habitat for splittail adults and rearing habitat for juveniles. Therefore, enhancing and expanding such habitat would likely be beneficial to Sacramento splittail. For further discussion, see Impact AQUA-9.

CM6 Channel Margin Enhancement

Channel margin habitat is important for splittail during migration to and from upstream spawning habitats. Channel margin enhancement along such migration routes provides refuge from high flows and overhead and instream cover for protection from predators. Enhanced channel margins in the vicinity of the proposed north Delta intakes (upstream, between the intakes, and downstream) would provide resting spots and refuge for fish migrating through this area. Removal of bank protection is also expected to reestablish floodplain processes and create low-velocity, vegetated backwater habitats for Sacramento splittail spawning (see Impact AQUA-9). This habitat may be of particular importance in drier years when the availability of floodplain habitat is reduced.

CM7 Riparian Natural Community Restoration

For discussion of the effect on Sacramento splittail, see the discussion under Impact AQUA-9.

CM7 Riparian Natural Community Restoration is intended to restore riparian habitat within the context of flood control objectives and managed upstream hydrology, to provide direct and indirect benefits along migration corridors for aquatic, such as Sacramento splittail. Splittail also benefit from contributions of the riparian community to the aquatic foodweb, in the form of terrestrial insects and leaf litter that enter the water. Riparian vegetation also supports the formation of steep, undercut banks that provide cover for Sacramento splittail. The increased habitat complexity provided by riparian restorations is expected to be beneficial to Sacramento splittail, which use low-velocity backwater habitats for spawning.

CM10 Nontidal Marsh Restoration

The potential types of effects of *CM10 Nontidal Marsh Restoration* would be similar to those discussed for delta smelt under Impact AQUA-9.

NEPA Effects: The types of effects of floodplain, tidal, channel margin and riparian habitat restoration activities on Sacramento splittail, are expected to be similar to those discussed for delta smelt (see Impact AQUA-9); additional rearing habitat will be provided in the Yolo Bypass. In general these effects are expected to be beneficial for Sacramento splittail, providing increased amounts and quality of available habitat, increasing habitat diversity and connectivity, increasing food and overall productivity and reducing predation.

Despite the improvements in habitat and habitat functions in the Delta from floodplain, tidal, channel margin and riparian habitat restoration activities, habitat quality is expected to decline in the LLT primarily because of climate change. Although these changes might result in a loss of individuals and a decline in habitat suitability, these may be offset by an increase in available habitat from restoration. The overall effect of restoration activities is expected to remain beneficial for Sacramento splittail.

However, it is important to note that benefits would not be derived in all years, and that an adaptive management plan would be needed to determine an operational protocol that optimizes benefits both locally and in adjacent habitats.

CEQA Conclusion: As with delta smelt, the overall effects of floodplain, tidal, channel margin and riparian habitat restoration activities are expected to be beneficial for Sacramento splittail (see Impact AQUA-9). The general benefits include providing increased amounts and quality of available habitat, increasing habitat diversity, increasing overall productivity and reducing predation. Despite the improvements in habitat and habitat functions in the Delta from floodplain, tidal, channel margin, and riparian habitat restoration activities, habitat quality is expected to decline in the LLT primarily because of climate change. However, the overall impact of restoration activities is expected to remain beneficial for Sacramento splittail because they increase habitat. Consequently, no mitigation would be required.

Other Conservation Measures (CM12–CM19 and CM21)

Impact AQUA-118: Effects of Methylmercury Management on Sacramento Splittail (CM12)

Refer to Impact AQUA-10 under delta smelt for a discussion of the potential effects of methylmercury management on Sacramento splittail except that Sacramento splittail is a benthic forager so any minimization of methylmercury amounts as the result of this conservation measure would likely be more beneficial for this species.

Impact AQUA-119: Effects of Invasive Aquatic Vegetation Management on Sacramento Splittail (CM13)

Potential effects on Sacramento splittail from IAV control during operations are expected to be similar to those discussed for delta smelt (see Impact AQUA-11), which are expected to be somewhat beneficial.

Control of IAV would reduce habitat that supports predatory fish in freshwater nearshore habitat. Largemouth bass are strongly associated with dense IAV beds (Nobriga and Feyrer 2007; Conrad et al. 2010). A decrease in IAV in the Delta should open up nearshore habitats used by juvenile splittail for cover and rearing while reducing their encounters with piscivorous predators like largemouth bass. Dense IAV cover has also been associated with reduction of water turbidity in the Delta (Brown and Michniuk 2007). Removal of IAV may also provide increased turbidity, which is associated with reduced hunting success of visual predators like largemouth bass and striped bass (Gregory and Levings 1998).

NEPA Effects: The control of SAV is expected to reduce predation mortality, increase spawning and rearing habitat, and result in an increase in available food resources. Therefore, the overall effect of IAV removal and control is expected to be modestly beneficial to Sacramento splittail.

CEQA Conclusion: The control of IAV should provide a modest net benefit to Sacramento splittail during operations through chemical and mechanical treatment and should reduce predation mortality, increase food availability and increase the amount of suitable spawning and rearing habitat. This impact is expected to be beneficial, consequently, no mitigation would be required.

Impact AQUA-120: Effects of Dissolved Oxygen Level Management on Sacramento Splittail (CM14)

NEPA Effects: As discussed in Chapter 8, *Water Quality*, dissolved oxygen levels would be very similar to Existing Conditions in the areas upstream of the Delta, in the Delta, and in the SWP/CVP export service areas (see discussion of Impacts WQ-10 and WQ-11). As noted there, however, *CM14 Stockton Deepwater Ship Channel Dissolved Oxygen Levels* management would increase the dissolved oxygen levels and improve aquatic habitat conditions for Sacramento splittail. The effect would be beneficial to Sacramento splittail.

CEQA Conclusion: As discussed in Chapter 8, *Water Quality*, *CM14 Stockton Deepwater Ship Channel Dissolved Oxygen Levels* management would increase the dissolved oxygen levels and improve aquatic habitat conditions. Sacramento splittail occur in the channel and the increased dissolved oxygen levels would improve habitat conditions for them, which would be a benefit. Consequently, no mitigation would be required.

Impact AQUA-121: Effects of Localized Reduction of Predatory Fish on Sacramento Splittail (CM15)

NEPA Effects: Potential impacts on Sacramento splittail from predator removal at targeted local hotspots are expected to be similar to those for delta smelt (see Impact AQUA-13). Removing predators from localized hotspots, particularly at NPBs, is expected to slightly reduce the predation rates on Sacramento splittail. However, since the affected proportion of the population would be very small this effect would not be detectable.

CEQA Conclusion: Slightly reduced predation rates on Sacramento splittail from predator management would result in a slight benefit to the species. Since the affected proportion of the population would be very small, this expected benefit is would likely not be measurable. Consequently, no mitigation would be required.

Impact AQUA-122: Effects of Nonphysical Fish Barriers on Sacramento Splittail (CM16)

The quantitative benefits of the installation of NPBs to Sacramento splittail are unknown and are described under Impact AQUA-14 for delta smelt. Considering species-specific factors such as water column position, hearing ability, and escape ability, NPBs at the entrances to CCF and the DMC have the most potential to considerably reduce entrainment of juvenile and adult Sacramento splittail, compared to other covered species.

Although NPBs are constructed and operated mainly with salmonids in mind, Sacramento splittail are likely to also be deterred by the NPBs based on their hearing ability and strong swimming ability as young juveniles. During wetter years, Sacramento splittail may migrate up the Sacramento and San Joaquin Rivers beyond the northern and southern boundaries of the Delta and therefore are likely to encounter the NPBs at head of Old River and Georgiana Slough. Although NPBs would likely be operated to coincide mainly with the juvenile salmonid emigration period, juvenile splittail outmigration to the Delta is most likely from April-August (Moyle 2002). Therefore, the first months of the juvenile Sacramento splittail migration to the Delta overlap with the main juvenile salmonid outmigration period. If NPBs are effective at deterring splittail away from areas with high mortality rates, such as Georgiana Slough, then the risks of predation for juvenile splittail would be reduced.

NEPA Effects: The NPBs also have the potential to attract predatory fish, which often hold around underwater human-made structure. Therefore, there is a slightly increased risk of predation for juvenile Sacramento splittail in the area immediately around the NPBs. However, the overall effects of NPBs would not be adverse.

CEQA Conclusion: Although NPBs are constructed and operated mainly with salmonids in mind, Sacramento splittail are likely to also be deterred by the NPBs based on their hearing ability and strong swimming ability as young juveniles. During wetter years, Sacramento splittail may migrate up the Sacramento and San Joaquin Rivers beyond the northern and southern boundaries of the Delta and therefore are likely to encounter the NPBs at head of Old River and Georgiana Slough. Although NPBs would likely be operated to coincide mainly with the juvenile salmonid emigration period, juvenile splittail outmigration to the Delta is most likely from April-August (Moyle 2002). Therefore, the first months of the juvenile Sacramento splittail migration to the Delta overlap with the main juvenile salmonid outmigration period. If NPBs are effective at deterring splittail away from areas with high mortality rates, such as Georgiana Slough, then the risks of predation for juvenile splittail would be reduced. The NPBs also have the potential to attract predatory fish, which often hold around underwater human-made structure. Therefore, there is a slightly increased risk of predation for juvenile Sacramento splittail in the area immediately around the NPBs. However the overall impacts of the NPBs are expected to be less than significant on Sacramento splittail because they would reduce entrainment which would potentially increase their numbers. Consequently, no mitigation would be required.

Impact AQUA-123: Effects of Illegal Harvest Reduction on Sacramento Splittail (CM17)

NEPA Effects: *CM17 Illegal Harvest Reduction* would be applied to Chinook salmon, Central Valley steelhead, green sturgeon and white sturgeon and are expected to have positive effects on their populations. Since this conservation measure is not applied to Sacramento splittail it would have no direct effect on them. Therefore, the effect would not be adverse.

CEQA Conclusion: *CM17 Illegal Harvest Reduction* would be applied to Chinook salmon, Central Valley steelhead, green sturgeon and white sturgeon and are expected to have positive effects on their populations. Since this conservation measure is not applied to Sacramento splittail it would have no direct effect on them. Consequently, no mitigation would be required.

Impact AQUA-124: Effects of Conservation Hatcheries on Sacramento Splittail (CM18)

NEPA Effects: *CM18 Conservation Hatcheries* would establish new and expand existing conservation propagation programs for delta and longfin smelt. This conservation measure would have no effect on Sacramento splittail.

CEQA Conclusion: *CM18 Conservation Hatcheries* would establish new and expand existing conservation propagation programs for delta and longfin smelt. This conservation measure would have no impact on Sacramento splittail. Consequently, no mitigation would be required.

Impact AQUA-125: Effects of Urban Stormwater Treatment on Sacramento Splittail (CM19)

NEPA Effects: The effects of urban stormwater treatment (CM19) would reduce contaminants associated with urban areas because it provides for the treatment of stormwater discharges. As discussed in Chapter 8, *Water Quality*, and previously under Impact AQUA-8 in the section titled *Pyrethroids, Organophosphate Pesticides, and Organochlorine Pesticides,* stormwater treatment would reduce urban loadings of pesticides (including pyrethroids), phosphorous, trace metals and other contaminants. These reductions would contribute to improved water quality in the Delta. Sacramento splittail are benthic feeders, so any reductions in sediment borne contaminants would be particularly beneficial. Based on the improved overall water quality conditions and reduced pesticides the effect could be beneficial.

CEQA Conclusion: Urban stormwater treatment (CM19) would reduce contaminants associated with urban areas because it would provide for the treatment of stormwater discharges. As discussed in Chapter 8, *Water Quality*, and previously under Impact AQUA-8 in the section titled *Pyrethroids, Organophosphate Pesticides, and Organochlorine Pesticides,* stormwater treatment would reduce urban loadings of pesticides(including pyrethroids), phosphorous, trace metals and other water contaminants. These reductions would contribute to improved water quality in the Delta. Sacramento splittail are benthic feeders. Therefore, the impacts of urban stormwater treatment would be beneficial because it would have a beneficial effect both directly and through habitat modifications on Sacramento splittail. Consequently, no mitigation would be required.

Impact AQUA-126: Effects of Removal/Relocation of Nonproject Diversions on Sacramento Splittail (CM21)

NEPA Effects: There is no evidence of substantial entrainment of covered fish species at agricultural diversions in the Plan Area, but some entrainment likely is occurring. Whatever entrainment is occurring would be reduced by decommissioning agricultural diversions in the ROAs. PTM runs and extrapolations to a hypothetical number of diversions to be removed from the ROAs (i.e., approximately 4–12% of diversions) estimated slight reductions in entrainment for delta smelt and longfin smelt. While the amount of reduced entrainment for Sacramento splittail might be lower, the effects would be beneficial.

CEQA Conclusion: There is no evidence of substantial entrainment of covered fish species at agricultural diversions in the Plan Area, but some entrainment likely is occurring. Whatever entrainment is occurring would be reduced by decommissioning agricultural diversions in the ROAs. PTM runs and extrapolations to a hypothetical number of diversions to be removed from the ROAs (i.e., approximately 4–12% of diversions) estimated slight reductions in entrainment for delta smelt and longfin smelt. While the amount of reduced entrainment for Sacramento splittail might be lower, the impacts would be beneficial because it would reduce entrainment which could have a positive impact on Sacramento splittail numbers. Consequently, no mitigation would be required.

Green Sturgeon

Construction

Impact AQUA-127: Effects of Construction of Water Conveyance Facilities on Green Sturgeon

Juvenile green sturgeon are present year-round and could be present during construction of both intakes and barge landings (see Table 11-4). Juvenile sturgeon can rear for up to 3 years in freshwater before migrating to the ocean. In the north Delta and east Delta, adult sturgeon could be present any time of the year although peak occurrence is primarily in April through June, with moderate numbers between September and March. In the south Delta, green sturgeon adults are present year-round. The potential for exposure of green sturgeon to construction-related activities is expected to be low to moderate. In addition, adherence to the expected in-water work window (June through October) would help to minimize, but would not eliminate, construction effects on green sturgeon.

Temporary Increases in Turbidity

Because green sturgeon are benthic fish, they inhabit naturally turbid water. They are unlikely to be affected by a temporary increase in turbidity. As discussed for delta smelt (see Impact AQUA-1), environmental commitments would be implemented to reduce turbidity during construction activities (see Appendix 3B, *Environmental Commitments*: *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*). Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Accidental Spills

Potential impacts on green sturgeon from accidental spills during construction are similar to those discussed for delta smelt (see Impact AQUA-1). These impacts would be minimized by implementing environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*. (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*). Specifically, the *Spill Prevention, Containment, and Countermeasure Plan* would be expected to minimize the potential for introduction of contaminants to surface waters and provide for effective containment and cleanup should accidental spills occur. Pertinent details of these plans are discussed under Impact AQUA-1 for delta smelt.

Disturbance of Contaminated Sediments

There is a potential risk of contaminated sediments affecting green sturgeon during construction of intakes and barge landings if they are present in the vicinity of in-water construction activities (see Impact AQUA-1 for delta smelt). These risks can include reduced reproduction and growth rates, as well as potentially higher mortality rates, particularly for larval and juvenile life stages (Silvestre, et al. 2010; Lee et al. 2011). Because green sturgeon are mainly benthic dwellers, they may be more susceptible to contaminants than other fish species. However, the suspension of sediments would be minimized by implementation of environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*). Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Underwater Noise

Underwater sound generated by impact pile driving in or near surface waters can potentially harm green sturgeon. It is important to note that this impact would be realized only where piles must be impact driven; underwater sound generated by vibratory pile installation methods are not sufficiently loud to injure fish.

Green sturgeon larvae could experience underwater sound effects, should they occur in the locations of the intakes and barge landings during the in-water construction period, and would be affected by underwater noise levels that exceed injury or disturbance thresholds (see Impact AQUA-1). Juvenile and adult green sturgeon could be present near the intakes during June through October, when pile driving would occur, as they migrate to and from upstream spawning areas. Adult green sturgeon are large and less susceptible to noise from impact driving, and might be able to avoid injurious exposure to underwater noise from pile driving. They may experience short delays in migration past the intakes when pile driving occurs; however, pile driving would occur only intermittently through a portion of the day, and minor migration delays would not affect their ability to successfully reach spawning grounds. Therefore, the potential for adult green sturgeon to experience an adverse effect (e.g., injury or mortality, or substantial migratory disturbance) from impact pile driving would likely be low-to-moderate because of their size, ability to move away from the underwater sound, and their potentially low temporal and spatial distribution during construction areas. Furthermore, potential exposure of green sturgeon to underwater sound above the threshold criterion would be typically be intermittent and limited.

Juvenile green sturgeon would have a relatively low abundance near the intakes and barge landings throughout the June through October pile driving period. Given these numbers in the east and south Delta areas; the relatively small areas affected by underwater noise in these areas; and the intermittent nature of potential exposure to underwater sound above the threshold, there is a low chance that juvenile green sturgeon would be exposed to noise levels from impact pile driving at the barge landing sites. However, a greater number of juveniles could be present in the north Delta during construction of the intake cofferdams, resulting in a moderate risk of exposure to potentially harmful underwater sound levels. Therefore, there is a moderate potential for juvenile green sturgeon to experience an adverse effect (e.g., injury or mortality).

If an individual juvenile green sturgeon (less than 2 grams in size) were present in an area affected by underwater sound from impact pile driving above the effects threshold of 183-dB $SEL_{cumulative}$, and proximate to an impact-driven pile, it could experience an adverse effect, such as injury or mortality. However, because of the overall low-to-moderate densities of juvenile green sturgeon expected in all pile driving locations, the limited area subject to underwater sound exceeding the effects threshold, and implementation of the avoidance and minimization measures included in

Mitigation Measures AQUA-1a and AQUA-1b, the potential for juvenile green sturgeon to experience an adverse effect from impact pile driving (e.g., injury or mortality) would be low.

Fish Stranding

Green sturgeon trapped within cofferdams or other fish exclusion structures would be at some risk for injury during fish removal activities. Because adults and juvenile green sturgeon could be present at any time during the year, some low risk of impact exists. Fish removal activities from construction areas would be implemented according to environmental commitment *Fish Rescue and Salvage Plan*, as described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*). Pertinent details of this plan are discussed under Impact AQUA-1 for delta smelt. Because of these measures, the risk of substantial effects would be minimized.

In-Water Work Activities

As discussed for delta smelt (see Impact AQUA-1), in-water work activities have the potential disturb, injure or kill fish through direct physical injury from construction activities. Although fish would likely avoid the noise and activity of pile installation and placement of riprap protection, these activities have the potential to affect fish. Primarily juvenile green sturgeon would be expected in the vicinity of the intake facilities and barge landings during construction. Because of the relatively low densities of juvenile green sturgeon expected in all construction areas, the potential for effects would be limited. Potential effects would also be minimized by implementation of environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments,* including *Erosion and Sediment Control Plan*; *Dispose of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*.

Loss of Spawning, Rearing, or Migration Habitat

There is no suitable spawning habitat for green sturgeon in the vicinity of the proposed in-water work; therefore, green sturgeon spawning habitat would not be affected by construction activities. However, construction would temporarily and permanently affect migration and rearing habitat. Any activity that occurs in a species migration corridor has the potential to affect the behavior (i.e., through a change in migration route within the channel, delay from a noise deterrent, artificial light sources, etc.). However, effects on migration habitat would be limited because much of the construction would be confined within the cofferdams, and would not obstruct the remainder of the river channel, which would be of the same quality as in the construction area. The existing migration and rearing habitat is of relatively low quality, due to the armored levees with limited riparian vegetation. Therefore, the overall effects would be limited.

Implementation of *CM6 Channel Margin Enhancement* would enhance channel margin habitat along 20 miles of the Sacramento River, including the vicinity of the intake structures, and would be designed to result in a net improvement in channel margin habitat function. Implementation of environmental commitment *Barge Operations Plan* (see Impact AQUA-1 for delta smelt and Appendix 3B, *Environmental Commitments*) would limit the potential for impacts from vessel wakes and propeller wash on shoreline habitat.

Construction of the intakes and barge landings will temporarily affect green sturgeon migration and rearing habitat, and the intakes screens will permanently alter the nearshore portion of this habitat in the Sacramento River. Because of implementation of *CM6 Channel Margin Enhancement* the overall effects would be limited because of the relatively poor quality of the current habitat, and the addition of new, higher quality habitat associated with *CM6 Channel Margin Enhancement*.

Predation

Construction of in-water pilings and over-water structures and local temporary increases in turbidity associated with construction may affect predation on various fish species, including green sturgeon. In a laboratory study, prickly sculpin and northern pikeminnow have been observed to consume juvenile sturgeon (Gadomski and Parsley 2005), and some degree of predation occurs. However, due to the armored scutes (bony external scale)(French et al. 2010) and relatively rapid growth of sturgeon, predation would likely be low following the early life stages. Nobriga and Feyrer (2008) examined data for striped bass stomach contents collected between 1963 and 2003, and did not find any sturgeon among the more than 4,000 samples. The increase in cover habitat for bass and other predatory fish that would be created at the barge landings would likely result in only a minimal effect on green sturgeon.

Summary

In-water construction activities would be scheduled to occur when a limited number of green sturgeon would likely to be present in or near the construction areas, although some sturgeon are expected to occur in river and Delta throughout the in-water construction period. Potential effects of construction activities relate to turbidity, accidental spills, onsite and offsite sediment transport to surface waters, and re-suspension and redistribution of potentially contaminated sediments. Along with the species' tolerance to turbidity, implementation of environmental commitments (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan;* and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material; Fish Rescue and Salvage Plan*; and *Barge Operations Plan* described under Impact AQUA-1 for delta smelt and Appendix 3B, *Environmental Commitments*) would minimize the effects of these construction activities. The limited number of green sturgeon that could be present during the expected in-water work window would also reduce the potential for green sturgeon to be injured or killed as a result of in-water construction activities. Therefore, these effects would not be adverse to green sturgeon.

Impact pile driving could result in significant impacts on individual green sturgeon because they could be exposed to sound levels exceeding the interim $SEL_{cumulative}$ threshold. However, the numbers of fish affected by this level of noise would be relatively small, pile driving would be limited to periods of relatively low fish abundance, and vibratory methods would be used whenever possible (to avoid the noise associated with impact pile driving). Implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the occurrence, or severity, of these potential effects. Implementation of environmental commitments *Fish Rescue and Salvage Plan* and *Barge Operations Plan* (as described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*) would also reduce potential effects of construction activities on green sturgeon. Accordingly, underwater noise from impact pile driving would not result in adverse effects on green sturgeon.

Construction of the approach canal and Byron Tract Forebay would not affect fish-accessible waterways and therefore would not affect green sturgeon. As a result, these construction activities would not result in adverse effects on green sturgeon.

The effect of temporary and permanent rearing and migration habitat loss for green sturgeon would not be adverse due to the relatively small areas occupied by the construction and barge landing sites, the relatively low abundance of green sturgeon expected in the vicinity of these facilities during construction, and the low quality of the habitat affected by construction, as well as implementation of the environmental commitment *Barge Operations Plan* (see Impact AQUA-1 for delta smelt and Appendix 3B, *Environmental Commitments*). Overall, the potential effects of construction activities on migration and rearing habitat are not expected to adversely affect green sturgeon.

Locally increased predator habitat and predation from the temporary construction structures (cofferdams and barge landing docks) would not have population level effects. Therefore, predation effects on green sturgeon from construction activities would not be adverse.

NEPA Effects: The effects would not be adverse for green sturgeon.

CEQA Conclusion: As discussed above, in-water construction activities would be scheduled to occur when the least number of green sturgeon would likely be present in or near the construction areas. Implementation of environmental commitments *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan;* and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material* (see Impact AQUA-1 for delta smelt and Appendix 3B, *Environmental Commitments*)—as well as the species' tolerance to turbidity—would minimize the effects of construction activities on turbidity, accidental spills, onsite and offsite sediment transport to surface waters, and re-suspension and redistribution of potentially contaminated sediments. As a result, these impacts would be less than significant to green sturgeon.

Although only a limited occurrence of green sturgeon is expected in the construction areas the direct effects of underwater construction noise on them would be a significant impact because of the high likelihood that it would cause injury or death to most impacted fish in the immediate vicinity of the activity. However, Mitigation Measures AQUA-1a and AQUA-1b would reduce the potential for effects from underwater noise and would reduce the severity of impacts to a less-than-significant level. Implementation of environmental commitments *Fish Rescue and Salvage Plan* and *Barge Operations Plan* (as described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*) would also minimize potential impacts of construction activities on green sturgeon.

The limited susceptibility of sturgeon to predation and the locally increased predator habitat and predation from the temporary construction structures (cofferdams and barge landing docks) would not have population level effects. The effect of temporary and permanent rearing and migration habitat loss for green sturgeon would be limited due to the relatively small areas occupied by the construction and barge landing sites, and the low quality of the habitat affected by construction, as well as implementation of the environmental commitment *Barge Operations Plan* (see Impact AQUA-1 for delta smelt and Appendix 3B). Implementation of *CM6 Channel Margin Enhancement* would also result in a net improvement in channel margin habitat function. Overall, the potential impacts of construction activities are expected to be less than significant. No additional mitigation would be required.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 for delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 for delta smelt.

Impact AQUA-128: Effects of Maintenance of Water Conveyance Facilities on Green Sturgeon

Temporary Increases in Turbidity

As discussed for construction-related effects on turbidity (Impact AQUA-127), the potential increases in turbidity would be minimized to the extent possible through implementing the environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*).

Accidental Spills

Maintenance activities such as dredging, levee repair and placement of riprap could accidently introduce contaminants into the aquatic environment. However, implementation of the environmental commitments described under Impact AQUA-1 and in Appendix 3B, *Environmental Commitments,* would reduce the likelihood of any significant contaminant input to the Sacramento River and potential effects on green sturgeon survival. These environmental commitments are *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*.

Underwater Noise

As discussed for delta smelt (see Impact AQUA-2), underwater noise levels produced by in-water maintenance activities are not expected to reach a level that would harm juvenile or adult fishes. NMFS has found that underwater sound pressure levels less than the 150 dB RMS behavioral effects threshold may result in temporary altered behavior of fishes indicative of stress but would not result in permanent harm or injury (National Marine Fisheries Service 2001). Any increases in underwater noise would be temporary and infrequent, and would occur when the least number of green sturgeon are likely to be present.

Maintenance-Related Disturbance

Direct injury and mortality of green sturgeon from the use of in-water equipment during maintenance are most likely to occur during dredging activities around the new intakes. Suction dredging and mechanical excavation can capture or crush fish, causing injury or mortality. Green sturgeon are present year-round in the Sacramento River. Because sturgeon are benthic feeders, they may become entrained or injured by the dredge. However, potential effects would be minimized because maintenance dredging would occur infrequently, for a short duration, and in limited areas. Furthermore, effects would be minimized by implementation of environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*).

Loss of Spawning, Rearing, or Migration Habitat

Green sturgeon habitat near the intake structures is limited to rearing and migration. A small area of rearing habitat (i.e., 600 m^2) could be affected due to maintenance dredging. Dredging would remove benthic macroinvertebrates that are consumed by green sturgeon. Migration habitat would be available farther out in the channel and would be unaffected by dredging or riprap placement. Rearing and migration habitat of similar quantity and quality would also be readily accessible to green sturgeon in the immediate area. Effects would be minimized by implementation of environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*, including *Erosion and Sediment Control Plan*; *Dispose of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*.

Predation

Maintenance activities would be unlikely to have any measurable effect on green sturgeon predation rates. These activities may include the use of barges and other watercraft that could theoretically provide cover, shelter, and perching areas for delta smelt predators. However, the limited duration of maintenance activities and the associated noise and disturbance would be expected to dissuade predators from concentrating at sufficient density to measurably affect predation rates on green sturgeon. Additionally, due to the armored scutes (bony external scale) and relatively rapid growth of sturgeon, predation might be lower compared to other covered fish species following the early life stages (French et al. 2010).

Summary

In-water activities would be scheduled to occur when the least number of green sturgeon could be present in or near the maintenance areas. In addition, green sturgeon are tolerant to increases in turbidity, which might occur during maintenance activities. Such activities would include maintenance dredging at the intake sites, and installation or repair of riprap bank armoring. Implementation of the environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*, would further minimize or eliminate effects on green sturgeon by reducing the amount of turbidity and guiding the rapid and effective response in the case of inadvertent spills of hazardous materials. These environmental commitments include *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*.

Implementation of these environmental commitments, along with low numbers of green sturgeon expected to occur in the maintenance areas during the expected in-water work windows, and the limited frequency and duration of in-water maintenance activities would result in a very low potential for adverse effects on green sturgeon. In addition, no spawning habitat occurs in the areas potentially affected by maintenance activities, and ample rearing, and migration habitat of the same quality is readily accessible in the area, and this habitat would not be affected by maintenance activities.

NEPA Effects: As a result, the effects of short-term maintenance activities would not be adverse to green sturgeon.

CEQA Conclusion: Green sturgeon are benthic fish that inhabit naturally turbid water and are not expected to be affected by temporary increases in turbidity during maintenance activities. In addition to the limited frequency and duration of in-water maintenance activities and implementation of the commitments identified above and described in detail under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*, would minimize the potential for maintenance activities to affect green sturgeon by reducing the amount of turbidity and guiding the rapid and effective response to inadvertent spills of hazardous materials. These environmental commitments include *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*. Potential changes to habitat would also be limited and temporary.

In addition to being benthic dwellers, green sturgeon are present year-round in the Sacramento River, so they could potentially become entrained or injured by dredging equipment. Although the number of green sturgeon that could be affected by dredging is unknown, but expected to be low. Because maintenance dredging would occur infrequently, for a short duration, and in limited areas, in-water maintenance activities would not affect green sturgeon.

Green sturgeon habitat near the intake structures is limited to rearing and migration, and similar habitat occurs in adjacent areas. Therefore, the limited extent of habitat disturbance expected from periodic maintenance activities is not expected to substantially decrease the available rearing and migration habitat in the area. Overall, the potential impact of maintenance activities is considered less than significant because it would not substantially reduce green sturgeon habitat, restrict its range, or interfere with its movement. Consequently, no mitigation would be required.

Water Operations of CM1

Impact AQUA-129: Effects of Water Operations on Entrainment of Green Sturgeon

Water Exports from SWP/CVP South Delta Facilities

Alternative 1A would result in an overall annual average reduction in salvage of juvenile green sturgeon at the SWP/CVP south Delta facilities of approximately 56% to 60% (60–70 fish) compared to baseline scenarios.

Total annual average salvage of juvenile green sturgeon at the SWP south delta facilities was estimated at approximately 70 fish under all baseline scenarios and 18 fish under the two Alternative 1A scenarios. Differences between baseline and Alternative 1A were less at the CVP, where baseline scenario salvage ranged from 37 to 45 green sturgeon and the Alternative 1A scenario salvage was approximately 18 green sturgeon.

Reductions in salvage under Alternative 1A scenarios compared to baseline scenarios ranged from very little change in March–June (0–3 fewer fish per month) to considerable changes in February (approximately 25 fewer green sturgeon, or a 95% reduction) and in August–September (7–15 fewer fish, or a 33–65% reduction). The Juvenile Green Sturgeon Entrainment Index (Number of

Fish as Expanded Salvage ± 95% Confidence Intervals) was estimated at the CVP during wet and above-normal years. Salvage is estimated to peak in October and November at the CVP under all model scenarios. Total annual average salvage of juvenile green sturgeon at the SWP was estimated at approximately 12–14 fish under all baseline scenarios and 13 fish under the two Alternative 1A scenarios. At the CVP, baseline scenario total annual salvage ranged from 29 to 36 green sturgeon, and Alternative 1A scenario salvage was 25–30 green sturgeon.

Reductions in salvage at both facilities combined under Alternative 1A scenarios compared to baseline scenarios were low throughout the year (fewer than 10 green sturgeon per month, with no measurable differences in many months). The overall annual average decrease in salvage under Alternative 1A scenarios compared to baseline scenarios ranged from three to 12 green sturgeon (7–25% reductions).

Under the assumption that reduced export pumping in the south Delta is directly proportional to entrainment of juvenile green sturgeon, entrainment is expected to decrease under Alternative 1A relative to NAA. The decrease would be greater in wet and above-normal years (40–60%) than in below-normal, dry, and critical years (10–30% or less).

Water Exports from SWP/CVP North Delta Intake Facilities

Potential entrainment at the north Delta intakes occurs only under the action alternatives, including Alternative 1A, because there are no north Delta intakes operational under NAA. The north Delta intakes would be screened, which will be designed and built to specifications that are developed to reduce the entrainment and impingement of covered fish species. They are expected to exclude juvenile fish less than about 15 mm long, which is smaller than most life stages of all the covered fish, the screens are expected to be protective of nearly all life stages of all covered fish species (as evaluated in *BDCP Effects Analysis – Appendix 5B, Entrainment, Section B.5.9.2.1 Screening Effectiveness Analysis, hereby incorporated by reference*). Exceptions could be smaller larvae of delta smelt, Sacramento splittail, and sturgeon that may occur in the intake vicinity. Very little is known of the densities of these species in this area, so entrainment and impingement monitoring will determine the extent to which they are present. The project's adaptive management plan includes monitoring of the new screens to determine their effectiveness and if they are not meeting expectations additional measures may be implemented to improve screen performance. These measures may include modifications to the screens or other structural components at the intakes, or changes in water diversion operations to reduce entrainment or impingement rates of juvenile green sturgeon.

Water Exports with a Dual Conveyance for the SWP North Bay Aqueduct

Entrainment of green sturgeon at the North Bay Aqueduct has not been explicitly analyzed. However, the Barker Slough Pumping Plant is screened for fish >25mm and the alternative intake would presumably have screens of 1.75-m mesh and therefore it would exclude green sturgeon >10mm based on north Delta intake analysis. Overall effects would be expected to be no greater than for delta smelt.

If unforeseen changes in distributions or other factors occur as a result of project operations that would increase proportional loss of green sturgeon to entrainment, monitoring and the BDCP-proposed Real-Time Response Team would implement measures to avoid or minimize any potential threats to the species that might occur. Based on the current analysis, this would not be necessary.

Predation Associated with Entrainment

Predation can occur in association with the various intakes. The proportion of juvenile sturgeon lost to predation after entrainment, especially in CCF, is also unknown but should not be altered under CM1. Increased presence of predators around the north Delta intakes may increase predation loss of juveniles emigrating downstream to rear in the Delta. Juvenile sturgeon begin to emigrate at a small size and may be small enough to still be preyed upon by piscivorous fish as they pass by the north Delta facilities, although they do grow very rapidly early in their development.

NEPA Effects: Based on the projected entrainment of green sturgeon under the BDCP, a slight reduction of entrainment is expected at the south Delta facilities. However, the potential entrainment of larval sturgeon at the north Delta facility raises some uncertainty of the overall change in entrainment rate. This uncertainty will be addressed through monitoring and adaptive management actions. Based on available information, overall entrainment effects on green sturgeon are not expected to substantially change under Alternative 1A. Consequently, the effect would not be adverse.

CEQA Conclusion: As described above, operational activities associated with water exports from south SWP/CVP facilities are expected to result in a slight decrease in entrainment of green sturgeon. However, operational activities associated with water exports from SWP/CVP north Delta intake facilities could result in an increase in entrainment or a loss of individual sturgeon at that location. However, monitoring and adaptive management protocols will be implemented to confirm that fish are being excluded from entrainment and impingement in the manner that the design specifications suggest and which are consistent with biological objectives. Overall, impacts of water operations on entrainment of green sturgeon would be less than significant because they would not reduce their numbers. Consequently, no mitigation would be required.

Impact AQUA-130: Effects of Water Operations on Spawning and Egg Incubation Habitat for Green Sturgeon

In general, Alternative 1A would not affect spawning and egg incubation habitat for green sturgeon relative to NAA.

Sacramento River

Mean monthly flows were examined in the Sacramento River between Keswick and upstream of Red Bluff during the March to July spawning and egg incubation period for green sturgeon. Lower flows can reduce the instream area available for spawning and egg incubation. Flows under A1A_LLT would always be similar to or greater (up to 17%) than flows under NAA throughout the period at both locations although flows can be lower or higher in individual months of individual years (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Bend Bridge were examined during the March through July green sturgeon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

The number of days on which temperature exceeded 63°F by >0.5°F to >5°F in 0.5°F increments was determined for each month (May through September) and year of the 82-year modeling period (Table 11-1A-11). The combination of number of days and degrees above the 63°F threshold were further assigned a "level of concern", as defined in Table 11-1A-12. Differences between baselines and Alternative 1A in the highest level of concern across all months and all 82 modeled years are presented in Table 11-1A-62. There would be no difference in levels of concern between NAA and Alternative 1A.

Table 11-1A-62. Differences between Baseline and Alternative 1A Scenarios in the Number of Years in Which Water Temperature Exceedances above 63°F Are within Each Level of Concern, Sacramento River at Bend Bridge, May through September

Level of Concern	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Red	10 (250%)	1 (7%)
Orange	1 (100%)	1 (50%)
Yellow	3 (150%)	0 (0%)
None	-14 (-19%)	-2 (-3%)

Total degree-days exceeding 63°F at Bend Bridge were summed by month and water year type during May through September (Table 11-1A-63). Total degree-days under Alternative 1A would be 5% and 50% lower than under NAA during May and June, respectively, and 5% to 6% higher during July through September.

Table 11-1A-63. Differences between Baseline and Alternative 1A Scenarios in Total Degree-Days (°F-Days) by Month and Water Year Type for Water Temperature Exceedances above 63°F in the Sacramento River at Bend Bridge, May through September

Month	Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
May	Wet	51 (392%)	-4 (-6%)
	Above Normal	0 (NA)	-5 (-100%)
	Below Normal	4 (NA)	2 (100%)
	Dry	0 (NA)	0 (NA)
	Critical	4 (NA)	3 (300%)
	All	59 (454%)	-4 (-5%)
June	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	2 (NA)	2 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	7 (NA)	-11 (-61%)
	All	9 (NA)	-9 (-50%)
July	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	1 (NA)	1 (NA)
	Dry	6 (NA)	6 (NA)
	Critical	660 (8,250%)	30 (4.7%)
	All	667 (8,338%)	37 (6%)
August	Wet	2 (NA)	-1 (-33%)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	3 (NA)	3 (NA)
	Dry	118 (NA)	52 (79%)
	Critical	1,618 (805%)	57 (3%)
	All	1,741 (866%)	111 (6%)
September	Wet	0 (NA)	0 (NA)
	Above Normal	17 (NA)	15 (750%)
	Below Normal	77 (NA)	64 (492%)
	Dry	512 (1,652%)	29 (6%)
	Critical	1,267 (475%)	5 (0%)
	All	1,873 (629%)	113 (5%)

NA = could not be calculated because the denominator was 0.

Feather River

Flows were examined in the Feather River between Thermalito Afterbay and the confluence with the Sacramento River during the February through June spawning and egg incubation period for green sturgeon. At Thermalito Afterbay, flows under A1A_LLT would be greater by up to 138% than flows under NAA throughout the period depending on month and water year type. (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). At the confluence, flows under Alternative 1A would generally be similar to or up to 44% greater than flows under NAA depending on month and water year type, except during April through June in the ELT and during March in the LLT.

Mean monthly water temperatures in the Feather River at Gridley were examined during the February through June green sturgeon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

The percent of months exceeding the 64°F temperature threshold in the Feather River at Gridley was evaluated during May through September (Table 11-1A-64). For this impact, only the months of May and June were examined because spawning and egg incubation does not generally extend beyond June in the Feather River. Subsequent months are examined under Impact AQUA-131. In both May and June, the percent of months exceeding the threshold under Alternative 1A would be similar to or lower (up to 21% lower on an absolute scale) than the percent under NAA.

Table 11-1A-64. Differences between Baseline and Alternative 1A Scenarios in Percent of Months during the 82-Year CALSIM Modeling Period during Which Water Temperatures in the Feather River at Gridley Exceed the 64°F Threshold, May through September

	Degrees Above Threshold				
Month	>1.0	>2.0	>3.0	>4.0	>5.0
EXISTING CONDITIONS vs. A1A_LLT					
May	23 (73%)	17 (93%)	11 (113%)	10 (267%)	7 (300%)
June	1 (1%)	1 (1%)	9 (11%)	10 (15%)	21 (44%)
July	0 (0%)	0 (0%)	0 (0%)	10 (11%)	26 (38%)
August	0 (0%)	0 (0%)	6 (7%)	16 (20%)	32 (52%)
September	27 (39%)	33 (61%)	47 (165%)	53 (717%)	38 (1,550%)
NAA vs. A1A_LLT					
May	-16 (-22%)	-21 (-37%)	-11 (-35%)	-5 (-27%)	-2 (-20%)
June	-5 (-5%)	-7 (-8%)	-7 (-8%)	-19 (-20%)	-19 (-21%)
July	0 (0%)	0 (0%)	0 (0%)	0 (0%)	-2 (-3%)
August	0 (0%)	0 (0%)	-2 (-2%)	-4 (-4%)	-2 (-3%)
September	28 (42%)	28 (48%)	26 (53%)	17 (40%)	12 (43%)

Total degree-days exceeding 64°F were summed by month and water year type at Gridley during May through September (Table 11-1A-65). Only May and June were examined for spawning and egg incubation habitat here. Subsequent months are examined under Impact AQUA-131. Total degree-months exceeding the threshold under Alternative 1A would be 13% to 15% lower than those under NAA during May and June.

Table 11-1A-65. Differences between Baseline and Alternative 1A Scenarios in Total Degree-Months (°F-Months) by Month and Water Year Type for Water Temperature Exceedances above 64°F in the Feather River at Gridley, May through September

Month	Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
May	Wet	15 (250%)	-9 (-30%)
	Above Normal	10 (91%)	-4 (-16%)
	Below Normal	13 (163%)	-11 (-34%)
	Dry	26 (186%)	-3 (-7%)
	Critical	21 (124%)	1 (3%)
	All	86 (154%)	-25 (-15%)
June	Wet	42 (56%)	-25 (-18%)
	Above Normal	7 (14%)	-22 (-28%)
	Below Normal	9 (14%)	-23 (-24%)
	Dry	47 (50%)	-6 (-4%)
	Critical	39 (70%)	0 (0%)
	All	145 (43%)	-75 (-13%)
July	Wet	59 (35%)	43 (23%)
	Above Normal	33 (62%)	16 (23%)
	Below Normal	60 (88%)	28 (28%)
	Dry	98 (114%)	54 (42%)
	Critical	78 (99%)	24 (18%)
	All	328 (72%)	165 (27%)
August	Wet	54 (30%)	37 (19%)
	Above Normal	40 (89%)	18 (27%)
	Below Normal	64 (91%)	32 (31%)
	Dry	100 (147%)	22 (15%)
	Critical	50 (59%)	0 (0%)
	All	308 (69%)	109 (17%)
September	Wet	61 (156%)	88 (733%)
	Above Normal	23 (144%)	32 (457%)
	Below Normal	35 (125%)	-5 (-7%)
	Dry	50 (179%)	-2 (-3%)
	Critical	52 (260%)	-2 (-3%)
	All	221 (169%)	111 (46%)

San Joaquin River

Flows in the San Joaquin River at Vernalis under Alternative 1A during March through June would not be different from flows under NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*.

No water temperature modeling was conducted in the San Joaquin River.

NEPA Effects: Collectively, these results indicate that the effect is not adverse because it does not have the potential to substantially reduce the amount of suitable habitat. Flows in the Sacramento and Feather Rivers under Alternative 1A would be similar or greater than those under the NEPA baseline and water temperature conditions would improve for green sturgeon under Alternative 1A. There would be no effects of Alternative 1A on flows in the San Joaquin River.

CEQA Conclusion: In general, Alternative 1A would not affect spawning and egg incubation habitat for green sturgeon relative to the Existing Conditions.

Sacramento River

Mean monthly flows were examined in the Sacramento River between Keswick and upstream of Red Bluff during the March to July spawning and egg incubation period for green sturgeon (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).Flows under A1A_LLT would generally be similar to or greater (up to 24%) than those under Existing Conditions. Exceptions include in above normal and below normal years during March at Keswick (6% reduction), wet years during May in both locations (14% to 17% reduction depending on location and water year type), and below normal, dry, and critical water years during July in both locations (5% to 11% lower depending on location and water year type). Also, flows can be lower or higher in individual months of individual years. These results indicate that there would be very few reductions in flows in the Sacramento River under Alternative 1A relative to the Existing Conditions.

Mean monthly water temperatures in the Sacramento River at Bend Bridge were examined during the March through July green sturgeon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 1A in any month or water year type throughout the period.

The number of days on which temperature exceeded 63°F by >0.5°F to >5°F in 0.5°F increments was determined for each month (May through September) and year of the 82-year modeling period (Table 11-1A-62). The combination of number of days and degrees above the 63°F threshold were further assigned a "level of concern", as defined in Table 11-1A-12. Differences between baselines and Alternative 1A in the highest level of concern across all months and all 82 modeled years are presented in Table 11-1A-13. The number of "red" years would be 250% higher under Alternative 1A relative to Existing Conditions.

Total degree-days exceeding 63°F at Bend Bridge were summed by month and water year type during May through September (Table 11-1A-63). Water temperatures under Alternative 1A would exceed the threshold 59 degree-days (454%) and 9 degree-days (no relative change calculation possible due to division by 0) more than those under Existing Conditions during May and June, respectively. Water temperatures under Alternative 1A would exceed the threshold 667(8338%) to 1873 (629%) degree-days more than those under Existing Conditions.

Feather River

In the Feather River between Thermalito Afterbay and the confluence with the Sacramento River during February through June, flows under A1A_LLT would nearly always be similar to or greater (up to 204%) than those under Existing Conditions with few exceptions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These results indicate that there would be very few reductions in flows in the Feather River under Alternative 1A relative to the Existing Conditions.

Mean monthly water temperatures in the Feather River at Gridley were examined during the February through June green sturgeon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would generally be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 1A in any month or water year type throughout the period, except during February, in which mean monthly temperatures under Alternative 1A would be 6% lower than those under Existing Conditions.

The percent of months exceeding the 64°F temperature threshold in the Feather River at Gridley was evaluated during May through September (Table 11-1A-64). For this impact, only the months of May and June were examined because spawning and egg incubation does not generally extend beyond June in the Feather River. Subsequent months are examined under Impact AQUA-131. During the period, the percent of months exceeding the threshold under Alternative 1A would be similar to or higher (up to 23% higher on an absolute scale) than the percent under Existing Conditions.

Total degree-days exceeding 64°F were summed by month and water year type at Gridley during May through September (Table 11-1A-65). Only May and June were examined for spawning and egg incubation habitat here. Subsequent months are examined under Impact AQUA-131. Total degree-months exceeding the threshold under Alternative 1A would be 43% to 154% higher than those under Existing Conditions during May and June.

San Joaquin River

Flows in the San Joaquin River at Vernalis under Alternative 1A would be up to 38% lower than flows under Existing Conditions during the March through June spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

No water temperature modeling was conducted in the San Joaquin River.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-130 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 1A could be significant because, under the CEQA baseline, the alternative could substantially reduce suitable spawning and egg incubation habitat, contrary to the NEPA conclusion set forth above. Flows in the Sacramento, Feather, and San Joaquin River would generally be similar between Alternative 1A and the CEQA baseline, but the exceedance above NMFS temperature thresholds would be greater in the Sacramento and Feather Rivers under Alternative 1A.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 1A does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 1A indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 1A. This indicates that the differences between Existing Conditions and Alternative 1A found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 1A, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on green sturgeon spawning and egg incubation habitat. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-131: Effects of Water Operations on Rearing Habitat for Green Sturgeon

In general, Alternative 1A would not affect the quantity and quality of green sturgeon larval and juvenile rearing habitat relative to NAA.

Water temperature was used to determine the potential effects of Alternative 1A on green sturgeon larval and juvenile rearing habitat because larvae and juveniles are benthic-oriented and, therefore, their habitat is more likely to be limited by changes in water temperature than flow rates.

Sacramento River

Mean monthly water temperatures in the Sacramento River at Bend Bridge were examined during the May through October green sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

Feather River

Mean monthly water temperatures in the Feather River at Gridley were examined during the April through August green sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

The percent of months exceeding the 64°F temperature threshold in the Feather River at Gridley was evaluated during May through September (Table 11-1A-64). The percent of months exceeding the threshold under Alternative 1A would be similar to or lower (up to 21% lower on an absolute scale) than the percent under NAA in all months except September, in which the percent of months under Alternative 1A would be 12% to 28% (absolute scale) lower than the percent under NAA.

Total degree-days exceeding 64°F were summed by month and water year type at Gridley during May through September (Table 11-1A-65). Total degree-months exceeding the threshold under Alternative 1A would be 13% to 15% lower than those under NAA during May and June and 17% to 46% greater than those under NAA during July through September.

San Joaquin River

Water temperature modeling was not conducted in the San Joaquin River.

NEPA Effects: Collectively, these results indicate that the effect is not adverse because it does not have the potential to substantially reduce the amount of suitable habitat. Water temperature conditions in the Sacramento and Feather Rivers under Alternative 1A would generally be similar than those under the NEPA baseline.

CEQA Conclusion: In general, Alternative 1A would not affect the quantity or quality of green sturgeon larval and juvenile rearing habitat relative to the Existing Conditions.

Water temperature was used to determine the potential effects of Alternative 1A on green sturgeon larval and juvenile rearing habitat because larvae and juveniles are benthic-oriented and, therefore, their habitat is more likely to be limited by changes in water temperature than flow rates.

Sacramento River

Mean monthly water temperatures in the Sacramento River at Bend Bridge were examined during the May through October green sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperature under Alternative 1A would be similar to those under Existing Conditions during May and June, but 5% to 7% lower than those under Existing Conditions during July through October.

Feather River

Mean monthly water temperatures in the Feather River at Gridley were examined during the April through August green sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 1A in any month except August, in which temperatures under Alternative 1A would be 5% greater than those under Existing Conditions.

The percent of months exceeding the 64°F temperature threshold in the Feather River at Gridley was evaluated during May through September (Table 11-1A-64). The percent of months exceeding the threshold under Alternative 1A would be similar to or greater (up to 53% higher on an absolute scale) than the percent under Existing Conditions in all months during the period.

Total degree-days exceeding 64°F were summed by month and water year type at Gridley during May through September (Table 11-1A-65). Total degree-months exceeding the threshold under Alternative 1A would be 43% to 169% greater than those under Existing Conditions depending on month.

San Joaquin River

Water temperature modeling was not conducted in the San Joaquin River.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-131 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 1A could be significant because, under the CEQA baseline, the alternative could substantially reduce suitable rearing habitat, contrary to the NEPA conclusion set forth above. Water temperatures under Alternative 1A would be greater than those under Existing Conditions during the majority of the rearing period in the Sacramento and Feather River and therefore, the exceedance above NMFS temperature thresholds would be greater in the Feather River.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 1A does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 1A indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 1A. This indicates that the differences between Existing Conditions and Alternative 1A found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 1A, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on green sturgeon rearing habitat. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-132: Effects of Water Operations on Migration Conditions for Green Sturgeon

In general, Alternative 1A would reduce green sturgeon migration conditions relative to NAA.

Analyses for green sturgeon migration conditions focused on flows in the Sacramento River between Keswick and Wilkins Slough and in the Feather River between Thermalito and the confluence with the Sacramento River during the April through October larval migration period, the August through March juvenile migration period, and the November through June adult migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Because these periods encompass the entire year, flows during all months were compared. Reduced flows could slow or inhibit downstream migration of larvae and juveniles and reduce the ability to sense upstream migration cues and pass impediments by adults.

Sacramento River flows under A1A_LLT would generally be similar to or greater than flows under NAA in all months except July through September and November, during which flows would be up to 46% lower depending on location, month, and water year type.

Larval transport flows were also examined by utilizing the positive correlation between white sturgeon year class strength and Delta outflow during April and May (USFWS 1995) under the assumption that the mechanism responsible for the relationship is that Delta outflow provides improved green sturgeon larval transport that results in improved year class strength. Results for white sturgeon presented in Impact AQUA-150 below suggest that, using the positive correlation between Delta outflow and year class strength, green sturgeon year class strength would be lower under Alternative 1A.

Feather River flows under A1A_LLT would generally be lower by up to 86% than those under NAA during July through September. Flows during other months under A1A_LLT would generally be similar to or greater than flows under NAA with some exceptions.

NEPA Effects: Collectively, these results indicate that the effect is adverse because it has the potential to substantially interfere with the movement of green sturgeon. Reductions in flows in the Sacramento and Feather Rivers during substantial portions of the migration period could slow or inhibit migration.

This effect is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this effect to a level that is not adverse would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this would be an unavoidable adverse effect because there is no feasible mitigation available. Even so, the mitigation measures listed below have the potential to reduce the severity of impact, but not necessarily to a level considered not adverse.

CEQA Conclusion: In general, Alternative 1A would reduce green sturgeon migration conditions relative to the Existing Conditions.

Analyses for green sturgeon migration conditions focused on flows in the Sacramento River between Keswick and Wilkins Slough and in the Feather River between Thermalito and the confluence with the Sacramento River during the April through October larval migration period, the August through March juvenile migration period, and the November through July adult migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Because these periods encompass the entire year, flows during all months were compared. Reduced flows could slow or inhibit downstream migration of larvae and juveniles and reduce the ability to sense upstream migration cues and pass impediments by adults.

Sacramento River flows under A1A_LLT would generally be similar to or greater than flows under Existing Conditions in all months except July through September, and November when flows generally decreased by up to 28%. Flows during other months would generally be similar to or greater than flows under Existing Conditions.

Flows in the Feather River under A1A_LLT would generally be up to 60% lower than flows under Existing Conditions in June through September, and November. Flows during other months under A1A_LLT would generally be similar to or greater than flows under Existing Conditions.

For Delta outflow, the percent of months exceeding flow thresholds under A1A_LLT would consistently be lower than those under Existing Conditions for each flow threshold, water year type, and month (16% to 75% lower on a relative scale) (see Table 11-1A-70 below).

Summary of CEQA Conclusion

Collectively, these results indicate that the impact would be significant because it has the potential to substantially interfere with the movement of fish. The reduction in flows in the Sacramento River during August, September, and November and in the Feather River during July, August, September, November, and December would affect larval and juvenile migration period, which could slow or inhibit their downstream migration.

This impact is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this impact to a less-than-significant level would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this impact is significant and unavoidable because there is no feasible mitigation available. Even so, proposed below is mitigation that has the potential to reduce the severity of impact though not necessarily to a less-than-significant level.

Mitigation Measure AQUA-132a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Green Sturgeon to Determine Feasibility of Mitigation to Reduce Impacts to Migration Conditions

Although analysis conducted as part of the EIR/EIS determined that Alternative 1A would have significant and unavoidable adverse effects on spawning habitat, this conclusion was based on the best available scientific information at the time and may prove to have been over- or understated. Upon the commencement of operations of CM1 and continuing through the life of the permit, the BDCP proponents will monitor effects on migration habitat in order to determine whether such effects would be as extensive as concluded at the time of preparation of this document and to determine any potentially feasible means of reducing the severity of such effects. This mitigation measure requires a series of actions to accomplish these purposes, consistent with the operational framework for Alternative 1A.

The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 1A operations only. Development of mitigation actions for the incremental impact on migration habitat attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 1A.

Mitigation Measure AQUA-132b: Conduct Additional Evaluation and Modeling of Impacts on Green Sturgeon Migration Conditions Following Initial Operations of CM1

Following commencement of initial operations of CM1 and continuing through the life of the permit, the BDCP proponents will conduct additional evaluations to define the extent to which modified operations could reduce impacts to migration habitat under Alternative 1A. The analysis required under this measure may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6).

Mitigation Measure AQUA-132c: Consult with USFWS and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Green Sturgeon Migration Conditions Consistent with CM1

In order to determine the feasibility of reducing the effects of CM1 operations on green sturgeon habitat, the BDCP proponents will consult with USFWS and the Department of Fish and Wildlife to identify and implement any feasible operational means to minimize effects on migration habitat. Any such action will be developed in conjunction with the ongoing monitoring and evaluation of habitat conditions required by Mitigation Measure AQUA-132a.

If feasible means are identified to reduce impacts on migration habitat consistent with the overall operational framework of Alternative 1A without causing new significant adverse impacts on other covered species, such means shall be implemented. If sufficient operational flexibility to reduce effects on green sturgeon habitat is not feasible under Alternative 1A operations, achieving further impact reduction pursuant to this mitigation measure would not be feasible under this Alternative, and the impact on green sturgeon would remain significant and unavoidable.

Restoration Measures (CM2, CM4–CM7, and CM10)

Impact AQUA-133: Effects of Construction of Restoration Measures on Green Sturgeon

Temporary Increases in Turbidity

Restoration construction activities such as riprap removal, shoreline excavation and re-contouring, and planting riparian vegetation have the potential to result in temporary increases in turbidity conditions in adjacent waterways. However, green sturgeon inhabit naturally turbid water and are unlikely to be affected by temporary increases in turbidity during restoration construction. Implementation of environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments,* would minimize the potential for turbidity to affect green sturgeon. These environmental commitments include *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*.

Increased Exposure to Mercury

As discussed above for delta smelt (Impact AQUA-7), the implementation of *CM12 Methylmercury Management* would minimize potential effects of methylmercury mobilization from restoration sites, on green sturgeon. As a result, restoration activities are not likely to produce the biogeochemical conditions that would support methylation of mercury; thus increased bioavailability and toxicity as a result of restoration activities are not expected. However, the cycling of mercury is a complicated process, and is difficult to predict based on existing information.

Accidental Spills

As discussed above for construction and maintenance activities (see Impact AQUA-1 and Impact AQUA-2 for delta smelt), implementation of environmental commitments described in Appendix 3B, *Environmental Commitments,* would minimize the potential for introduction of contaminants to surface waters and provide for effective containment and cleanup should accidental spills occur. These environmental commitments are *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; and *Spill Prevention, Containment, and Countermeasure Plan*. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Disturbance of Contaminated Sediments

Runoff and resuspension of contaminants could cause short-term, localized increases in the concentrations of contaminants in and near restoration sites (see discussion for delta smelt under Impact AQUA-7). Sturgeon typically feed on prey items that are associated with the substrate, and are prone to exposure to sediment borne toxicants. They also tend to bioaccumulate toxicants that occur in the Plan Area, such as methylmercury, pesticides and selenium, and spend several years rearing in the Plan Area. As a result, they have an increased risk of effects from disturbances of contaminated sediments. Adhering to the expected in-water construction window would provide limited protection for sturgeon, because juvenile sturgeon can occur in the Plan Area throughout the year. Although juvenile sturgeon could be present during the in-water work window, the limited frequency and duration and spatial extent of in-water restoration activities, and implementation of environmental commitments (see Appendix 3B), would minimize exposure levels. These environmental commitments are *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt. Because of the temporary nature of toxicity spikes, the potential effects would be minimized.

In-Water Work Activities

Restoration construction activities could temporarily produce noise levels and disturbances that could affect nearby fishes. Such activities are not expected to elevate underwater noise above the threshold sound pressure levels established for fish (see discussion for delta smelt under Impact AQUA-1). Any changes in disturbance levels would be minor and temporary, and fish are expected to generally avoid areas where shoreline construction activities are occurring. Potential effects of in-water activity would be minimized by implementation of the environmental commitments described under Impact AQUA-1 and in Appendix 3B, *Environmental Commitments*, including *Erosion and Sediment Control Plan*; *Dispose of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*.

Predation

The creation of permanent tidal brackish habitat within Suisun Marsh would create permanent year-round rearing habitat for juvenile green sturgeon. Once these habitats became fully established they are expected to provide highly productive food and refuge habitats. Due to their salinities, these habitats would be expected to provide some refuge from black bass. Also since younger juvenile sturgeon are less tolerant of saltwater, juveniles that occupy these brackish habitats are likely larger and have developed armored bony plating to substantially reduce predation vulnerability.

Summary

In-water and shoreline construction activities associated with habitat restoration would be scheduled to occur when the least number of green sturgeon would be present in or near the restoration sites. Such activities would include riprap removal and levee breaching, and shoreline excavation and re-contouring. In addition, runoff from upland construction areas would also have the potential to affect aquatic habitats and green sturgeon. Green sturgeon are tolerant to increases in turbidity, which might occur during shoreline restoration construction activities. Implementation of the environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*), would minimize or eliminate effects on green sturgeon (see Impact AQUA-7).

While implementation of these environmental commitments would minimize or eliminate short-term effects occurring during restoration construction, long-term effects could also occur. For example, removing or breaching levees would result in the expansion of floodplain habitat, and more frequent inundation these areas, potentially promoting conversion of mercury to methylated mercury, and runoff containing agricultural-related toxins such as copper and organochlorine pesticides. However, the overall effect of increased bioavailability of methylmercury and other pollutants on green sturgeon is likely to be of low magnitude, periodic and localized. In addition, potential increases would be minimized to the extent possible because of implementation of *CM12 Methylmercury Management* (see Impact AQUA-10).

NEPA Effects: For these reasons, green sturgeon would not be adversely affected by restoration construction activities.

CEQA Conclusion: Green sturgeon inhabit naturally turbid water and are not expected to be affected by temporary increases in turbidity during restoration construction activities. In addition to the limited frequency and duration and spatial extent of in-water restoration activities and implementation of the environmental commitments identified above and described in detail under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*), would minimize the potential for turbidity, accidental spills, resuspension of contaminated sediments, or construction noise to affect green sturgeon. Therefore, this impact is considered less than significant for green sturgeon because it would not substantially reduce habitat, restrict its range or interfere with its movement. Consequently, no mitigation would be required.

Impact AQUA-134: Effects of Contaminants Associated with Restoration Measures on Green Sturgeon

As described for delta smelt (see Impact AQUA-8), effects on covered fish species will depend on the species/life stage present in the area of elevated toxins and the duration of exposure. A complete analysis can be found in the *BDCP Effects Analysis – Appendix D, Contaminants (hereby incorporated by reference)*. Potential impacts on green sturgeon from effects of methylmercury, copper, ammonia, and pesticides associated with habitat restoration activities would also be similar to those discussed for delta smelt (see Impact AQUA-8). The effects of selenium are influenced by different factors, which are discussed below.

A description of the potential for mobilization and bioavailability of selenium associated with restorations measures is included in impact AQUA-8, which addresses delta smelt specifically. There is a greater potential for effects on green sturgeon than delta smelt because sturgeon are bottom feeders, and selenium can bioaccumulate in some sessile filter feeders, such as clams.

An increase of residence time, due to BDCP activities, in areas with dense clam populations (such as Suisun Bay) and benthic-feeding covered fish species (such as sturgeon), could result in increased mobilization and bioaccumulation of selenium in the food chain of benthic-feeding fish. However, residence time is directly related to outflow in Suisun Bay, and CALSIM modeling results indicate that outflow and residence time will not change significantly under Alternative 1A, and effects on selenium biogeochemical cycling are not anticipated. Comparison of the monthly mean residence time (averaged over years 1992 through 2003) indicates that residence time in Suisun Bay may change from a decrease of 13 days to an increase of 5 days. Because mobilization of selenium due to increased residence time is not expected, effects related to BDCP restoration activities on sturgeon feeding on clams in Suisun Bay are expected to be limited, but would need to be evaluated on a site-specific basis.

The higher contribution of San Joaquin River flow to Delta outflow in Alternative 1A relative to the NAA is expected to increase the loading and by extension possibly the bioaccumulation of selenium in the low-salinity zone food web. However, regulation of both Grasslands in the San Joaquin River basin and oil refineries near Suisun Bay could help in decreasing the loading of selenium to the Delta. Because selenium would be mobilized into the food chain under a narrow set of conditions, the overall effects within the Plan Area are likely low.

NEPA Effects: While Alternative 1A actions are likely to result in increased production, mobilization, and bioavailability of methylmercury, selenium, copper, and pesticides in the aquatic system, any such releases would be short-term and localized, and would be unlikely to result in measurable increases in the bioaccumulation in green sturgeon. Although green sturgeon are known to bioaccumulate selenium due in large part to their consumption of the overbite clam (*C. amurensis*), habitat restoration measures under Alternative 1A are expected to have little effect on selenium bioaccumulation in the Plan Area. Overall, the effects of contaminants associated with restoration measures would not be adverse for green sturgeon with respect to copper, ammonia and pesticides. The effects of methylmercury and selenium on green sturgeon are uncertain.

CEQA Conclusion: Alternative 1A actions are likely to result in increased production, mobilization, and bioavailability of methylmercury, selenium, copper, and pesticides in the aquatic system. However, such releases would typically be short-term and localized, and would be unlikely to result in measurable increases in the bioaccumulation in green sturgeon. For selenium, evaluation of the factors that influence it's bioavailability and bioaccumulation indicate a low probability for effects. For methylmercury, implementation of *CM12 Methylmercury Management* would help to minimize the increased mobilization of methylmercury at restoration areas. Therefore, the impact of contaminants is considered less than significant because it would not substantially effect green sturgeon either directly or through habitat modifications and, with restoration, would be beneficial in the long-term. Consequently, no mitigation would be required.

Impact AQUA-135: Effects of Restored Habitat Conditions on Green Sturgeon

For discussion of the potential effects on green sturgeon, see the discussion under Impact AQUA-9 for delta smelt.

CM2 Yolo Bypass Fisheries Enhancement

As discussed under Impact AQUA-9, Yolo Bypass fisheries enhancement modifications are designed to increase the frequency, duration and magnitude of seasonal floodplain inundation in the Yolo Bypass. These actions would improve passage and habitat for sturgeon. These modifications, which include fish passage improvements and flow management, would reduce migratory delays and loss of sturgeon at Fremont Weir and other structures. The Yolo Bypass would potentially provide temporary habitat for green sturgeon but would not be a substantial benefit.

CM4 Tidal Natural Communities Restoration

For discussion of the effect on green sturgeon, see the discussion under Impact AQUA-9.

Although tidal habitat restoration would benefit green sturgeon, habitat conditions are likely to decrease for juvenile sturgeon over time, because of temperature effects associated with climate change during the late spring. It is anticipated that the overall effect of *CM4 Tidal Natural Communities Restoration* would remain positive because increases in habitat quantity are greater than decreases in quality, providing a mechanism to at least partially offset the future effects of climate change (see Impact AQUA-9).

As discussed under Impact AQUA-9, increased food productivity is expected in all ROAs as a result of the BDCP, but the Suisun Marsh, Cache Slough, and South Delta ROAs are expected to see the greatest increases in productivity. Sturgeon feed on benthic invertebrates, including those found on marsh mudflats, which will benefit from the transfer of increased production to mudflat fauna in restored marshes. Therefore, the substantial increase in these habitats would likely increase total food availability for sturgeon. While green sturgeon are not expected to extensively use floodplain or floodplain wetland habitat, potential increases in food resources from seasonal inundation of these habitats is considered beneficial to the species.

CM5 Seasonally Inundated Floodplain Restoration

Periodic inundation of the restored floodplain also will benefit sturgeon by cycling nutrients, supporting growth of plankton and aquatic insects. Providing river–floodplain connectivity would increase production of lower trophic levels at relatively rapid time scales, with some food web organisms responding within days at high densities. Although food is not likely a limiting factor to the abundance of sturgeon in the Delta, BDCP actions, notably the restoration and enhancement of upstream habitats, may increase sturgeon food availability relative to Existing Conditions. If the upstream productivity transfer occurs at the planktonic level, downstream benthic habitats utilized for foraging by adult sturgeon may experience a greater increase in productivity due to the potential increase in Corbula than if this upstream transfer occurs at higher trophic levels, such as planktivorous fish.

BDCP habitat restoration would also increase the availability of foraging and refuge habitats available to rearing juvenile sturgeon. For further discussion, see Impact AQUA-9.

CM6 Channel Margin Enhancement

Expanded nearshore habitat with improved inputs of terrestrial organic matter and insects, as well as woody material, riparian shade, and underwater cover will increase the quality and area of potential rearing habitat for sturgeon. Enhancements are also expected to improve migration conditions for sturgeon, by increasing the availability and quality of resting (refuge) habitat as a result of increased channel margin complexity (e.g., woody material), particularly during high flows.

Despite the potential benefits of channel margin habitat on green sturgeon, the overall effect is expected to be minimal because of the relatively short period of their life history spent in these shallow nearshore areas; therefore, the effect is not considered adverse. For further discussion see Impact AQUA-9.

CM7 Riparian Natural Community Restoration

White and green sturgeon rely on ecological attributes of valley/foothill riparian habitat in the Plan Area. BDCP habitat restoration, including riparian restoration, are expected to improve the quality and quantity of Delta rearing habitats for juvenile sturgeon. Once established, these habitats would likely provide suitable food resources for juvenile sturgeon. For further discussion, see Impact AQUA-9.

CM10 Nontidal Marsh Restoration

As discussed under delta smelt, upland restoration under *CM10 Nontidal Marsh Restoration* is expected to have minor indirect beneficial effects on green sturgeon in the main river systems and Delta. These upland wetlands provide hydrologic and water quality functions, such as storing water during floods and filtering contaminants. These sites would also provide some additional food resources such as insects, zooplankton, phytoplankton and dissolved organic carbon. These materials would be exported during flood stages when the upland might be connected to the river system. Although the contribution from 400 acres would be small, it would be beneficial. For additional discussion, see Impact AQUA-9.

NEPA Effects: The effects of floodplain, tidal, channel margin and riparian habitat restoration activities on green sturgeon are expected to be similar to those discussed for delta smelt (see Impact AQUA-9). In general these effects are expected to be beneficial for green sturgeon, although the primary benefits are likely to be the result of increased productivity from more frequent inundations of restoration areas and increased amount and quality of available rearing and migration habitat.

Despite the improvements in habitat and habitat functions in the Delta from floodplain, tidal, channel margin and riparian habitat restoration activities, habitat quality is expected to decline in the LLT primarily because of climate change. However, the overall effect of restoration activities is expected to remain beneficial for green sturgeon.

However, it is important to note that benefits would not be derived in all years, and that an adaptive management plan would be needed to determine an operational protocol that optimizes benefits both locally and in adjacent habitats.

CEQA Conclusion: As with delta smelt, the overall effects of floodplain, tidal, channel margin and riparian habitat restoration activities are expected to be beneficial for green sturgeon (see Impact AQUA-9). The primary benefits are likely due to increased productivity from more frequent inundations of restoration areas and increased amount and quality of available rearing and migration habitat. Despite the improvements in habitat and habitat functions in the Delta from these restoration activities, habitat quality is expected to decline in the LLT, primarily because of climate change. However, the overall impact of restoration activities is expected to remain beneficial for green sturgeon because they increase habitat. Consequently, no mitigation would be required.

Other Conservation Measures (CM12–CM19 and CM21)

Impact AQUA-136: Effects of Methylmercury Management on Green Sturgeon (CM12)

Refer to Impact AQUA-10 under delta smelt for a discussion of the potential effects of methylmercury management on green sturgeon.

Impact AQUA-137: Effects of Invasive Aquatic Vegetation Management on Green Sturgeon (CM13)

The following analysis is based on the more detailed analysis included in *BDCP Effects Analysis – Appendix F*, *Biological Stressors, Section F.1.1 Invasive Aquatic Vegetation, Section F.4 Invasive Aquatic Vegetation, and F.5.3.2.3 Nonnative Aquatic Vegetation Control (Conservation Measure 13) (hereby incorporated by reference)*.

A general analysis of the effects on covered fish species has been conducted that was described above for delta smelt (see Impact AQUA-11). Potential impacts on green sturgeon from IAV control during operations are similar to those discussed for delta smelt. The control of IAV with implementation of *CM13 Invasive Aquatic Vegetation Control* is expected to maintain or improve turbidity conditions that could benefit green sturgeon rearing conditions, reducing their susceptibility to predation. Sturgeon grow rapidly and can quickly outgrow the size range where predation could occur. Sturgeon also have a protective amour like plating making them unappealing to predators even at a young age (French et al. 2010). Therefore the impact of IAV removal on predation risk for sturgeon is expected to be slight.

The control of IAV would also increase the amount of rearing habitat, as well as access to the habitat and potential increases in food availability.

NEPA Effects: The effects of IAV control are expected to provide an overall benefit to green sturgeon.

CEQA Conclusion: The control of IAV should provide a modest net benefit to green sturgeon during operations through chemical and mechanical treatment and is considered a beneficial impact by reducing predation mortality, increasing food availability, and increasing rearing habitat. This impact is expected to be beneficial.

Impact AQUA-138: Effects of Dissolved Oxygen Level Management on Green Sturgeon (CM14)

NEPA Effects: As discussed in Chapter 8, *Water Quality*, dissolved oxygen levels would be very similar to Existing Conditions in the areas upstream of the Delta, in the Delta, and in the SWP/CVP export service areas (see discussion of Impacts WQ-10 and WQ-11). As noted there, however, *CM14 Stockton Deepwater Ship Channel Dissolved Oxygen Levels* management would increase the dissolved oxygen levels and improve aquatic habitat conditions for green sturgeon The effect would be beneficial for green sturgeon.

CEQA Conclusion: As discussed in Chapter 8, *Water Quality*, *CM14 Stockton Deepwater Ship Channel Dissolved Oxygen Levels* management would increase the dissolved oxygen levels and improve aquatic habitat conditions. Green sturgeon occur in the channel and the increased dissolved oxygen levels also provide improved habitat conditions for them, which would be a benefit. Consequently, no mitigation would be required**.**

Impact AQUA-139: Effects of Localized Reduction of Predatory Fish on Green Sturgeon (CM15)

To the extent that localized predator control efforts of *CM15 Localized Reduction of Predatory Fish* reduce the overall abundance of fish predators in the Delta occupied by green sturgeon, it is possible, but not assured that there would be some reduction in losses to predation, although no quantitative information is available regarding the current magnitude of green sturgeon loss to predation (see Impact AQUA-13). Due to these uncertainties, there would be no demonstrable effect of this conservation measure on green sturgeon.

Additionally, although little is known about predation of juvenile sturgeon in the Delta they grow rapidly in their first year of development (probably reaching 30 cm (12 inches) in their first year, Kohlhorst and Cech 2001a) and grow protective bony plating at an early age. Due to their rapid growth early in their development, the period in which juvenile sturgeon are vulnerable to piscivorous fish predators in the Delta is likely limited, and therefore the potential beneficial effects from implementation of *CM15 Localized Reduction of Predatory Fish* are likely limited.

One potential risk of localized predator removal is by-catch of sturgeon during beach seining, gill netting, angling, electrofishing, or other capture methods. Sturgeon tend to reside in deep water areas and should be protected from electrofishing, however they would be more susceptible to injury because of their large size. Striped bass monitoring by CDFW at Knights Landing using fyke traps caught four adult green sturgeon in 16,100 hours; gillnetting on the lower Sacramento resulted in the capture of two green sturgeon in 15,450 hours. (Dubois and Mayfield 2009; Dubois et al. 2010). Adult sturgeon aren't susceptible to being caught using artificial lures commonly used to catch striped bass but would be susceptible to baited hooks. Injuries to sturgeon would be similar to those experiences by salmonids listed above. Adult sturgeon in deep water should be able to avoid most types of nets. Adult sturgeon caught in nets (fyke, beach seine, or gill nets) could suffer similar injuries as salmonids such as ones listed above. However, the number of sturgeon affected by this variety of methods is expected to be very low.

NEPA Effects: The overall effect would not be adverse.

CEQA Conclusion: Due to the uncertainties concerning overall fish predator reduction and actual predation rates on green sturgeon in the Delta, there would be no demonstrable effect from this conservation measure on green sturgeon. Little is known about predation of juvenile sturgeon in the Delta. Sturgeon grow rapidly in their first year of development and grow protective bony plating at an early age. Due to rapid early growth, the period in which juvenile sturgeon are vulnerable to piscivorous fish predators in the Delta is likely limited, and therefore the potential beneficial impacts from implementation of *CM15 Localized Reduction of Predatory Fish* are likely limited.

One potential risk of localized predator removal is by-catch of sturgeon during beach seining, gill netting, angling, electrofishing, or other capture methods. Sturgeon tend to reside in deep water areas and should be protected from electrofishing, however they would be more susceptible to injury because of their large size. Striped bass monitoring by CDFW at Knights Landing using fyke traps caught four adult green sturgeon in 16,100 hours; gillnetting on the lower Sacramento resulted in the capture of two green sturgeon in 15,450 hours. (Dubois and Mayfield 2009; Dubois et al. 2010). Adult sturgeon aren't susceptible to being caught using artificial lures commonly used to catch striped bass but would be susceptible to baited hooks. Adult sturgeon in deep water should be able to avoid most types of nets. However, the number of sturgeon affected by this variety of methods is expected to be very low. The impact is considered less than significant because it would not have a substantial effect on their numbers. Consequently, no mitigation would be required.

Impact AQUA-140: Effects of Nonphysical Fish Barriers on Green Sturgeon (CM16)

NEPA Effects: Green sturgeon are not known to currently spawn in the San Joaquin River although they may have historically (Moyle 2002; Beamesderfer et al. 2007). Therefore, the level of interaction of sturgeon juveniles with the Old River NPB is likely to be minimal. Green sturgeon are known to spawn upstream in the upper Sacramento River basin (Moyle 2002), and emigrating juveniles would likely encounter the Georgiana Slough barrier. Sturgeon may also be deterred by the sound and lights of the barrier (Popper 2005; Meyer et al. 2010; Halvorsen et al. 2012) thereby minimizing their entry into areas of the central Delta where high predation rates would be likely. Also, due to the armored scutes (bony external scale) and rapid growth of sturgeon, predation would likely be low following the early life stages (French et al. 2010). No overall adverse effect on green sturgeon is likely from NPBs.

CEQA Conclusion: Green sturgeon are not known to currently spawn in the San Joaquin River although they may have historically (Moyle 2002; Beamesderfer et al. 2007). Therefore, the level of interaction of sturgeon juveniles with the Old River NPB is likely to be minimal. Green sturgeon are known to spawn upstream in the upper Sacramento River basin (Moyle 2002), and emigrating juveniles would likely encounter the Georgiana Slough barrier. Sturgeon may also be deterred by the sound and lights of the barrier (Popper 2005; Meyer et al. 2010; Halvorsen et al. 2012) thereby minimizing their entry into areas of the central Delta where high predation rates would be likely. Also, due to the armored scutes (bony external scale) and rapid growth of sturgeon, predation would likely be low following the early life stages. The overall impact on green sturgeon from NPBs is less than significant because it would not substantially reduce their numbers. Consequently, no mitigation would be required.

Impact AQUA-141: Effects of Illegal Harvest Reduction on Green Sturgeon (CM17)

NEPA Effects: *CM17 Illegal Harvest Reduction* would be applied to Chinook salmon, Central Valley steelhead, green sturgeon and white sturgeon and are expected to have beneficial effects on their populations.

CEQA Conclusion: *CM17 Illegal Harvest Reduction* would be applied to Chinook salmon, Central Valley steelhead, green sturgeon and white sturgeon. Although the numbers cannot be quantified implementation is expected to have positive effects on their populations. The impact would be beneficial because it would increase the numbers of progeny in the next generation. Consequently, no mitigation would be required.

Impact AQUA-142: Effects of Conservation Hatcheries on Green Sturgeon (CM18)

NEPA Effects: *CM18 Conservation Hatcheries* would establish new and expand existing conservation propagation programs for delta and longfin smelt. This conservation measure would have no effect on green sturgeon.

CEQA Conclusion: *CM18 Conservation Hatcheries* would establish new and expand existing conservation propagation programs for delta and longfin smelt. This conservation measure would have no impact on green sturgeon. Consequently, no mitigation would be required.

Impact AQUA-143: Effects of Urban Stormwater Treatment on Green Sturgeon (CM19)

NEPA Effects: The effects of Urban stormwater treatment (CM19) would reduce contaminants associated with urban areas because it provides for the treatment of stormwater discharges. As discussed in Chapter 8, *Water Quality*, and previously under Impact AQUA-8 in the section titled *Pyrethroids, Organophosphate Pesticides, and Organochlorine Pesticides,* stormwater treatment would reduce urban loadings of pesticides (including pyrethroids), phosphorous, trace metals and other contaminants. These reductions would contribute to improved water quality in the Delta. Based on the improved overall water quality conditions and reduced pesticides the effect would be beneficial.

CEQA Conclusion: Urban stormwater treatment (CM19) would reduce contaminants associated with urban areas because it would provide for the treatment of stormwater discharges. As discussed in Chapter 8, *Water Quality*, and previously under Impact AQUA-8 in the section titled *Pyrethroids, Organophosphate Pesticides, and Organochlorine Pesticides,* stormwater treatment would reduce urban loadings of pesticides(including pyrethroids), phosphorous, trace metals and other water contaminants. These reductions would contribute to improved water quality in the Delta. Therefore, the impacts of urban stormwater treatment would be beneficial because it would have a beneficial effect both directly and through habitat modifications on green sturgeon. Consequently, no mitigation would be required.

Impact AQUA-144: Effects of Removal/Relocation of Nonproject Diversions on Green Sturgeon (CM21)

NEPA Effects: As discussed above for other species, there is no evidence of substantial entrainment of covered fish species at agricultural diversions in the Plan Area, but slight reductions in entrainment are expected from decommissioning agricultural diversions in the ROAs (see Impact AQUA-18). ***:*** These effects would not be adverse and may be beneficial.

CEQA Conclusion: Although there is no evidence of substantial entrainment of covered fish species at agricultural diversions in the Plan Area, slight reductions in entrainment are expected from decommissioning agricultural diversions in the ROAs (see Impact AQUA-18). This impact would be less than significant and may result in a slight benefit to green sturgeon because it would reduce entrainment which would have a positive impact on green sturgeon numbers. Consequently, no mitigation would be required.

White Sturgeon

Construction and Maintenance of CM1

Impact AQUA-145: Effects of Construction of Water Conveyance Facilities on White Sturgeon

Juvenile and adult spawning white sturgeon could be present in the vicinity of the intake and barge landings during in-water construction. Table 11-4 illustrates the life stages of white sturgeon present in the north, east, and south Delta during the expected in-water construction window (June 1–October 31). Juveniles may be present year-round in all the construction areas. The potential for exposure of white sturgeon to construction-related activities is expected to be relatively high, but would likely be limited to two construction seasons (one for installation of cofferdams and barge landings, and one for removal of cofferdams and barge landings).

Temporary Increases in Turbidity

Because white sturgeon are benthic fish, they inhabit naturally turbid water. They are unlikely to be affected by a temporary increase in turbidity. As discussed for delta smelt (see Impact AQUA-1), environmental commitments would be implemented to minimize turbidity during construction activities (see Impact AQUA-1 for delta smelt and Appendix 3B, *Environmental Commitments: Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*).

Accidental Spills

Potential impacts on white sturgeon from accidental spills during construction are similar to those discussed for delta smelt (see Impact AQUA-1). Implementing the environmental commitments described under Impact AQUA-1 for delta smelt, and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*), and specifically the *Spill Prevention, Containment, and Countermeasure Plan,* would be expected to minimize the potential for introduction of contaminants to surface waters and provide for effective containment and cleanup should accidental spills occur.

Disturbance of Contaminated Sediments

There is a potential risk of contaminated sediments affecting white sturgeon during construction of intake and barge landings if they are present in the vicinity of in-water construction activities (see Impact AQUA-1 for delta smelt). These risks include the potential for reduced reproduction and growth rates, as well as potentially higher mortality rates, particularly for larval and juvenile life stages (Silvestre et al. 2010; Lee et al. 2011). Because white sturgeon are mainly benthic dwellers, they may be more susceptible to contaminants than other fish species. However, the suspension of sediments would be minimized by implementation of environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*).

Underwater Noise

Underwater sound generated by impact pile driving in or near surface waters can potentially harm white sturgeon. It is important to note that this impact would be realized only where piles must be impact driven ; underwater sound generated by vibratory pile installation methods are not sufficiently loud to injure fish.

White sturgeon eggs and larvae could experience underwater sound effects because they are expected to occur in the locations of the intakes and barge landings during the in-water construction period, and would be affected by underwater noise levels that exceed injury or disturbance thresholds (see Impact AQUA-1). Juvenile and adult white sturgeon could be present near the intakes during June through October, when pile driving would occur, as they migrate to and from upstream spawning areas. Adult white sturgeon are large and less susceptible to noise from impact driving, and are able to avoid injurious exposure to underwater noise from pile driving. They may experience short delays in migration past the intakes when pile driving occurs; however, pile driving would occur only intermittently through a portion of the day, and minor migration delays would not affect their ability to successfully reach spawning grounds. Therefore, the potential for adult white sturgeon to experience an adverse effect (e.g., injury or mortality, or substantial migratory disturbance) from impact pile driving would be low-to-moderate because of their size, ability to move away from the underwater sound, and their potentially low temporal and spatial distribution during construction. Furthermore, potential exposure of white sturgeon to underwater sound above the threshold criterion would be intermittent and limited.

Juvenile white sturgeon would have relatively low densities near the intakes and barge landings throughout the June through October pile driving period. Given these numbers in the east and south Delta areas; the relatively small areas affected by underwater noise in these areas; and the intermittent nature of potential exposure to underwater sound above the threshold, there is a low chance that juvenile white sturgeon would be exposed to noise levels from impact pile driving at the barge landing sites. However, a greater number of juveniles could be present in the north Delta during construction of the intake cofferdams, resulting in a moderate risk of exposure to potentially harmful underwater sound levels. Therefore, there is a moderate potential for juvenile white sturgeon to experience an adverse effect (e.g., injury or mortality).

If an individual juvenile white sturgeon were present in an area affected by underwater sound from impact pile driving above the 183-dB $SEL_{cumulative}$ effects threshold level, and proximate to an impact-driven pile, it could experience an adverse effect, such as injury or mortality. However, because of the overall low-to-moderate densities of juvenile white sturgeon expected in all pile driving locations, the relatively limited extent of area subject to underwater sound exceeding the effects threshold, and implementation of the avoidance and minimization measures included in

Mitigation Measures AQUA-1a and AQUA-1b, the potential for juvenile white sturgeon to experience an adverse effect from impact pile driving (e.g., injury or mortality) would be low.

Fish Stranding

White sturgeon trapped within cofferdams or other fish exclusion structures would be at some risk for injury during fish removal activities. Because adults and juvenile white sturgeon could be present at any time during the year, some low risk of impact exists. Fish removal activities from construction areas would be implemented according to environmental commitment *Fish Rescue and Salvage Plan*, as described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*). Because of these measures, the risk of substantial effects would be minimized.

In-Water Work Activities

As discussed for delta smelt (see Impact AQUA-1), in-water work activities have the potential disturb, injure or kill fish through direct physical injury from construction activities. Although most fish would likely avoid the noise and activity of pile installation and placement of riprap protection, these activities have the potential to affect fish. Primarily juvenile white sturgeon would be expected in the vicinity of the intake facilities and barge landings during construction, because adults are expected to more easily avoid these areas. Because of the relatively low densities of juvenile white sturgeon expected in all construction areas, the potential for effects would be somewhat limited. Furthermore, effects would be minimized by implementation of environmental commitments described in Appendix 3B, *Environmental Commitments*, including *Erosion and Sediment Control Plan*; *Dispose of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Loss of Spawning, Rearing, or Migration Habitat

There is no suitable spawning habitat for white sturgeon in the vicinity of the proposed in-water work; therefore, white sturgeon spawning habitat would not be affected by construction activities. However, construction would temporarily and permanently affect migration and rearing habitat. Any activity that occurs in a species migration corridor has the potential to affect the behavior (i.e., through a change in migration route within the channel, delay from a noise deterrent, artificial light sources, etc.). However, migration habitat would not be substantially affected by construction activities, as the majority of the work will be conducted within cofferdams, and ample migration habitat would be available in adjacent areas. The existing migration and rearing habitat is of relatively low quality, due to the armored levees with limited riparian vegetation. Because of the poor quality of the existing habitat, the overall effect of this habitat loss would be limited.

Implementation of *CM6 Channel Margin Enhancement* would enhance channel margin habitat along 20 miles of the Sacramento River, including the vicinity of the intake structures, and would be designed to result in a net improvement in channel margin habitat function. Implementation of the environmental commitment *Barge Operations Plan* (see Impact AQUA-1 for delta smelt and Appendix 3B, *Environmental Commitments*) would limit the potential for impacts from vessel wakes and propeller wash on shoreline habitat.

The construction of the intakes and barge landings will temporarily affect white sturgeon migration and rearing habitat, and the intakes screens will permanently alter the nearshore portion of this habitat in the Sacramento River. Because of implementation of *CM6 Channel Margin Enhancement*, the overall effects would be limited because of the relatively poor quality of the current habitat, and the addition of new, higher quality habitat associated with *CM6 Channel Margin Enhancement*.

Predation

Construction of in-water pilings and over-water structures and local temporary increases in turbidity associated with construction may affect predation on various fish species, including white sturgeon. In a laboratory study, prickly sculpin and northern pikeminnow have been observed to consume sturgeon larvae (Gadomski and Parsley 2005), and some degree of predation could occur on juveniles. However, due to the armored scutes (bony external scale) (French et al. 2010) and relatively rapid growth of sturgeon, predation would likely be low following the early life stages. Nobriga and Feyrer (2008) examined data for striped bass stomach contents collected between 1963 and 2003, and did not find any sturgeon among the more than 4,000 samples. The increase in cover habitat for bass and other predatory fish that would be created at the barge landings would likely result in only a minimal effect on white sturgeon.

Summary

The potential for exposure of white sturgeon to construction-related activities is expected to be low. Implementation of environmental commitments *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan;* and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material* (see Appendix 3B, *Environmental Commitments*)—as well as the species' tolerance to turbidity—would minimize the effects of construction activities on turbidity, accidental spills, onsite and offsite sediment transport to surface waters, and re-suspension and redistribution of potentially contaminated sediments. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt. As a result, these effects would not likely be adverse to white sturgeon.

The moderate number of white sturgeon that would likely be present during the expected in-water work window would also limit the potential for white sturgeon to be injured or killed as a result of in-water construction activities. Impact pile driving could result in significant impacts on individual juvenile white sturgeon because they could be exposed to sound levels exceeding the interim $SEL_{cumulative}$ threshold. However, the numbers of fish affected by this level of noise would be relatively small, and pile driving would be limited to periods of relatively low fish abundance, and vibratory methods would be used whenever possible (avoiding the noise associated with impact pile driving). Implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of these potential impacts. Implementation of Environmental Commitments *Fish Rescue and Salvage Plan* and *Barge Operations Plan* (as described in Appendix 3B) would also offset some potential effects of construction activities on white sturgeon. Construction of the approach canal and Byron Tract Forebay would not affect fish-accessible waterways and therefore would not affect white sturgeon. As a result, these construction activities would not be adverse.

Locally increased predator habitat and predation from the temporary construction structures (cofferdams and barge landing docks) would not have population level effects. Therefore, predation effects on white sturgeon from construction activities would not be adverse.

The effect of temporary and permanent rearing and migration habitat loss for white sturgeon would not be adverse due to the relatively small areas occupied by the construction and barge landing sites, the relatively low abundance of white sturgeon expected in the vicinity of these facilities during construction, and the low quality of the habitat affected by construction, as well as implementation of environmental commitment *Barge Operations Plan* (see Impact AQUA-1 for delta smelt and Appendix 3B).

NEPA Effects: Overall, the potential effects of construction activities are not expected to adversely affect white sturgeon.

CEQA Conclusion: The potential for exposure of white sturgeon to construction-related activities is expected to be low. Implementation of environmental commitments *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan;* and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material* (see Impact AQUA-1 for delta smelt and Appendix 3B, *Environmental Commitments*) would reduce the amount of turbidity from in-water construction and would guide rapid and effective response in the case of inadvertent spills of hazardous materials. These measures—as well as the species' tolerance to turbidity—would minimize the effects of construction activities on turbidity, accidental spills, onsite and offsite sediment transport to surface waters, and re-suspension and redistribution of potentially contaminated sediments.

Although only a limited occurrence of white sturgeon is expected in the construction areas the direct effects of underwater construction noise on them would be a significant impact because of the high likelihood that it would cause injury or death to most impacted fish in the immediate vicinity of the activity. However, Mitigation Measures AQUA-1a and AQUA-1b would reduce the potential for effects from underwater noise and would reduce the severity of impacts to a less-than-significant level. Implementation of environmental commitments *Fish Rescue and Salvage Plan* and *Barge Operations Plan* (as described under Impact AQUA-1 for delta smelt and in Appendix 3B) would also minimize potential effects of construction activities on white sturgeon.

The limited susceptibility of sturgeon to predation and only locally increased predator habitat and predation from the temporary construction structures (cofferdams and barge landing docks) would not have population level effects. The effect of temporary and permanent rearing and migration habitat loss for white sturgeon would be limited due to the relatively small areas occupied by the construction and barge landing sites, and the low quality of the habitat affected by construction, as well as implementation of Environmental Commitment *Barge Operations Plan* (see Appendix 3B). Implementation of *CM6 Channel Margin Enhancement* would also result in a net improvement in channel margin habitat function. Based on the above the overall potential impacts of construction activities are expected to be less than significant, and no mitigation would be required.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 for delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 for delta smelt.

Impact AQUA-146: Effects of Maintenance of Water Conveyance Facilities on White Sturgeon

Temporary Increases in Turbidity

As discussed for construction-related effects on turbidity (Impact AQUA-145), the potential increases in turbidity would be minimized to the extent possible through implementing the environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*).

Accidental Spills

Maintenance activities such as dredging, levee repair and placement of riprap could accidently introduce contaminants into the aquatic environment. Effects would be minimized by implementing the environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*). Implementation of the environmental commitments would reduce the likelihood of any significant contaminant input to the Sacramento River and potential effects on white sturgeon survival.

Underwater Noise

As discussed for delta smelt (see Impact AQUA-2), underwater noise levels produced by in-water maintenance activities are not expected to reach a level that would harm juvenile or adult fishes. NMFS has found that underwater sound pressure levels less than the 150 dB RMS behavioral effects threshold may result in temporary altered behavior of fishes indicative of stress but would not result in permanent harm or injury (National Marine Fisheries Service 2001). Any increases in underwater noise would be temporary and infrequent, and would occur when the least number of white sturgeon are likely to be present.

Maintenance-Related Disturbance

Direct injury and mortality of white sturgeon from the use of in-water equipment during maintenance are most likely to occur during dredging activities around the new intakes. Suction dredging and mechanical excavation can capture or crush fish, causing injury or mortality. White sturgeon are present year-round in the Sacramento River. Because sturgeon are benthic feeders, they may become entrained or injured by the dredge. However, potential effects would be minimized because maintenance dredging would occur infrequently, for a short duration, and in limited areas. Furthermore, effects would be minimized by implementation of environmental commitments including *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan;* and *Barge Operations Plan*, described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*.

Loss of Spawning, Rearing, or Migration Habitat

White sturgeon habitat near the intake structures is limited to rearing and migration. A small area of rearing habitat (i.e., 600 m^2) could be affected due to maintenance dredging. Dredging would remove benthic macroinvertebrates that are consumed by white sturgeon. Migration habitat would be available farther out in the channel and would be unaffected by dredging or riprap placement. Rearing and migration habitat of similar quality would also be readily accessible to white sturgeon in the immediate area. Furthermore, potential effects would be minimized by implementation of environmental commitments described in Appendix 3B, *Environmental Commitments*. These environmental commitments include *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan;* and *Dispose of Spoils, Reusable Tunnel Material, and Dredged Material*. Pertinent details of these plans are provided under Impact AQUA-1.

Predation

Maintenance activities would be unlikely to have any measurable effect on white sturgeon predation rates. These activities may include the use of barges and other watercraft that could theoretically provide cover, shelter, and perching areas for various predators. However, the limited duration of maintenance activities and the associated noise and disturbance would be expected to dissuade predators from concentrating at sufficient density to measurably affect predation rates on white sturgeon.

Summary

White sturgeon are tolerant to increases in turbidity, which might occur during maintenance activities. Such activities would include maintenance dredging at the intake sites, and installation or repair of riprap bank armoring. Implementation of the environmental commitments described in Appendix 3B, *Environmental Commitments*, would further minimize or eliminate effects on white sturgeon by limiting turbidity increases, and by guiding the rapid and effective response in the case of inadvertent spills of hazardous materials. These Environmental Commitments are *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Implementation of these environmental commitments, along with the limited number of white sturgeon expected to occur in the maintenance areas during the expected in-water work windows, and the limited frequency and duration of in-water maintenance activities, would result in a very low potential for adverse effects on white sturgeon. In addition, no spawning habitat occurs in the areas potentially affected by maintenance activities, and ample rearing, and migration habitat of the same quality is readily accessible in the area, and this habitat would not be affected by maintenance activities.

NEPA Effects: As a result, the effects of short-term maintenance activities would not be adverse to white sturgeon.

CEQA Conclusion: White sturgeon are benthic fish that inhabit naturally turbid water and are not expected to be affected by temporary increases in turbidity during maintenance activities. In addition to the limited frequency and duration of in-water maintenance activities and implementation of environmental commitments identified above and described in detail under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*, would minimize the potential for maintenance activities to affect white sturgeon by limiting turbidity increases, and by guiding the rapid and effective response in the case of inadvertent spills of hazardous materials.

These environmental commitments are *environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*. Potential changes to habitat would also be limited and temporary.

In addition to being benthic dwellers, white sturgeon are present year-round in the Sacramento River, so they could potentially become entrained or injured by dredging equipment. Although the number of white sturgeon that could be affected by dredging is unknown, but expected to be low. Because maintenance dredging would occur infrequently, for a short duration, and in limited areas, in-water maintenance activities would not affect white sturgeon populations.

White sturgeon habitat near the intake structures is limited to rearing and migration, and similar habitat occurs in adjacent areas. Therefore, the limited extent of habitat disturbance expected from periodic maintenance activities is not expected to substantially decrease the available rearing and migration habitat in the area. Overall, the potential impacts of maintenance activities are considered less than significant because it would not reduce white sturgeon habitat, restrict its range, or interfere with its movement. Consequently, no mitigation would be required.

Water Operations of CM1

Impact AQUA-147: Effects of Water Operations on Entrainment of White Sturgeon

Water Exports from SWP/CVP South Delta Facilities

Alternative 1A would reduce the estimated total annual average salvage of white sturgeon at the combined SWP/CVP south Delta facilities by approximately 43% to 52%, compared to baseline scenarios. Total annual average salvage of juvenile white sturgeon at the SWP was estimated at 135–160 fish under baseline scenarios and just over 60 fish under the two Alternative 1A scenarios. At the CVP, baseline scenario annual salvage ranged from 110 to 130 white sturgeon, and Alternative 1A scenario salvage was approximately 80 white sturgeon.

Reductions in salvage under Alternative 1A scenarios compared to baseline scenarios ranged from very little change in April–June (7 or fewer fish per month) to considerable changes in January–March (14–24 fewer fish, or ~95% reduction). The overall annual average reduction in salvage of juvenile white sturgeon from baseline scenarios to Alternative 1A scenarios is estimated at approximately 100–150 fish (42–50% reduction).

Overall, salvage of white sturgeon juveniles is estimated to be considerably lower in drier years than wetter years. The SWP salvage estimates indicate peaks in December, April–May, and August under all model scenarios; with similar values between scenarios for most months except April–May, when Alternative 1A scenarios had higher values. Salvage is estimated to peak in February–April and July–August at the CVP facility under all model scenarios. Total annual average salvage of juvenile white sturgeon at SWP was estimated to be similar among all scenarios at 21–27 fish per year. At the CVP, baseline scenario total annual salvage ranged from 12 to 14 white sturgeon, and Alternative 1A scenario salvage was 8–9 white sturgeon.

Under the assumption that reduced export pumping in the south Delta is directly proportional to entrainment of juvenile white sturgeon, entrainment should decrease under Alternative 1A relative to NAA. The decrease would be greater in wet and above-normal years (40–60%) than in below-normal, dry, and critical years (10–30% or less).

Water Exports from SWP/CVP North Delta Intake Facilities

Similar to discussion for green sturgeon (see Impact AQUA-129), entrainment losses of white sturgeon is expected to be minimized by screen designs at the north Delta intake facilities, which will be designed and built to specifications that are developed to reduce the entrainment and impingement of covered fish species. Exceptions could occur for smaller larvae that may occur in the intake vicinity. Entrainment of larval fish by water diversions in the south Delta are highly variable, ranging from zero to an estimated 10,000 individuals for at least one of the facilities between 1981 and 2006 (Israel et al. 2009). Very little is known of the larval densities in the north Delta area, so entrainment and impingement monitoring will determine the extent to which they are present. The projects adaptive management plan includes monitoring of the new screens to determine their effectiveness and if they are not meeting expectations additional measures may be implemented to improve screen performance. These measures may include modifications to the screens or other structural components at the intakes, or changes in water diversion operations to reduce entrainment or impingement rates of juvenile white sturgeon.

Water Exports with a Dual Conveyance for the SWP North Bay Aqueduct

Entrainment of white sturgeon at the North Bay Aqueduct has not been explicitly analyzed. However, the Barker Slough Pumping Plant is screened for fish >25mm and the alternative intake would presumably have screens of 1.75-m mesh and therefore it would exclude white sturgeon >10 mm based on north Delta intake analysis (as evaluated in *BDCP Effects Analysis – Appendix 5B, Entrainment, Section B.5.9.2.1 Screening Effectiveness Analysis, hereby incorporated by reference*). Overall effects would be expected to be no greater than for delta smelt.

If unforeseen changes in distributions or other factors occur as a result of project operations that would increase proportional loss of white sturgeon to entrainment, monitoring and the BDCP-proposed Real-Time Response Team would implement measures to avoid or minimize any potential threats to the species that might occur. Based on the current analysis, this would not be necessary.

NEPA Effects: Based on the projected entrainment of white sturgeon under the BDCP, a reduction is expected at the south Delta facilities. However, the potential entrainment of larval sturgeon at the north Delta facility raises some uncertainty of the overall change in entrainment rate. This uncertainty will be addressed through monitoring and adaptive management actions. Based on available information, overall entrainment effects on white sturgeon populations are not expected to substantially change under Alternative 1A. These effects would likely not be adverse.

CEQA Conclusion: As described above, operational activities associated with water exports from south SWP/CVP facilities are expected to result in a slight decrease in entrainment of white sturgeon. However, operational activities associated with water exports from SWP/CVP north Delta intake facilities could result in an increase in entrainment or a loss of individual sturgeon at that location. Monitoring and adaptive management protocols will be implemented to confirm that fish are being excluded from entrainment and impingement in the manner that the design specifications suggest. Overall, the impacts of water operations on white sturgeon would be less than significant because they would not reduce their numbers. Consequently, no mitigation would be required.

Impact AQUA-148: Effects of Water Operations on Spawning and Egg Incubation Habitat for White Sturgeon

In general, Alternative 1A would not affect spawning and egg incubation habitat for white sturgeon relative to NAA.

Sacramento River

Flows in the Sacramento River at Wilkins Slough and Verona were examined during the February to May spawning and egg incubation period for white sturgeon. Flows under A1A_LLT would typically be similar to or greater than flows under NAA during February to May (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A1A_LLT would be similar to those under NAA during all water year types in February and March, and generally greater than NAA flows in April and May, with one exception in April during wet water years with a small decrease of 7%. These results indicate either no effect or a slight beneficial effect from increased flows, depending on month and water year type, compared to NAA.

Mean monthly water temperatures in the Sacramento River at Hamilton City were examined during the February through May white sturgeon spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period.

The number of days on which temperature exceeded a 61°F optimal and 68°F lethal threshold by >0.5°F to >5°F in 0.5°F increments were determined for each month (March through June) and year of the 82-year modeling period (Table 11-1A-11). The combination of number of days and degrees above each threshold were further assigned a "level of concern", as defined in Table 11-1A-12. Differences between baselines and Alternative 1A in the highest level of concern across all months and all 82 modeled years are presented in Table 11-1A-66. For the 61°F threshold, there would be 17 fewer (43% fewer) "red" years under Alternative 1A than under NAA. For the 68°F threshold, there would be negligible differences in the number of years under each level of concern between NAA and Alternative 1A.

Table 11-1A-66. Differences between Baseline and Alternative 1A Scenarios in the Number of Years in Which Water Temperature Exceedances above the 61°F and 68°F Thresholds Are within Each Level of Concern, Sacramento River at Hamilton City, March through June

Level of Concern	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
61°F threshold		
Red	32 (178%)	-17 (-43%)
Orange	1 (17%)	4 (25%)
Yellow	-15 (125%)	6 (38%)
None	-18 (150%)	7 (70%)
68°F threshold		
Red	0 (NA)	0 (NA)
Orange	0 (NA)	0 (NA)
Yellow	1 (NA)	-2 (-200%)
None	-1 (-1%)	2 (2%)
NA = could not be calculated because the denominator was 0.		

Total degree-days exceeding 61°F and 68°F were summed by month and water year type at Hamilton City during March through June (Table 11-1A-67, Table 11-1A-68). Total degree-days exceeding the 61°F threshold under Alternative 1A would be 31% higher than those under NAA during March, although this is an increase of only 5 degree-days, which would not cause biologically meaningful effect to white sturgeon. During April through June, total degree days exceeding the threshold would be 17% to 23% lower than those under NAA. Total degree-days exceeding the 68°F threshold would not differ between NAA and Alternative 1A during March and April, but would be 29% to 36% lower under Alternative 1A than under NAA during May and June.

Table 11-1A-67. Differences between Baseline and Alternative 1A Scenarios in Total Degree-Days (°F-Days) by Month and Water Year Type for Water Temperature Exceedances above 61°F in the Sacramento River at Hamilton City, March through June

Month	Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
March	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	9 (NA)	5 (125%)
	Dry	11 (NA)	0 (0%)
	Critical	1 (NA)	0 (0%)
	All	21 (NA)	5 (31%)
April	Wet	65 (542%)	-1 (-1%)
	Above Normal	60 (600%)	-8 (-10%)
	Below Normal	62 (1,033%)	0 (0%)
	Dry	53 (104%)	-91 (-47%)
	Critical	15 (1,500%)	1 (7%)
	All	255 (319%)	-99 (-23%)
May	Wet	857 (257%)	-258 (-18%)
	Above Normal	206 (94%)	-145 (-25%)
	Below Normal	389 (211%)	-60 (-9%)
	Dry	175 (87%)	-258 (-41%)
	Critical	340 (168%)	-10 (-2%)
	All	1,967 (173%)	-731 (-19%)
June	Wet	435 (75%)	-523 (-34%)
	Above Normal	112 (37%)	-254 (-38%)
	Below Normal	473 (224%)	-29 (-4%)
	Dry	649 (194%)	-53 (-5%)
	Critical	555 (148%)	9 (1%)
	All	2,224 (123%)	-850 (-17%)

NA = could not be calculated because the denominator was 0.

Table 11-1A-68. Differences between Baseline and Alternative 1A Scenarios in Total Degree-Days (°F-Days) by Month and Water Year Type for Water Temperature Exceedances above 68°F in the Sacramento River at Hamilton City, March through June

Month	Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
March	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
April	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
May	Wet	31 (443%)	-5 (-12%)
	Above Normal	2 (NA)	-18 (-90%)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	-2 (-100%)
	Critical	2 (NA)	1 (100%)
	All	35 (500%)	-24 (-36%)
June	Wet	3 (NA)	-5 (-63%)
	Above Normal	2 (200%)	-2 (-40%)
	Below Normal	4 (NA)	2 (100%)
	Dry	0 (NA)	0 (NA)
	Critical	20 (NA)	-7 (-26%)
	All	29 (2,900%)	-12 (-29%)

NA = could not be calculated because the denominator was 0.

Feather River

In the Feather River between Thermalito Afterbay and the confluence with the Sacramento River during February to May, flows under A1A_LLT would be similar to or up to 110% greater than flows under NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These results indicate that there would be mostly beneficial flow-related effects of Alternative 1A on white sturgeon spawning and egg incubation in the Feather River.

Mean monthly water temperatures in the Feather River below Thermalito Afterbay and at the confluence with the Sacramento River were examined during the February through May white sturgeon spawning and egg incubation period. Mean monthly water temperatures would not differ between NAA and Alternative 1A at either location throughout the period.

San Joaquin River

Flows in the San Joaquin River at Vernalis under Alternative 1A during February through May would not be different from flows under NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*.

Water temperature modeling was not conducted for the San Joaquin River.

NEPA Effects: Collectively, these results indicate that the effect is not adverse because it does not have the potential to substantially reduce the amount of suitable habitat. Flows under Alternative 1A are generally similar or greater than flows under NAA in all rivers. In addition, water temperatures and exceedances above NMFS temperature thresholds for spawning adults and egg incubation under Alternative 1A would generally be similar to or lower than exceedances under NAA.

CEQA Conclusion:

In general, under Alternative 1A water operations, the quantity and quality of spawning and egg incubation habitat for white sturgeon would not be affected relative to the CEQA baseline.

Sacramento River

Flows in the Sacramento River at Wilkins Slough and Verona were examined during the February to May spawning and egg incubation period for white sturgeon. Flows at Wilkins Slough under A1A_LLT would generally be similar to or greater than flows under Existing Conditions with few exceptions (up to 18% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows at Verona under A1A_LLT would generally be similar to those under Existing Conditions except in below normal years in February and March in which flows would be up to 7% lower. Flows would also be lower in wet years in April (8%) and May (18%), and in above normal years in April (6%). These results indicate that there would be some limited reductions in flows in the Sacramento River during this period under Alternative 1A compared to Existing Conditions.

Mean monthly water temperatures in the Sacramento River at Hamilton City were examined during the February through May white sturgeon spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 1A in any month or water year type throughout the period.

The number of days on which temperature exceeded a 61°F optimal and 68°F lethal threshold by >0.5°F to >5°F in 0.5°F increments were determined for each month (March through June) and year of the 82-year modeling period (Table 11-1A-11). The combination of number of days and degrees above each threshold were further assigned a "level of concern", as defined in Table 11-1A-12. Differences between baselines and Alternative 1A in the highest level of concern across all months and all 82 modeled years are presented in Table 11-1A-66. For the 61°F threshold, there would be 32 more (178% increase) "red" years under Alternative 1A than under Existing Conditions. For the 68°F threshold, there would be negligible differences in the number of years under each level of concern between Existing Conditions and Alternative 1A.

Total degree-days exceeding 61°F and 68°F were summed by month and water year type at Hamilton City during March through June (Table 11-1A-67, Table 11-1A-68). Total degree-days exceeding the 61°F threshold under Alternative 1A would be 21 degree-days (percent change unable to be calculated due to division by 0) to 2224 degree-days (123%) higher depending on month. Total degree-days exceeding the 68°F threshold would not differ between NAA and Alternative 1A during March and April. During May and June, total degree-days would be 35 (500%) and 29 (2900%) degree-days higher under Alternative 1A, although these small absolute differences would not cause a biologically meaningful effect on white sturgeon.

Feather River

In the Feather River between Thermalito Afterbay and the confluence with the Sacramento River during February to May, flows under A1A_LLT would generally be similar to or greater than those under Existing Conditions, except for below normal years in February and March and during wet years in May, in which flows would be up to 28% lower depending on location (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These results indicate that there would be very few reductions in flows in the Feather River under Alternative 1A.

Mean monthly water temperatures in the Feather River below Thermalito Afterbay and at the confluence with the Sacramento River were examined during the February through May white sturgeon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures would not differ between NAA and Alternative 1A at either location throughout the period, except below Thermalito Afterbay during February, in which temperatures under Alternative 1A would be 6% higher than temperatures under Existing Conditions.

San Joaquin River

Flows in the San Joaquin River under Alternative 1A would be similar to flows under Existing Conditions during February and up to 43% lower during March through July.

Water temperatures were not modeled for the San Joaquin River.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-148 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 1A could be significant because, under the CEQA baseline, the alternative could substantially reduce the amount of suitable habitat, contrary to the NEPA conclusion set forth above. Flows in the Sacramento and Feather rivers would generally be similar between Alternative 1A and Existing Conditions. However, water temperatures and exceedances above NMFS temperature thresholds in the Sacramento River would be greater under Alternative 1A relative to Existing Conditions. There would be small to moderate decreases in flows during most of the spawning and egg incubation period in the San Joaquin River.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 1A does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 1A indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 1A. This indicates that the differences between Existing Conditions and Alternative 1A found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 1A, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on spawning and egg incubation habitat for white sturgeon. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-149: Effects of Water Operations on Rearing Habitat for White Sturgeon

In general, Alternative 1A would not affect the quantity and quality of white sturgeon larval and juvenile rearing habitat relative to NAA.

Water temperature was used to determine the potential effects of Alternative 1A on white sturgeon larval and juvenile rearing habitat because larvae and juveniles are benthic-oriented and, therefore, their habitat is more likely to be limited by changes in water temperature than flow rates.

Mean monthly water temperatures in the Sacramento River at Hamilton City were examined during the year-round white sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period, except for a 5% higher mean monthly temperature in wet years during September under Alternative 1A.

Mean monthly water temperatures in the Feather River at Honcut Creek were examined during the year-round white sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A in any month or water year type throughout the period

Water temperatures were not modeled in the San Joaquin River.

NEPA Effects: These results indicate that the effect is not adverse because it does not have the potential to substantially reduce the amount of suitable habitat. There would be no differences in water temperatures between Alternative 1A and NAA in the Sacramento and Feather Rivers.

CEQA Conclusion: In general, Alternative 1A would not affect the quantity and quality of white sturgeon larval and juvenile rearing habitat relative to the Existing Conditions.

Water temperature was used to determine the potential effects of Alternative 1A on white sturgeon larval and juvenile rearing habitat because larvae and juveniles are benthic-oriented and, therefore, their habitat is more likely to be limited by changes in water temperature than flow rates.

Mean monthly water temperatures in the Sacramento River at Hamilton City were examined during the year-round white sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures would be similar between Existing Conditions and Alternative 1A during October through July, but 7% lower under Alternative 1A relative to Existing Conditions during August and September.

Mean monthly water temperatures in the Feather River at Honcut Creek were examined during the year-round white sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures would be similar between Existing Conditions during March through June and September, but 5% to 8% higher under Alternative 1A relative to Existing Conditions during July through August and October through February.

Water temperatures were not modeled in the San Joaquin River.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-148 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 1A could be significant because, under the CEQA baseline, the alternative could substantially reduce the quantity and quality of suitable rearing habitat, contrary to the NEPA conclusion set forth above. There would be effect of Alterative 1A on temperatures in the Sacramento River. There would be small, but persistent increases in temperatures in the Feather River during a substantial portion of the rearing period.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 1A does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 1A indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 1A. This indicates that the differences between Existing Conditions and Alternative 1A found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 1A, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on rearing habitat for white sturgeon. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-150: Effects of Water Operations on Migration Conditions for White Sturgeon

In general, the effects of Alternative 1A on white sturgeon migration conditions relative to NAA are uncertain.

Analyses for white sturgeon focused on the Sacramento River (North Delta to RM 143—i.e., Wilkins Slough and Verona CALSIM nodes). Larval transport flows were represented by the average number of months per year that exceeded thresholds of 17,700 cfs (Wilkins Slough) and 31,000 cfs (Verona) (Table 11-1A-69). Exceedances of the 17,700 cfs threshold for Wilkins Slough under A1A_LLT were similar to those under NAA. The number of months per year above 31,000 cfs at Verona would be lower for all water year types (up to 50% lower) relative to NAA depending on water year type, except above normal years (6% increase). However, on an absolute scale, none of these differences would be biologically meaningful to white sturgeon (up to 0.2 months). Overall, there is no consistent difference between Alternative 1A and NAA.

Table 11-1A-69. Difference and Percent Difference in Number of Months between February and May in Which Flow Rates Exceed 17,700 and 5,300 Cubic Feet per Second (cfs) in the Sacramento River at Wilkins Slough and 31,000 cfs at Verona

	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Wilkins Slough, 17,700 cfs[a]		
Wet	-0.04 (-2%)	0 (0%)
Above Normal	0.3 (18%)	0.1 (5%)
Below Normal	-0.1 (-25%)	0 (0%)
Dry	0 (0%)	0 (0%)
Critical	0 (0%)	0 (0%)
Wilkins Slough, 5,300 cfs[b]		
Wet	-0.1 (-1%)	0.1 (2%)
Above Normal	-0.1 (-1%)	0.3 (4%)
Below Normal	0.1 (3%)	0.4 (9%)
Dry	0.6 (13%)	0.3 (6%)
Critical	0.3 (10%)	0.3 (7%)
Verona, 31,000 cfs[a]		
Wet	-0.5 (-21%)	-0.2 (-9%)
Above Normal	-0.1 (-5%)	0.1 (6%)
Below Normal	-0.2 (-43%)	-0.1 (-33%)
Dry	-0.2 (-60%)	-0.1 (-50%)
Critical	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.
[a] Months analyzed: February through May.
[b] Months analyzed: November through May.

Larval transport flows were also examined by utilizing the positive correlation between year class strength and Delta outflow during April and May (USFWS 1995) under the assumption that the mechanism responsible for the relationship is that Delta outflow provides improved larval transport that results in improved year class strength. The percent of months exceeding flow thresholds under A1A_LLT would be lower than those under NAA (up to 67%) (Table 11-1A-70). These results indicate that, using the positive correlation between Delta outflow and year class strength, year class strength would be lower under Alternative 1A.

Table 11-1A-70. Difference and Percent Difference in Percentage of Months in Which Average Delta Outflow is Predicted to Exceed 15,000, 20,000, and 25,000 Cubic Feet per Second (cfs) in April and May of Wet and Above-Normal Water Years

Flow	Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
April			
15,000 cfs	Wet	-15 (-16%)	-15 (-16%)
	Above Normal	-25 (-27%)	-25 (-27%)
20,000 cfs	Wet	-12 (-14%)	-12 (-14%)
	Above Normal	-33 (-44%)	-25 (-38%)
25,000 cfs	Wet	-15 (-19%)	-12 (-15%)
	Above Normal	-17 (-29%)	-8 (-17%)
May			
15,000 cfs	Wet	-15 (-17%)	-8 (-10%)
	Above Normal	-33 (-40%)	-8 (-14%)
20,000 cfs	Wet	-38 (-45%)	-15 (-25%)
	Above Normal	-25 (-60%)	-17 (-50%)
25,000 cfs	Wet	-31 (-44%)	-19 (-33%)
	Above Normal	-25 (-75%)	-17 (-67%)
April/May Average			
15,000 cfs	Wet	-15 (-16%)	-8 (-9%)
	Above Normal	-33 (-33%)	-25 (-27%)
20,000 cfs	Wet	-23 (-26%)	-19 (-23%)
	Above Normal	-17 (-25%)	0 (0%)
25,000 cfs	Wet	-19 (-24%)	-8 (-11%)
	Above Normal	-25 (-50%)	-25 (-50%)

For juveniles, year-round migration flows at Verona were up to 55% lower under A1A_LLT relative to NAA during July through September and November (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Migration flows during other months were typically similar of greater than NAA, with few exceptions in some months or water years.

For adults, the average number of months per year during the November through May adult migration period in which flows in the Sacramento River at Wilkins Slough exceed 5,300 cfs was determined (Table 11-1A-69). The average number of months exceeding 5,300 cfs under A1A_LLT would be similar to the number of months under NAA in wet and above normal years and higher in remaining water year types (6% to 9% higher). These increase in exceedances are considered small (<15%) and would not likely affect white sturgeon adult migration.

NEPA Effects: Upstream flows (above north Delta intakes) are similar between Alternative 1A and NAA (Table 11-1A-69). However, due to the removal of water at the north Delta intakes, there are substantial differences in through-Delta flows between Alternative 1A and NAA (Table 11-1A-70). Analysis of white sturgeon year-class strength (USFWS 1995) found a positive correlation between year class strength and Delta outflow during April and May. However, this conclusion was reached in the absence of north Delta intakes and the exact mechanism that causes this correlation is not known at this time. One hypothesis suggests that the correlation is caused by high flows in the upper river resulting in improved migration, spawning, and rearing conditions in the upper river. Another hypothesis suggests that the positive correlation is a result of higher flows through the Delta triggering more adult sturgeon to move up into the river to spawn. It is also possible that some combination of these factors are working together to produce the positive correlation between high flows and sturgeon year-class strength.

The scientific uncertainty regarding which mechanisms are responsible for the positive correlation between year class strength and river/Delta flow will be addressed through targeted research and monitoring to be conducted in the years leading up to the initiation of north Delta facilities operations. If these targeted investigations determine that the primary mechanisms behind the positive correlation between high flows and sturgeon year-class strength are related to upstream conditions, then Alternative 1A would be deemed Not Adverse due to the similarities in upstream flow conditions between Alternative 1A and NAA. However, if the targeted investigations lead to a conclusion that the primary mechanisms behind the positive correlation are related to in-Delta and through-Delta flow conditions, then Alternative 1A would be deemed Adverse due to the magnitude of reductions in through-Delta flow conditions in Alternative 1A as compared to NAA.

CEQA Conclusion: In general, under Alternative 1A water operation, migration conditions for white sturgeon would be similar to those under the CEQA baseline.

The number of months per year with exceedances above the 17,700 cfs threshold for Wilkins Slough under A1A_LLT would be similar to those under Existing Conditions in wet, dry, and critical years (Table 11-1A-69). The number of months per year above 17,000 cfs at Wilkins Slough under A1A_LLT would be 18% greater than under Existing Conditions in above normal years and 25% lower than under Existing Conditions in below normal water years. The number of months per year above 31,000 cfs at Verona would range from a reduction of 0.1 months (5% reduction in above normal years) to a decrease of 0.2 months (60% lower in dry years) relative to Existing Conditions depending on water year type.

For Delta outflow, the percent of months exceeding flow thresholds under A1A_LLT would consistently be lower than those under Existing Conditions for each flow threshold, water year type, and month (16% to 75% lower on a relative scale) (Table 11-1A-70).

For juveniles, year-round migration flows at Verona would be up to 35% lower under A1A_LLT relative to Existing Conditions during July through September and November (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Migration flows during other months were typically similar of greater than Existing Conditions, with few exceptions in some months or water years.

For adult migration, the average number of months exceeding 5,300 cfs under A1A_LLT would generally be similar to the number of months under Existing Conditions, except in dry (13% greater) and critical water years (10% greater) (Table 11-1A-69).

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-150 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 1A could be significant because, under the CEQA baseline, the alternative could substantially reduce migration conditions for green sturgeon, contrary to the NEPA conclusion set forth above. The exceedance of flow thresholds in the Sacramento River and for Delta outflow would be lower under Alternative 1A than under Existing Conditions, although there is high uncertainty that year class strength is due to Delta outflow or if both year class strength and

Delta outflows co-vary with another unknown factor. There are increases and decreases in exceedances above flow thresholds in the Sacramento River under Alternative 1A relative to Existing Conditions and reductions in juvenile migration flows in the Sacramento River. These reduced flows would have a substantial effect on the ability to migrate downstream, delaying or slowing rates of successful migration downstream and increasing the risk of mortality.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 1A does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 1A indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 1A. This indicates that the differences between Existing Conditions and Alternative 1A found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 1A, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion of not adverse, and therefore would not in itself result in a significant impact on migration conditions for white sturgeon. Additionally, as described above in the NEPA Effects statement, further investigation is needed to better understand the association of Delta outflow to sturgeon recruitment, and if needed, adaptive management would be used to make adjustments to meet the biological goals and objectives. This impact is found to be less than significant and no mitigation is required.

Restoration Measures (CM2, CM4–CM7, and CM10)

Impact AQUA-151: Effects of Construction of Restoration Measures on White Sturgeon

Temporary Increases in Turbidity

Restoration construction activities such as riprap removal, shoreline excavation and re-contouring, and planting riparian vegetation have the potential to result in temporary increases in turbidity conditions in adjacent waterways. However, white sturgeon inhabit naturally turbid water and are unlikely to be affected by temporary increases in turbidity during restoration construction. Implementing the environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Fish Rescue and Salvage Plan*; and *Barge Operations Plan*), would minimize the potential for turbidity to affect white sturgeon.

Increased Exposure to Mercury

As discussed above for delta smelt (Impact AQUA-7), the implementation of *CM12 Methylmercury Management* would minimize potential effects of methylmercury mobilization from restoration sites, on white sturgeon. As a result, restoration activities are not likely to produce the biogeochemical conditions that would support methylation of mercury; thus increased bioavailability and toxicity as a result of restoration activities are not expected. However, the cycling of mercury is a complicated process, and is difficult to predict based on existing information.

Accidental Spills

As discussed above for construction and maintenance activities (see Impact AQUA-1 and Impact AQUA-2 for delta smelt), implementation of the environmental commitments described in Appendix 3B, *Environmental Commitments,* would minimize the potential for introduction of contaminants to surface waters and provide for effective containment and cleanup should accidental spills occur. These environmental commitments are *Environmental Training; Stormwater Pollution Prevention Plan; Erosion and Sediment Control Plan; Hazardous Materials Management Plan; Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material; and Barge Operations Plan*. Specifically, the *Spill Prevention, Containment, and Countermeasure Plan* will be implemented to minimize the risk of spills occurring and to provide for rapid and effective response to contain any accidental spills.

Disturbance of Contaminated Sediments

Runoff and resuspension of contaminants could cause short-term, localized increases in the concentrations of contaminants in and near restoration sites (see discussion for delta smelt under Impact AQUA-7). Sturgeon typically feed on prey items that are associated with the substrate, and are prone to exposure to sediment borne toxicants. They also tend to bioaccumulate toxicants that occur in the Plan Area, such as methylmercury, pesticides and selenium, and spend several years rearing in the Plan Area. As a result, they have an increased risk of effects from disturbances of contaminated sediments. Adhering to the expected in-water construction window would provide limited protection for sturgeon, because juvenile sturgeon can occur in the Plan Area throughout the year. Although juvenile sturgeon could be present during the in-water work window, the limited frequency, duration, and spatial extent of in-water restoration activities and implementation of appropriate environmental commitments (see Appendix 3B*; Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*) would minimize exposure levels. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt. Because of the temporary nature of toxicity spikes, the potential effects would be minimized.

In-Water Work Activities

Restoration construction activities such as equipment mobilization, development of staging areas, and dry levee preparation could temporarily produce noise levels that penetrate ground soils and affect nearby fishes. Such activities are not expected to elevate underwater noise above the threshold sound pressure levels established for fish (see discussion for delta smelt under Impact AQUA-1). Any changes in disturbance levels would be minor and temporary, and fish are expected to generally avoid areas where shoreline construction activities are occurring. Potential effects of in-water activity would be minimized by implementation of the environmental commitments described under Impact AQUA-1 and in Appendix 3B, *Environmental Commitments*, including

Erosion and Sediment Control Plan; *Dispose of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Predation

The creation of permanent tidal brackish habitat within Suisun Marsh would create permanent year-round rearing habitat for juvenile white sturgeon. Once these habitats became fully established they are expected to provide highly productive food and refuge habitats. Due to their salinities, these habitats would be expected to provide some refuge from black bass. Also since younger juvenile sturgeon are less tolerant of saltwater, juveniles that occupy these brackish habitats are likely larger and have developed armored bony plating to substantially reduce predation vulnerability.

Summary

In-water and shoreline construction activities associated with habitat restoration would be scheduled to occur when the least number of white sturgeon would be present in or near the restoration sites. Such activities would include riprap removal and levee breaching, and shoreline excavation and re-contouring. In addition, runoff from upland construction areas would also have the potential to affect aquatic habitats and white sturgeon. White sturgeon would likely tolerant the increases in turbidity which might occur during shoreline restoration construction activities. Implementation of the environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*), would minimize or eliminate effects on white sturgeon (see Impact AQUA-7). Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

While implementation of these environmental commitments would minimize or eliminate short-term effects occurring during restoration construction, long-term effects could also occur. For example, removing or breaching levees would result in the expansion of floodplain habitat, and more frequent inundation these areas, potentially promoting conversion of mercury to methylated mercury, and runoff containing agricultural-related toxins such as copper and organochlorine pesticides. However, the overall effect of increased bioavailability of methylmercury and other pollutants on white sturgeon is likely to be of low magnitude, periodic and localized. In addition, potential increases would be minimized to the extent possible because of implementation of *CM12 Methylmercury Management* (see Impact AQUA-10).

NEPA Effects: For these reasons, white sturgeon would not be adversely affected by restoration construction activities.

***CEQA Conclusion*:** White sturgeon inhabit naturally turbid water and are not expected to be affected by temporary increases in turbidity during restoration construction activities. In addition to the limited frequency and duration and spatial extent of in-water restoration activities and implementation of environmental commitments identified above and described in detail under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*), would minimize the potential for turbidity, accidental spills, resuspension of contaminated sediments, or construction noise to affect white sturgeon. Therefore, this impact is considered less than significant for white sturgeon because it would not substantially reduce habitat, restrict its range or interfere with its movement. Consequently, no mitigation would be required.

Impact AQUA-152: Effects of Contaminants Associated with Restoration Measures on White Sturgeon

Effects of contaminants on white sturgeon would be similar to those described for green sturgeon under AQUA-134. While white sturgeon are less sensitive than green sturgeon to selenium contamination, white sturgeon are a resident species and could have more prolonged exposure to San Joaquin River selenium concentrations.

NEPA Effects: While Alternative 1A actions are likely to result in increased production, mobilization, and bioavailability of methylmercury, selenium, copper, and pesticides in the aquatic system, any such releases would typically be short-term and localized, and would be unlikely to result in measurable increases in the bioaccumulation in white sturgeon. Although white sturgeon are known to bioaccumulate selenium due in large part to their consumption of the overbite clam (*C. amurensis*), habitat restoration measures under Alternative 1A are expected to have little effect on selenium bioaccumulation in the Plan Area. Overall, the effects of contaminants associated with restoration measures would not be adverse for white sturgeon with respect to copper, ammonia and pesticides. The effects of methylmercury and selenium on white sturgeon are uncertain.

CEQA Conclusion: Alternative 1A actions are likely to result in increased production, mobilization, and bioavailability of methylmercury, selenium, copper, and pesticides in the aquatic system. However, such releases would typically be short-term and localized, and would be unlikely to result in measurable increases in the bioaccumulation in white sturgeon. For selenium, evaluation of the factors that influence it's bioavailability and bioaccumulation indicate a low probability for effects. For methylmercury, implementation of *CM12 Methylmercury Management* would help to minimize the increased mobilization of methylmercury at restoration areas. Therefore, the impact of contaminants is considered less than significant because it would not substantially effect white sturgeon either directly or through habitat modifications and, with restoration, would be beneficial in the long-term. Consequently, no mitigation would be required.

In addition, implementation of *CM12 Methylmercury Management* would help to minimize the increased mobilization of methylmercury at restoration areas. In addition, the overall effects associated with habitat restoration are expected to result in an overall benefit to white sturgeon.

Impact AQUA-153: Effects of Restored Habitat Conditions on White Sturgeon

For discussion of the potential effects of restored habitat conditions on white sturgeon, see the discussion under Impact AQUA-9 for delta smelt.

CM2 Yolo Bypass Fisheries Enhancement

As discussed under Impact AQUA-9, Yolo Bypass fisheries enhancement modifications are designed to increase the frequency, duration and magnitude of seasonal floodplain inundation in the Yolo Bypass. These actions would improve passage and habitat conditions for white sturgeon. These modifications, which include fish passage improvements and flow management, would reduce migratory delays and loss of adult sturgeon at Fremont Weir and other structures. The Yolo Bypass would potentially provide temporary habitat for white sturgeon but would not be a substantial benefit.

CM4 Tidal Natural Communities Restoration

For discussion of the potential effects of *CM4 Tidal Natural Communities Restoration* on white sturgeon, see the discussion under Impact AQUA-9. Although tidal habitat restoration would benefit white sturgeon, habitat conditions are likely to decrease for larval and juvenile sturgeon over time, because of temperature effects associated with climate change during the late spring. It is anticipated that the overall effect of *CM4 Tidal Natural Communities Restoration* would remain positive because increases in habitat quantity could increase overall productivity and survival, providing a potential mechanism to at least partially offset the future effects of climate change (see Impact AQUA-9).

As discussed under Impact AQUA-9, increased food productivity is expected in all ROAs as a result of the BDCP, but the Suisun Marsh, Cache Slough, and South Delta ROAs are expected to see the greatest increases in productivity. Sturgeon feed on benthic invertebrates, including those found on marsh mudflats, which will benefit from the transfer of increased production to mudflat fauna in restored marshes. Therefore, the substantial increase in these habitats would likely increase total food availability for sturgeon. While white sturgeon are not expected to extensively use floodplain or floodplain wetland habitat, potential increases in food resources from seasonal inundation of these habitats is considered beneficial to the species. For further discussion see Impact AQUA-9.

CM5 Seasonally Inundated Floodplain Restoration

While white sturgeon are not expected to extensively use floodplain habitat, periodic inundation of the restored floodplain also will benefit sturgeon by cycling nutrients, supporting growth of plankton and aquatic insects. Providing river–floodplain connectivity would increase production of lower trophic levels at relatively rapid time scales, with some food web organisms responding within days at high densities.

Although food is not likely a limiting factor to the abundance of sturgeon in the Delta, BDCP actions, notably the restoration and enhancement of upstream habitats, may increase sturgeon food availability relative to Existing Conditions. If the upstream productivity transfer occurs at the planktonic level, downstream benthic habitats utilized for foraging by adult sturgeon may experience a greater increase in productivity due to the potential increase in *Corbula* than if this upstream transfer occurs at higher trophic levels, such as planktivorous fish. BDCP habitat restoration would increase the availability of foraging and refuge habitats available to rearing juvenile sturgeon. For further discussion, see Impact AQUA-9.

CM6 Channel Margin Enhancement

Expanded nearshore habitat with improved inputs of terrestrial organic matter and insects, as well as woody debris, riparian shade, and underwater cover will increase the quality and area of potential rearing habitat for sturgeon. Enhancements are also expected to improve migration conditions for sturgeon, by increasing the availability and quality of resting (refuge) habitat, as a result of increased channel margin complexity (e.g., woody material), particularly during high flows. Despite the potential benefits of channel margin habitat restoration on white sturgeon, the overall effect is expected to be minimal because of the relatively short period of their life history spent in these areas and therefore, the effect is not considered adverse. For further discussion see Impact AQUA-9.

CM7 Riparian Natural Community Restoration

White and green sturgeon rely on ecological attributes of valley/foothill riparian habitat in the Plan Area.

BDCP habitat restoration, including riparian restoration, are expected to improve the quality and quantity of Delta rearing habitats for juvenile sturgeon. Once established, these habitats would likely provide suitable food resources for juvenile sturgeon. For further discussion, see Impact AQUA-9.

CM10 Nontidal Marsh Restoration

As discussed under delta smelt, upland restoration under *CM10 Nontidal Marsh Restoration* is expected to have minor indirect beneficial effects on white sturgeon in the main river systems and Delta. These upland wetlands provide hydrologic and water quality functions such as storing water during floods and filtering contaminants. These sites would also provide some additional food resources such as insects, zooplankton, phytoplankton and dissolved organic carbon. These materials would be exported during flood stages when the upland might be connected to the river system. Although the contribution from 400 acres would be small, it would be beneficial**.** For additional discussion, see Impact AQUA-9.

NEPA Effects: The effects on white sturgeon from floodplain, tidal, channel margin, and riparian habitat restoration activities are expected to be similar to those discussed for delta smelt (see Impact AQUA-9). In general, these effects are expected to be beneficial for white sturgeon, although the primary benefits are likely to be the result of increased productivity from more frequent inundations of restoration areas and the increased amount and quality of available rearing and migration habitat.

Despite the improvements in habitat and habitat functions in the Delta from floodplain, tidal, channel margin, and riparian habitat restoration activities, habitat quality is expected to decline in the LLT primarily because of climate change. However, the overall effect of restoration activities is expected to remain beneficial for white sturgeon.

However, it is important to note that benefits would not be derived in all years, and that an adaptive management plan would be needed to determine an operational protocol that optimizes benefits both locally and in adjacent habitats.

CEQA Conclusion: As with delta smelt, the overall effects of floodplain, tidal, channel margin, and riparian habitat restoration activities are expected to be beneficial for white sturgeon (see Impact AQUA-9). The primary benefits are likely due to increased productivity from more frequent inundations of restoration areas and increased amount and quality of available rearing and migration habitat. Despite the improvements in habitat and habitat functions in the Delta from these habitat restoration activities, habitat quality is expected to decline in the LLT primarily because of climate change. However, the overall impact of restoration activities is expected to remain beneficial for white sturgeon because they increase habitat. Consequently, no mitigation would be required.

Other Conservation Measures (CM12–CM19 and CM21)

Impact AQUA-154: Effects of Methylmercury Management on White Sturgeon (CM12)

Refer to Impact AQUA-10 under delta smelt for a discussion of the potential effects of methylmercury management on white sturgeon.

Impact AQUA-155: Effects of Invasive Aquatic Vegetation Management on White Sturgeon (CM13)

NEPA Effects: The following analysis is based on the more detailed analysis included in *BDCP Effects Analysis – Appendix F, Biological Stressors, Section F.1.1 Invasive Aquatic Vegetation, Section F.4 Invasive Aquatic Vegetation, and F.5.3.2.3 Nonnative Aquatic Vegetation Control (Conservation Measure 13) hereby incorporated by reference*.

A general analysis of the effects on covered fish species has been conducted that was described above for delta smelt (see Impact AQUA-11). Potential impacts on white sturgeon from IAV control during operations are similar to those discussed for delta smelt. The impact of IAV removal on predation risk for sturgeon is expected to be low. Sturgeon grow rapidly and can quickly outgrow the size range where predation could occur. Sturgeon also have a protective amour like plating making them unappealing to predators even at a young age. Therefore, the effect of IAV removal on white sturgeon is expected to be slight.

The control of IAV with implementation of *CM13 Invasive Aquatic Vegetation Control* is expected to maintain or improve turbidity conditions that could benefit white sturgeon rearing conditions, reducing their susceptibility to predation. The control of IAV would also increase the amount of rearing habitat, as well as access to the habitat and potential increases in food availability. Therefore, IAV control is expected to provide an overall benefit to white sturgeon.

CEQA Conclusion: The control of IAV should provide a modest net benefit to white sturgeon during operations through chemical and mechanical treatment. Control of IAV is considered a beneficial impact by reducing predation mortality, increasing food availability, and increasing rearing habitat. This impact is expected to be beneficial, consequently, no mitigation would be required.

Impact AQUA-156: Effects of Dissolved Oxygen Level Management on White Sturgeon (CM14)

NEPA Effects: As discussed in Chapter 8, *Water Quality*, dissolved oxygen levels would be very similar to Existing Conditions in the areas upstream of the Delta, in the Delta, and in the SWP/CVP export service areas (see discussion of Impacts WQ-10 and WQ-11). As noted there, however, *CM14 Stockton Deepwater Ship Channel Dissolved Oxygen Levels* management would increase the dissolved oxygen levels and improve the rearing and upstream migration conditions for white sturgeon, which would be a benefit.

CEQA Conclusion: As discussed in Chapter 8, *Water Quality*, *CM14 Stockton Deepwater Ship Channel Dissolved Oxygen Levels* management would increase the dissolved oxygen levels and improve the rearing and upstream migration conditions for white sturgeon, which would be a benefit. Consequently, no mitigation would be required.

Impact AQUA-157: Effects of Localized Reduction of Predatory Fish on White Sturgeon (CM15)

To the extent that localized predator control efforts of *CM15 Localized Reduction of Predatory Fish* reduce the overall abundance of fish predators in the Delta occupied by white sturgeon, it is possible, but not assured that there would be some reduction in losses to predation, although no quantitative information is available regarding the current magnitude of white sturgeon loss to predation (see Impact AQUA-13). Due to these uncertainties, there would be no demonstrable effect of this conservation measure on white sturgeon.

Additionally, although little is known about predation of juvenile sturgeon in the Delta. Sturgeon grow rapidly in their first year of development and grow protective bony plating at an early age. Young sturgeon grow quickly in their first year, probably reaching 30 cm (12 inches) in their first year (Kohlhorst and Cech 2001b). Due to their rapid growth early in their development, the period in which juvenile sturgeon are vulnerable to piscivorous fish predators in the Delta is likely limited, and therefore the any potential beneficial effects from implementation of *CM15 Localized Reduction of Predatory Fish* are further limited. In addition, sturgeon are benthic feeders, which may limit their encounters with pelagic predators like striped bass.

As discussed for green sturgeon, a potential risk of localized predator removal is the by-catch of sturgeon during beach seining, gill netting, angling, electrofishing, or other capture methods. Sturgeon tend to reside in deep water areas and should be protected from electrofishing effects. Striped bass monitoring by CDFW at Knights Landing using fyke traps caught 86 white sturgeon but only four green sturgeon in 26 days of sampling in 2008 (Dubois and Mayfield 2008), they also report the capture of 14 white sturgeon and one green sturgeon during up to 24 days of gill net sampling. Adult sturgeon are not susceptible to being caught using artificial lures commonly used to catch striped bass but would be susceptible to baited hooks. Injuries to sturgeon would be similar to those experiences by salmonids listed above. Adult sturgeon in deep water should be able to avoid most types of nets fished in shallow nearshore areas. Adult sturgeon caught in nets (fyke, beach seine, or gill nets) could suffer similar injuries as salmonids such as ones listed above.

NEPA Effects: This effect would not be adverse because the number of sturgeon affected by this variety of methods is expected to be very low.

CEQA Conclusion: Due to the uncertainties concerning overall fish predator reduction and actual predation rates on white sturgeon in the Delta, there would be no demonstrable effect on this conservation measure on white sturgeon. Little is known about predation of juvenile sturgeon in the Delta. Sturgeon grow rapidly in their first year of development and grow protective bony plating at an early age. Due to rapid early growth, the period in which juvenile sturgeon are vulnerable to piscivorous fish predators in the Delta is likely limited, and therefore any potential beneficial impacts from implementation of *CM15 Localized Reduction of Predatory Fish* are further limited.

One potential risk of localized predator removal is by-catch of sturgeon during beach seining, gill netting, angling, electrofishing, or other capture methods. As indicated above, these methods have variable effectiveness at capturing sturgeon. Adult sturgeon aren't susceptible to being caught using artificial lures commonly used to catch striped bass but would be susceptible to baited hooks. Adult sturgeon in deep water should be able to avoid most types of nets fished in shallow nearshore areas. Therefore the impact is considered less than significant because it would not have a substantial effect on white sturgeon numbers. Consequently, no mitigation would be required.

Impact AQUA-158: Effects of Nonphysical Fish Barriers on White Sturgeon (CM16)

NEPA Effects: Effects on sturgeon from predation associated with the construction of NPBs is unknown. White sturgeon are known to spawn in the Sacramento and Feather rivers in the Central Valley (Israel et al. 2010) and emigrating juveniles would likely encounter the Georgiana Slough barrier. White sturgeon rarely occur or spawn in the San Joaquin River (Moyle 2002; Beamesderfer et al. 2007), so the level of interaction of sturgeon juveniles with the Old River NPB is likely to be minimal. NPBs are likely to attract piscivorous predators hiding among the physical structures of the barrier and may create an increased predation risk for small sturgeon juveniles. Sturgeon may also be deterred by the sound and lights of the barrier (Popper 2005; Meyer et al. 2010; Halvorsen et al. 2012) thereby minimizing their entry into areas of the central Delta where high predation rates would be likely. The effect would not be adverse, compared to NAA.

CEQA Conclusion: Effects on sturgeon from predation associated with the construction of NPBs is unknown. White sturgeon are known to spawn in the Sacramento and Feather rivers in the Central Valley (Israel et al. 2010) and emigrating juveniles would likely encounter the Georgiana Slough barrier. White sturgeon are not known to currently spawn in the San Joaquin River although they may have historically (Moyle 2002; Beamesderfer et al. 2007). Therefore, the level of interaction of sturgeon juveniles with the Old River NPB is likely to be minimal. NPBs are likely to attract piscivorous predators hiding among the physical structures of the barrier and may create an increased predation risk for small sturgeon juveniles. Sturgeon may also be deterred by the sound and lights of the barrier (Popper 2005; Meyer et al. 2010; Halvorsen et al. 2012) thereby minimizing their entry into areas of the central Delta where high predation rates would be likely. The overall impact on white sturgeon from NPBs is less than significant because it would not reduce their numbers. Consequently, no mitigation would be required.

Impact AQUA-159: Effects of Illegal Harvest Reduction on White Sturgeon (CM17)

NEPA Effects: *CM17 Illegal Harvest Reduction* would be applied to Chinook salmon, Central Valley steelhead, green sturgeon and white sturgeon and are expected to have beneficial effects on their populations.

CEQA Conclusion: *CM17 Illegal Harvest Reduction* would be applied to Chinook salmon, Central Valley steelhead, green sturgeon and white sturgeon. Although the numbers cannot be quantified implementation is expected to have positive effects on their populations. The impact would be beneficial because it would increase their numbers. Consequently, no mitigation would be required.

Impact AQUA-160: Effects of Conservation Hatcheries on White Sturgeon (CM18)

NEPA Effects: *CM18 Conservation Hatcheries* would establish new and expand existing conservation propagation programs for delta and longfin smelt. This conservation measure would have no effect on white sturgeon.

CEQA Conclusion: *CM18 Conservation Hatcheries* would establish new and expand existing conservation propagation programs for delta and longfin smelt. This conservation measure would have no impact on white sturgeon. Consequently, no mitigation would be required.

Impact AQUA-161: Effects of Urban Stormwater Treatment on White Sturgeon (CM19)

NEPA Effects: The effects of Urban stormwater treatment (CM19) would reduce contaminants associated with urban areas because it provides for the treatment of stormwater discharges. As discussed in Chapter 8, *Water Quality*, and previously under Impact AQUA-8 in the section titled *Pyrethroids, Organophosphate Pesticides, and Organochlorine Pesticides,* stormwater treatment would reduce urban loadings of pesticides (including pyrethroids), phosphorous, trace metals and other contaminants. These reductions would contribute to improved water quality in the Delta. Based on the improved overall water quality conditions and reduced pesticides the effect would be beneficial.

CEQA Conclusion: Urban stormwater treatment (CM19) would reduce contaminants associated with urban areas because it would provide for the treatment of stormwater discharges. As discussed in Chapter 8, *Water Quality*, and previously under Impact AQUA-8 in the section titled *Pyrethroids, Organophosphate Pesticides, and Organochlorine Pesticides,* stormwater treatment would reduce urban loadings of pesticides(including pyrethroids), phosphorous, trace metals and other water contaminants. These reductions would contribute to improved water quality in the Delta. Therefore, the impacts of urban stormwater treatment would be beneficial because it would have a beneficial effect both directly and through habitat modifications on white sturgeon. Consequently, no mitigation would be required.

Impact AQUA-162: Effects of Removal/Relocation of Nonproject Diversions on White Sturgeon (CM21)

NEPA Effects: As discussed above for other species, there is no evidence of substantial entrainment of covered fish species at agricultural diversions in the Plan Area, but slight reductions in entrainment are expected from decommissioning agricultural diversions in the ROAs (see Impact AQUA-18). These effects would not be adverse, and a slight benefit may result.

CEQA Conclusion: Although there is no evidence of substantial entrainment of covered fish species at agricultural diversions in the Plan Area, slight reductions in entrainment are expected from decommissioning agricultural diversions in the ROAs (see Impact AQUA-18). This impact would be less than significant and may result in a slight benefit to white sturgeon because it would reduce entrainment which would have a positive impact on white sturgeon numbers. Consequently, no mitigation would be required.

Pacific Lamprey

Construction and Maintenance of CM1

Impact AQUA-163: Effects of Construction of Water Conveyance Facilities on Pacific Lamprey

Pacific lamprey are present throughout the Delta. Table 11-4 illustrates the life stages of Pacific lamprey present in these areas during the expected in-water construction window (June 1–October 31). Ammocoetes (larvae) are present year-round in all of the regions. Adult and macropthalmia life stages may also be migrating by the construction sites for intakes and barge landings from June to August in all Delta subregions

Temporary Increases in Turbidity

Pacific lamprey ammocoetes may occur throughout the Delta during construction of the intake structures and barge landings, and adults and macropthalmia may also occur during portions of the in-water construction period. Pacific lamprey typically inhabit turbid water; therefore, they are unlikely to be affected by a temporary increase in turbidity. As discussed for delta smelt (see Impact

AQUA-1), environmental commitments would be implemented to minimize turbidity during construction activities (see Impact AQUA-1 for delta smelt and Appendix 3B, *Environmental Commitments: Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*). Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Accidental Spills

Potential impacts on Pacific lamprey from accidental spills during construction are similar to those discussed for delta smelt (see Impact AQUA-1). Effects would be minimized by implementing the environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*). Specifically, the *Spill Prevention, Containment, and Countermeasure Plan* would be expected to minimize the potential for introduction of contaminants to surface waters and provide for effective containment and cleanup should accidental spills occur. Pertinent details of these plans are discussed under Impact AQUA-1 for delta smelt

Disturbance of Contaminated Sediments

There is a potential risk of contaminated sediments affecting Pacific lamprey during construction of intake structures and barge landings. Because they are filter feeders and are partially buried in the substrate, the ammocoetes could be the most affected life stage by the disturbance of sediment contaminants. However, the suspension of sediments would be minimized by implementation of environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*). Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Underwater Noise

Underwater sound generated by impact pile driving in or near surface waters can potentially harm Pacific lamprey. It is important to note that the impact would be realized only where piles must be impact driven; underwater sound generated by vibratory pile installation methods are not sufficiently loud to injure fish.

Potential impacts on Pacific lamprey from pile driving are different from other fish species. In a study done by Popper (2005) on hearing by sturgeon and lamprey, it was found that lamprey do not have the typical hearing structures of other fish. Although there have been no studies to determine responses of lamprey to sound (Popper 2005), ammocoetes are partially buried in the substrate, and the substrate dampens vibrations and noise. As a result, at least some life stages of Pacific lamprey could be somewhat less susceptible to injury from impact pile driving than other fish species.

Adult, ammocoete, and macropthalmia life stages could be present in the vicinity of the intakes and barge landings during in-water pile driving activities. While adults would primarily occur between

June and July and macropthalmia in June, ammocoetes would occur throughout the year. However, the abundance of ammocoetes is low at all in-water pile driving sites. Adults are considered moderately abundant in June and July near the intakes, but of low abundance in the east and south Delta where barge landings would be located. Macropthalmia would be primarily migrating downstream, and during only a portion of the in-water construction period. Therefore their exposure to pile driving sound levels would likely be limited.

Given their likely low numbers in the east and south Delta, the relatively small areas affected by underwater noise in the east and south Delta, and the intermittent nature of potential exposure above the effects threshold, there is only a small chance that lamprey would be exposed to injurious underwater sounds from impact pile driving at the barge landings. However, adults would be moderately abundant in June and July near the intakes, resulting in the potential for adverse effects as a result of underwater pile driving sound levels. Implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of these effects. Overall, underwater construction noise would be expected to adversely affect individual lamprey, although these effects are not expected to affect the overall population.

Fish Stranding

In-water work activities have the potential to injure or kill fish through the process of rescuing fish from construction areas. Pacific lamprey adults pass by the proposed intake facilities during the spawning migration from saltwater to freshwater spawning areas. The adults pass upstream of the proposed facilities during spring and early summer, and may be present from March through August. Ammocoetes could be present in the vicinity of the intake facilities, depending on the presence of mud or sand substrate. Outmigrating juveniles (macrothalmia life stage) also pass through the area, typically during high-flow events in winter and spring (January through June) and could be in the vicinity of construction during the early portion of the expected (June through October) in-water work window (see Table 11-4).

Pacific lamprey may be present during cofferdam installation, and could be trapped within the cofferdams, and would therefore need to be removed. Fish removal activities from construction areas would be implemented according to environmental commitment *Fish Rescue and Salvage Plan*, as described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*. Pertinent details of this plan are discussed under Impact AQUA-1 for delta smelt. Because of these measures, the risk of substantial effects would be minimized.

In-Water Work Activities

As discussed for delta smelt (see Impact AQUA-1), in-water work activities have the potential to disturb, injure or kill fish through direct physical injury from construction activities. Although some fish might avoid the noise and activity of pile installation and placement of riprap protection, these activities have the potential to injure or kill fish. Pacific lamprey ammocoetes are buried in the substrate and are likely to stay under the substrate unless directly disturbed. Installation of sheet piles, support piles, and riprap has the potential to injure or kill those lamprey ammocoetes that have not been displaced by other construction activities. Due to the low number of Pacific lamprey or their ammocoetes expected in these locations, and implementation of environmental commitment *Fish Rescue and Salvage Plan*, as described under Impact AQUA-1 and in Appendix 3B, *Environmental Commitments*, the risk of substantial effects would be minimized.

Loss of Spawning, Rearing, or Migration Habitat

The habitat affected by construction activities is used by Pacific lamprey for migration and possibly rearing, depending on the specific site conditions. No spawning habitat is present for Pacific lamprey in the project areas. Because only about 10% of the river cross section would be blocked by the cofferdams, fish passage would be relatively unaffected, and there would be no substantial loss of Pacific lamprey migration habitat. If rearing habitat is present because of specific site conditions that habitat would be lost because of construction of permanent structures. However, other rearing habitat of similar quantity and quality is available for ammocoetes in the Sacramento River.

The construction of the intakes and barge landings will temporarily affect Pacific lamprey migration and rearing habitat, if present, and the intakes will permanently alter the nearshore portion of this habitat in the Sacramento River to the extent such habitat is present at the location of intakes. Because of implementation of *CM6 Channel Margin Enhancement*, the overall effects would be limited because of the relatively poor quality of the current habitat, and the enhancement or addition of new, higher quality habitat associated with *CM6 Channel Margin Enhancement*. Furthermore, environmental commitments described under Impact AQUA-1 and in Appendix 3B, *Environmental Commitments*, including *Erosion and Sediment Control Plan*; *Dispose of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan,* would minimize potential effects. Pertinent measures included in these plans are discussed under Impact AQUA-1 for delta smelt.

Predation

Adult lamprey are generally not preyed on by other fish in the Delta. Juvenile Pacific lamprey (macrothalmia life stage) pass rapidly through the Delta, limiting the opportunity for larger fish to prey on them while they are in freshwater. Consequently, the addition of structures in the river and sloughs that could provide habitat for predatory fishes would likely result in a negligible effect on Pacific lamprey.

Summary

Ammocoetes (larvae) are present year-round in all of the regions, and adult spawner and macropthalmia life stages may be migrating by the construction sites during portions of the in-water construction window in all Delta subregions. However, implementation of environmental commitments *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan;* and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material* (see Impact AQUA-1 and Appendix 3B, *Environmental Commitments*) would reduce the amount of turbidity from in-water construction and would guide rapid and effective response in the case of inadvertent spills of hazardous materials. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt. These measures —as well as the species' tolerance to turbidity—would minimize the effects of construction activities on turbidity, accidental spills, onsite and offsite sediment transport to surface waters, and re-suspension and redistribution of potentially contaminated sediments. As a result, these effects would not be adverse to Pacific lamprey.

Some lamprey are expected to be present in the vicinity of the intakes and barge landings during pile driving activities. While the abundance of ammocoetes is expected to be low at all in-water pile driving sites, adults are likely to be moderately abundant in June and July near the intakes and in low abundance in the east and south Delta where barge landings would be located. Given their likely low numbers in the east and south Delta, the relatively small areas affected by underwater noise in the east and south Delta, and the intermittent nature of potential exposure above the threshold, there is only a small chance that Pacific lamprey would be exposed to injurious underwater sounds from impact pile driving at the barge landings. However, adults would be moderately abundant in June and July near the intakes, resulting in a potential for adverse effects as a result of underwater sound. Implementation of Mitigation Measures Mitigation Measures AQUA-1a and AQUA 1b would reduce the severity of these effects. Overall, while pile driving could adversely affect individual lamprey, the effects on the overall population is not expected to be adverse.

Ammocoetes could be present in the vicinity of the intake facilities, depending on substrate conditions, and their removal may require handling, which could result in injury or mortality. Implementation of environmental commitments *Fish Rescue and Salvage Plan* and *Barge Operations Plan* (as described under Impact AQUA-1 and in Appendix 3B) would offset potential effects of construction activities on Pacific lamprey. As a result, these construction activities would not likely result in adverse effects on Pacific lamprey populations.

Adult lamprey are generally not preyed on by other fish in the Delta. Juvenile Pacific lamprey (macrothalmia life stage) pass rapidly through the Delta, limiting the opportunity for larger fish to prey on them while they are in freshwater. Consequently, the addition of structures in the river and sloughs that could provide habitat for predatory fishes would result in a negligible effect on Pacific lamprey.

The habitat affected by construction activities is used by Pacific lamprey for migration and possibly rearing, depending on the specific site conditions. No spawning habitat is present for Pacific lamprey in the project areas. Because fish passage would be unaffected, there would be no substantial loss of Pacific lamprey migration habitat. Rearing habitat would be lost because of construction of permanent structures. However, other rearing habitat of similar quantity and quality is available for ammocoetes in the Sacramento River.

NEPA Effects: Overall, the potential effects of construction activities could adversely affect individual Pacific lamprey, but would not be expected to adversely affect the populations.

CEQA Conclusion**:** As discussed above, implementation of environmental commitments *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan;* and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material* (see Impact AQUA-1 for delta smelt and Appendix 3B, *Environmental Commitments*) would reduce the amount of turbidity from in-water construction and would guide rapid and effective response in the case of inadvertent spills of hazardous materials. These measures—as well as the species' tolerance to turbidity—would minimize the effects of construction activities on turbidity, accidental spills, onsite and offsite sediment transport to surface waters, and re-suspension and redistribution of potentially contaminated sediments.

Pacific lamprey are expected to occur in the construction areas, and would be subject to the direct effects of underwater construction noise, which could be a significant impact because of the high likelihood that it could cause injury or death to fish in the immediate vicinity of the activity. However, Mitigation Measures AQUA-1a and AQUA-1b would reduce the potential for effects from underwater noise and would reduce the severity of impacts to a less-than-significant level. Implementation of environmental commitments *Fish Rescue and Salvage Plan* and *Barge Operations Plan* (as described under Impact AQUA-1 and in Appendix 3B) would also minimize potential impacts of construction activities on Pacific lamprey.

The limited susceptibility of lamprey to predation and only locally increased predator habitat and predation from the temporary construction structures (cofferdams and barge landing docks) would not have population level effects. The effect of temporary and permanent rearing and migration habitat loss for Pacific lamprey would be limited due to the relatively small areas occupied by the construction and barge landing sites, and the low quality of the habitat affected by construction, as well as by implementation of the Environmental Commitment *Barge Operations Plan* (see Appendix 3B). Implementation of *CM6 Channel Margin Enhancement* would also result in a net improvement in channel margin habitat function. Based on the above the overall potential impacts of construction activities are expected to be less than significant, and no additional mitigation would be required.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 for delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 for delta smelt.

Impact AQUA-164: Effects of Maintenance of Water Conveyance Facilities on Pacific Lamprey

Temporary Increases in Turbidity

As discussed for construction-related effects on turbidity (Impact AQUA-1), the potential increases in turbidity would be minimized to the extent possible through implementing the environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*). In addition, maintenance dredging would be conducted when the least numbers of Pacific lamprey are likely to be present. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Accidental Spills

Maintenance activities such as dredging, levee repair and placement of riprap could accidently introduce contaminants into the aquatic environment. However, implementing the environmental commitments discussed under Impact AQUA-1 (Appendix 3B, *Environmental Commitments*: *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*), as well as the limited frequency and duration of in-water maintenance, would reduce the likelihood of any significant contaminant input to the Sacramento River and potential effects on Pacific lamprey survival. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Underwater Noise

As discussed for delta smelt (see Impact AQUA-2), underwater noise levels produced by in-water maintenance activities are not expected to reach a level that would harm juvenile or adult lamprey. NMFS has found that underwater sound pressure levels less than the 150 dB RMS behavioral effects threshold may result in temporary altered behavior of fishes indicative of stress but would not result in permanent harm or injury (National Marine Fisheries Service 2001). Any increases in underwater noise would be temporary and infrequent, and would occur when the least number of Pacific lamprey are likely to be present.

Maintenance-Related Disturbance

Direct injury and mortality of Pacific lamprey from the use of in-water equipment during maintenance are most likely to occur during dredging activities around the new intakes. Suction dredging and mechanical excavation can capture or crush fish, causing injury or mortality. Pacific lamprey ammocoetes are present year-round in the Sacramento River. The ammocoetes may use both main channel areas and nearshore areas for rearing and migration. Because Pacific lamprey ammocoetes are buried in sediment, they may become entrained in the dredge. Maintenance dredging would take place when Pacific lamprey ammocoetes are in the area (they are present year-round). The number of Pacific lamprey ammocoetes that could be affected by dredging is unknown. However, because maintenance dredging would occur infrequently, for a short duration, and in limited areas, in-water maintenance activities would not affect Pacific lamprey populations. Furthermore, effects would be minimized by implementation of environmental commitments including *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan;* and *Barge Operations Plan*, described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*.

Loss of Spawning, Rearing, or Migration Habitat

Pacific lamprey habitat near the intake structures is available for rearing and migration. Dredging would remove rearing habitat, especially if ammocoetes were present in the dredging footprint. Placing riprap on the bank would likely have limited effects on available rearing habitat. Migration habitat would not likely be affected by dredging or riprap placement, and additional migration habitat is available farther out in the channel. Maintenance activities would have limited effects on overall rearing habitat, because available rearing habitat of similar quality is readily accessible to Pacific lamprey. Furthermore, effects would be minimized by implementation of environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*.

Predation

Adult lamprey are generally not preyed on by other fish in the Delta. Juvenile Pacific lamprey (macrothalmia life stage) pass rapidly through the Delta, limiting the opportunity for larger fish to prey on them while they are in freshwater. Maintenance activities would be unlikely to have any measurable effect on Pacific lamprey predation rates. These activities may include the use of barges and other watercraft that could theoretically provide cover, shelter, and perching areas for delta smelt predators. However, the limited duration of maintenance activities and the associated noise and disturbance would be expected to dissuade predators from concentrating at sufficient density to measurably affect predation rates on Pacific lamprey.

Summary

Pacific lamprey are tolerant to increases in turbidity, which might occur during maintenance activities. Such activities would include maintenance dredging at the intake sites, and installation or repair of riprap bank armoring. Implementation of the environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*), would further minimize or eliminate effects of turbidity, and accidental spills to Pacific lamprey. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt. In addition, underwater noise levels generated by maintenance activities are unlikely to affect lamprey.

While maintenance dredging would remove rearing habitat, especially if ammocoetes use habitat in the dredging footprint, placing riprap on the bank would likely have limited effects on available rearing habitat, because similar quality habitat is readily accessible to Pacific lamprey. Migration habitat would not be substantially affected by dredging or riprap placement, and additional migration habitat is available farther out in the channel. In addition, no spawning habitat occurs in the areas potentially affected by maintenance activities, and ample rearing, and migration habitat of the same quality is readily accessible in the area, and this habitat would not be affected by maintenance activities.

NEPA Effects: As a result, the effects of short-term maintenance activities would not likely be adverse to Pacific lamprey.

CEQA Conclusion: As described above, Pacific lamprey are tolerant to increases in turbidity, and implementation of the environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*), would minimize or eliminate effects of turbidity, as well as potential effects from accidental spills to Pacific lamprey. In addition, underwater noise levels generated by maintenance activities are unlikely to affect lamprey.

While maintenance dredging would remove rearing habitat, especially if ammocoetes use habitat in the dredging footprint, effects would be limited because similar quality habitat is readily accessible to Pacific lamprey. Migration habitat would not be substantially affected by maintenance activities, and no spawning habitat occurs in these areas. In addition, ample rearing and migration habitat of the same quality is readily accessible in areas that would not be affected by maintenance activities. As a result, the impacts of short-term maintenance activities would be less than significant because it would not reduce Pacific lamprey habitat, restrict its range, or interfere with its movement. Consequently, no mitigation would be required.

Water Operations of CM1

Impact AQUA-165: Effects of Water Operations on Entrainment of Pacific Lamprey

Water Exports from SWP/CVP South Delta Facilities

Alternative 1A is expected to result in decreased entrainment of Pacific and river lamprey macrothalmia and adults at the south Delta export facility compared to NAA. The estimated level of reduction (approximately 50%) is based solely on an assumption that proportional changes in flow lead to similar proportional changes in entrainment.

The analysis for Pacific and river lamprey was combined because the CVP and SWP fish salvage facilities do not distinguish between the two species. Salvage density estimates indicate that lamprey are most vulnerable to south Delta entrainment in January through May, particularly during January and February. CVP salvage is generally much higher than SWP salvage, particularly during peak salvage months. The large majority (approximately 85%) of salvaged lamprey are less than 200 mm fork length (California Department of Fish and Wildlife 2013c), indicating that they are macrothalmia, with the rest adults.

Estimated mean expanded salvage densities of lamprey for each month as reported by the facilities during water years 1996–2009 used in this analysis reflect historical expanded salvage density data. CVP lamprey salvage levels are estimated to be greater than SWP salvage levels. Salvage is estimated to occur primarily during January and February at the CVP, and during December to February with a minor second peak in May at the SWP.

Estimated average expanded salvage under baseline scenarios (all time periods) ranged from zero in September at the SWP to more than 1,300 at the CVP in January, for average annual totals of approximately 720–740 lamprey at the SWP and 2,600 lamprey at the CVP. The total annual estimated expanded salvage under Alternative 1A was approximately 50% less (1,700–1,800 lamprey), and this was quite consistent across all time periods.

As with white and green sturgeon, reductions in south Delta export pumping are expected to decrease entrainment of Pacific and river lamprey macrothalmia and adults under Alternative 1A relative to NAA. The estimated level of reduction (approximately 50%) is based solely on the assumption that proportional changes in flow lead to similar proportional changes in entrainment.

Water Exports from SWP/CVP North Delta Intake Facilities

Potential entrainment at the north Delta intakes occurs only under the action alternatives, including Alternative 1A, because there are no north Delta intakes operational under NAA. The north Delta intakes would be screened to exclude juvenile fish less than about 15 mm long (as evaluated in *BDCP Effects Analysis – Appendix 5B, Entrainment, Section B.5.9.2.1 Screening Effectiveness Analysis, hereby incorporated by reference*). Thus, the screens are expected to be protective of nearly all life stages of all covered fish species. While the screens would have varying effectiveness, based on species characteristic and diversion rates, the overall effectiveness is expected to be greater than for the existing screens at the south Delta facilities. However, the north Delta facilities would be located along the primary migration route for lamprey, which would likely offset the benefits achieved by the improved screen designs. Therefore, the overall effect could be a net increase in overall entrainment and impingement rates on lamprey and other covered fish species. The considerable along-bank length of each of the intakes necessitates monitoring (which is included in the adaptive management component of the project) to confirm that fish are indeed being excluded from entrainment and impingement in the manner that the design specifications suggest.

Water Exports with a Dual Conveyance for the SWP North Bay Aqueduct

Entrainment of Pacific lamprey at the North Bay Aqueduct has not been explicitly analyzed. However, the Barker Slough Pumping Plant is screened for fish >25mm although lamprey would be longer than this because of their body shape. The alternative intake would presumably have screens of 1.75-m mesh and therefore it would exclude lamprey >50-60 mm based on north Delta intake analysis (as evaluated in *BDCP Effects Analysis – Appendix 5B, Entrainment, Section B.5.9.2.1*

Screening Effectiveness Analysis, hereby incorporated by reference). Overall effects would be expected to be no greater than for delta smelt.

If unforeseen changes in distributions or other factors occur as a result of project operations that would increase proportional loss of Pacific lamprey to entrainment, monitoring and the BDCP-proposed Real-Time Response Team would implement measures to avoid or minimize any potential threats to the species that might occur. Based on the current analysis, this would not be necessary.

Predation Associated with Entrainment

Predation can occur in association with the various intakes. No studies have been performed to assess the vulnerability of lamprey to predation within CCF as a consequence of fish salvage operations. Based on their size it has been assumed for purposes of this document that lamprey would be vulnerable to predation in a manner similar to that observed for juvenile salmon, striped bass, and steelhead (Gingras 1997; Clark et al. 2009). Therefore, the risk of predation mortality within CCF is assumed to be approximately 80%, and the risk of predation associated with the CVP trash racks is assumed to be 15%. Reduced exports from the south Delta would reduce the total number of lamprey entrained at the export facilities, but the proportion of entrained lamprey lost to predation is expected to remain the same under CM1. Lamprey are expected to experience increased predation in the Sacramento River due to the construction of the north Delta export facilities, although the certainty is very low.

NEPA Effects: Based on the projected entrainment (salvage rates) of Pacific lamprey under the BDCP, a substantial reduction is expected at the south Delta export facilities. However, the potential entrainment of juvenile lamprey at the north Delta intake facilities raises some uncertainty concerning the overall change in entrainment rate. This uncertainty will be addressed through monitoring and adaptive management actions. The project adaptive management plan includes monitoring of the new north Delta screens to determine their effectiveness and if they are not meeting expectations additional measures (i.e., modifications to screens or other structural components or changes in water diversion operations) may be implemented to improve screen performance. Based on available information, overall entrainment effects on Pacific lamprey populations are not expected to be substantial reduced under Alternative 1A, therefore it is anticipated that there will not be an adverse effect on Pacific lamprey and there may be beneficial effects due to design, installation and operation of new screens in the north Delta.

CEQA Conclusion: As described above, operational activities associated with water exports from south SWP/CVP facilities are expected to substantially reduce entrainment of lamprey. However, operational activities associated with water exports from SWP/CVP north Delta intake facilities could result in an increase in entrainment or a loss of individual lamprey at that location. Monitoring and adaptive management protocols will be implemented to confirm that fish, including lamprey, are being excluded from entrainment and impingement in the manner that the design specifications suggest. Overall, the impacts of Alternative 1A water operations to Pacific lamprey are considered less than significant because they would not substantially reduce their numbers. Consequently, no mitigation would be required.

Impact AQUA-166: Effects of Water Operations on Spawning and Egg Incubation Habitat for Pacific Lamprey

In general, effects of Alternative 1A would reduce the quantity and quality of Pacific lamprey spawning habitat relative to NAA.

Flow-related impacts on Pacific lamprey spawning habitat were evaluated by estimating effects of flow alterations on egg exposure, called redd dewatering risk, and effects on water temperature. A redd is a gravel-covered nest of eggs; Pacific lamprey eggs take between 18 and 49 days to incubate and must remain covered by sufficient water for that time. Rapid reductions in flow can dewater redds leading to mortality. Locations for each river used in the dewatering risk analysis were based on available literature, personal conversations with agency experts, and spatial limitations of the CALSIM II model, and include the Sacramento River at Keswick, Sacramento River at Red Bluff, Trinity River downstream of Lewiston, Feather River at Thermalito Afterbay, and American River at Nimbus Dam and at the confluence with the Sacramento River. Pacific lamprey spawn in these rivers between January and August so flow reductions during those months have the potential to dewater redds, which could result in incomplete development of the eggs to ammocoetes (the larval stage). Water temperature results from the SRWQM and the Reclamation Temperature Model were used to assess the exceedances of water temperatures under all model scenarios in the upper Sacramento, Trinity, Feather, American, and Stanislaus rivers.

Dewatering risk to redd cohorts was characterized by the number of cohorts experiencing a month-over-month reduction in flows (using CALSIM II outputs) of greater than 50%. Small-scale spawning location suitability characteristics (e.g., depth, velocity, substrate) of Pacific lamprey are not adequately described to employ a more formal analysis such as a weighted usable area analysis. Therefore, the change in month-over-month flows is used as a surrogate for a more formal analysis, and a month-over-month flow reduction of 50% was chosen as a best professional estimate of flow conditions in which redd dewatering is expected to occur, but does not estimate empirically derived redd dewatering events. As such, there is uncertainty that these values represent actual redd dewatering events, and results should be treated as rough estimates of flow fluctuations under each model scenario. Results were expressed as the number of cohorts exposed to dewatering risk and as a percentage of the total number of cohorts anticipated in the river based on the applicable time-frame, January to August.

These results indicate no effect or a beneficial effect of Alternative 1A on the number of Pacific lamprey redd cohorts predicted to experience a month-over-month change in flow of greater than 50% in the Sacramento, Trinity, and American Rivers. Alternative 1A would result in an increase (42%) in the number of cohorts predicted to experience a month-over-month change of flow greater than 50% in the Feather River (Table 11-1A-71). Because this is isolated to a single location in the Feather River, it is not expected to cause a population level effect on Pacific lamprey.

Table 11-1A-71. Differences between Model Scenarios in Dewatering Risk of Pacific Lamprey Redd Cohorts[a]

Location	Comparison[b]	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Sacramento River at Keswick	Difference	7	-15
	Percent Difference	13%	-19%
Sacramento River at Red Bluff	Difference	-3	-21
	Percent Difference	-6%	-29%
Trinity River downstream of Lewiston	Difference	-2	-2
	Percent Difference	-2%	-2%
Feather River at Thermalito Afterbay	Difference	3	45
	Percent Difference	2%	42%
American River at Nimbus Dam	Difference	27	-10
	Percent Difference	32%	-8%
American River at Sacramento River confluence	Difference	35	-5
	Percent Difference	37%	-4%

[a] Difference and percent difference between model scenarios in the number of Pacific lamprey redd cohorts experiencing a month-over-month reduction in flows of greater than 50%.
[b] Positive values indicate a higher value in Alternative 1A than in the baseline.

Significant reduction in survival of eggs and embryos of Pacific lamprey were observed at 22°C (71.6°F; Meeuwig et al. 2005). Therefore, in the Sacramento River, this analysis predicted the number of consecutive 49 day periods for the entire 82-year CALSIM period during which at least one day exceeds 22°C (71.6°F) using daily data from SRWQM. For other rivers, the analysis predicted the number of consecutive 2 month periods during which at least one month exceeds 22°C (71.6°F) using monthly averaged data from the Reclamation temperature model. Each individual day or month starts a new "egg cohort" such that there are 19,928 cohorts for the Sacramento River, corresponding to 82 years of eggs being laid every day each year from January 1 through August 31, and 648 cohorts for the other rivers using monthly data over the same period. The incubation periods used in this analysis are conservative and represent the extreme long end of the egg incubation period (Brumo 2006). Also, the utility of the monthly average time step is limited because the extreme temperatures are masked; however, no better analytical tools are currently available for this analysis. Exact spawning locations of Pacific lamprey are not well defined. Therefore, this analysis uses the widest range in which the species is thought to spawn in each river.

In most locations, egg cohort exposure would not differ between NAA and Alternative 1A (Table 11-1A-72). However, the number of cohorts exposed to 22°C (71.6°F) under Alternative 1A would be 5% lower in the Sacramento River at Hamilton City and 91% higher in the Feather River at Thermalito Afterbay. Because this is isolated to a single location in the Feather River, it is not expected to cause a population level effect on Pacific lamprey.

Table 11-1A-72. Differences (Percent Differences) between Model Scenarios in Pacific Lamprey Egg Cohort Temperature Exposure[a]

Location	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Sacramento River at Keswick	0 (NA)	1 (2%)
Sacramento River at Hamilton City	369 (NA)	-56 (-5%)
Trinity River at Lewiston	2 (NA)	2 (40%)
Trinity River at North Fork	-2 (NA)	-5 (-28%)
Feather River at Fish Barrier Dam	0 (NA)	-1 (-100%)
Feather River below Thermalito Afterbay	89 (371%)	84 (91%)
American River at Nimbus	33 (300%)	2 (2%)
American River at Sacramento River Confluence	87 (155%)	-3 (-1%)
Stanislaus River at Knights Ferry	0 (NA)	0 (0%)
Stanislaus River at Riverbank	22 (1,100%)	0 (0%)

NA = could not be calculated because the denominator was 0.

[a] Difference and percent difference between model scenarios in the number of Pacific lamprey egg cohorts experiencing water temperatures above 71.6°F during January to August on at least one day during a 49-Day incubation period in the Sacramento River or for at least one month during a 2-month incubation period for each model scenario in other rivers. Positive values indicate a higher value in the proposed project than in EXISTING CONDITIONS or NAA.

NEPA Effects: These results indicate that the effect would be adverse because it has the potential to substantially reduce suitable spawning habitat and substantially reduce the number of fish as a result of egg mortality. There would be increases in egg cohorts (exposed to redd dewatering risk (45 cohorts or 45%) and temperatures greater than 71.6°F (84 cohorts or 91%) in the Feather River below Thermalito Afterbay. Increased redd dewatering risk and exposure risk to egg cohorts below Thermalito Afterbay would reduce spawning success. These effects would cause substantial reductions in habitat available for spawning and egg incubation in the Feather River. While the implementation of the mitigation measures listed below (Mitigation Measures AQUA-166a through AQUA-166c) would reduce the severity of effects, this would not necessarily result in a not adverse determination.

CEQA Conclusion: In general, Alternative 1A would reduce the quantity and quality of Pacific lamprey spawning habitat relative to the Existing Conditions.

Rapid reductions in flow can dewater redds leading to mortality. Predicted effects of Alternative 1A in the Sacramento River and American River are for increases in the number of redd cohorts predicted to experience a month-over-month change in flow of greater than 50% relative to Existing Conditions (Table 11-1A-71). Changes would be most substantial for the American River (increased risk of dewatering exposure to 35 cohorts or 37% at Nimbus Dam, and 40 cohorts or 42% at the confluence). There would be 13% higher dewatering risk in the Sacramento River at Keswick, but a 6% reduction at Red Bluff. In the Feather River, there are 3 more redd cohorts (2%) predicted to experience a month-over-month change in flow of greater than 50% for Alternative 1A relative to Existing Conditions. No effects are predicted for the Feather or Trinity Rivers (<5%). Therefore, Alternative 1A would not have biologically meaningful effects on Pacific lamprey redd dewatering risk in the Feather River, Trinity River, and Sacramento River at Red Bluff; but would affect dewatering risk in the Sacramento River at Keswick and the American River).

The number of egg cohorts exposed to 22°C (71.6°F) under Alternative 1A would be greater than that under Existing Conditions in all rivers except the Trinity River (Table 11-1A-72).

Collectively, the results indicate that the impact would be significant because the alternative could substantially reduce suitable spawning habitat and substantially reduce the number of fish as a result of egg mortality, contrary to the NEPA conclusion set forth above. There would be increases in egg cohorts exposed to redd dewatering risk in the Sacramento and American Rivers (7 to 35 more cohorts, or 13% to 37%). There would also be increases in egg cohorts exposed to water temperatures above 71.6°F in at least one location in all rivers except the Trinity River (22 to 269 more cohorts, or up to 1100%). Increased exposure to redd dewatering and elevated water temperatures would reduce egg survival. While the implementation of the mitigation measures listed below (Mitigation Measures AQUA-166a through AQUA-166c) would reduce the severity of effects, this would not necessarily result in a less than significant determination.

Mitigation Measure AQUA-166a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Pacific Lamprey to Determine Feasibility of Mitigation to Reduce Impacts to Spawning Habitat

Although analysis conducted as part of the EIR/EIS determined that Alternative 1A would have significant and unavoidable adverse effects on spawning habitat, this conclusion was based on the best available scientific information at the time and may prove to have been over- or understated. Upon the commencement of operations of CM1 and continuing through the life of the permit, the BDCP proponents will monitor effects on spawning habitat in order to determine whether such effects would be as extensive as concluded at the time of preparation of this document and to determine any potentially feasible means of reducing the severity of such effects. This mitigation measure requires a series of actions to accomplish these purposes, consistent with the operational framework for Alternative 1A.

The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 1A operations only. Development of mitigation actions for the incremental impact on spawning habitat attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 1A.

Mitigation Measure AQUA-166b: Conduct Additional Evaluation and Modeling of Impacts on Pacific Lamprey Spawning Habitat Following Initial Operations of CM1

Following commencement of initial operations of CM1 and continuing through the life of the permit, the BDCP proponents will conduct additional evaluations to define the extent to which modified operations could reduce impacts to spawning habitat under Alternative 1A. The analysis required under this measure may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6).

Mitigation Measure AQUA-166c: Consult with USFWS and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Pacific Lamprey Spawning Habitat Consistent with CM1

In order to determine the feasibility of reducing the effects of CM1 operations on river lamprey habitat, the BDCP proponents will consult with USFWS and the Department of Fish and Wildlife to identify and implement any feasible operational means to minimize effects on spawning habitat. Any such action will be developed in conjunction with the ongoing monitoring and evaluation of habitat conditions required by Mitigation Measure AQUA-166a.

If feasible means are identified to reduce impacts on rearing habitat consistent with the overall operational framework of Alternative 1A without causing new significant adverse impacts on other covered species, such means shall be implemented. If sufficient operational flexibility to reduce effects on Pacific lamprey habitat is not feasible under Alternative 1A operations, achieving further impact reduction pursuant to this mitigation measure would not be feasible under this alternative, and the impact on river lamprey would remain significant and unavoidable.

Impact AQUA-167: Effects of Water Operations on Rearing Habitat for Pacific Lamprey

In general, Alternative 1A would have negligible effects on Pacific lamprey rearing habitat conditions relative to NAA due to negligible effects on critical water temperatures and flow reductions that would increase stranding risk. Flow-related impacts to Pacific lamprey rearing habitat were evaluated by estimating effects of flow alterations on ammocoete exposure, called ammocoete stranding risk. Lower flows can reduce the instream area available for rearing and rapid reductions in flow can strand ammocoetes leading to mortality. Comparisons of effects were made for ammocoete cohorts in the Sacramento River at Keswick and Red Bluff, the Trinity River, Feather River, and the American River at Nimbus Dam and at the confluence with the Sacramento River. An ammocoete is the filter-feeding larval stage of the lamprey that remains relatively immobile in the sediment in the same location for 5 to 7 years, after which it migrates downstream. During the upstream rearing period there is potential for ammocoete stranding from rapid reductions in flow.

The analysis of ammocoete stranding was conducted by analyzing a range of month-over-month flow reductions from CALSIM II outputs, using the range of 50%–90% in 5% increments. A cohort of ammocoetes was assumed to be born every month during their spawning period (January through August) and spend 7 years rearing upstream. Therefore, a cohort was considered stranded if at least one month-over-month flow reduction was greater than the flow reduction at any time during the period.

Effects of Alternative 1A on Pacific lamprey ammocoete stranding were analyzed by calculating month-over-month flow reductions for the Sacramento River at Keswick for January through August (Table 11-1A-73). There would generally be no effects of A1A_LLT on stranding risk, except at the 65% reduction value (7% increase).

Results of comparisons for the Sacramento River at Red Bluff provide similar conclusions (Table 11-1A-74). There would generally be no effect or a decrease in the risk of ammocoete stranding under A1A_LLT relative to NAA, except in the 60% flow reduction (5% increase in exposure risk).

Table 11-1A-73. Percent Difference between Model Scenarios in the Number of Pacific Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Sacramento River at Keswick

Percent Flow Reduction	Percent Difference[a]	
	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
-50%	0	0
-55%	0	0
-60%	0	0
-65%	0	7
-70%	4	0
-75%	1	0
-80%	9	1
-85%	4	0
-90%	NA	NA

NA = all values were 0.

[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 1A.

Table 11-1A-74. Percent Difference between Model Scenarios in the Number of Pacific Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Sacramento River at Red Bluff

Percent Flow Reduction	Percent Difference[a]	
	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
-50%	0	0
-55%	4	0
-60%	7	5
-65%	-2	-3
-70%	9	-2
-75%	0	-9
-80%	5	-7
-85%	100	0
-90%	NA	NA

NA = could not be calculated because the denominator was 0.

[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 1A.

Comparisons for the Trinity River indicate no effect (0%) or negligible changes (4%) attributable to A1A_LLT (Table 11-1A-75).

Table 11-1A-75. Percent Difference between Model Scenarios in the Number of Pacific Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Trinity River at Lewiston

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
-50%	0	0
-55%	0	0
-60%	0	0
-65%	0	0
-70%	0	0
-75%	21	-3
-80%	28	0
-85%	18	0
-90%	41	4

[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 1A.

In the Feather River, all comparisons resulted in no difference (0%) or reductions in the occurrence of flow reductions between 28% to 42% (Table 11-1A-76).

Table 11-1A-76. Percent Difference between Model Scenarios in the Number of Pacific Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Feather River at Thermalito Afterbay

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
-50%	0	0
-55%	0	0
-60%	0	0
-65%	0	0
-70%	0	0
-75%	0	0
-80%	-1	1
-85%	12	-42
-90%	-64	-28

[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 1A.

Comparisons for the American River at Nimbus Dam (Table 11-1A-77) and at the confluence with the Sacramento River (Table 11-1A-78) indicate negligible increases (2%) or substantial decreases (-1 to -60%) attributable to the project (Table 11-1A-77), with an increase of 14% for only one flow reduction category, 80% flow reduction, for the confluence.

Table 11-1A-77. Percent Difference between Model Scenarios in the Number of Pacific Lamprey Ammocoete Cohorts Exposed to Month-Over-Month Flow Reductions, American River at Nimbus Dam

Percent Flow Reduction	Percent Difference[a]	
	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
-50%	0	0
-55%	0	0
-60%	1	0
-65%	1	-1
-70%	33	-5
-75%	80	-6
-80%	245	-9
-85%	332	-15
-90%	214	5

[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 1A.

Table 11-1A-78. Percent Difference between Model Scenarios in the Number of Pacific Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, American River at the Confluence with the Sacramento River

Percent Flow Reduction	Percent Difference[a]	
	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
-50%	0	0
-55%	0	0
-60%	1	0
-65%	1	0
-70%	4	-4
-75%	39	2
-80%	198	1
-85%	236	-4
-90%	289	-7

[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 1A.

To evaluate water temperature-related effects of Alternative 1A on Pacific lamprey ammocoetes, we examined the predicted number of ammocoete "cohorts" that experience water temperatures greater than 71.6°F for at least one day in the Sacramento River (because daily water temperature data are available) or for at least one month in the Feather, American, Stanislaus, and Trinity rivers over a 7 year period, the maximum likely duration of the ammocoete life stage (Moyle 2002). Each individual day or month starts a new "cohort" such that there are 18,244 cohorts for the Sacramento River, corresponding to 82 years of ammocoetes being "born" every day each year from January 1 through August 31, and 593 cohorts for the other rivers using monthly data over the same period.

In general, there would be no differences in the number of ammocoete cohorts exposed to temperatures greater than 71.6°F in each river (Table 11-1A-79).There would be 24 more cohorts

(21% increase) exposed under Alternative 1A in the Trinity River at Lewiston, but there would be 32 fewer cohorts (10% decrease) exposed at North Fork. In addition, there would be 72 more cohorts (14% increase) exposed under Alternative 1A in the Feather River below Thermalito Afterbay, but there would be River at Fish Barrier Dam, but there would be 56 fewer cohorts (100% decrease) exposed at North Fork. Overall, the small to moderate increases and decreases will balance out within rivers such that there would be no overall effect on Pacific lamprey ammocoetes.

Table 11-1A-79. Differences (Percent Differences) between Model Scenarios in Pacific Lamprey Ammocoete Cohorts Exposed to Temperatures Greater than 71.6°F in at Least One Day or Month

Location	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Sacramento River at Keswick[b]	0 (NA)	1 (0.1%)
Sacramento River at Hamilton City[b]	5,299 (NA)	-274 (-2%)
Trinity River at Lewiston	56 (NA)	24 (21%)
Trinity River at North Fork	112 (NA)	-32 (-10%)
Feather River at Fish Barrier Dam	0 (NA)	-56 (-100%)
Feather River below Thermalito Afterbay	188 (49%)	72 (14%)
American River at Nimbus	258 (133%)	-14 (-2%)
American River at Sacramento River Confluence	151 (35%)	0 (0%)
Stanislaus River at Knights Ferry	0 (NA)	0 (0%)
Stanislaus River at Riverbank	282 (504%)	0 (0%)

NA = could not be calculated because the denominator was 0.
[a] Positive values indicate a higher value in Alternative 1A than in EXISTING CONDITIONS or NAA.
[b] Based on daily data; all other locations use monthly data; 1922–2003.

NEPA Effects: These results indicate that the effect would not be adverse because it would not substantially reduce rearing habitat or substantially reduce the number of fish as a result of ammocoete mortality. Alternative 1A would have negligible effects on temperature-related ammocoete cohort survival for all locations, with a small increase (14%) in exposures to critical temperatures in the Feather River below Thermalito Afterbay that would not be considered an adverse effect. There would be beneficial effects from substantial decreases in the occurrence of flow reductions in the Feather River and the American River.

CEQA Conclusion: In general, the quantity and quality of Pacific lamprey rearing habitat would not be affected by Alternative 1A relative to the CEQA baseline. Lower flows can reduce the instream area available for rearing and rapid reductions in flow can strand ammocoetes leading to mortality. Comparisons of Alternative 1A to Existing Conditions for the Sacramento River at Keswick indicate negligible changes (<5%) in occurrence of flow reductions for all flow reduction categories, except the 80% reduction (9% increase in exposure risk) (Table 11-1A-73). Comparisons for the Sacramento River at Red Bluff indicate that there would generally be no effect of A1A_LLT, except in the 70%, 80%, and 85% flow reductions (9%, 5%, and 100% increase in exposure risk, respectively) (Table 11-1A-74).

Increases of 18% to 41% are predicted for flow reduction categories from 75% to 90% for the Trinity River (Table 11-1A-75) based on increases from approximately 400 to 500 ammocoete cohorts exposed to stranding risk.

The number of Pacific lamprey ammocoete cohorts exposed to 71.6°F temperatures under Alternative 1A would be higher than those under Existing Conditions in at least one location in all rivers (Table 11-1A-79).

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-167 CEQA analysis indicate that that the difference between the CEQA baseline and Alternative 1A could be significant because, under the CEQA baseline, the alternative could substantially reduce rearing habitat and substantially reduce the number of fish as a result of ammocoete mortality, contrary to the NEPA conclusion set forth above. Increased exposure to elevated water temperature in the Sacramento, Feather, American, and Stanislaus Rivers would have biologically meaningful impacts on Pacific lamprey rearing habitat. Increased water temperatures would increase stress and reduce survival of lamprey ammocoetes. Increased stranding risk in the American and Trinity Rivers would increase the risk of desiccation and reduce survival of ammocoete cohorts.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 1A does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 1A indicates that flows and reservoir storage in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 1A. This indicates that the differences between Existing Conditions and Alternative 1A found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 1A, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on rearing habitat for Pacific lamprey. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-168: Effects of Water Operations on Migration Conditions for Pacific Lamprey

In general, Alternative 1A would not affect the quality and quantity of migration habitat for Pacific lamprey relative to the NAA.

After 5–7 years, Pacific lamprey ammocoetes migrate downstream and become macropthalmia (juveniles) once they reach the Delta. Migration generally is associated with large flow pulses in winter months (December through March) (USFWS unpublished data) meaning alterations in flow have the potential to affect downstream migration conditions. The effects of Alternative 1A on seasonal migration flows for Pacific lamprey macropthalmia were assessed using CALSIM II flow output. Flow rates along the migration pathways of Pacific lamprey during the likely migration period (December through May) were examined for the Sacramento River at Rio Vista and Red Bluff, the Feather River at the confluence with the Sacramento River, and the American River at the confluence with the Sacramento River.

Sacramento River

Juveniles

The difference in mean monthly flow rate for the Sacramento River at Rio Vista for December to May for Alternative 1A compared to NAA indicates reductions in flow for most months/water year types in the migration period with persistent flow reductions ranging from 5% to 29% depending on the specific month and water year (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*. There would be decreases in flow during January to April (up to 22%) when reductions in flow would have the greatest effect on migration conditions. The decreases in flow in the Sacramento River at Rio Vista could adversely affect outmigrating macropthalmia during these months.

For the Sacramento River at Red Bluff, the difference in mean monthly flow rate for Alternative 1A compared to NAA indicate generally negligible effects (<5%) on flow attributable to the project for December through April and increases in flow attributable to the project during April and May ranging from 6% to 14% (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*. The increases in flow in the Sacramento River at Red Bluff would have a beneficial effect on migration conditions.

These results indicate that effects of Alternative 1A on flow consist of negligible effects (<5%), or small increases in flow that would have a beneficial effect on migration in the Sacramento River at Red Bluff, but that effects for Sacramento River at Rio Vista would consist primarily of reductions in flow, including during drier water years, for much of the macropthalmia migration period that would adversely affect outmigrating macropthalmia.

Adults

For the Sacramento River at Red Bluff for the time-frame January to June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*), effects of Alternative 1A on mean monthly flow indicate effects would typically be negligible (<5%) with small increases in flow (up to 16%) during April through June for some water years. Increases in flow would have a beneficial effect on migration conditions.

Feather River

Juveniles

Comparisons for the Feather River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) indicate primarily increases in flow (up to 59%) for December through May. Increases in mean monthly flow would be beneficial for migration conditions.

Adults

For the Feather River at the confluence with the Sacramento River, January to June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*), mean monthly flows under Alternative 1A would generally be higher (up to 44%) than flows under NAA with few exceptions,

American River

Juveniles

Comparisons for the American River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) indicate negligible effects (<5%)of A1A_LLT relative to NAA during December through April. During May, flows under A1A_LLT would be up to 32% greater than under NAA.

Adults

Comparisons of mean monthly flow for the American River at the confluence with the Sacramento River for January to June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) indicate negligible effects (<5%)of A1A_LLT relative to NAA during January through April. During May and June, flows under A1A_LLT would be up to 34% greater than flows under NAA.

NEPA Effects: Collectively, these results indicate that the effect is not adverse because it would not substantially reduce the amount of suitable habitat and substantially interfere with the movement of fish. Flows in the Sacramento River at Rio Vista under Alternative 1A would be reduced relative to NAA, with persistent flow reductions of 5% to 29% throughout the migration period that would affect conditions for outmigrating macropthalmia at that location. However, this is the only location with such persistent negative effects on flows and negative effects on Pacific lamprey migration success would be offset by beneficial effects in the other locations analyzed. Effects of Alternative 1A in the other locations analyzed would consist primarily of negligible effects (<5%), that would not have biologically meaningful effects, and small-to-large (up to 59%) increases in flow that would have beneficial effects on migration conditions.

CEQA Conclusion: In general, Alternative 1A would not affect the quality and quantity of migration habitat for Pacific lamprey relative to CEQA Existing Conditions.

Sacramento River

Juveniles

Comparisons of mean monthly flow rates in the Sacramento River at Rio Vista (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for December to May for Alternative 1A relative to Existing Conditions indicate reductions in flow ranging from 5% to 47% in most water years for each of these months. These results indicate that effects of Alternative 1A on flow would have negative effects on outmigrating macropthalmia in the Sacramento River. Comparisons for the Sacramento River at Red Bluff (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) indicate primarily negligible (<5%) or small increases in flow (up to 18%) that would not have biologically meaningful effects on migration conditions. Exceptions include a decrease in flow of 14% during May in wet years when flow reductions would not be as critical for migration conditions. Therefore, Alternative 1A would not have biologically meaningful negative effects on outmigrating macropthalmia at this location.

Adults

Comparisons of mean monthly flow for the Sacramento River at Red Bluff (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) during the Pacific lamprey adult migration period from January through June indicate that for most months and water year types, flows under Alternative

1A would be similar to (<5% difference), or greater (up to 21%) than flows under Existing Conditions, with one occurrence of decreased flow in wet years during May (14%) when effects of flow reductions would be less critical for migration. Therefore, effects of Alternative 1A consist of negligible effects or increases in flow that would have beneficial effects, and small reductions in flow that would not have biologically meaningful effects.

Feather River

Juveniles

Comparisons for the Feather River at the confluence (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for December to May indicate primarily increases in flow (up to 37%), with some infrequent conditions of negligible (<5%) or reduced flows (up to 23%). Reduced flow would occur in below normal water years in January (12% lower) and March (11% lower), and during wet years in May (23% lower). Increases in flow would have beneficial effects on migration conditions, while decreases would have negative effects on migration. Based on this limited occurrence of flow decreases at times that would be most critical for migration, and the prevalence of increased flows or negligible differences for most of the migration period, effects of Alternative 1A on flows would not have biologically meaningful effects on macropthalmia migration in the Feather River.

Adults

Comparisons of mean monthly flow for the Feather River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for January to June indicate variable effects of Alternative 1A depending on the month and water year type, with primarily increased flow (to 39%) and negligible effects (<5%), which would have beneficial effects on migration conditions. However, the occurrence of relatively small decreases in flow (up to 23%), that would typically not have biologically meaningful effects on migration conditions. primarily occur in May and June. The more substantial decreases in flow would occur during below normal years in January (12% lower), and March (11% lower), wet years in May (9% lower) and June (19% lower), and in June during dry (7% lower) and critical years (17% lower). These flow reductions are isolated occurrences of relatively small magnitude and would therefore not have biologically meaningful effects on migration conditions. Therefore, effects of Alternative 1A on flow would not affect migration conditions in the Feather River.

American River

Juveniles

Comparisons for the American River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for December to May indicate variable effects, primarily consisting of relatively small increases (up to 29%) or decreases (up to 27%) in flow, depending on month and water year type. Although these results were variable, the increased flows tended to occur in February (up to 29%) and March (up to 19%), and the decreased flows tended to occur in December (up to 24%), January (up to 27%) and May (up to 27%). Decreases in drier water years for December through March and May encompass much of the migration period and would affect macropthalmia migration conditions for that time-frame (particularly critical years).

Adults

Comparisons of mean monthly flow for the American River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for January to June indicate variable effects of Alternative 1A depending on the month and water year type, with meaningful changes in flow (≥±5%) consisting of increases up to 32% (June, below normal years) that would have beneficial effects on migration conditions, and decreases to 37% in June of drier years. While the increased flows would occur more frequently in February and March, and decreased flows primarily in January and May, these two flow conditions would occur at about the same frequency and magnitude range over the adult migration period. Conclusions are that effects of Alternative 1A consist of variable effects on flow and predicted flow reductions would not have biologically meaningful effects on river lamprey migration based on the magnitude of the decreases and infrequent or isolated occurrences.

Summary of CEQA Conclusion

Collectively, these results indicate that the impact is not significant because it would not substantially reduce the amount of suitable habitat or substantially interfere with the movement of fish, and no mitigation is necessary. Effects of Alternative 1A compared to Existing Conditions during the January to June adult Pacific lamprey migration period consist of relatively small increases or decreases in flow, along with periodic negligible effects (<5%), that would not have biologically meaningful effects on migration conditions.

Restoration Measures (CM2, CM4–CM7, and CM10)

Impact AQUA-169: Effects of Construction of Restoration Measures on Pacific Lamprey

Temporary Increases in Turbidity

Restoration construction activities such as riprap removal, shoreline excavation and re-contouring, and planting riparian vegetation have the potential to result in temporary increases in turbidity conditions in adjacent waterways. However, Pacific lamprey are tolerant of turbid water conditions and are unlikely to be affected by temporary increases in turbidity during restoration construction. Implementing the environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Fish Rescue and Salvage Plan*; and *Barge Operations Plan*), would minimize the potential for turbidity to affect Pacific lamprey.

Increased Exposure to Mercury

As discussed above for delta smelt (Impact AQUA-7), the implementation of *CM12 Methylmercury Management* would minimize potential effects of methylmercury mobilization from restoration sites, on Pacific lamprey. As a result, restoration activities are not likely to produce the biogeochemical conditions that would support methylation of mercury; thus increased bioavailability and toxicity as a result of restoration activities are not expected. However, the cycling of mercury is a complicated process, and is difficult to predict based on existing information.

Accidental Spills

As discussed above for construction and maintenance activities (see Impact AQUA-1 and Impact AQUA-2 for delta smelt), implementation of environmental commitments would minimize the potential for introduction of contaminants to surface waters and provide for effective containment and cleanup should accidental spills occur. These environmental commitments are *Environmental Training; Stormwater Pollution Prevention Plan; Erosion and Sediment Control Plan; Hazardous Materials Management Plan; Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material; and Barge Operations Plan;* (see Appendix 3B, *Environmental Commitments* and Impact AQUA-1). Specifically, the *Spill Prevention, Containment, and Countermeasure Plan* will be implemented to minimize the risk of spills occurring and to provide for rapid and effective response to contain any accidental spills.

Disturbance of Contaminated Sediments

Runoff and suspension of contaminants could cause short-term, localized increases in the concentrations of contaminants in and near restoration sites (see discussion for delta smelt under Impact AQUA-7). The potential impacts of toxics on fish would be minimized to the extent possible by timing construction activities so that vulnerable early life stages of fish are not present. Although adult and ammocoete Pacific lamprey would likely be present during the expected in-water work window, implementation of environmental commitments (see Appendix 3B, *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*) would minimize exposure levels. The periodic and temporary nature of toxicity spikes that may occur during restoration activities would also minimize the extent of potential effects on Pacific lamprey. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

In-Water Work Activities

Restoration construction activities could temporarily produce noise levels and disturbances that could affect nearby fishes. Such activities are not expected to elevate underwater noise above the threshold sound pressure levels established for fish (see discussion for delta smelt under Impact AQUA-1). Any changes in disturbance levels would be minor and temporary, and fish are expected to generally avoid areas where shoreline construction activities are occurring. Potential effects of in-water activity would be minimized by implementation of the environmental commitments described under Impact AQUA-1 and in Appendix 3B, *Environmental Commitments*, including *Erosion and Sediment Control Plan*; *Dispose of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Predation

Although there is low certainty regarding their behavior in the Delta, lamprey macropthalmia likely use the Delta primarily as a migration corridor, as evidenced by low catches in beach seines in back sloughs and higher catches in beach seines in mainstem sampling (U.S. Fish and Wildlife Service 2013). Only a small proportion of the proposed habitat restoration would be located along major migration corridors, such as the mainstem Sacramento and San Joaquin rivers, in the West and South Delta ROAs. Therefore, it is presumed that lamprey will not spend large amounts of time in the vicinity of restored tidal marsh or floodplain habitat while they are being constructed. Additionally any in-water work may cause predatory fish to temporarily avoid those locations reducing the predation potential. Predation is not expected to increase. Therefore, the effect would not be adverse.

NEPA Effects: In-water and shoreline construction activities associated with habitat restoration would be scheduled to occur when the least number of Pacific lamprey would be present in or near the restoration sites. Such activities would include riprap removal and levee breaching, and shoreline excavation and re-contouring. Pacific lamprey are tolerant to increases in turbidity, which might occur during shoreline restoration construction activities. Implementation of the environmental commitments described in Appendix 3B, *Environmental Commitments*, would minimize or eliminate effects on Pacific lamprey smelt by reducing the amount of turbidity and guiding the rapid and effective response in case of inadvertent spills of hazardous materials (see Impact AQUA-7). These Environmental Commitments are *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt. As a result, the effects of short-term restoration construction activities would not be adverse to longfin smelt.

While implementation of these environmental commitments would minimize or eliminate short-term effects occurring during restoration construction, long-term effects could also occur. For example, removing or breaching levees would result in the expansion of floodplain habitat, and more frequent inundation these areas, potentially promoting conversion of mercury to methylated mercury, and runoff containing agricultural-related toxins such as copper and organochlorine pesticides. However, the overall effect of increased bioavailability of methylmercury and other pollutants on Pacific lamprey is likely to be of low magnitude, periodic and localized. In addition, potential increases would be minimized to the extent possible because of implementation of *CM12 Methylmercury Management* (see Impact AQUA-10). For these reasons, the effect on Pacific lamprey would not be adverse.

CEQA Conclusion: As described above, in-water and shoreline construction activities associated with habitat restoration would be scheduled to occur when the least number of Pacific lamprey would be present in or near the restoration sites. Pacific lamprey are tolerant to increases in turbidity, which might occur during shoreline restoration construction activities, and implementation of the environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments (see Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material)*, would minimize the potential for turbidity, accidental spills, resuspension of contaminated sediments, or construction noise to affect Pacific lamprey. Therefore, this impact is considered less than significant for Pacific lamprey because it would not substantially reduce habitat, restrict its range or interfere with its movement. Consequently no mitigation would be required.

Impact AQUA-170: Effects of Contaminants Associated with Restoration Measures on Pacific Lamprey

NEPA Effects: As described above for delta smelt (see Impact AQUA-8), effects on covered fish species will depend on the species/life stage present in the area of elevated toxins and the duration of exposure. A complete analysis can be found in the *BDCP Effects Analysis – Appendix D*, *Contaminants (hereby incorporated by reference)*. Potential impacts on lamprey from effects of methylmercury, selenium, copper, ammonia, and pesticides associated with habitat restoration activities would be similar to those discussed for delta smelt (see Impact AQUA-8).

As with delta smelt, the potential contaminants associated with habitat restoration activities are not expected to result in any adverse effects on lamprey (see detailed discussion for delta smelt under Impact AQUA-8). While Alternative 1A actions are likely to result in increased production, mobilization, and bioavailability of methylmercury, selenium, copper, and pesticides in the aquatic system, any such releases would be sporadic, short term and localized, and would be unlikely to result in measurable increases in the bioaccumulation in Pacific lamprey. In addition, implementation of *CM12 Methylmercury Management* would help to minimize the increased mobilization of methylmercury at restoration areas. In addition, the overall effects associated with habitat restoration are expected to result in an overall benefit to Pacific lamprey.

CEQA Conclusion: Alternative 1A actions are likely to result in increased production, mobilization, and bioavailability of methylmercury, selenium, copper, and pesticides in the aquatic system. However, any such releases would be sporadic, short-term and localized, and would be unlikely to result in measurable increases in the bioaccumulation in Pacific lamprey. Implementation of *CM12 Methylmercury Management* would also help to minimize the increased mobilization of methylmercury at restoration areas. Therefore, the impact of contaminants is considered less than significant because it would not substantially effect Pacific lamprey either directly or through habitat modifications and, with restoration, would be beneficial in the long-term. Consequently, no mitigation would be required.

Impact AQUA-171: Effects of Restored Habitat Conditions on Pacific Lamprey

The full analysis of habitat restoration can be found in the *BDCP Effects Analysis – Appendix E, Habitat Restoration (hereby incorporated by reference)*. As analyzed further below, the proposed tidal marsh, channel margin, floodplain, and riparian restoration measures are intended to increase access to suitable habitat for Pacific and river lamprey, as well as other covered fish species, and restore important ecological functions of the Delta. For further discussion see Impact AQUA-9 for delta smelt.

Little is known about the occurrence and potential function of various habitat types to Pacific lamprey in the Plan Area. As described above, there have been occasional catches of lamprey during seine surveys and more than 2,100 Pacific lamprey ammocoetes were collected during electrofishing at bank protection sites (H.T. Harvey and Associates with PRBO Conservation Science 2011). Lamprey ammocoetes generally are thought of as occurring upstream of the Plan Area, but there appear also to be appreciable numbers in the Plan Area. Enhancement of channel margin habitat would increase the amount of ammocoete burial habitat where hardened substrates are removed or covered with soft substrate of a sufficient depth (at least 30 cm) (Close et al. 2003).

CM2 Yolo Bypass Fisheries Enhancement

Yolo Bypass fisheries enhancement is discussed above under delta smelt (Impact AQUA-9). Pacific lamprey do not substantially use floodplains so the increase in this habitat would have limited beneficial effect on Pacific lamprey.

CM4 Tidal Natural Communities Restoration

Little is known about the occurrence and potential function of tidal wetland habitat to Pacific lamprey in the Plan Area. However, the increase in habitat area may help to increase species diversity and abundance. For further discussion, see Impact AQUA-9. Increased food productivity is expected in all ROAs as a result of the BDCP. A phytoplankton growth model was developed to estimate the change in food production expected from tidal restoration in the ROAs. The model was based on a strong relationship between phytoplankton growth rate and depth, but could not be extended to zooplankton production (the primary food of many of the covered fish), due to uncertainty in that relationship and the unknown effects of invasive filter feeders such as the Asian clam. However, overall primary productivity is assumed to translate directly to increases in food production for lamprey ammocoetes, which are filter feeders.

CM5 Seasonally Inundated Floodplain Restoration

Pacific lamprey do not substantially use floodplains, so the increase in this habitat would have limited beneficial effect on Pacific lamprey. However, periodic inundation of the restored floodplain would likely benefit lamprey by cycling nutrients, supporting growth of plankton and aquatic insects. Providing river–floodplain connectivity would increase production of lower trophic levels at relatively rapid time scales, with some food web organisms responding within days at high densities. For further discussion see Impact AQUA-9.

Although food is not likely a limiting factor to the abundance of lamprey in the Delta, BDCP actions, notably the restoration and enhancement of upstream habitats, may increase lamprey food availability relative to Existing Conditions. If the upstream productivity transfer occurs at the planktonic level, lamprey ammocoetes would directly benefit. For further discussion, see Impact AQUA-9.

CM6 Channel Margin Enhancement

Although little is known about lamprey use of channel margin habitat, the species may benefit from enhancement that increases the area of non-revetted substrate into which ammocoetes can bury; recent monitoring indicates that ammocoetes may be relatively abundant in the substrates in the Plan Area

Lamprey spawn upstream of the Plan Area and so would not likely benefit from an increase in spawning habitat under *CM6 Channel Margin Enhancement*.

However, CM6 Channel Margin Enhancement is expected to increase the availability and quality of resting habitat for migrating lamprey as a result of increased channel margin complexity (e.g., woody material) providing refuge from high flows. The benefits of this increased resting habitat are uncertain because of a lack of research on lamprey migration behavior.

CM7 Riparian Natural Community Restoration

BDCP habitat restoration, including riparian restoration, are expected to improve the quality and quantity of Delta rearing habitats for lamprey. Once established, these habitats could provide suitable food resources for lamprey. However, it is uncertain whether lamprey would directly benefit for riparian restoration (*CM7 Riparian Natural Community Restoration*). For further discussion, see Impact AQUA-9.

CM10 Nontidal Marsh Restoration

For discussion of the potential effects of nontidal marsh restoration on Pacific lamprey, see the discussion under Impact AQUA-9. Upland restoration could have minor indirect beneficial effects on Pacific lamprey in the main river systems and Delta. These upland wetlands provide hydrologic and water quality functions such as storing water during floods and filtering contaminants. These sites would also provide some additional food resources such as insects, zooplankton, phytoplankton and dissolved organic carbon. These materials would be exported during flood stages when the upland might be connected to the river system. Although the contribution from 400 acres would be small, it could be slightly beneficial.

NEPA Effects: The effects of floodplain, tidal, channel margin and riparian habitat restoration activities on Pacific lamprey, are expected to be similar to those discussed for delta smelt (see Impact AQUA-9). In general, these effects are expected to have limited benefits for lamprey, with the primary benefits likely to be the result of increased productivity from more frequent inundations of restoration areas and increased amount and quality of available rearing and migration habitat.

Despite the improvements in habitat and habitat functions in the Delta from these habitat restoration activities, habitat quality is expected to decline in the LLT primarily because of climate change. However, the overall effect of restoration activities is expected to remain beneficial for lamprey.

However, it is important to note that benefits would not be derived in all years, and that an adaptive management plan would be needed to determine an operational protocol that optimizes benefits both locally and in adjacent habitats.

CEQA Conclusion: As with delta smelt, the overall effects of floodplain, tidal, channel margin and riparian habitat restoration activities are expected to be beneficial for lamprey (see Impact AQUA-9). The primary benefits are likely to be the result of increased productivity from more frequent inundations of restoration areas and increased amount and quality of available rearing and migration habitat. Despite the improvements in habitat and habitat functions in the Delta from these habitat restoration activities, habitat quality is expected to decline in the LLT primarily because of climate change. However, the overall impact of restoration activities is expected to remain beneficial for lamprey because they increase habitat. Consequently, no mitigation would be required.

Other Conservation Measures (CM12–CM19 and CM21)

Impact AQUA-172: Effects of Methylmercury Management on Pacific Lamprey (CM12)

Refer to Impact AQUA-10 under delta smelt for a discussion of the effects of methylmercury management on Pacific lamprey.

Impact AQUA-173: Effects of Invasive Aquatic Vegetation Management on Pacific Lamprey (CM13)

The following analysis is based on the more detailed analysis included in *BDCP Effects Analysis – Appendix F, Biological Stressors, Section F.1.1 Invasive Aquatic Vegetation, Section F.4 Invasive Aquatic Vegetation, and F.5.3.2.3 Nonnative Aquatic Vegetation Control (Conservation Measure 13) (hereby incorporated by reference)*.

NEPA Effects: A general analysis of the effects on covered fish species has been conducted that was described above for delta smelt (see Impact AQUA-11). Potential impacts on Pacific lamprey from IAV control during operations are similar to those discussed for delta smelt. The control of IAV with implementation of *CM13 Invasive Aquatic Vegetation Control* is expected to maintain or improve turbidity conditions that could benefit Pacific lamprey rearing conditions. The control of IAV would also increase the amount of rearing habitat, as well as access to the habitat and potential increases in food availability. Removal of IAV would reduce habitat supporting predatory fish. The effects of IAV control are expected to provide an overall benefit to Pacific lamprey.

CEQA Conclusion: The control of IAV should provide a modest net benefit to Pacific lamprey during operations through chemical and mechanical treatment and is considered a beneficial impact by reducing predation mortality, increasing food availability, and increasing rearing habitat. The impact is expected to be beneficial; consequently, no mitigation would be required.

Impact AQUA-174: Effects of Dissolved Oxygen Level Management on Pacific Lamprey (CM14)

NEPA Effects: As discussed in Chapter 8, *Water Quality*, dissolved oxygen levels would be very similar to Existing Conditions in the areas upstream of the Delta, in the Delta, and in the SWP/CVP export service areas (see discussion of Impacts WQ-10 and WQ-11). As noted there, however, *CM14 Stockton Deepwater Ship Channel Dissolved Oxygen Levels* management would increase the dissolved oxygen levels and improve the aquatic habitat conditions. Pacific lamprey occur in the channel and the increased dissolved oxygen levels also provide improved habitat conditions for them, which would be a benefit. Consequently, the effect would not be adverse, and could be slightly beneficial.

CEQA Conclusion: As discussed in Chapter 8, *Water Quality*, *CM14 Stockton Deepwater Ship Channel Dissolved Oxygen Levels* management would increase the dissolved oxygen levels and improve aquatic habitat conditions. Pacific lamprey occur in the channel and the increased dissolved oxygen levels also provide improved habitat conditions for them, which would be beneficial. Consequently, no mitigation would be required

Impact AQUA-175: Effects of Localized Reduction of Predatory Fish on Pacific Lamprey (CM15)

Adult lamprey are generally not preyed on by other fish in the Delta. Juvenile Pacific lamprey (macrothalmia life stage) would be expected to pass through the channel rapidly limiting the opportunity for larger fish to prey on them. Previous diet studies (Stevens 1966; Nobriga and Feyrer 2007) did not find a single Pacific lamprey in the gut of striped bass, largemouth bass, or Sacramento pikeminnow, despite examining thousands of predator guts (9,197 striped bass, 320 largemouth bass, and 322 pikeminnow combined in the two studies). However, the sampling periods of these studies (Stevens 1966: February–November; Nobriga and Feyrer 2007: March–October) did not generally overlap with peak lamprey migration periods. Approximately 79% of lamprey salvage between 1993 and 2004 at state and federal facilities occurred during January and February (California Department of Fish and Wildlife 2013c). Therefore, it is assumed that predation of lamprey occurs in the Delta, although there is low certainty of the effect that predation has on the species. To the extent that localized predator control efforts of *CM15 Localized Reduction of Predatory Fish* reduce the overall abundance of fish predators in the Delta occupied by Pacific lamprey, it is possible, but not assured that there would be some reduction in losses to predation, (see Impact AQUA-13).

NEPA Effects: Due to these uncertainties, there would be no demonstrable effect of this conservation measure on Pacific lamprey.

CEQA Conclusion: Due to the uncertainties concerning overall fish predator reduction and actual predation reduction on Pacific lamprey in the Delta, there would be no demonstrable effect on this conservation measure on Pacific lamprey. Consequently, no mitigation would be required.

Impact AQUA-176: Effects of Nonphysical Fish Barriers on Pacific Lamprey (CM16)

NEPA Effects: Effects on lamprey species from predation associated with construction of NPBs are unknown. Pacific lamprey are known to inhabit reaches of the Sacramento and San Joaquin River basins upstream of the Delta, so they would encounter the NPBs at Georgiana Slough and the head of Old River. The NPBs are likely to attract piscivorous predators hiding among the physical structures of the barrier. Unlike salmon, lamprey are not deterred by the sounds and lights of the barrier, and therefore are not deterred from entering areas of the Delta associated with high predation. Implementation of *CM16 Nonphysical Fish Barriers* is expected to be generally ineffective with lamprey. The additional predation on Pacific lamprey would be expected to be low and the population level effect would not be adverse.

CEQA Conclusion: Effects on lamprey species from predation associated with construction of NPBs is uncertain. The NPBs are likely to attract piscivorous predators hiding among the physical structures of the barrier. Unlike salmon, lamprey are not deterred by the sounds and lights of the barrier, and therefore are not deterred from entering areas of the Delta associated with high predation. Implementation of *CM16 Nonphysical Fish Barriers* is expected to be generally ineffective with lamprey. The additional predation on Pacific lamprey is expected to be low. The overall impact on Pacific lamprey from NPBs is less than significant because it would not substantially reduce their numbers. Consequently, the impact would be less than significant. No mitigation would be required.

Impact AQUA-177: Effects of Illegal Harvest Reduction on Pacific Lamprey (CM17)

NEPA Effects: *CM17 Illegal Harvest Reduction* would be applied to Chinook salmon, Central Valley steelhead, green sturgeon and white sturgeon and are expected to have positive effects on their populations. Since this conservation measure is not applied to Pacific lamprey it would have no direct effect on them. Therefore, the effect would not be adverse.

CEQA Conclusion: *CM17 Illegal Harvest Reduction* would be applied to Chinook salmon, Central Valley steelhead, green sturgeon and white sturgeon and are expected to have positive effects on their populations. Since this conservation measure is not applied to Pacific lamprey it would have no direct effect on them. Consequently, no mitigation would be required.

Impact AQUA-178: Effects of Conservation Hatcheries on Pacific Lamprey (CM18)

NEPA Effects: *CM18 Conservation Hatcheries* would establish new and expand existing conservation propagation programs for delta and longfin smelt. This conservation measure would have no effect on Pacific lamprey.

CEQA Conclusion: *CM18 Conservation Hatcheries* would establish new and expand existing conservation propagation programs for delta and longfin smelt. This conservation measure would have no impact on Pacific lamprey. Consequently, no mitigation would be required.

Impact AQUA-179: Effects of Urban Stormwater Treatment on Pacific Lamprey (CM19)

NEPA Effects: The effects of *CM19 Urban Stormwater Treatment* would reduce contaminants associated with urban areas because it provides for the treatment of stormwater discharges. As discussed in Chapter 8, *Water Quality*, and previously under Impact AQUA-8 in the section titled *Pyrethroids, Organophosphate Pesticides, and Organochlorine Pesticides,* stormwater treatment would reduce urban loadings of pesticides (including pyrethroids), phosphorous, trace metals and other contaminants. These reductions would contribute to improved water quality in the Delta. Based on the improved overall water quality conditions and reduced pesticides the effect would be beneficial.

CEQA Conclusion: *CM19 Urban Stormwater Treatment* would reduce contaminants associated with urban areas because it would provide for the treatment of stormwater discharges. As discussed in Chapter 8, *Water Quality*, and previously under Impact AQUA-8 in the section titled *Pyrethroids, Organophosphate Pesticides, and Organochlorine Pesticides,* stormwater treatment would reduce urban loadings of pesticides(including pyrethroids), phosphorous, trace metals and other water contaminants. These reductions would contribute to improved water quality in the Delta. Therefore, the impacts of urban stormwater treatment would be beneficial because it would have a beneficial effect both directly and through habitat modifications on Pacific lamprey. Consequently, no mitigation would be required.

Impact AQUA-180: Effects of Removal/Relocation of Nonproject Diversions on Pacific Lamprey (CM21)

NEPA Effects: As discussed above for other species, there is no evidence of substantial entrainment of covered fish species at agricultural diversions in the Plan Area, although slight reductions are expected from decommissioning agricultural diversions in the ROAs (see Impact AQUA-18). The effect would be beneficial.

CEQA Conclusion: Although there is no evidence of substantial entrainment of covered fish species at agricultural diversions in the Plan Area, slight reductions are expected from decommissioning agricultural diversions in the ROAs (see Impact AQUA-18). The impact on Pacific lamprey would be beneficial because it would reduce entrainment which would have a positive impact on Pacific lamprey numbers. Consequently, no mitigation would be required.

River Lamprey

Construction and Maintenance of CM1

Impact AQUA-181: Effects of Construction of Water Conveyance Facilities on River Lamprey

River lamprey are present in the north, east, and south Delta. Table 11-4 illustrates the life stages of river lamprey present in these areas during the in-water construction window (expected to be June 1–October 31). Ammocoetes are present year-round in all of these areas. Adult spawners may be migrating by construction sites for the intakes and barge landings during September and October. Macrothalmia (migrating juveniles) may be in the north and south Delta in June and July.

Temporary Increases in Turbidity

River lamprey ammocoetes, adults, and migrating juveniles may occur in the area during construction of the intake structures and barge landings. Because river lamprey typically inhabit turbid water, they are unlikely to be affected by a temporary increase in turbidity. As discussed for delta smelt (see Impact AQUA-1), environmental commitments would be implemented to minimize turbidity during construction activities (see Impact AQUA-1 and Appendix 3B, *Environmental Commitments Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*). Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Accidental Spills

Potential impacts on river lamprey from accidental spills during construction are similar to those discussed for delta smelt (see Impact AQUA-1). Implementing the environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*), and specifically the *Spill Prevention, Containment, and Countermeasure Plan*, would be expected to minimize the potential for introduction of contaminants to surface waters and provide for effective containment and cleanup should accidental spills occur.

Disturbance of Contaminated Sediments

There is a potential risk of contaminated sediments affecting river lamprey during construction of intake structures and barge landings. Because they are filter feeders and are buried in the substrate, the ammocoetes could be the most affected life stage by the disturbance of sediment contaminants. However, the suspension of sediments would be minimized by implementation of environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitment*, (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*). Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Underwater Noise

Underwater sound generated by impact pile driving in or near surface waters can potentially harm river lamprey. It is important to note that the impact would be realized only where piles must be impact driven; underwater sound generated by vibratory pile installation methods are not sufficiently loud to injure fish.

Potential effects on river lamprey from pile driving are different from other fish species. In a study done by Popper (2005) on hearing by sturgeon and lamprey, it was found that lamprey do not have the typical hearing structures of other fish. While there have been no definitive studies to determine responses of lamprey to sound (Popper 2005), ammocoetes are buried below the substrate, and the substrate dampens vibrations and noise. As a result, at least some life stages of river lamprey may be somewhat less susceptible to injury from impact pile driving activities, than other fish species. Implementation of Mitigation Measures AQUA-1a and AQUA-1b would also reduce the severity of these effects. Overall, construction noise would be expected to adversely affects individual lamprey, although the effects are not expected to affect the overall population.

Fish Stranding

In-water work activities have the potential to injure or kill fish through the process of rescuing fish from construction areas. River lamprey adults may be present from September through June. Outmigrating juveniles (macrothalmia life stage) also pass through the area from May to July, but in small numbers. Although adult river lamprey may be present during cofferdam installation, some may avoid the noise and disturbance associated with cofferdam installation. Ammocoetes could emerge during cofferdam installation and might need to be rescued and removed. Fish removal activities from construction areas would be implemented according to environmental commitment *Fish Rescue and Salvage Plan*, as described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*. Pertinent details of this plan are discussed under Impact AQUA-1 for delta smelt. Because of these measures, the risk of substantial effects would be minimized.

In-Water Work Activities

As discussed for delta smelt (see Impact AQUA-1), in-water work activities have the potential to disturb, injure or kill fish through direct physical injury from construction activities. Although some fish may avoid the noise and activity of pile installation and placement of riprap protection, these activities have the potential to injure or kill fish. River lamprey ammocoetes are buried in the substrate and are likely to stay under the substrate unless directly disturbed. The installation of sheet piles, support piles, and riprap has the potential to injure or kill lamprey ammocoetes, which are displaced by other construction activities. Due to the low number of lamprey or their ammocoetes expected in these locations, and implementation of environmental commitment *Fish Rescue and Salvage Plan*, as described under Impact AQUA-1 and in Appendix 3B, *Environmental Commitments*. Because of these measures, the risk of substantial effects would be minimized.

Loss of Spawning, Rearing, or Migration Habitat

The habitat affected by construction activities is used by river lamprey for migration and possibly rearing, depending on the specific site conditions. No spawning habitat is present for river lamprey in the project areas. Because only about 10% of the river cross section would be blocked by the cofferdams, fish passage would be relatively unaffected, and there would be no substantial loss of river lamprey migration habitat. Rearing habitat would be lost because of construction of permanent structures. However, other rearing habitat of similar quantity and quality is available for ammocoetes in the Sacramento River.

The construction of the intakes and barge landings will temporarily affect river lamprey migration and rearing habitat, and the intakes will permanently alter the nearshore portion of this habitat in the Sacramento River. Because of implementation of *CM6 Channel Margin Enhancement*, the overall effects would be limited because of the relatively poor quality of the current habitat, and the enhancement or addition of new, higher quality habitat associated with *CM6 Channel Margin Enhancement*. Furthermore, environmental commitments described under Impact AQUA-1 and in Appendix 3B, *Environmental Commitments*, including *Erosion and Sediment Control Plan*; *Dispose of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan,* would minimize potential effects. Pertinent measures included in these plans are discussed under Impact AQUA-1 for delta smelt.

Predation

Adult lamprey are generally not preyed upon by other fish in the Delta. Juvenile river lamprey (macrothalmia life stage) pass rapidly through the Delta, limiting the opportunity for larger fish to prey on them while they are in freshwater. Consequently, the addition of structures in the river and sloughs that could provide habitat for predatory fishes would likely result in a negligible effect on river lamprey.

Summary

Ammocoetes (larvae) are present year-round in all of the regions, and adult spawner and macropthalmia life stages may be migrating by the construction sites during the in-water construction window in all Delta subregions. Overall, the potential effects of project construction activities would be very similar to those described for Pacific lamprey (see Impact AQUA-163). Implementation of the environmental commitments described under Impact AQUA-1 and in Appendix 3B, *Environmental Commitments (Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan;* and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material)*, would minimize effects of construction activities related to turbidity, accidental spills, onsite and offsite sediment transport to surface waters, and re-suspension and redistribution of potentially contaminated sediments for river lamprey. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

NEPA Effects: As a result, these effects could be adverse to individuals, but would not be adverse to river lamprey populations.

CEQA Conclusion: As discussed above, and for Pacific lamprey (see Impact AQUA-163), implementation of the environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments (Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan;* and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material)*, would minimize effects of construction activities related to turbidity, accidental spills, onsite and offsite sediment transport to surface waters, and re-suspension and redistribution of potentially contaminated sediments for river lamprey. Although only a limited occurrence of river lamprey is expected in the construction areas, the direct effects of underwater construction noise on them would be a significant impact because of the high likelihood that it would cause injury or death to some fish in the immediate vicinity of the activity. However, Mitigation Measures AQUA-1a and AQUA-1b would reduce the potential for effects from underwater noise and would reduce the severity of impacts to a less-than-significant level. As a result, the overall construction effects are considered less than significant, and no additional mitigation would be required.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 for delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 for delta smelt.

Impact AQUA-182: Effects of Maintenance of Water Conveyance Facilities on River Lamprey

Temporary Increases in Turbidity

As discussed for construction-related effects on turbidity (Impact AQUA-1), the potential increases in turbidity would be minimized to the extent possible through implementation of environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*). Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt. In addition, river lamprey are tolerant of turbid conditions, and maintenance activities would be conducted when the least numbers of river lamprey are likely to be present.

Accidental Spills

Maintenance activities such as dredging, levee repair and placement of riprap could accidently introduce contaminants into the aquatic environment. Effects would be minimized by implementing the environmental commitments described under Impact AQUA-1 and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*). Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt. Additionally, the limited frequency and duration of in-water maintenance would reduce the likelihood of any significant contaminant input to the Sacramento River and potential effects on river lamprey survival.

Underwater Noise

As discussed for delta smelt (see Impact AQUA-2), underwater noise levels produced by in-water maintenance activities are not expected to reach a level that would harm juvenile or adult lamprey. NMFS has found that underwater sound pressure levels less than the 150 dB RMS behavioral effects threshold may result in temporary altered behavior of fishes indicative of stress but would not result in permanent harm or injury (National Marine Fisheries Service 2001). Any increases in underwater noise would be temporary and infrequent, and would occur when the least number of river lamprey are likely to be present.

Maintenance-Related Disturbance

Direct injury and mortality of river lamprey from the use of in-water equipment during maintenance are most likely to occur during dredging activities around the new intakes. Suction dredging and mechanical excavation can capture or crush fish, causing injury or mortality. river lamprey ammocoetes are present year-round in the Sacramento River. The ammocoetes may use both main channel areas and nearshore areas for rearing and migration. Because river lamprey ammocoetes are buried in sediment, they may become entrained in the dredge. Maintenance dredging would take place when river lamprey ammocoetes are in the area (they are present year-round). The number of river lamprey ammocoetes that could be affected by dredging is unknown. However, because maintenance dredging would occur infrequently, for a short duration, and in limited areas, in-water maintenance activities would not affect river lamprey populations. Furthermore, effects would be minimized by implementation of environmental commitments including *Environmental Training*;

Stormwater Pollution Prevention Plan; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan;* and *Barge Operations Plan*, described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*.

Loss of Spawning, Rearing, or Migration Habitat

River lamprey habitat near the intake structures is available for rearing and migration. Dredging would remove rearing habitat, especially if ammocoetes were present in the dredging footprint. Placing riprap on the bank would likely have limited effects on available rearing habitat. Migration habitat would not be substantially affected by dredging or riprap placement, and additional migration habitat is available farther out in the channel. Maintenance activities would have limited effects on overall rearing habitat, because available rearing habitat of similar quality is readily accessible to river lamprey. Furthermore, effects would be minimized by implementation of environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*.

Predation

Adult lamprey are generally not preyed on by other fish in the Delta. Juvenile river lamprey (macrothalmia life stage) pass rapidly through the Delta, limiting the opportunity for larger fish to prey on them while they are in freshwater. Maintenance activities would be unlikely to have any measurable effect on river lamprey predation rates. These activities may include the use of barges and other watercraft that could theoretically provide cover, shelter, and perching areas for delta smelt predators. However, the limited duration of maintenance activities and the associated noise and disturbance would be expected to dissuade predators from concentrating at sufficient density to measurably affect predation rates on river lamprey.

Summary

River lamprey are tolerant to increases in turbidity, which might occur during maintenance activities. Such activities would include maintenance dredging at the intake sites, and installation or repair of riprap bank armoring. Implementation of the environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*, would further minimize or eliminate effects of turbidity, and accidental spills to river lamprey by limiting turbidity increases, and by guiding the rapid and effective response in the case of inadvertent spills of hazardous materials. These environmental commitments are *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt. In addition, underwater noise levels generated by maintenance activities are unlikely to affect lamprey.

While maintenance dredging would remove rearing habitat, especially if ammocoetes use habitat in the dredging footprint, placing riprap on the bank would likely have limited effects on available rearing habitat, because similar quality habitat is readily accessible to river lamprey. Migration habitat would not be substantially affected by dredging or riprap placement, and additional migration habitat is available farther out in the channel. In addition, no spawning habitat occurs in the areas potentially affected by maintenance activities, and ample rearing, and migration habitat of the same quality is readily accessible in the area, and this habitat would not be affected by maintenance activities.

NEPA Effects: The effects of short-term maintenance activities would not be adverse to river lamprey.

CEQA Conclusion: As described above, river lamprey are tolerant to increases in turbidity, and implementation of the environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments (Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material)*, would minimize or eliminate effects of turbidity, as well as potential effects from accidental spills to river lamprey. In addition, underwater noise levels generated by maintenance activities are unlikely to affect lamprey.

While maintenance dredging would remove rearing habitat, especially if ammocoetes use habitat in the dredging footprint, effects would be limited because similar quality habitat is readily accessible to river lamprey. Migration habitat would not be substantially affected by maintenance activities, and no spawning habitat occurs in these areas. In addition, ample rearing and migration habitat of the same quality is readily accessible in areas that would not be affected by maintenance activities. Accordingly, the effects of short-term maintenance activities would be less than significant because it would not reduce river lamprey habitat, restrict its range, or interfere with its movement. Consequently, no mitigation would be required.

Water Operations of CM1

Impact AQUA-183: Effects of Water Operations on Entrainment of River Lamprey

Water Exports from SWP/CVP South Delta Facilities

Alternative 1A is expected to result in decreased entrainment of Pacific and river lamprey macrothalmia and adults at the south Delta export facilities compared to NAA. The estimated level of reduction (approximately 50%) is based solely on the assumption that proportional changes in flow lead to similar proportional changes in entrainment.

The analysis for Pacific and river lamprey was combined because the CVP and SWP fish salvage facilities do not distinguish between the two species (see discussion for Pacific lamprey in Impact AQUA-165).

Water Exports from SWP/CVP North Delta Intake Facilities

The analysis for Pacific and river lamprey was combined because the CVP and SWP fish salvage facilities do not distinguish between the two species (see discussion for Pacific lamprey in Impact AQUA-165).

Water Exports with a Dual Conveyance for the SWP North Bay Aqueduct

Entrainment of river lamprey at the North Bay Aqueduct has not been explicitly analyzed. However, the Barker Slough Pumping Plant is screened for fish >25mm although lamprey would be longer than this because of their body shape. The alternative intake would presumably have screens of 1.75-m mesh and therefore it would exclude lamprey >50-60 mm based on north Delta intake analysis (as evaluated in *BDCP Effects Analysis – Appendix 5B, Entrainment, Section B.5.9.2.1 Screening Effectiveness Analysis, hereby incorporated by reference*). Overall effects would be expected to be no greater than for delta smelt.

If unforeseen changes in distributions or other factors occur as a result of project operations that would increase the proportional loss of river lamprey to entrainment, monitoring and the BDCP-proposed Real-Time Response Team would implement measures to avoid or minimize any potential threats to the species that might occur. Based on the current analysis, this would not be necessary.

NEPA Effects: Based on the projected entrainment (salvage rates) of river lamprey under the BDCP, a substantial reduction is expected at the south Delta facilities. However, the potential entrainment of juvenile lamprey at the north Delta facility raises some uncertainty of the overall change in entrainment rate. This uncertainty will be addressed through monitoring and adaptive management actions. The project adaptive management plan includes monitoring of the new north Delta screens to determine their effectiveness and if they are not meeting expectations additional measures (i.e., modifications to screens or other structural components or changes in water diversion operations) may be implemented to improve screen performance. Based on available information, overall entrainment effects on river lamprey populations are not expected to be substantial under Alternative 1A. It is anticipated that there will not be an adverse effect on river lamprey and that there may be beneficial effects due to design, installation, and operation of new screens in the north Delta.

CEQA Conclusion: As described above, operational activities associated with water exports from south SWP/CVP facilities are expected to substantially reduce entrainment of lamprey. However, operational activities associated with water exports from SWP/CVP north Delta intake facilities could result in an increase in entrainment or a loss of individual lamprey at that location. Monitoring and adaptive management protocols will be implemented to confirm that fish are being excluded from entrainment and impingement in the manner that the design specifications suggest. Overall, impacts of Alternative 1A water operations on entrainment of river lamprey are considered less than significant because they would not reduce their numbers. Consequently, no mitigation would be required.

Impact AQUA-184: Effects of Water Operations on Spawning and Egg Incubation Habitat for River Lamprey

In general, Alternative 1A would not affect the quantity and quality of river lamprey spawning and egg incubation habitat relative to NAA.

Flow-related impacts to river lamprey spawning habitat were evaluated by estimating effects of flow alterations on redd dewatering risk as described for Pacific lamprey with appropriate time-frames for river lamprey incorporated into the analysis. Lower flows can reduce the instream area available for spawning and rapid reductions in flow can dewater redds leading to mortality. The same locations were analyzed as for Pacific lamprey: the Sacramento River at Keswick and Red Bluff, Trinity River downstream of Lewiston, Feather River at Thermalito Afterbay, and American River at Nimbus Dam and at the confluence with the Sacramento River. River lamprey spawn in these rivers between February and June so flow reductions during those months have the potential to dewater redds, which could result in incomplete development of the eggs to ammocoetes (the larval stage).

Dewatering risk to redd cohorts was characterized by the number of cohorts experiencing a month-over-month reduction in flows (using CALSIM II outputs) of greater than 50%. Small-scale spawning location suitability characteristics (e.g., depth, velocity, substrate) of river lamprey are not adequately described to employ a more formal analysis such as a weighted usable area analysis. Therefore, as described for Pacific lamprey, there is uncertainty that these values represent actual redd dewatering events, and results should be treated as rough estimates of flow fluctuations under each model scenario. Results were expressed as the number of cohorts exposed to dewatering risk and as a percentage of the total number of cohorts anticipated in the river based on the applicable time-frame, February to June.

Flows in all rivers evaluated indicated increases in redd cohorts exposed would only occur in the Feather River (17% increase) (Table 11-1A-80). All other locations would experience negligible changes (±5%) or reductions in redd cohort exposure under A1A_LLT relative to NAA.

Table 11-1A-80. Differences between Model Scenarios in Dewatering Risk of River Lamprey Redd Cohorts[a]

Location	Comparison[b]	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Sacramento River at Keswick	Difference	3	-2
	Percent Difference	9%	-6%
Sacramento River at Red Bluff	Difference	4	-5
	Percent Difference	11%	-13%
Trinity River downstream of Lewiston	Difference	-1	-1
	Percent Difference	-1%	-1%
Feather River Below Thermalito Afterbay	Difference	7	10
	Percent Difference	10%	17%
American River at Nimbus	Difference	4	1
	Percent Difference	7%	2%
American River at Sacramento River confluence	Difference	9	-2
	Percent Difference	15%	-3%

[a] Difference and percent difference between model scenarios in the number of Pacific lamprey redd cohorts experiencing a month-over-month reduction in flows of greater than 50%.

[b] Positive values indicate a higher value in Alternative 1A than in existing biological conditions.

River lamprey generally spawn between February and June (Beamish 1980, Moyle 2002). Using Pacific lamprey as a surrogate, eggs are assumed to hatch in 18-49 days depending on water temperature (Brumo 2006) and are, therefore, assumed to be present during roughly the same period and locations as spawners. Moyle et al. (1995) indicate that river lamprey “adults need… temperatures [that] do not exceed 25°C,” although there is no mention of thermal requirements for eggs in this or any existing literature. Meeuwig et al. (2005) reported that, for Pacific lamprey eggs, significant reductions in survival were observed at 22°C (71.6°F). Therefore, for this analysis, both temperatures, 22°C (71.6°F) and 25°C (77°F), were used as upper thresholds of river lamprey eggs. The analysis predicted the number of consecutive 49 day periods for the entire 82-year CALSIM period during which at least one day exceeds 22°C (71.6°F) or 25°C (77°F) using daily data from USRWQM. For other rivers, the analysis predicted the number of consecutive two-month periods during which at least one month exceeds 22°C (71.6°F) or 25°C (77°F) using monthly averaged data from the Bureau's temperature model. Each individual day or month starts a new "egg cohort" such that there are 12.320 cohorts for the Sacramento River, corresponding to 82 years of eggs being laid every day each year from February 1 through June 30, and 405 cohorts for the other rivers using monthly data over the same period. The incubation periods used in this analysis are conservative and represent the extreme long end of the egg incubation period (Brumo 2006). Also, the utility of the monthly average time step is limited because the extreme temperatures are masked; however, no better analytical tools are currently available for this analysis. Spawning locations of river lamprey are not well defined. Therefore, this analysis uses the widest range in which the species is thought to spawn in each river.

For both thresholds, there would be few differences in egg cohort exposure between NAA and Alternative 1A among all sites (Table 11-1A-81). Differences of 25 to 39 cohorts in the Sacramento River at Hamilton City are negligible to the population considering the total number of cohorts is 12,320. In the Feather River below Thermalito Afterbay, there would be 23 more cohorts (61% increase) exposed to the 71.6°F threshold under Alternative 1A relative to NAA, although differences at the 77°F threshold would be negligible. In addition, there would be no differences between NAA and Alternative 1A in egg exposure at the Fish Barrier Dam in the Feather River. Overall, except at one location in the Feather River for the more conservative threshold temperature (71.6°F), these results indicate that there would be no differences in egg exposure to elevated temperatures under Alternative 1A.

Table 11-1A-81. Differences (Percent Differences) between Model Scenarios in River Lamprey Egg Cohort Temperature Exposure[a]

Location	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
71.6°F Threshold		
Sacramento River at Keswick	0 (NA)	0 (NA)
Sacramento River at Hamilton City	94 (NA)	-39 (-12%)
Trinity River at Lewiston	0 (NA)	0 (0%)
Trinity River at North Fork	2 (NA)	-2 (-40%)
Feather River at Fish Barrier Dam	0 (NA)	0 (NA)
Feather River below Thermalito Afterbay	33 (367%)	23 (61%)
American River at Nimbus	11 (220%)	-1 (-3%)
American River at Sacramento River Confluence	16 (57%)	-12 (-15%)
Stanislaus River at Knights Ferry	0 (NA)	0 (NA)
Stanislaus River at Riverbank	11 (1,100%)	0 (0%)
77°F Threshold		
Sacramento River at Keswick	0 (NA)	0 (NA)
Sacramento River at Hamilton City	0 (NA)	25 (69%)
Trinity River at Lewiston	0 (NA)	0 (NA)
Trinity River at North Fork	0 (NA)	0 (NA)
Feather River at Fish Barrier Dam	0 (NA)	0 (NA)
Feather River below Thermalito Afterbay	2 (NA)	2 (100%)
American River at Nimbus	1 (NA)	1 (25%)
American River at Sacramento River Confluence	4 (NA)	3 (50%)
Stanislaus River at Knights Ferry	0 (NA)	0 (NA)
Stanislaus River at Riverbank	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.

[a] Difference and percent difference between model scenarios in the number of Pacific lamprey egg cohorts experiencing water temperatures above 71.6°F and 77°F F during February to June on at least one day during a 49-Day incubation period in the Sacramento River or for at least one month during a 2-month incubation period for each model scenario in other rivers. Positive values indicate a higher value in the proposed project than in EXISTING CONDITIONS or NAA.

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because it does not have the potential to substantially reduce spawning and egg incubation habitat. An increased risk of exposure by river lamprey eggs to redd dewatering and elevated temperatures under Alternative 1A would be limited to the Feather River below Thermalito Afterbay. There would be negligible or beneficial effects of Alternative 1A on redd dewatering risk and exposure to elevated water temperatures in all other locations examined.

CEQA Conclusion: In general, Alternative 1A would not affect the quantity and quality of river lamprey spawning and egg incubation habitat relative to the Existing Conditions.

Lower flows can reduce the instream area available for spawning and rapid reductions in flow can dewater redds leading to mortality. Effects of Alternative 1A on flow reductions during the river lamprey spawning period from February to June in the Sacramento, Feather, and American Rivers consist of small increases in river lamprey redd cohort dewatering risk relative to Existing Conditions (Table 11-1A-80). Changes would be greatest in the American River (7% to 15% increase).

In the Sacramento River at Hamilton City, there would be 94 more cohorts (could not calculate relative difference due to division by 0) exposed to the 71.6°F threshold under Alternative 1A relative to Existing Conditions, although this represents a very small proportion of the total number of cohorts evaluated (12,320 cohorts) (Table 11-1A-81). Therefore, this slight increase in cohort exposure would not be biologically meaningful on a population level. There would be no differences between Existing Conditions and Alternative 1A at either location in the Trinity River. In the Feather River below Thermalito Afterbay, there would be 33 more cohorts (367% higher) exposed to the 71.6°F threshold under Alternative 1A relative to Existing Conditions, although there would be no difference at the Fish Barrier Dam. At both locations in the American River, there would be 11 to 16 more cohorts (57% to 220% higher) exposed to the 71.6°F threshold under Alternative 1A relative to Existing Conditions. In the Stanislaus River at Riverbank, there would be 11 more cohorts (1100% higher) exposed to the 71.6°F threshold under Alternative 1A relative to Existing Conditions, although there would be no difference at the Knights Ferry. There would be no differences between Existing Conditions and Alternative 1A at any location examined in exposure of egg cohorts to the 77°F threshold.

Summary of CEQA Conclusion

The results of the Impact AQUA-184 CEQA analysis indicate that that the difference between the CEQA baseline and Alternative 1A could be significant because, under the CEQA baseline, the alternative could substantially reduce the quality and quantity of spawning and egg incubation habitat and substantially reduce the number of fish as a result of egg mortality, contrary to the NEPA conclusion set forth above. Alternative 1A would reduce river lamprey survival due to increased exposure to redd dewatering and increased water temperatures in multiple rivers relative to the Existing Conditions. Increased water temperatures would increase stress and reduce survival of lamprey eggs.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 1A does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 1A indicates that flows and reservoir storage in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 1A. This indicates that the differences between Existing Conditions and Alternative 1A found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative

1A, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on spawning and egg incubation habitat for river lamprey. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-185: Effects of Water Operations on Rearing Habitat for River Lamprey

In general, Alternative 1A would reduce the quantity and quality of river lamprey rearing habitat relative to NAA. Flow-related effects on river lamprey rearing habitat were evaluated by estimating effects of flow alterations on ammocoete exposure, or stranding risk, as described for Pacific lamprey. Lower flows can reduce the instream area available for rearing and rapid reductions in flow can strand ammocoetes leading to mortality. Effects of Alternative 1A on flow were evaluated in the Sacramento River at Keswick and Red Bluff, the Trinity River, Feather River, and the American River at Nimbus Dam and at the confluence with the Sacramento River. As for Pacific lamprey, the analysis of river lamprey ammocoete stranding was conducted by analyzing a range of month-over-month flow reductions from CALSIM II outputs, using the range of 50%–90% in 5% increments. A cohort of ammocoetes was assumed to be born every month during their spawning period (February through June) and spend 5 years rearing upstream. Therefore, a cohort was considered stranded if at least one month-over-month flow reduction was greater than the flow reduction at any time during the period.

Ammocoete stranding risk under A1A_LLT relative to NAA for the Sacramento River at Keswick (Table 11-1A-82) would be mostly negligible, except in the 65% flow reduction (12% higher risk).

Ammocoete stranding risk under A1A_LLT in the Sacramento River at Red Bluff would be similar to or lower relative to NAA except in the 60% flow reduction (5% higher risk) (Table 11-1A-83).

Table 11-1A-82. Percent Difference between Model Scenarios in the Number of River Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Sacramento River at Keswick

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
-50%	0	0
-55%	0	0
-60%	2	2
-65%	1	12
-70%	6	0
-75%	2	0
-80%	19	4
-85%	15	0
-90%	NA	0

NA = could not be calculated because the denominator was 0.
[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 1A.

Table 11-1A-83. Percent Difference between Model Scenarios in the Number of River Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Sacramento River at Red Bluff

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
-50%	0	0
-55%	0	2
-60%	6	5
-65%	2	-4
-70%	15	0
-75%	5	-10
-80%	-6	-4
-85%	-9	0
-90%	NA	NA

NA = could not be calculated because the denominator was 0.
[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 1A.

In the Trinity River, there would be no difference in ammocoete stranding risk between NAA and A1A_LLT (Table 11-1A-84).

Table 11-1A-84. Percent Difference between Model Scenarios in the Number of River Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Trinity River at Lewiston

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
-50%	0	0
-55%	0	0
-60%	0	0
-65%	0	0
-70%	0	0
-75%	0	-5
-80%	0	-2
-85%	0	-2
-90%	1	4

[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 1A.

In the Feather River at Thermalito Afterbay, there would be no difference in ammocoete stranding risk (Table 11-1A-85).

Table 11-1A-85. Percent Difference between Model Scenarios in the Number of River Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Feather River at Thermalito Afterbay

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
-50%	0	0
-55%	0	0
-60%	0	0
-65%	0	0
-70%	0	0
-75%	0	0
-80%	0	3
-85%	0	-19
-90%	0	-32

[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 1A.

There would be no difference in ammocoete stranding risk except in the 90% flow reduction (7% increase in stranding risk) at the confluence with the Sacramento River (Table 11-1A-86, Table 11-1A-87) Based on the general decrease in frequency of most of the flow reduction categories, the small increase (7%) predicted for a single flow reduction category (9%) at one location would not have biologically meaningful effects.

Table 11-1A-86. Percent Difference between Model Scenarios in the Number of River Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, American River at Nimbus Dam

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
-50%	0	0
-55%	0	0
-60%	0	0
-65%	0	-4
-70%	6	-9
-75%	3	-5
-80%	22	-11
-85%	11	-9
-90%	408	7

[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 1A.

Table 11-1A-87. Relative Difference between Model Scenarios in the Number of River Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, American River at the Confluence with the Sacramento River

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
-50%	0	0
-55%	0	0
-60%	0	0
-65%	0	-1
-70%	4	-6
-75%	2	2
-80%	18	4
-85%	7	-6
-90%	196	-9

[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 1A.

Because the thermal tolerance of river lamprey ammocoetes is unknown, the thermal tolerance of Pacific lamprey ammocoetes of 22°C (71.6°F) and of river lamprey adults of 25°C (77°F) (Moyle et al. 1995) was used. River lamprey ammocoetes rear upstream for 3–5 years (Moyle 2002). To be conservative, this analysis assumed a maximum ammocoete duration of 5 years. Each individual day or month starts a new "cohort" such that there are 18,730 cohorts for the Sacramento River, corresponding to 82 years of ammocoetes being "born" every day each year from January 1 through August 31, and 380 cohorts for the other rivers using monthly data over the same period.

In most locations, the number of ammocoete cohorts exposed to each threshold under Alternative 1A would be similar to or lower than those under NAA (Table 11-A1-88). Biologically meaningful exceptions includes the Trinity River at Lewiston and Feather River below Thermalito Afterbay for the 71.6°F threshold and the Sacramento River at Hamilton City, Feather River below Thermalito Afterbay, and American River at the Sacramento River confluence for the 77°F threshold.

Table 11-1A-88. Differences (Percent Differences) between Model Scenarios in River Lamprey Ammocoete Cohorts Exposed to Temperatures in the Feather River Greater than 71.6°F and 77°F in at Least One Month

Location	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
71.6°F Threshold		
Sacramento River at Keswick[b]	0 (NA)	1 (0.1%)
Sacramento River at Hamilton City[b]	4,326 (NA)	-715 (-8%)
Trinity River at Lewiston	25 (NA)	15 (30%)
Trinity River at North Fork	50 (NA)	-30 (-19%)
Feather River at Fish Barrier Dam	0 (NA)	-25 (-100%)
Feather River below Thermalito Afterbay	165 (87%)	60 (19%)
American River at Nimbus	175 (194%)	-15 (-4%)
American River at Sacramento River Confluence	120 (49%)	0 (0%)
Stanislaus River at Knights Ferry	0 (NA)	0 (0%)
Stanislaus River at Riverbank	155 (620%)	0 (0%)
77°F Threshold		
Sacramento River at Keswick[b]	0 (NA)	0 (NA)
Sacramento River at Hamilton City[b]	0 (NA)	1,948 (79%)
Trinity River at Lewiston	0 (NA)	0 (NA)
Trinity River at North Fork	0 (NA)	0 (NA)
Feather River at Fish Barrier Dam	0 (NA)	0 (NA)
Feather River below Thermalito Afterbay	50 (NA)	60 (150%)
American River at Nimbus	90 (NA)	-25 (-11%)
American River at Sacramento River Confluence	130 (NA)	45 (20%)
Stanislaus River at Knights Ferry	0 (NA)	0 (NA)
Stanislaus River at Riverbank	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.

[a] Positive values indicate a higher value in the preliminary proposal than in EXISTING CONDITIONS or NAA.

[b] Based on daily data; all other locations use monthly data; 1922–2003.

NEPA Effects: Collectively, these results indicate that the effect would be adverse because it has the potential to substantially reduce rearing habitat and substantially reduce the number of fish as a result of ammocoete mortality. Increases in water temperatures under Alternative 1A would have adverse effects on ammocoete rearing conditions in the Sacramento, Feather, and American Rivers. Increased water temperatures would increase stress and reduce survival of lamprey ammocoetes. Alternative 1A would generally not affect river lamprey ammocoete stranding, except in the American River, in which there would be a beneficial effect from substantial decreases in exposure to flow reductions. This effect is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this effect to a level that is not adverse would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this would be an unavoidable adverse effect because there is no feasible mitigation available. While the implementation of the mitigation measures listed below has the potential to reduce the severity of the impact, these would not necessarily reduce the impact to a not adverse level.

CEQA Conclusion: In general, Alternative 1A would reduce the quantity and quality of river lamprey rearing habitat relative to the Existing Conditions.

Lower flows can reduce the instream area available for rearing and rapid reductions in flow can strand ammocoetes leading to mortality. Differences in stranding risk between Existing Conditions and A1A_LLT in the Sacramento River at Keswick would be negligible under most flow reductions and 6% to 19% higher risk under 70%, 80% and 85% flow reductions (Table 11-1A-82). Stranding risk under A1A_LLT at Red Bluff would be up to 15% greater than risk under Existing Conditions in 60% 70% and 75% flow reductions, up to 9% lower in 80% and 90% flow reductions, and negligible in 50% and 55% flow reductions (Table 11-1A-83).

In the Trinity River and Feather River, there would be no difference in ammocoete stranding risk between Existing Conditions and A1A_LLT (Table 11-1A-84, Table 11-1A-85).Comparisons for the American River at Nimbus Dam (Table 11-1A-86) and at the confluence with the Sacramento River (Table 11-1A-87) indicated increased stranding risk under flow reductions of 70% and 80% to 90% for Alternative 1A compared to Existing Conditions.

The number of ammocoete cohorts exposed to 71.6°F under Alternative 1A would be higher than those under Existing Conditions in most locations examined (Table 11-A1-88). The number of ammocoete cohorts exposed to 77°F under Alternative 1A would be similar at all locations except the Feather River below Thermalito Afterbay and at both locations in the American River.

Summary of CEQA Conclusion

Collectively, these results indicate that the impact would be significant because it has the potential to substantially reduce rearing habitat and substantially reduce the number of fish as a result of ammocoete mortality. There would be increased exposure to critical water temperatures in the Sacramento, Feather, American, and Stanislaus River and substantial increases in exposure to flow reductions that could lead to stranding in the American River. Increased stranding risk in these rivers would increase the risk of desiccation and reduce survival of ammocoete cohorts. Increased water temperatures would increase stress and reduce survival of lamprey ammocoetes. This impact is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this impact to a less-than-significant level would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this impact is significant and unavoidable because there is no feasible mitigation available. Even so, proposed below is mitigation that has the potential to reduce the severity of impact though not necessarily to a less-than-significant level.

Mitigation Measure AQUA-185a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to River Lamprey to Determine Feasibility of Mitigation to Reduce Impacts to Rearing Habitat

Although analysis conducted as part of the EIR/EIS determined that Alternative 1A would have significant and unavoidable adverse effects on rearing habitat, this conclusion was based on the best available scientific information at the time and may prove to have been over- or understated. Upon the commencement of operations of CM1 and continuing through the life of the permit, the BDCP proponents will monitor effects on rearing habitat in order to determine whether such effects would be as extensive as concluded at the time of preparation of this document and to determine any potentially feasible means of reducing the severity of such effects. This mitigation measure requires a series of actions to accomplish these purposes, consistent with the operational framework for Alternative 1A.

The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 1A operations only. Development of mitigation actions for the incremental impact on rearing habitat attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 1A.

Mitigation Measure AQUA-185b: Conduct Additional Evaluation and Modeling of Impacts River Lamprey Rearing Habitat Following Initial Operations of CM1

Following commencement of initial operations of CM1 and continuing through the life of the permit, the BDCP proponents will conduct additional evaluations to define the extent to which modified operations could reduce impacts to rearing habitat under Alternative 1A. The analysis required under this measure may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6).

Mitigation Measure AQUA-185c: Consult with USFWS and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on River Lamprey Rearing Habitat Consistent with CM1

In order to determine the feasibility of reducing the effects of CM1 operations on river lamprey habitat, the BDCP proponents will consult with USFWS and the Department of Fish and Wildlife to identify and implement any feasible operational means to minimize effects on rearing habitat. Any such action will be developed in conjunction with the ongoing monitoring and evaluation of habitat conditions required by Mitigation Measure AQUA-185a.

If feasible means are identified to reduce impacts on rearing habitat consistent with the overall operational framework of Alternative 1A without causing new significant adverse impacts on other covered species, such means shall be implemented. If sufficient operational flexibility to reduce effects on river lamprey habitat is not feasible under Alternative 1A operations, achieving further impact reduction pursuant to this mitigation measure would not be feasible under this alternative, and the impact on river lamprey would remain significant and unavoidable.

Impact AQUA-186: Effects of Water Operations on Migration Conditions for River Lamprey

In general, Alternative 1A would have negligible effects on river lamprey migration conditions relative to NAA.

Macropthalmia

After 3 to 5 years river lamprey ammocoetes migrate downstream and become macropthalmia once they reach the Delta. River lamprey migration generally occurs September through November (USFWS unpublished data). The effects of water operations on seasonal migration flows for river lamprey macropthalmia were assessed using CALSIM II flow output. Flow rates along the likely migration pathways of river lamprey during the likely migration period (September through

November) were examined to predict how Alternative 1A may affect migration flows for outmigrating macropthalmia.

Analyses were conducted for the Sacramento River at Red Bluff, Feather River at the confluence with the Sacramento River, and the American River at the confluence with the Sacramento River.

Sacramento River

Comparisons for the Sacramento River at Red Bluff for September through November indicate variable effects of Alternative 1A depending on the month and the water year type. Alternative 1A indicates variable effects, with project-related increases (5% to 33%) in dry and critical years in September, and all water year types in October that would have beneficial effects on migration conditions, relative to NAA. In contrast, decreased flows of between 5% to 44% in wetter years in September, and between 9% and 30% in all water year types in November, would result in negative effects. Decreases in wetter years would be less detrimental because flows are higher; the increases in drier water years would be beneficial for outmigration. Decreases (to 30%) for all years in November would affect migration conditions during that month, which is the last month in the relatively short migration period.

Feather River

Comparisons for the Feather River at the confluence with the Sacramento River for September through November indicate decreases in flow during wetter years in September (69%, 57%, and 33% for wet, above normal, below normal, respectively) and increases in flow during drier years (17% and 18% for dry and critical years, respectively). The increases in flow during dry and critical years for September would have a positive effect on migration when flow conditions are most critical. There would also be project-related increases in flow during October in all water years, ranging from 5% to 55% depending on water year type. Project-related effects during November would be slightly increased (up to 7%) in all water year types with the exception of a small decrease in mean monthly flow (7%) during above normal years that would not have biologically meaningful effects, and a negligible difference in below normal years. These results indicate Alternative 1A would have generally beneficial effects on migration in the Feather River, relative to NAA.

American River

Comparisons for the American River at the confluence with the Sacramento River for September through November indicate decreased flows during September in wetter water years (up to 50%) and negligible effects (<5%) in drier water years when flow effects would be more detrimental for migration. The comparisons also indicated increases in mean monthly flows during October for all water year types (13 to 42%) and generally negligible project-related changes during November, except for a decrease of 18% in above normal years. These results indicate Alternative 1A would not substantially affect migration conditions for river lamprey in the American River.

Overall, with some variation in results by location, month, and water year type, Alternative 1A would generally not have biologically meaningful effects on macropthalmia migration conditions based on negligible effects (<5%), decreases in flow during wetter water year types that would not have biologically meaningful effects, and increases in flow during drier water years that would have a beneficial effect on migration.

Adults

Effects of Alternative 1A on flow during the adult migration period, September through November, would be the same as described for the macropthalmia migration period, September through November, above.

NEPA Effects: Collectively, these results indicate that effects would not be adverse because it would not substantially reduce the amount of suitable habitat or substantially interfere with the movement of fish. Flows under Alternative 1A would be lower in wetter years in the Sacramento River, would be greater in the Feather River, and would not change in the American River relative to NAA. Flow reductions in wetter years would be less detrimental than reductions in drier years. In fact, flows in drier years in the Sacramento River would improve under Alternative 1A.

CEQA Conclusion: In general, under Alternative 1A water operations, the quantity and quality of suitable migration habitat for river lamprey would not be affected relative to the CEQA baseline.

Macropthalmia

Sacramento River

Comparisons for the Sacramento River at Red Bluff for September through November indicate variable effects of Alternative 1A during September, with decreases (up to 24%) occurring in all water year types, except for above normal years (6% increase) and below normal years (<5%). Alternative 1A would have beneficial effects for October with increased flows of between 15% and 36% during all water years. Alternative 1A would result in decreases in mean monthly flows compared to Existing Conditions for all water year types in November (10 to 21%), except for a negligible difference in wet years. Persistent small to moderate reductions in flow in drier water years for two of the three months in the migration period would affect migration conditions in the Sacramento River.

Feather River

Comparisons for the Feather River at the confluence with the Sacramento River for September through November indicate variable results by month and water year type, with decreases (10% to 27%) in all but critical water years in September and, variable results with primarily increases in October (between 18 and 35%), except for negligible differences in wet and below normal years. Relatively small and variable flow effects would occur in November, with decreases in wet (13%) and below normal (11%) years, an increase (6%) in critical years, and negligible changes in above normal and dry years. Decreased mean monthly flows in September and November during wetter water years would be less detrimental because flows are higher; the increases in drier water years in all three migration months would be beneficial for outmigration.

American River

Comparisons for the American River at the confluence with the Sacramento River for September through November indicate reductions in flow for all water year types in September (44% to 58%) and November (19% to 38%), but flow increases in all water years during October (5% to 45%). The overall predominance of decreased flows for Alternative 1A compared to Existing Conditions would affect migration conditions, with substantial decreases for dry and critical years in September (44 and 52%, respectively) and November (38 and 19%, respectively).

Overall, these results indicate that Alternative 1A would cause decreases in mean monthly flow during substantial portions of the river lamprey macropthalmia migration period in the Sacramento River (to -21%), Feather River (to -27%), and American River (to -58%), compared to Existing Conditions.

Adults

Effects of Alternative 1A on flow during the adult migration period, September through November, would be the same as described for the macropthalmia migration period, September through November, above.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-186 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 1A could be significant because, under the CEQA baseline, the alternative could substantially reduce the amount of suitable habitat and substantially interfere with the movement of fish, contrary to the NEPA conclusion set forth above. Reductions in flows during substantial portions of the macropthalmia and adult migration periods in the Sacramento and American Rivers would reduce migration ability of both life stages. For macropthalmia, reduced migration ability would increase straying risk and delay initiation of the oceanic life stage. For adults, reduced flows would reduce the ability to sense olfactory cues if adults use such cues to return to natal spawning grounds.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 1A does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 1A indicates that flows and reservoir storage in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 1A. This indicates that the differences between Existing Conditions and Alternative 1A found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 1A, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on migration conditions for river lamprey. This impact is found to be less than significant and no mitigation is required.

Restoration Measures (CM2, CM4–CM7, and CM10)

Impact AQUA-187: Effects of Construction of Restoration Measures on River Lamprey

Temporary Increases in Turbidity

As with Pacific lamprey (see Impact AQUA-169), river lamprey are tolerant of turbid water conditions and are unlikely to be affected by temporary increases in turbidity during restoration construction. Implementing the environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Fish Rescue and Salvage Plan*; and *Barge Operations Plan*), would minimize the potential for turbidity to affect river lamprey.

Increased Exposure to Mercury

The conversion of subtidal, unvegetated conditions to vegetated wetlands could enhance the cycling of mercury into biota by increasing the conversion of mercury to methylated mercury. The overall effect of increased bioavailability of methylmercury on lamprey is likely to be of low magnitude and localized (see discussion for delta smelt under Impact AQUA-7). With implementation of *CM12 Methylmercury Management*, the potential effects of increased mobilization on lamprey at the restoration sites are expected to be minimized. However, the cycling of mercury is a complicated process, and is difficult to predict based on existing information.

Accidental Spills

The potential risks of accidental spills (see the discussion for delta smelt under Impact AQUA-7) would be minimized by implementing the environmental commitments *Environmental Training; Stormwater Pollution Prevention Plan; Erosion and Sediment Control Plan; Hazardous Materials Management Plan; Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material; and Barge Operations Plan;* see Appendix 3B, *Environmental Commitments* and Impact AQUA-1). Specifically, the *Spill Prevention, Containment, and Countermeasure Plan* will be implemented to minimize the risk of spills occurring and to provide for rapid and effective response to contain any accidental spills.

Disturbance of Contaminated Sediments

Runoff and resuspension of contaminants could cause short-term, localized increases in the concentrations of contaminants in and near restoration sites (see discussion for delta smelt under Impact AQUA-7). The potential impacts of toxics on lamprey would be minimized to the extent possible by timing construction activities so that vulnerable early life stages of fish are not present. Although lamprey ammocoetes would likely be present during the in-water work window, implementation of environmental commitments (see Appendix 3B) (*Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*) would minimize exposure levels. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt. Because of the expected periodic and temporary nature of toxicity spikes and the timing of activities relative to species' presence, the potential effects would be minimized.

In-Water Work Activities

Restoration construction activities could temporarily produce noise levels and disturbances that could affect nearby lamprey. Such activities are not expected to elevate underwater noise above the threshold sound pressure levels established for fish (see discussion for delta smelt under Impact AQUA-1). Any changes in disturbance levels would be minor and temporary, and unlikely to affect lamprey. Potential effects of in-water activity would be minimized by implementation of the environmental commitments described under Impact AQUA-1 and in Appendix 3B, *Environmental Commitments*, including *Erosion and Sediment Control Plan*; *Dispose of Spoils, Reusable Tunnel Material, and Dredged Material*; and *Barge Operations Plan*. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt.

Predation

Although there is low certainty regarding their behavior in the Delta, lamprey macrothalmia likely use the Delta primarily as a migration corridor, as evidenced by low catches in beach seines in back sloughs and higher catches in beach seines in mainstem sampling (U.S. Fish and Wildlife Service 2013). Only a small proportion of the proposed habitat restoration would be located along major migration corridors, such as the mainstem Sacramento and San Joaquin rivers, in the West and South Delta ROAs. Therefore, it is presumed that lamprey will not spend large amounts of time in the vicinity of restored tidal marsh or floodplain habitat while they are being constructed. Additionally any in-water work may cause predatory fish to temporarily avoid those locations reducing the predation potential. Therefore, predation is not expected to increase, and the effect would not be adverse.

Summary

In-water and shoreline construction activities associated with habitat restoration would be scheduled to occur when the least number of river lamprey are expected in or near the restoration sites. Such activities would include riprap removal and levee breaching, and shoreline excavation and re-contouring. River lamprey are tolerant to increases in turbidity, which might occur during shoreline restoration construction activities. Implementation of the environmental commitments described in Appendix 3B, *Environmental Commitments*, would minimize or eliminate effects on river lamprey (see Impact AQUA-181) by reducing the amount of turbidity and guiding the rapid and effective response in case of inadvertent spills of hazardous materials. These environmental commitments are *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*. Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt and Appendix 3B, *Environmental Commitments*. As a result, the effects of short-term restoration construction activities would not be adverse to river lamprey.

While implementation of these environmental commitments would minimize or eliminate short-term effects occurring during restoration construction, long-term effects could also occur. For example, removing or breaching levees would result in the expansion of floodplain habitat, and more frequent inundation these areas, potentially promoting conversion of mercury to methylated mercury, and runoff containing agricultural-related toxins such as copper and organochlorine pesticides. However, the overall effect of increased bioavailability of methylmercury and other pollutants on river lamprey is likely to be of low magnitude, periodic and localized. In addition, potential increases would be minimized to the extent possible because of implementation of *CM12 Methylmercury Management* (see Impact AQUA-181).

NEPA Effects: For the reasons described above, the effect would not adversely affect river lamprey populations.

CEQA Conclusion: In-water and shoreline construction activities associated with habitat restoration would be scheduled to occur when the least number of river lamprey would be expected to occur in or near the restoration sites. River lamprey are tolerant to increases in turbidity, which might occur during shoreline restoration construction activities, and implementation of the environmental commitments described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments* (*see Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan*; and *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*), would minimize or eliminate the potential for turbidity, accidental spills, resuspension of contaminated sediments, or construction noise to affect river lamprey. Therefore, this impact is considered less than significant for river lamprey because it would not substantially reduce available habitat, or restrict the range or movement of river lamprey. Consequently, no mitigation would be required.

Impact AQUA-188: Effects of Contaminants Associated with Restoration Measures on River Lamprey

A complete analysis can be found in the *BDCP Effects Analysis – Appendix D*, *Contaminants (hereby incorporated by reference)*. The effects of contaminants on river lamprey associated with project operations and habitat restoration are expected to be similar to that for Pacific lamprey (Impact AQUA-170).

NEPA Effects: Alternative 1A actions are likely to result in increased production, mobilization, and bioavailability of methylmercury, selenium, copper, and pesticides in the aquatic system. However, any such releases would be sporadic, short-term and localized, and would be unlikely to result in measurable increases in the bioaccumulation in river lamprey. Implementation of *CM12 Methylmercury Management* would also help to minimize the increased mobilization of methylmercury at restoration areas. The effects of contaminants on river lamprey associated with restoration measures would not be adverse, while the overall effects of the restored habitat are expected to be beneficial.

CEQA Conclusion: Alternative 1A actions are likely to result in increased production, mobilization, and bioavailability of methylmercury, selenium, copper, and pesticides in the aquatic system. However, any such releases would be sporadic, short-term and localized, and would be unlikely to result in measurable increases in the bioaccumulation in river lamprey. Implementation of *CM12 Methylmercury Management* would also help to minimize the increased mobilization of methylmercury at restoration areas. Therefore, the impact of contaminants would be less than significant because it would not substantially affect river lamprey either directly or through habitat modifications and, with restoration, would be beneficial in the long-term. Consequently, no mitigation would be required

Impact AQUA-189: Effects of Restored Habitat Conditions on River Lamprey

Refer to Impact AQUA-171 under Pacific lamprey for a discussion of the effects or restored habitat conditions on river lamprey.

Other Conservation Measures (CM12–CM19 and CM21)

Impact AQUA-190: Effects of Methylmercury Management on River Lamprey (CM12)

Refer to Impact AQUA-172 under Pacific lamprey for a discussion of the effects of methylmercury management on river lamprey.

Impact AQUA-191: Effects of Invasive Aquatic Vegetation Management on River Lamprey (CM13)

The following analysis is based on the more detailed analysis included in *BDCP Effects Analysis – Appendix F, Biological Stressors, Section F.1.1 Invasive Aquatic Vegetation, Section F.4 Invasive Aquatic Vegetation, and F.5.3.2.3 Nonnative Aquatic Vegetation Control (Conservation Measure 13) (hereby incorporated by reference)*.

NEPA Effects: A general analysis of the effects on covered fish species has been conducted that was described above for delta smelt (see Impact AQUA-11). Potential impacts on river lamprey from IAV control during operations are similar to those discussed above for Pacific lamprey (see Impact AQUA-173). The control of IAV with implementation of *CM13 Invasive Aquatic Vegetation Control* is expected to maintain or improve turbidity conditions that could benefit river lamprey rearing conditions. The control of IAV would also increase the amount of rearing habitat, as well as access to the habitat and potential increases in food availability. Therefore, the effects of IAV control are expected to provide an overall benefit to river lamprey.

CEQA Conclusion: The control of IAV should provide a modest net benefit to river lamprey during operations through chemical and mechanical treatment and is considered a beneficial impact by reducing predation mortality, increasing food availability, and increasing rearing habitat. The impact is expected to be beneficial, consequently, no mitigation would be required.

Impact AQUA-192: Effects of Dissolved Oxygen Level Management on River Lamprey (CM14)

Refer to Impact AQUA-174 under Pacific lamprey for a discussion of the effects of oxygen level management on river lamprey.

Impact AQUA-193: Effects of Localized Reduction of Predatory Fish on River Lamprey (CM15)

Refer to Impact AQUA-175 under Pacific lamprey for a discussion of the effects of predator management on river lamprey.

Impact AQUA-194: Effects of Nonphysical Fish Barriers on River Lamprey (CM16)

Refer to Impact AQUA-176 under Pacific lamprey for a discussion of the effects of nonphysical fish barriers on river lamprey.

Impact AQUA-195: Effects of Illegal Harvest Reduction on River Lamprey (CM17)

Refer to Impact AQUA-177 under Pacific lamprey for a discussion of illegal harvest reduction on river lamprey.

Impact AQUA-196: Effects of Conservation Hatcheries on River Lamprey (CM18)

Refer to Impact AQUA-178 under Pacific lamprey for a discussion of conservation hatcheries on river lamprey.

Impact AQUA-197: Effects of Urban Stormwater Treatment on River Lamprey (CM19)

Refer to Impact AQUA-179 under Pacific lamprey for a discussion of urban stormwater treatment on river lamprey.

Impact AQUA-198: Effects of Removal/Relocation of Nonproject Diversions on River Lamprey (CM21)

Refer to Impact AQUA-180 under Pacific lamprey for a discussion of removal/relocation of nonproject diversions on river lamprey.

Non-Covered Aquatic Species of Primary Management Concern

The non-covered fish and aquatic species identified as special status by state or federal agencies, or that are of particular ecological, recreational, or commercial importance are listed below.

- Striped bass
- American shad
- Threadfin shad
- Largemouth bass
- Sacramento tule perch
- Sacramento-San Joaquin roach – California species of special concern
- Hardhead – California species of special concern – California species of special concern
- California bay shrimp

Striped bass, American shad, and largemouth bass are all sport fish species and were introduced into rivers for that purpose. All three species are regulated by CDFW for recreational fishing. Roach, hardhead, and Sacramento tule perch are native fish species that are important to the aquatic ecosystem. Threadfin shad are nonnative fish species that were introduced as forage fish for game fish. All of these fish species could be present during construction activities for intakes and barge landings, although it is unlikely that roach or hardhead would be affected as they reside primarily within tributary streams and their primary distributions are upstream of the action area. California bay shrimp occur in San Francisco and San Pablo bays, Suisun Bay and Suisun Marsh, and the western delta in low salinity waters.

Construction and Maintenance of CM1

The effects of construction and maintenance of CM1 under Alternative 1A would be similar for all non-covered species depending on abundance within the area; therefore, the analysis below is combined for all non-covered species instead of analyzed by individual species.

Impact AQUA-199: Effects of Construction of Water Conveyance Facilities on Non-Covered Aquatic Species of Primary Management Concern

NEPA Effects: Refer to Impact AQUA-1 under delta smelt for a discussion of the effects of construction of water conveyance facilities on non-covered species of primary management concern. That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. The potential effects of the construction of water conveyance facilities would be similar to those described there. California bay shrimp would not be affected because they do not occur in the vicinity. Similarly, it is unlikely that roach or hardhead would be affected, as they reside primarily within tributary streams, upstream of the construction areas. Consequently, the effects would not be adverse.

CEQA Conclusion: As described in Impact AQUA-1 under Alternative 1A for delta smelt, the impact of the construction of water conveyance facilities would not be significant on non-covered aquatic species of primary management concern except potentially for construction noise associated with pile driving. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Alternative 1A, Impact AQUA-1.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Alternative 1A, Impact AQUA-1.

Impact AQUA-200: Effects of Maintenance of Water Conveyance Facilities on Non-Covered Aquatic Species of Primary Management Concern

NEPA Effects: Refer to Impact AQUA-2 under delta smelt for a discussion of the effects of maintenance of water conveyance facilities on non-covered species of primary management concern. That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. The potential effects of the construction of maintenance of water conveyance facilities would be similar to those described there. California bay shrimp would not be affected because they do not occur in the vicinity. Consequently, the effects would not be adverse. Similarly, it is unlikely that roach or hardhead would be affected as they occur primarily in tributary streams and upstream of the maintenance areas.

CEQA Conclusion: As described above, these impacts would be less than significant.

Water Operations of CM1

The effects of water operations of CM1 under Alternative 1A include analysis of the following species:

- Striped Bass
- American Shad
- Threadfin Shad

- Largemouth Bass
- Sacramento Tule Perch
- Sacramento-San Joaquin roach – California species of special concern
- Hardhead – California species of special concern
- California bay shrimp

Impact AQUA-201: Effects of Water Operations on Entrainment of Non-Covered Aquatic Species of Primary Management Concern

NEPA Effects: Refer to Impact AQUA-3 under delta smelt for a discussion of the effects of water operations on entrainment of non-covered species of primary management concern. That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. The potential effects of water operations would be similar to those described there, although there are some caveats for each species. Striped bass larvae could be entrained at the water diversion facilities in both the north and south Delta, although larval entrainment is not thought to have population consequences due to the large fecundity of individual females and the fact that population levels do not correspond to numbers of adults (Moyle 2002). Largemouth bass are nest builders and typically build their nests in quiet, low flow backwaters and are unlikely to be entrained at facilities. Both shad species are very similar in morphology at the larval stage to Delta smelt and entrainment would be similar. The difference lies in the larval and early juvenile distribution which would create more opportunities for interaction with diversion facilities, although it is not thought that entrainment is a limiting factor for any of these species. Tule perch is a live bearing surf perch usually found in heavy cover or rip-rap and are unlikely to be affected, as the population is widespread and is not easily entrained, and on average it makes up only a fraction of all species salvaged at the south Delta facilities. California bay shrimp do not occur in freshwater and would not be affected, and it is unlikely that hardhead or roach would be affected, because their distributions are almost exclusively in upstream areas. Consequently, the effects would not be adverse.

CEQA Conclusion: As described above, these impacts would be less than significant.

Impact AQUA-202: Effects of Water Operations on Spawning and Egg Incubation Habitat for Non-Covered Aquatic Species of Primary Management Concern

Striped Bass

In general, Alternative 1A would slightly improve the quality and quantity of upstream habitat conditions for striped bass relative to the NAA.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the April through June striped bass spawning, embryo incubation, and initial rearing period. Lower flows could reduce the quantity and quality of instream habitat available for spawning, egg incubation, and rearing, although striped bass distribution occurs below Red Bluff Diversion Dam which would exclude striped bass from the upper Sacramento and Clear Creek (Moyle 2002). Striped bass are also not known to occur in the Trinity River (Moyle 2002) Striped bass are broadcast spawners not needing substrate like salmon for egg incubation. The eggs are slightly heavier that water but any amount of current will suspend the eggs off the bottom, thus the lowering of current will not affect viability of embryos.

Striped bass are not thought to occur above Red Bluff in the Sacramento River and are not known from the Trinity River or Clear Creek.

In the Feather River at Thermalito Afterbay, flows under A1A_LLT would generally be substantially greater (up to 219% greater) than flows under NAA during April through June (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

In the American River at Nimbus Dam, flows under A1A_LLT would always be greater than flows under NAA regardless of water year type (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

Flow rates in the San Joaquin and Stanislaus rivers would be the same as described above for covered fish species under Alternative 1A (see Impacts AQUA-76 through 78 under Chinook salmon fall-/late-fall run ESU). The analysis for Alternative 1A indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months outside of the 59°F to 68°F suitable water temperature range for striped bass spawning, embryo incubation, and initial rearing during April through June was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced spawning success and increased egg and larval stress and mortality. Striped bass are known to migrate upstream until temperatures reach 59°F and then spawn, thus in low temperature years they migrate upstream farther then when temperatures are warmer. It is unlikely that striped bass would spawn under less than minimal temperature needs for embryo development, thus temperature is not a likely stressor on striped bass embryo development. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

In the Sacramento River upstream of Red Bluff, the percentage of months under A1A_LLT outside the range would be lower than the percentage under NAA in all water years (Table 11-1A-89). The percentage of months under A1A_LLT outside the range would be similar to or lower than the percentage under NAA in below normal and critical water year types and slightly higher in all other types (up to 11% higher). Striped bass spawning distribution is known to occur below Red Bluff, (Moyle 2002).

In the Trinity River below Lewiston Reservoir, the percentage of months under A1A_LLT outside the range would be similar to or lower than the percentage under NAA in all water years except critical years compared to NAA (7% higher) (Table 11-1A-89). Striped bass are not known to occur in the Trinity River (Moyle 2002).

Table 11-1A-89. Difference and Percent Difference in the Percentage of Months during April–June in Which Water Temperatures Are outside the 59°F to 68°F Water Temperature Range for Striped Bass Spawning, Embryo Incubation, and Initial Rearing[a]

Location	Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Sacramento River upstream of Red Bluff	Wet	-13 (-14%)	9 (11%)
	Above Normal	-12 (-13%)	6 (7%)
	Below Normal	-19 (-20%)	2 (2%)
	Dry	-15 (-16%)	6 (7%)
	Critical	-23 (-27%)	-1 (-1%)
	All	-16 (-17%)	5 (7%)
Trinity River below Lewiston Reservoir	Wet	0 (0%)	0 (0%)
	Above Normal	-3 (-3%)	0 (0%)
	Below Normal	0 (0%)	0 (0%)
	Dry	-2 (-2%)	0 (0%)
	Critical	-17 (-17%)	6 (7%)
	All	-3 (-3%)	1 (1%)
Feather River below Thermalito Afterbay	Wet	0 (0%)	-5 (-12%)
	Above Normal	-18 (-40%)	-15 (-56%)
	Below Normal	-12 (-28%)	-14 (-46%)
	Dry	-2 (-4%)	2 (4%)
	Critical	11 (29%)	-3 (-6%)
	All	-3 (-8%)	-6 (-15%)
American River below Nimbus Dam	Wet	-27 (-54%)	-8 (-33%)
	Above Normal	-15 (-45%)	-6 (-33%)
	Below Normal	-19 (-53%)	-5 (-29%)
	Dry	-2 (-7%)	-11 (-43%)
	Critical	14 (42%)	6 (12%)
	All	-12 (-33%)	-6 (-23%)
Stanislaus River below New Melones Dam	Wet	0 (0%)	0 (0%)
	Above Normal	0 (0%)	0 (0%)
	Below Normal	0 (0%)	0 (0%)
	Dry	0 (0%)	0 (0%)
	Critical	-3 (-3%)	0 (0%)
	All	0 (0%)	0 (0%)

[a] A negative value indicates a benefit (reduction in percentage of months outside suitable range) of the alternative.

In the Feather River below Thermalito Afterbay, the percentage of months under A1A_LLT outside the range would be lower than the percentage under NAA in all water years except critical years (16% higher) (Table 11-1A-89). The percentage of months under A1A_LLT outside the range would be similar to or lower than the percentage under NAA in all water year types.

In the American River below Nimbus Dam, the percentage of months under A1A_LLT outside the range would be lower than the percentage under NAA in all water years except critical years (12% higher compared to NAA) (Table 11-1A-89).

In the Stanislaus River below New Melones Dam, the percentage of months under A1A_LLT outside the range would be similar to or lower than the percentage under NAA in all water years (Table 11-1A-89).

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because Alternative 1A would not cause a substantial reduction in striped bass spawning, incubation, or initial rearing habitat. Flows in all rivers examined during the April through June spawning, incubation, and initial rearing period under Alternative 1A would generally be similar to or greater than flows under the NAA. Overall, there would be flow increases in all waterways except Trinity River and Clear Creek. The percentage of months outside the 59°F to 68°F water temperature range would generally be lower under Alternative 1A than under the NAA. The increased frequency in months outside the temperature range in the Sacramento River would not be of sufficient magnitude to have a population level effect on striped bass.

CEQA Conclusion: In general, Alternative 1A would slightly improve the quality and quantity of upstream habitat conditions for striped bass relative to Existing Conditions.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the April through June striped bass spawning, embryo incubation, and initial rearing period. Lower flows could reduce the quantity and quality of instream habitat available for spawning, egg incubation, and rearing.

Striped bass are not thought to occur above Red Bluff in the Sacramento River and are not known to occur in the Trinity River or Clear Creek.

In the Feather River at Thermalito Afterbay, flows under A1A_LLT would generally be similar to or greater than flows under Existing Conditions during April through June, except in wet years during May (28% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

In the American River at Nimbus Dam, flows under A1A_LLT would generally be similar to or greater than flows under Existing Conditions during April and June, except in above normal years during April (6% lower) and wet and critical years during June (24% and 31% lower, respectively), but generally lower, by up to 24%, during May (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

Flow rates in the San Joaquin and Stanislaus rivers would be the same as described above for covered fish species under Alternative 1A (see AQUA-76, -77, and -78 under Chinook salmon fall-/late-fall run ESU). The analysis indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months outside of the 59°F to 68°F suitable water temperature range for striped bass spawning, embryo incubation, and initial rearing during April through June was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced spawning success and increased egg and larval stress and mortality.

Striped bass are known to migrate upstream until temperatures reach 59°F and then spawn, thus in low temperature years they migrate upstream farther then when temperatures are warmer. It is unlikely that striped bass would spawn under less than minimal temperature needs for embryo development, thus temperature is not a likely stressor on striped bass embryo development. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

In the Feather River below Thermalito Afterbay, the percentage of months under A1A_LLT outside the range would be lower than the percentage under Existing Conditions in all water years except critical years (29% higher) (Table 11-1A-89).

In the American River below Nimbus Dam, the percentage of months under A1A_LLT outside the range would be lower than the percentage under Existing Conditions in all water years except critical years (42% higher) (Table 11-1A-89).

In the Stanislaus River below New Melones Dam, the percentage of months under A1A_LLT outside the range would be similar to or lower than the percentage under Existing Conditions in all water years (Table 11-1A-89).

Collectively, these results indicate that the impact would not be significant because Alternative 1A would not cause a substantial reduction in spawning, incubation, and initial rearing habitat of striped bass. Therefore, no mitigation is necessary. Flows in all rivers except the San Joaquin and Stanislaus rivers during the April through June spawning, incubation, or initial rearing period under Alternative 1A would generally be similar to or greater than flows under Existing Conditions. Flows in the San Joaquin and Stanislaus rivers would be lower under Alternative 1A, although this effect would not be biologically meaningful to striped bass. The percentage of months outside the 59°F to 68°F water temperature range would generally be lower under Alternative 1A than under CEQA baseline, particularly in the American River (up to 54% reduction in percentage of months).

American Shad

In general, Alternative 1A would slightly improve the quality and quantity of upstream habitat conditions for American shad relative to the NAA.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the April through June American shad adult migration and spawning period. Lower flows could reduce migration ability and instream habitat quantity and quality for spawning. It is unlikely that the lesser amount of flow will impact the migration ability of American shad. Given their much smaller body size and their known use of much smaller streams (e.g., Cosumnes River), plus their use of broadcast spawning it is unlikely that lowered flow would have a negative effect on them in this way.

In the Sacramento River upstream of Red Bluff, flows under A1A_LLT would generally be similar to or greater than flows under NAA during April through June (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Although American shad juveniles do appear in screw trap data at Red Bluff the numbers are very small. For example, four American shad were caught in 2000 out of over 889,000 fish caught (Gaines and Martin 2001).

In the Trinity River below Lewiston Reservoir, flows under A1A_LLT would generally be similar to or greater than flows under NAA during April through June except in above normal years during

April compared (11% lower)(Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Although American shad juveniles do appear in screw trap data at Willow Creek the numbers are very small. For example one American shad was caught by screw trap at Willow Creek in 2007 (Pinnix et al. 2010).

American shad are not known from Clear Creek.

In the Feather River at Thermalito Afterbay, flows under A1A_LLT would generally be substantially greater (up to 219% greater) than flows under NAA during April through June (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

In the American River at Nimbus Dam, flows under A1A_LLT would generally be greater than flows under NAA regardless of water year type (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

Flow rates in the San Joaquin and Stanislaus rivers would be the same as described above for covered fish species under Alternative 1A (see AQUA-76, -77, and -78 under Chinook salmon fall-/late-fall run ESU). That analysis indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months outside of the 60°F to 70°F water temperature range for American shad adult migration and spawning during April through June was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced spawning success and increased adult migrant stress and mortality. The range of 60°F to 70°F is the spawning range in general of American shad in the Sacramento River. The spawning temperature range does not imply that temperatures below this would be stressful to migrating shad. Male shad migrate to spawning areas much earlier than females with much lower temperatures with no apparent migration stress or mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

In the Sacramento River upstream of Red Bluff, the percentage of months under A1A_LLT outside the range would be similar to or lower than the percentage under NAA in most water year types and slightly higher in wet and dry water year types (7% and 5% higher, respectively). Although American shad juveniles do appear in screw trap data at Red Bluff the numbers are very small. For example, four American shad were caught in 2000 out of over 889,000 fish caught (Gaines and Martin 2001).

In the Trinity River below Lewiston Reservoir, the percentage of months under A1A_LLT outside the range would be similar to or lower than the percentage under NAA in all water years (Table 11-1A-90). In the Feather River below Thermalito Afterbay, the percentage of months under A1A_LLT outside the range would be similar to or lower than the percentage under NAA in all water year types (Table 11-1A-90).

In the American River below Nimbus Dam, the percentage of months under A1A_LLT outside the 60°F to 70°F water temperature range would be similar to or lower than the percentage under NAA in all water year types (Table 11-1A-90).

In the Stanislaus River below New Melones Dam, the percentage of months under A1A_LLT outside the range would be similar to the percentage under NAA in all water year types (Table 11-1A-90).

Table 11-1A-90. Difference and Percent Difference in the Percentage of Months during April–June in Which Water Temperatures Are outside the 60°F to 70°F Water Temperature Range for American Shad Adult Migration and Spawning[a]

Location	Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Sacramento River upstream of Red Bluff	Wet	-9 (-9%)	6 (7%)
	Above Normal	-8 (-8%)	4 (4%)
	Below Normal	-15 (-15%)	-1 (-1%)
	Dry	-8 (-8%)	4 (5%)
	Critical	-18 (-20%)	0 (0%)
	All	-11 (-11%)	3 (4%)
Trinity River below Lewiston Reservoir	Wet	0 (0%)	0 (0%)
	Above Normal	-3 (-3%)	0 (0%)
	Below Normal	-2 (-2%)	0 (0%)
	Dry	-2 (-2%)	0 (0%)
	Critical	-11 (-11%)	0 (0%)
	All	-3 (-3%)	0 (0%)
Feather River below Thermalito Afterbay	Wet	-5 (-11%)	0 (0%)
	Above Normal	-3 (-8%)	-12 (-36%)
	Below Normal	0 (0%)	-7 (-23%)
	Dry	-2 (-5%)	-7 (-20%)
	Critical	3 (8%)	-3 (-7%)
	All	-2 (-5%)	-5 (-13%)
American River below Nimbus Dam	Wet	-32 (-56%)	0 (0%)
	Above Normal	-24 (-57%)	-6 (-33%)
	Below Normal	-21 (-50%)	-5 (-22%)
	Dry	-6 (-21%)	-4 (-18%)
	Critical	14 (63%)	-6 (-15%)
	All	-16 (-40%)	-3 (-14%)
Stanislaus River below New Melones Dam	Wet	0 (0%)	0 (0%)
	Above Normal	0 (0%)	0 (0%)
	Below Normal	0 (0%)	0 (0%)
	Dry	0 (0%)	0 (0%)
	Critical	0 (0%)	0 (0%)
	All	0 (0%)	0 (0%)

[a] A negative value indicates a benefit (reduction in percentage of months outside suitable range) of the alternative.

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because Alternative 1A would not cause a substantial reduction in American shad spawning or adult migration. Flows in all rivers examined during the April through June adult migration and spawning period under Alternative 1A would generally be similar to or greater than flows under NAA. Overall, there would be flow increases in all waterways except Trinity River and Clear Creek. The percentage of months outside the 60°F to 70°F water temperature range would generally be lower under Alternative 1A than under NAA in all waterways examined.

CEQA Conclusion: In general, Alternative 1A would slightly improve the quality and quantity of upstream habitat conditions for American shad relative to Existing Conditions.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the April through June American shad adult migration and spawning period. Lower flows could reduce migration ability and instream habitat quantity and quality for spawning. It is unlikely that the lesser amount of flow will impact the migration ability of American shad. Given their much smaller body size and their known use of much smaller streams (e.g., Cosumnes River), plus their use of broadcast spawning it is unlikely that lowered flow would affect them in this way.

In the Sacramento River upstream of Red Bluff, flows under A1A_LLT would generally be similar to or greater than flows under Existing Conditions during April through June, except in wet years during May (14% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Although American shad juveniles do appear in screw trap data at Red Bluff the numbers are very small. For example, four American shad were caught in 2000 out of over 889,000 fish caught (Gaines and Martin 2001).

In the Trinity River below Lewiston Reservoir, flows under A1A_LLT would generally be similar to or greater than flows under Existing Conditions during April through June, except in critical years during May (6% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Although American shad juveniles do appear in screw trap data at Willow Creek the numbers are very small. For example, one American shad was caught by screw trap at Willow Creek in 2007 (Pinnix et al. 2010).

American shad are not known from Clear Creek.

In the American River at Nimbus Dam, flows under A1A_LLT would generally be similar to or greater than flows under Existing Conditions during April and June, except in above normal years during April (6% lower) and wet and critical years during June (24% and 31% lower, respectively), but generally lower, by up to 24%, during May (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

Flow rates in the San Joaquin and Stanislaus rivers would be the same as described above for covered fish species under Alternative 1A (see Impacts AQUA-76 through 78 under Chinook salmon fall-/late-fall run ESU). That analysis indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months outside of the 60°F to 70°F water temperature range for American shad adult migration and spawning during April through June was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced spawning success and increased adult migrant stress and mortality. The range of 60°F to 70°F is the spawning range in general of American shad in the Sacramento River. The spawning temperature range does not imply that temperatures below this would be stressful to migrating shad. Male shad migrate to spawning areas much earlier than females with much lower temperatures with no apparent migration stress or mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

In the Sacramento River upstream of Red Bluff, the percentage of months under A1A_LLT outside the range would be lower than the percentage under Existing Conditions in all water years (Table 11-1A-90). Although American shad juveniles do appear in screw trap data at Red Bluff the numbers are very small. For example, four American shad were caught in 2000 out of over 889,000 fish caught (Gaines and Martin 2001).

In the Trinity River below Lewiston Reservoir, the percentage of months under A1A_LLT outside the range would be similar to or lower than the percentage under Existing Conditions in all water year types (Table 11-1A-90). Although American shad juveniles do appear in screw trap data at Willow Creek the numbers are very small. For example, one American shad was caught by screw trap at Willow Creek in 2007 (Pinnix et al. 2010).

In the Feather River below Thermalito Afterbay, the percentage of months under A1A_LLT outside the range would be similar to or lower than the percentage under Existing Conditions in all water years except critical years (8% higher) (Table 11-1A-90).

In the American River below Nimbus Dam, the percentage of months under A1A_LLT outside of the 60°F to 70°F water temperature range would be similar to or lower than the percentage under Existing Conditions in all water years except critical years (63% higher) (Table 11-1A-90).

In the Stanislaus River below New Melones Dam, the percentage of months under A1A_LLT outside the range would be similar to the percentage under Existing Conditions in all water year types (Table 11-1A-90).

Collectively, these results indicate that the impact would not be significant because Alternative 1A would not cause a substantial reduction in American shad adult migration or spawning habitat, and no mitigation is necessary. Flows in all rivers examined, except the San Joaquin and Stanislaus rivers during the April through June adult migration and spawning period under Alternative 1A, would generally be similar to or greater than flows under Existing Conditions. Flows in the San Joaquin and Stanislaus rivers would be lower under Alternative 1A, although this effect would not be biologically meaningful to American shad. The percentage of months outside the 60°F to 70°F water temperature range would generally be similar to or lower under Alternative 1A than under the CEQA baseline, particularly in the Sacramento and American rivers (up to 57% reduction) (Table 11-1A-90).

Threadfin Shad

In general, Alternative 1A would not affect the quality and quantity of upstream habitat conditions for threadfin shad relative to the NAA. The primary distribution of threadfin shad is within the Delta and lower rivers and in reservoirs. Threadfin shad that are seen in tributaries and the mainstem Sacramento River are produced in reservoirs and transported downstream during high flows. Threadfin shad are not migrating upstream to spawn in these areas, and may persist in these downstream areas during times of low flow. It is likely that there is a pattern of reintroduction that allows threadfin shad to persist in these upstream areas. Threadfin shad use floating objects such as vegetation and wood to spawn on so it is unlikely that their spawning habitat would be reduced (Moyle 2002).

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during April through August threadfin shad spawning period. Lower flows could reduce the quantity and quality of instream habitat (backwaters) available for spawning. Threadfin shad are just transient in these upstream areas as they are being flushed out of reservoirs downstream.

In the Sacramento River upstream of Red Bluff, flows under A1A_LLT would generally be similar to or greater than flows under NAA during April through July except in below normal and dry years during July (8% lower for both), and up to 19% lower during August (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Although the numbers are small as indicated by screw trap catches at Red Bluff Diversion Dam where 1,260 threadfin shad were caught out of a total of 857,727 total fish caught (Gaines and Martin 2001).

Threadfin shad are not known from the Trinity River system (Pinnix et al. 2010).

In Clear Creek at Whiskeytown Dam, flows under A1A_LLT would generally be similar to or greater than flows under NAA throughout the period, except in critical years during June (8% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Threadfin shad are not known from Clear Creek screw trap data (Gaines and Martin 2001; Greenwald et al. 2003; Earley et al. 2008a, 2008b, 2009, 2010).

In the Feather River at Thermalito Afterbay, flows under A1A_LLT would generally greater during April through June (up to 219% greater) and generally be lower than those under NAA during July and August (up to 51% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

In the American River at Nimbus Dam, flows under A1A_LLT would generally lower than flows under NAA during July and August (up to 30% lower), greater during May and June (up to 31% greater), and similar between NAA and A1A_LLT during April.

Flow rates in the San Joaquin and Stanislaus rivers would be the same as described above for covered fish species under Alternative 1A (see Impacts AQUA-76 through 78 under Chinook salmon fall-/late-fall run ESU). That analysis indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months below 68°F water temperature threshold for the April through August adult threadfin shad spawning period was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures below this threshold could delay spawning in these areas. According to Moyle (2002) the peak of spawning occurs at a temperature of 68°F, although spawning has been observed to occur from 57°F to 64°F. This makes it likely that threadfin shad can spawn successfully at much lower temperatures than 68°F, although their survival is higher at hatching ≥.8 at above 66°F (Betsill and Avyle 1997). Water temperatures were not modeled in the San Joaquin River or Clear Creek.

In the Sacramento River upstream of Red Bluff, the percentage of months under A1A_LLT outside the range would be similar to or lower than the percentage under NAA in all water year types (Table 11-1A-91). Although numbers are small as indicated by screw trap catches at Red Bluff Diversion Dam where 1,260 threadfin shad were caught out of a total of 857,727 total fish caught (Gaines and Martin 2001).

Threadfin shad are not known from the Trinity River system (Pinnix et al. 2010).

In the Feather River below Thermalito Afterbay, the percentage of months under A1A_LLT outside the range would be higher than the percentage under NAA in wet, above, and below normal water years (up to 9% higher) (Table 11-1A-91).

In the American River below Nimbus Dam, the percentage of months under A1A_LLT below the 68°F water temperature threshold would be similar to or lower than the percentage under NAA in all water year types (Table 11-1A-91).

In the Stanislaus River below New Melones Dam, the percentage of months under A1A_LLT below the 68°F water temperature threshold would be similar to or lower than the percentage under NAA in all water year types (Table 11-1A-91).

Table 11-1A-91. Difference and Percent Difference in the Percentage of Months in Which April–August Water Temperatures Fall below the 68°F Water Temperature Threshold for Threadfin Shad Spawning[a]

Location	Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Sacramento River upstream of Red Bluff	Wet	0 (0%)	0 (0%)
	Above Normal	0 (0%)	0 (0%)
	Below Normal	0 (0%)	0 (0%)
	Dry	0 (0%)	0 (0%)
	Critical	-16 (-16%)	0 (0%)
	All	-2 (-2%)	0 (0%)
Trinity River below Lewiston Reservoir	Wet	0 (0%)	0 (0%)
	Above Normal	0 (0%)	0 (0%)
	Below Normal	0 (0%)	0 (0%)
	Dry	0 (0%)	0 (0%)
	Critical	-13 (-13%)	0 (0%)
	All	-2 (-2%)	0 (0%)
Feather River below Thermalito Afterbay	Wet	-10 (-16%)	3 (6%)
	Above Normal	-25 (-33%)	4 (7%)
	Below Normal	-20 (-29%)	4 (9%)
	Dry	-34 (-46%)	-4 (-11%)
	Critical	-30 (-46%)	-2 (-5%)
	All	-22 (-32%)	1 (2%)
American River below Nimbus Dam	Wet	-28 (-29%)	0 (0%)
	Above Normal	-22 (-23%)	0 (0%)
	Below Normal	-23 (-25%)	-7 (-10%)
	Dry	-38 (-43%)	0 (0%)
	Critical	-23 (-41%)	-2 (-5%)
	All	-28 (-32%)	-1.5 (-2%)
Stanislaus River below New Melones Dam	Wet	0 (0%)	0 (0%)
	Above Normal	0 (0%)	0 (0%)
	Below Normal	0 (0%)	0 (0%)
	Dry	0 (0%)	0 (0%)
	Critical	-2 (-2%)	0 (0%)
	All	0 (0%)	0 (0%)

[a] A negative value indicates a benefit (reduction in percentage of months outside suitable range) of the alternative.

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because Alternative 1A would not cause a substantial reduction in spawning habitat. Flows in all rivers examined during the April through August spawning period under Alternative 1A would generally be similar to or greater than flows under the NAA, except during July and August in the Sacramento, Feather, and American rivers. Lower flows during these months in these rivers are not of sufficient magnitude or frequency to have a biologically meaningful effect on threadfin shad. The percentage of months below the spawning temperature threshold would generally be lower under Alternative 1A relative to the NAA.

CEQA Conclusion: In general, Alternative 1A would not affect the quality and quantity of upstream habitat conditions for threadfin shad relative to Existing Conditions.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during April through August spawning period. Lower flows could reduce the quantity and quality of instream habitat (backwaters) available for spawning. However, this is unlikely to affect threadfin shad as they spawn on floating objects such as vegetation or wood which would float up or down with the flow regime (Moyle 2002).

In the Sacramento River upstream of Red Bluff, flows under A1A_LLT during April through June would generally be similar to or greater than flows under Existing Conditions, except in wet years during May (14% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows under A1A_LLT during July and August would generally be lower than flows under Existing Conditions by up to 24%. Although numbers are small as indicated by screw trap catches at Red Bluff Diversion Dam where 1,260 threadfin shad were caught out of a total of 857,727 total fish caught (Gaines and Martin 2001).

Threadfin shad are not known from the Trinity River system (Pinnix et al. 2010).

In Clear Creek at Whiskeytown Dam, flows under A1A_LLT would nearly always be similar to or greater than flows under Existing Conditions throughout the period, except in critical years during August (17% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Threadfin shad are not known from Clear Creek screw trap data (Gaines and Martin 2001; Greenwald et al. 2003; Earley et al. 2008a, 2008b, 2009, 2010).

In the Feather River at Thermalito Afterbay, flows under A1A_LLT would generally be greater (up to 204% greater) than flows under Existing Conditions during April through June and lower (up to 56% lower) during July and August (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

In the American River at Nimbus Dam, flows under A1A_LLT would generally be similar to flows under Existing Conditions during April and June with some exceptions (up to 31% lower), and lower during May, July, and August (up to 49% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

Flow rates in the San Joaquin and Stanislaus rivers would be the same as described above for covered fish species under Alternative 1A (see Impacts AQUA-76 through 78 under Chinook salmon fall-/late-fall run ESU). That analysis indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months below 68°F water temperature threshold for the April through August adult threadfin shad spawning period was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures below this threshold could delay spawning in these areas. According to Moyle (2002) the peak of spawning occurs at a temperature of 68°F, although spawning has been observed to occur from 57°F to 64°F. This makes it likely that threadfin shad can spawn successfully at much lower temperatures than 68°F, although their larval survival rate is higher (0.6 vs. 0.8) at above 66°F (Betsill and Avyle 1997). Water temperatures were not modeled in the San Joaquin River or Clear Creek.

In the Sacramento River upstream of Red Bluff, the percentage of months under A1A_LLT outside the range would be similar to or lower than the percentage under Existing Conditions in all water year types (Table 11-1A-91). Although numbers are small as indicated by screw trap catches at Red Bluff Diversion Dam where 1,260 threadfin shad were caught out of a total of 857,727 total fish caught (Gaines and Martin 2001).

Threadfin shad are not known from the Trinity River system (Pinnix et al. 2010).

In the Feather River below Thermalito Afterbay, the percentage of months under A1A_LLT below the 68°F water temperature threshold would be lower than the percentage under Existing Conditions in all water year types (Table 11-1A-91).

In the American River below Nimbus Dam, the percentage of months under A1A_LLT below the 68°F water temperature threshold would be similar to or lower than the percentage under Existing Conditions in all water year types (Table 11-1A-91).

In the Stanislaus River below New Melones Dam, the percentage of months under A1A_LLT below the 68°F water temperature threshold would be similar to or lower than the percentage under Existing Conditions in all water year types (Table 11-1A-91).

Collectively, these results indicate that the impact would be less than significant because Alternative 1A would not cause a substantial reduction in habitat, and no mitigation is necessary. Flows in all rivers examined during the April through August spawning period under Alternative 1A would generally be similar to or greater than flows under Existing Conditions, except during summer months in the Sacramento, Feather, and American rivers. Lower flows during these months in the Sacramento and Feather rivers would not be of sufficient magnitude or frequency to cause a biologically meaningful effect on threadfin shad. Lower flows in the American River would occur during the majority of the period, but, due to the spatial diversity and movement ability of threadfin shad, these reductions are not expected to have a biologically meaningful effect on threadfin shad. The percentage of months outside all temperature thresholds are generally lower under Alternative 1A than under Existing Conditions, indicating that there would be a net temperature-related benefit of Alternative 1A to threadfin shad.

Largemouth Bass

In general, Alternative 1A would not affect the quality and quantity of upstream habitat conditions for largemouth bass relative to the NAA. The primary distribution of largemouth bass is in the central and south Delta, although they do occur in slower moving parts of the rivers, their tributaries and reservoirs. Given this fact it is unlikely that upstream flows and temperatures will have a discernible effect on largemouth bass population numbers.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the March through June largemouth bass spawning period. Lower flows could increase the quantity and quality of instream spawning habitat.

In the Sacramento River upstream of Red Bluff, flows under A1A_LLT would generally be similar to or greater than flows under NAA during March through June (Appendix 11C, CALSIM II Model

Results utilized in the Fish Analysis). Although few largemouth bass are expected to occur in this area, as indicated by screw trap catches at Red Bluff Diversion Dam where 185 largemouth bass were caught out of a total of 857,727 total fish caught (Gaines and Martin 2001).

In the Trinity River below Lewiston Reservoir, flows under A1A_LLT would generally be similar to or greater than flows under NAA during March through June, except in above normal years during April (11% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Largemouth bass were not found in Trinity River screw trap data (Pinnix et al. 2010), but are apparently found in low numbers when washed down from upstream reservoirs (USFWS and Hoopa Valley Tribe 1999).

In Clear Creek at Whiskeytown Dam, flows under A1A_LLT would generally be similar to or greater than flows under NAA during March through June, except in critical years during June (8% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Largemouth bass are caught in rotary screw traps in low numbers mostly in the fry form (Gaines and Martin 2001) most likely washed down from Whiskeytown Reservoir or local farm ponds. It is unlikely that these largemouth bass rear and spawn except in the lowest velocity areas of lower Clear Creek where they are most likely flushed out of the system by high flow events (Moyle 2002).

In the Feather River at Thermalito Afterbay, flows under A1A_LLT would be substantially greater (up to 219% greater) than flows under NAA during March through June (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

In the American River at Nimbus Dam, flows under A1A_LLT would generally be similar to or greater than flows under NAA throughout the period, except in dry and critical years during March (9% and 8% lower, respectively) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

Flow rates in the San Joaquin and Stanislaus rivers would be the same as described above for covered fish species under Alternative 1A (see Impacts AQUA-76 through 78 under Chinook salmon fall-/late-fall run ESU). That analysis indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months outside of the 59°F to 75°F suitable water temperature range for largemouth bass spawning during March through June was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced spawning success. Although Kelley (1968) found no difference in incubation survival of largemouth bass eggs in the temperature range of 55°F to 75°F. Thus it is unlikely that there would be reduced spawning success because of low temperatures. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

In the Sacramento River upstream of Red Bluff, the percentage of months under A1A_LLT outside the range would be similar to or lower than the percentage under NAA in below normal and critical water years and higher in all other water year types (up to 8% higher) (Table 11-1A-92). Although numbers are small as indicated by screw trap catches at Red Bluff Diversion Dam where 185 largemouth were caught out of a total of 857,727 total fish caught (Gaines and Martin 2001).

In the Trinity River below Lewiston Reservoir, the percentage of months under A1A_LLT outside the range would be similar to or lower than the percentage under NAA in all water years except critical years (5% higher) (Table 11-1A-92). Largemouth bass were not found in Trinity River screw trap data (Pinnix et al. 2010), but are apparently found in low numbers when washed down from upstream reservoirs (U.S. Fish and Wildlife Service and Hoopa Valley Tribe 1999).

In the Feather River below Thermalito Afterbay, the percentage of months under A1A_LLT outside the range would be similar to or lower than the percentage under NAA in all water year types (Table 11-1A-92).

In the American River below Nimbus Dam, the percentage of months under A1A_LLT outside the 59°F to 75°F water temperature range would be similar to or lower than the percentage under NAA in all water years except critical years (8% higher) (Table 11-1A-92).

In the Stanislaus River below New Melones Dam, the percentage of months under A1A_LLT outside the range would be similar to or lower than the percentage under NAA in all water year types (Table 11-1A-92).

Table 11-1A-92. Difference and Percent Difference in the Percentage of Months during March–June in Which Water Temperatures Are outside the 59°F to 75°F Water Temperature Range for Largemouth Bass Spawning[a]

Location	Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Sacramento River upstream of Red Bluff	Wet	-9 (-10%)	6 (8%)
	Above Normal	-9 (-10%)	4 (5%)
	Below Normal	-14 (-15%)	1 (1%)
	Dry	-12 (-12%)	4 (5%)
	Critical	-17 (-19%)	0 (-1%)
	All	-12 (-13%)	4 (5%)
Trinity River below Lewiston Reservoir	Wet	0 (0%)	0 (0%)
	Above Normal	-2 (-2%)	0 (0%)
	Below Normal	0 (0%)	0 (0%)
	Dry	-1 (-1%)	0 (0%)
	Critical	-13 (-13%)	4 (5%)
	All	-2 (-2%)	1 (1%)
Feather River below Thermalito Afterbay	Wet	-9 (-16%)	0 (0%)
	Above Normal	-20 (-41%)	-7 (-23%)
	Below Normal	-14 (-32%)	-4 (-12%)
	Dry	-18 (-38%)	0 (0%)
	Critical	-17 (-38%)	-6 (-23%)
	All	-15 (-30%)	-2 (-7%)
American River below Nimbus Dam	Wet	-21 (-35%)	0 (0%)
	Above Normal	-18 (-38%)	0 (0%)
	Below Normal	-18 (-38%)	-2 (-6%)
	Dry	-11 (-30%)	0 (0%)
	Critical	-8 (-25%)	2 (8%)
	All	-16 (-34%)	0 (0%)
Stanislaus River below New Melones Dam	Wet	0 (0%)	0 (0%)
	Above Normal	0 (0%)	0 (0%)
	Below Normal	0 (0%)	0 (0%)
	Dry	0 (0%)	0 (0%)
	Critical	-2 (-2%)	0 (0%)
	All	0 (0%)	0 (0%)

[a] A negative value indicates a benefit (reduction in percentage of months outside suitable range) of the alternative.

CEQA Conclusion: In general, Alternative 1A would reduce the quality and quantity of upstream habitat conditions for largemouth bass relative to Existing Conditions. Although at most this would be a minor effect as largemouth bass are not abundant in this area and the main distribution of this species abundance is found downstream of this area.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the March through June largemouth bass spawning period. Lower flows could reduce the quantity and quality of instream spawning habitat.

In the Sacramento River upstream of Red Bluff, flows under A1A_LLT would generally be similar to or greater than flows under Existing Conditions during March through June, except in wet years during May (14% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Although numbers are small as indicated by screw trap catches at Red Bluff Diversion Dam where 185 largemouth bass were caught out of a total of 857,727 total fish caught (Gaines and Martin 2001).

In the Trinity River below Lewiston Reservoir, flows under A1A_LLT would generally be similar to or greater than flows under Existing Conditions during March through June, except in below normal years during March and critical years during May (6% lower in both) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Largemouth bass were not found in Trinity River screw trap data (Pinnix et al. 2010), but are apparently found in low numbers when washed down from upstream reservoirs (U.S. Fish and Wildlife Service and Hoopa Valley Tribe 1999).

In Clear Creek at Whiskeytown Dam, flows under A1A_LLT would always be similar to or greater than flows under Existing Conditions during March through June (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Largemouth bass are caught in rotary screw traps in low numbers mostly in the fry form (Gaines and Martin 2001) most likely washed down from Whiskeytown Reservoir or local farm ponds. It is unlikely that these largemouth bass rear and spawn except in the lowest velocity areas of lower Clear Creek where they are most likely flushed out of the system by high flow events (Moyle 2002).

In the Feather River at Thermalito Afterbay, flows under A1A_LLT would generally be substantially greater (up to 204% greater) than flows under Existing Conditions during March through June, except in below normal years during March (31% lower) and wet years during May (28% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

In the American River at Nimbus Dam, flows under A1A_LLT would generally be similar to or greater than flows under Existing Conditions during March, April, and June, except in critical years during March and June (8% and 31% lower, respectively), above normal years during April (6% lower) and wet years during June (24% lower). Flows under A1A_LLT in May would generally be up to 24% lower than those under Existing Conditions (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

Flow rates in the San Joaquin and Stanislaus rivers would be the same as described above for covered fish species under Alternative 1A (see Impacts AQUA-76 through 78 under Chinook salmon fall-/late-fall run ESU). That analysis indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months outside of the 59°F to 75°F suitable water temperature range for largemouth bass spawning during March through June was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced spawning success. Kelley (1968) found no difference in incubation survival of largemouth bass eggs in the temperature range of 55°F to 75°F. This would seem to make it unlikely that there would be reduced spawning success because of low temperatures. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

In the Sacramento River upstream of Red Bluff, the percentage of months under A1A_LLT outside the range would be lower than the percentage under Existing Conditions in all water years (Table 11-1A-92). Although numbers are small as indicated by screw trap catches at Red Bluff Diversion Dam where 185 largemouth bass were caught out of a total of 857,727 total fish caught (Gaines and Martin 2001).

Trinity River below Lewiston Reservoir, the percentage of months under A1A_LLT outside the range would be similar to or lower than the percentage under Existing Conditions in all water year types (Table 11-1A-92). Largemouth bass were not found in Trinity River screw trap data (Pinnix et al. 2010), but are apparently found in low numbers when washed down from upstream reservoirs (U.S. Fish and Wildlife Service and Hoopa Valley Tribe 1999).

In the Feather River below Thermalito Afterbay, the percentage of months under A1A_LLT outside the range would be lower than the percentage under Existing Conditions in all water years except critical years (8% higher) (Table 11-1A-92).

In the American River below Nimbus Dam, the percentage of months under A1A_LLT outside of the 59°F to 75°F water temperature range would be lower than the percentage under Existing Conditions in all water years (Table 11-1A-92).

In the Stanislaus River below New Melones Dam, the percentage of months under A1A_LLT outside the range would be similar to or lower than the percentage under Existing Conditions in all water year types (Table 11-1A-92).

Sacramento Tule Perch

In general, Alternative 1A would not affect the quality and quantity of upstream habitat conditions for Sacramento tule perch relative to the NAA.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during year-round Sacramento tule perch presence. Lower flows could reduce the quantity and quality of instream habitat available for rearing. Sacramento tule perch are well adapted to high and low flows of the natural hydrograph in California streams (Baltz and Moyle 1982). It is unlikely that flows going up or down 10 percent or more would have a great impact on this species as it is well adapted to the wet winters and dry summers of the natural California climate. Also, Sacramento tule perch are a deep-bodied and laterally compressed fish, which is a body form not conducive to maintaining position in high velocity current without great effort (Cech et al. 1990). Unless lower flows increase high velocity habitat there is likely to be no effect on Sacramento tule perch, which prefer lower velocity high oxygenated habitats (Moyle and Baltz 1985).

Upstream of Red Bluff, Sacramento River flows under A1A_LLT in August, September, and November would be lower than flows under NAA (up to 44% lower), and generally similar to or greater than flows during the rest of the year, with some exceptions (up to 11% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Numbers as indicated by screw trap catches at Red Bluff Diversion Dam are small where 77 tule perch were caught out of a total of 857,727 total fish caught (Gaines and Martin 2001).

Sacramento tule perch are not found in the Trinity River (Pinnix et al. 2010), or within the Klamath Province (Moyle 2002).

In Clear Creek at Whiskeytown Dam, flows under A1A_LLT would generally be similar to or greater than NAA throughout the year, except in critical years during June and September (8% and 13% lower, respectively) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Numbers of Sacramento tule perch caught in screw traps are low with an average of less than 2 caught over an 8-year period (Gaines and Martin 2001; Greenwald et al. 2003; Earley et al. 2008a, 2008b, 2009, 2010).

In the Feather River at Thermalito Afterbay, flows under A1A_LLT would generally be greater than those under NAA during October through June (up to 219% greater) and lower during July through September (up to 86% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

In the American River at Nimbus Dam, flows under A1A_LLT would generally be greater than flows under NAA during May, June, and October (up to 37% greater), generally lower during July through September (up to 47% lower), and generally similar during the remaining months (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

Flow rates in the San Joaquin and Stanislaus rivers would be the same as described above for covered fish species under Alternative 1A (see Impacts AQUA-76 through 78 under Chinook salmon fall-/late-fall run ESU). That analysis indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months exceeding water temperature thresholds of 72°F and 75°F for the year-round occurrence of all life stages of Sacramento tule perch was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures exceeding these thresholds could lead to reduced rearing habitat quantity and quality and increased stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

In the Sacramento River upstream of Red Bluff, the percentage of months under A1A_LLT above the 72°F threshold would be similar to the percentage under NAA in all water years except critical years (16% higher) (Table 11-1A-93). These relative differences, however, represent very low percentages of years (<1%). Therefore, these differences would not be biologically meaningful to Sacramento tule perch. Numbers as indicated by screw trap catches at Red Bluff Diversion Dam are small where 77 Sacramento tule perch were caught out of a total of 857,727 total fish caught (Gaines and Martin 2001).

Sacramento tule perch are not found in Trinity River screw trap data (Pinnix et al. 2010), or within the Klamath Province (Moyle 2002).

In the Feather River below Thermalito Afterbay, the percentage of months under A1A_LLT above the 72°F threshold would be higher than the percentage under NAA in all water year types (up to 700% higher) (Table 11-1A-93).

In the American River below Nimbus Dam, the percentage of months under A1A_LLT above the 72°F threshold would be higher than the percentage under NAA in almost all water year types (up to

150% higher) (Table 11-1A-93). These relative differences, however, represent very low percentages of years (<3%). Therefore, these differences would not be biologically meaningful to Sacramento tule perch.

In the Stanislaus River below New Melones Dam, the percentage of months under A1A_LLT above the 72°F threshold would be similar to the percentage under NAA in all water year types (Table 11-1A-93).

Table 11-1A-93. Difference and Percent Difference in the Percentage of Months in Which Year-Round Water Temperatures Exceed 72°F and 75°F Water Temperature Thresholds for Sacramento Tule Perch Occurrence[a]

Location	Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
72°F Threshold			
Sacramento River upstream of Red Bluff	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	3 (NA)	1 (16%)
	All	1 (NA)	0.1 (16%)
Trinity River below Lewiston Reservoir	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	3 (NA)	1 (25%)
	All	0 (NA)	0.1 (25%)
Feather River below Thermalito Afterbay	Wet	6 (257%)	6 (76%)
	Above Normal	5 (NA)	5 (86%)
	Below Normal	11 (NA)	8 (72%)
	Dry	12 (NA)	6 (56%)
	Critical	14 (333%)	3 (19%)
	All	9 (677%)	6 (56%)
American River below Nimbus Dam	Wet	2 (NA)	0.3 (17%)
	Above Normal	2 (NA)	1 (33%)
	Below Normal	3 (NA)	-1 (-20%)
	Dry	10 (NA)	3 (32%)
	Critical	20 (414%)	1 (3%)
	All	7 (929%)	1 (13%)
Stanislaus River below New Melones Dam	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)

Location	Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
75°F Threshold			
Sacramento River upstream of Red Bluff	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	-0.1 (-500%)
	All	0 (NA)	-0.02 (-500%)
Trinity River below Lewiston Reservoir	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
Feather River below Thermalito Afterbay	Wet	1 (NA)	1 (100%)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	2 (NA)	2 (100%)
	Dry	3 (NA)	2 (67%)
	Critical	6 (900%)	0 (0%)
	All	2 (2,000%)	1 (43%)
American River below Nimbus Dam	Wet	1 (NA)	-0.3 (-50%)
	Above Normal	1 (NA)	1 (100%)
	Below Normal	1 (NA)	1 (100%)
	Dry	4 (NA)	2 (63%)
	Critical	12 (850%)	1 (5%)
	All	3 (1,450%)	1 (23%)
Stanislaus River below New Melones Dam	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.

[a] A negative value indicates a benefit (reduction in percentage of months outside suitable range) of the alternative.

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because Alternative 1A would not cause a substantial reduction in rearing habitat. Flows under Alternative 1A in all rivers examined throughout the year are generally similar to or greater than flows under the NAA, except during summer months in the Feather River and half the year in the American River. These reductions in flows, however, would not result in an overall biologically meaningful effect on Sacramento tule perch. The percentages of years outside all temperature thresholds under Alternative 1A are generally similar to the percentages under the NAA. Some increases in percentage of years outside temperature ranges under Alternative 1A would occur, but they would generally be small (<5% on an absolute scale) and would not affect Sacramento tule perch habitat at a population level.

CEQA Conclusion: In general, Alternative 1A would not reduce the quality and quantity of upstream habitat conditions for Sacramento tule perch relative to Existing Conditions.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during year-round Sacramento tule perch presence. Lower flows could reduce the quantity and quality of instream habitat available for rearing. Sacramento tule perch are well adapted to high and low flows of the natural hydrograph in California streams (Baltz and Moyle 1982). It is unlikely that flows going up or down 10 percent or more would have a great impact on this species as it is well adapted to the wet winters and dry summers of the natural California climate. Also, Sacramento tule perch are a deep-bodied and laterally compressed fish, a body form not conducive for maintaining position in high velocity current area without great effort (Cech et al. 1990). Unless lower flows increase high velocity habitat there is likely to be no effect on Sacramento tule perch, which prefer lower velocity high oxygenated habitats (Moyle and Baltz 1985).

In the Sacramento River upstream of Red Bluff, flows under A1A_LLT would generally be similar to or greater than flows under Existing Conditions during all months but July through September and November, except in wet years during May (14% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows under A1A_LLT during July through September and November would be lower than flows under Existing Conditions (up to 24% lower). Numbers as indicated by screw trap catches at Red Bluff Diversion Dam are small where 77 tule perch were caught out of a total of 857,727 total fish caught (Gaines and Martin 2001).

Sacramento tule perch are not found in Trinity River screw trap data (Pinnix et al. 2010), or within the Klamath Province (Moyle 2002).

In Clear Creek at Whiskeytown Dam, flows under A1A_LLT would generally be similar to or greater than flows under Existing Conditions throughout the year, except in critical years during August and September (17% and 38% lower, respectively) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Numbers of Sacramento tule perch caught in screw traps are low with an average of less than 2 tule perch caught over an 8-year period (Gaines and Martin 2001; Greenwald et al. 2003; Earley et al. 2008a, 2008b, 2009, 2010).

In the Feather River at Thermalito Afterbay, flows under A1A_LLT would generally be greater than those under Existing Conditions during February through June, October, and December (up to 204% greater), lower during July through September (up to 56% lower), and similar during November and January (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

In the American River at Nimbus Dam, flows under A1A_LLT would generally greater than flows under Existing Conditions during February, March, and October (up to 42% greater), lower during January, May, July through September, and November through December (up to 53% lower), and generally similar during the rest of the year (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

Flow rates in the San Joaquin and Stanislaus rivers would be the same as described above for covered fish species under Alternative 1A (see Impacts AQUA-76 through 78 under Chinook salmon fall-/late-fall run ESU). That analysis indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months exceeding water temperatures of 72°F and 75°F for the year-round occurrence of all life stages of Sacramento tule perch was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures exceeding these thresholds could lead to reduced rearing habitat quality and increased stress and mortality. Water temperatures were not modeled in Clear Creek or the San Joaquin River.

In the Sacramento River upstream of Red Bluff, the percentage of months under A1A_LLT above the 72°F threshold would be similar to the percentage under Existing Conditions in all water years (Table 11-1A-93). Numbers as indicated by screw trap catches at Red Bluff Diversion Dam are small where 77 tule perch were caught out of a total of 857,727 total fish caught (Gaines and Martin 2001).

Sacramento tule perch are not found in Trinity River screw trap data (Pinnix et al. 2010), or within the Klamath Province (Moyle 2002).

In the Feather River below Thermalito Afterbay, the percentage of months under A1A_LLT above the 72°F threshold would be similar to or higher than the percentage under Existing Conditions in all water year types (up to 333% higher) (Table 11-1A-93).

In the American River below Nimbus Dam, the percentage of months under A1A_LLT above the 72°F threshold would be similar to or higher than the percentage under Existing Conditions in almost all water year types (up to 414% higher) (Table 11-1A-93). The relative differences predicted in wet, above normal, and below normal years, however, represent low percentages of years (<3%). Therefore, these differences would not be biologically meaningful to Sacramento tule perch.

In the Stanislaus River below New Melones Dam, the percentage of months under A1A_LLT above the 72°F threshold would be similar to the percentage under Existing Conditions in all water year types (Table 11-1A-93).

Collectively, the results of the Impact AQUA-202 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 1A could be significant because the alternative could substantially reduce the amount of suitable habitat, contrary to the NEPA conclusion set forth above. There would be small to moderate flow-related effects and temperature-related effects of Alternative 1A on Sacramento tule perch in the American and Feather rivers. Flow reductions and increases in exceedances above temperature thresholds would have a biologically meaningful effect on the population. This impact is a result of the specific reservoir operations and resulting flows associated with this alternative. These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 1A does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 1A indicates that flows in the locations and during the months analyzed above would generally be similar between future conditions without BDCP and Alternative 1A. This indicates that the differences between Existing Conditions and Alternative 1A found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 1A, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on rearing habitat for Sacramento tule perch. This impact is found to be less than significant and no mitigation is required.

The NEPA and CEQA conclusions differ for this impact statement because they were determined using two unique baselines. The NEPA conclusion was based on the comparison of A1A_LLT with NAA and the CEQA conclusion was based on the comparison of A1A_LLT with Existing Conditions. These baselines differ in two ways. First, the NAA includes the Fall X2 standard in wet above normal water years whereas Existing Conditions do not. Second, the NAA is assumed to occur during the late long-term implementation period whereas the CEQA baseline is assumed to occur during existing climate conditions. Therefore, differences in model outputs between the CEQA baseline and the Alternative 1A are due to both the alternative and future climate change.

Sacramento-San Joaquin Roach

In general, Alternative 1A would not affect the quality and quantity of upstream habitat conditions for Sacramento-San Joaquin Roach relative to the NAA.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the March through June Sacramento-San Joaquin roach spawning period. Lower flows might reduce the quantity and quality of instream habitat available for spawning. In a study of roach over a whole season Moyle and Baltz (1985) found them in habitats with flows averaging 0.2 m/s but ranging from 0.025m/s to 0.38 m/s. Roach are typically considered a foothill stream species and it is unlikely that their population numbers are dependent on the Sacramento River and large tributaries (Moyle 2002).

In the Sacramento River upstream of Red Bluff, flows under A1A_LLT would generally be similar to or greater than flows under NAA during March through June (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Numbers as indicated by screw trap catches at Red Bluff Diversion Dam are small where 275 Sacramento-San Joaquin roach were caught out of a total of 857,727 total fish caught (Gaines and Martin 2001).

Sacramento-San Joaquin roach are not found in Trinity River screw trap data (Pinnix et al. 2010), or within the Klamath Province (Moyle 2002).

In Clear Creek at Whiskeytown Dam, flows under A1A_LLT would generally be similar to or greater than flows under NAA during March through June, except in critical years during June (8% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Numbers of Sacramento-San Joaquin roach caught in screw traps are low with an average of less than 45 caught over a 9-year period (Gaines and Martin 2001; Greenwald et al. 2003; Earley et al. 2008a, 2008b, 2009, 2010).

In the Feather River at Thermalito Afterbay, flows under A1A_LLT would be substantially greater (up to 219% greater) than flows under NAA during March through June (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

In the American River at Nimbus Dam, flows under A1A_LLT would generally be similar to or greater than flows under NAA throughout the period, except in dry and critical years during March (9% and 8% lower, respectively) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

Flow rates in the San Joaquin and Stanislaus rivers would be the same as described above for covered fish species under Alternative 1A (see Impacts AQUA-76 through 78 under Chinook salmon fall-/late-fall run ESU). That analysis indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months below the 60.8°F water temperature threshold for Sacramento-San Joaquin roach spawning initiation during March through June was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures below this threshold could delay or prevent spawning initiation. Water temperatures were not modeled in the San Joaquin River or Clear Creek. The Sacramento River and its large tributaries are most likely not the primary habitat of Sacramento-San Joaquin roach. It is more likely that they are washed into these bigger streams from smaller tributaries which would likely be warmer than the below dam releases that are made for salmonid fishes.

In the Sacramento River upstream of Red Bluff, the percentage of months under A1A_LLT outside the range would be lower than the percentage under NAA in all water year types (Table 11-1A-94). Numbers as indicated by screw trap catches at Red Bluff Diversion Dam are small where 275 Sacramento-San Joaquin roach were caught out of a total of 857,727 total fish caught (Gaines and Martin 2001).

Sacramento-San Joaquin roach are not found in Trinity River screw trap data (Pinnix et al. 2010), or within the Klamath Province (Moyle 2002).

In the Feather River below Thermalito Afterbay, the percentage of months under A1A_LLT outside the range would be similar to or lower than the percentage under NAA in all water year types except below normal years (7% higher) (Table 11-1A-94).

In the American River below Nimbus Dam, the percentage of months under A1A_LLT below the 60.8°F water temperature threshold would be similar to or lower than the percentage under NAA in all water year types (Table 11-1A-94).

In the Stanislaus River below New Melones Dam, the percentage of months under A1A_LLT outside the range would be similar to the percentage under NAA in all water year types (Table 11-1A-94).

Table 11-1A-94. Difference and Percent Difference in the Percentage of Months during March–June in Which Water Temperatures Fall below the 60.8°F Water Temperature Threshold Range for the Initiation of Sacramento-San Joaquin Roach Spawning[a]

Location	Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Sacramento River upstream of Red Bluff	Wet	-5 (-5%)	2 (3%)
	Above Normal	-3 (-3%)	4 (4%)
	Below Normal	-8 (-8%)	-1 (-1%)
	Dry	-3 (-3%)	2 (2%)
	Critical	-10 (-10%)	-1 (-1%)
	All	-5 (-5%)	1 (1%)
Trinity River below Lewiston Reservoir	Wet	0 (0%)	0 (0%)
	Above Normal	-2 (-2%)	0 (0%)
	Below Normal	-2 (-2%)	0 (0%)
	Dry	-3 (-3%)	0 (0%)
	Critical	-8 (-8%)	0 (0%)
	All	-2 (-2%)	0 (0%)
Feather River below Thermalito Afterbay	Wet	-13 (-19%)	0 (0%)
	Above Normal	-7 (-13%)	0 (0%)
	Below Normal	-2 (-4%)	4 (7%)
	Dry	-13 (-23%)	-1 (-3%)
	Critical	-19 (-33%)	-4 (-11%)
	All	-11 (-19%)	0 (-1%)
American River below Nimbus Dam	Wet	-22 (-32%)	0 (0%)
	Above Normal	-20 (-33%)	0 (0%)
	Below Normal	-23 (-36%)	0 (0%)
	Dry	-18 (-36%)	1 (4%)
	Critical	-15 (-30%)	0 (0%)
	All	-20 (-34%)	0.3 (1%)
Stanislaus River below New Melones Dam	Wet	0 (0%)	0 (0%)
	Above Normal	0 (0%)	0 (0%)
	Below Normal	0 (0%)	0 (0%)
	Dry	0 (0%)	0 (0%)
	Critical	0 (0%)	0 (0%)
	All	0 (0%)	0 (0%)

[a] A negative value indicates a benefit (reduction in percentage of months outside suitable range) of the alternative.

CEQA Conclusion: In general, Alternative 1A would reduce the quality and quantity of upstream habitat relative to Existing Conditions, although these mainstem river changes are not likely affect Sacramento-San Joaquin roach, which occur primarily in tributary areas.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the March through June Sacramento-San Joaquin roach spawning period. Lower flows could reduce the quantity and quality of instream habitat available for spawning. In a study of roach over a whole season Moyle and Baltz (1985) found them in habitats with flows averaging 0.2 m/s but ranging from 0.025m/s to 0.38 m/s. Roach are typically considered a foothill stream species and it is unlikely that their population numbers are dependent on the Sacramento River and large tributaries (Moyle 2002).

In the Sacramento River upstream of Red Bluff, flows under A1A_LLT would generally be similar to or greater than flows under Existing Conditions during March through June, except in wet years during May (14% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Numbers as indicated by screw trap catches at Red Bluff Diversion Dam are small where 275 Sacramento-San Joaquin roach were caught out of a total of 857,727 total fish caught (Gaines and Martin 2001).

Sacramento-San Joaquin roach are not found in Trinity River screw trap data (Pinnix et al. 2010), or within the Klamath Province (Moyle 2002).

In Clear Creek at Whiskeytown Dam, flows under A1A_LLT would always be similar to or greater than flows under Existing Conditions during March through June (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Numbers of Sacramento-San Joaquin roach caught in screw traps are low with an average of less than 45 caught over a 9-year period (Gaines and Martin 2001; Greenwald et al. 2003; Earley et al. 2008a, 2008b, 2009, 2010).

In the Feather River at Thermalito Afterbay, flows under A1A_LLT would generally be substantially greater (up to 204% greater) than flows under Existing Conditions during March through June, except in below normal years during March (31% lower) and wet years during May (28% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

In the American River at Nimbus Dam, flows under A1A_LLT would generally be similar to or greater than flows under Existing Conditions during March, April, and June, except in critical years during March and June (8% and 31% lower, respectively), above normal years during April (6% lower) and wet years during June (24% lower). Flows under A1A_LLT in May would generally be up to 24% lower than those under Existing Conditions (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

Flow rates in the San Joaquin and Stanislaus rivers would be the same as described above for covered fish species under Alternative 1A (see Impacts AQUA-76 through 78 under Chinook salmon fall-/late-fall run ESU). That analysis indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months below the 60.8°F water temperature threshold for Sacramento-San Joaquin roach spawning initiation during March through June was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures below this threshold could delay spawning initiation. Water temperatures were not modeled in the San Joaquin River or Clear Creek. The Sacramento River and its large tributaries are most likely not the primary habitat of Sacramento-San Joaquin roach. It is more likely that they are washed into these bigger streams from smaller tributaries which would likely be warmer than the below dam releases that are made for salmonid fishes.

In the Sacramento River upstream of Red Bluff, the percentage of months under A1A_LLT below the threshold would be lower than the percentage under Existing Conditions in all water years (Table

11-1A-94). Numbers as indicated by screw trap catches at Red Bluff Diversion Dam are small where 275 Sacramento-San Joaquin roach were caught out of a total of 857,727 total fish caught (Gaines and Martin 2001).

Sacramento-San Joaquin roach are not found in Trinity River screw trap data (Pinnix et al. 2010), or within the Klamath Province (Moyle 2002).

In the Feather River below Thermalito Afterbay, the percentage of months under A1A_LLT below the threshold would be lower than the percentage under Existing Conditions in all water year types (Table 11-1A-94).

In the American River below Nimbus Dam, the percentage of months under A1A_LLT below the threshold would be lower than the percentage under Existing Conditions in all water years (Table 11-1A-94).

In the Stanislaus River below New Melones Dam, the percentage of months under A1A_LLT below the threshold would be similar to the percentage under Existing Conditions in all water year types (Table 11-1A-94).

Hardhead

In general, Alternative 1A would not affect the quality and quantity of upstream habitat conditions for hardhead relative to the NAA.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the April through May hardhead spawning period. Lower flows could reduce the quantity and quality of instream habitat available for spawning.

In the Sacramento River upstream of Red Bluff, flows under A1A_LLT would generally be similar to or greater than flows under NAA throughout the period (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

Hardhead are not found in Trinity River screw trap data (Pinnix et al. 2010), or within the Klamath Province (Moyle 2002).

In Clear Creek at Whiskeytown Dam, flows under A1A_LLT would always to be similar to flows under NAA throughout the period regardless of water year type (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

In the Feather River at Thermalito Afterbay, flows under A1A_LLT would generally be substantially greater (up to 219% greater) than flows under NAA throughout the period (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

In the American River at Nimbus Dam, flows under A1A_LLT would be similar to or greater than flows under NAA during April. During May, flows under A1A_LLT would generally be greater than flows under NAA (up to 28% greater) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

Flow rates in the San Joaquin and Stanislaus rivers would be the same as described above for covered fish species under Alternative 1A (see AQUA-76, -77, and -78 under Chinook salmon fall-

/late-fall run ESU). That analysis indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months outside of the 59°F to 64°F suitable water temperature range for hardhead spawning during April through May was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced spawning success and increased egg and larval stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

In the Sacramento River upstream of Red Bluff, the percentage of months under A1A_LLT outside the range would be similar to or lower than the percentage under NAA in all water year except wet and dry years (5% and 9% higher, respectively) (Table 11-1A-95).

Hardhead are not found in Trinity River screw trap data (Pinnix et al. 2010), or within the Klamath Province (Moyle 2002).

In the Feather River below Thermalito Afterbay, the percentage of months under A1A_LLT outside the range would be lower than the percentage under NAA in all water year (Table 11-1A-95).

In the American River below Nimbus Dam, the percentage of months under A1A_LLT outside the 59°F to 75°F water temperature range would be similar to or lower than the percentage under NAA in all water years except critical years (6% higher) (Table 11-1A-95).

In the Stanislaus River below New Melones Dam, the percentage of months under A1A_LLT outside the range would be similar to the percentage under NAA in all water year types (Table 11-1A-95).

Table 11-1A-95. Difference and Percent Difference in the Percentage of Months during April–May in Which Water Temperatures Are outside the 59°F to 64°F Water Temperature Range for Hardhead Spawning[a]

Location	Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Sacramento River upstream of Red Bluff	Wet	-10 (-11%)	4 (5%)
	Above Normal	-13 (-14%)	2 (2%)
	Below Normal	-15 (-16%)	0.5 (1%)
	Dry	-6 (-6%)	8 (9%)
	Critical	-15 (-16%)	0 (0%)
	All	-11 (-12%)	3 (4%)
Trinity River below Lewiston Reservoir	Wet	0 (0%)	0 (0%)
	Above Normal	0 (0%)	0 (0%)
	Below Normal	0 (0%)	0 (0%)
	Dry	0 (0%)	0 (0%)
	Critical	0 (0%)	0 (0%)
	All	0 (0%)	0 (0%)
Feather River below Thermalito Afterbay	Wet	-6 (-9%)	-8 (-14%)
	Above Normal	-27 (-43%)	-18 (-50%)
	Below Normal	4 (8%)	-18 (-38%)
	Dry	-8 (-15%)	-3 (-6%)
	Critical	-8 (-15%)	-8 (-18%)
	All	-8 (-14%)	-10 (-21%)
American River below Nimbus Dam	Wet	-27 (-37%)	-4 (-8%)
	Above Normal	18 (40%)	0 (0%)
	Below Normal	4 (7%)	-4 (-7%)
	Dry	14 (29%)	-3 (-5%)
	Critical	38 (100%)	4 (6%)
	All	3 (6%)	-2 (-3%)
Stanislaus River below New Melones Dam	Wet	0 (0%)	0 (0%)
	Above Normal	0 (0%)	0 (0%)
	Below Normal	0 (0%)	0 (0%)
	Dry	0 (0%)	0 (0%)
	Critical	0 (0%)	0 (0%)
	All	0 (0%)	0 (0%)

[a] A negative value indicates a benefit (reduction in percentage of months outside suitable range) of the alternative.

CEQA Conclusion: In general, Alternative 1A would reduce the quality and quantity of upstream habitat conditions for hardhead relative to Existing Conditions.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the April through May hardhead spawning period. Lower flows could reduce the quantity and quality of instream habitat available for spawning.

In the Sacramento River upstream of Red Bluff, flows under A1A_LLT would generally be similar to or greater than flows under Existing Conditions throughout the period, except in wet years during May (14% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

Hardhead are not found in Trinity River screw trap data (Pinnix et al. 2010), or within the Klamath Province (Moyle 2002).

In Clear Creek at Whiskeytown Dam, flows under A1A_LLT would always be similar to or greater than flows under Existing Conditions throughout the period (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

In the Feather River at Thermalito Afterbay, flows under A1A_LLT would generally be similar to or greater than flows under Existing Conditions throughout the period, except in wet years during May (28% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

In the American River at Nimbus Dam, flows under A1A_LLT would be similar to or greater than flows under Existing Conditions during April except in above normal years (6% lower) and generally up to 24% lower than flows under Existing Conditions during May (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

Flow rates in the San Joaquin and Stanislaus rivers would be the same as described above for covered fish species under Alternative 1A (see Impacts AQUA-76 through 78 under Chinook salmon fall-/late-fall run ESU). That analysis indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months outside of the 59°F to 64°F suitable water temperature range for hardhead spawning during April through May was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced spawning success and increased egg and larval stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

In the Sacramento River upstream of Red Bluff, the percentage of months under A1A_LLT below the threshold would be lower than the percentage under Existing Conditions in all water years (Table 11-1A-95).

Hardhead are not found in Trinity River screw trap data (Pinnix et al. 2010), or within the Klamath Province (Moyle 2002).

In the Feather River below Thermalito Afterbay, the percentage of months under A1A_LLT below the threshold would be lower than the percentage under Existing Conditions in all water years except below normal years (8% higher) (Table 11-1A-95).

In the American River below Nimbus Dam, the percentage of months under A1A_LLT below the threshold would be higher than the percentage under Existing Conditions in almost all water years (up to 100% higher) (Table 11-1A-95).

In the Stanislaus River below New Melones Dam, the percentage of months under A1A_LLT below the threshold would be similar to the percentage under Existing Conditions in all water year types (Table 11-1A-99).

California Bay Shrimp

NEPA Effects: For California bay shrimp the overall flows and temperature within the estuary would be neutral or slightly improved with respect to spawning. These conditions would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of water operations on spawning conditions for California bay shrimp would not be significant and no mitigation is required.

Impact AQUA-203: Effects of Water Operations on Rearing Habitat of Non-Covered Aquatic Species of Primary Management Concern

Refer to Impact AQUA-5 under delta smelt and Impact AQUA-41 under Chinook salmon for a discussion of the effects of water operations on rearing habitat of non-covered species of primary management concern. Although there are minor differences the effects are similar. Although Delta smelt and Chinook salmon are used for the purpose of comparing changes in flow and temperature it is recognized that non-covered species may use habitat differently and may respond differently to these changes. The conclusion from these comparisons for AQUA-5 and AQUA-41 of adverse from comparisons with Delta smelt and Chinook salmon are likely not adverse for non-covered species because of range, different uses of habitat, and differing temperature tolerance.

Striped Bass

NEPA Effects: Refer to Impact AQUA-5 under delta smelt and Impact AQUA-41 under Chinook salmon for a discussion of the effects of water operations on rearing habitat for striped bass. The potential effects would be similar to those described there. The effects would not be adverse.

CEQA Conclusion: As described above the impacts on striped bass rearing habitat would be less than significant.

American Shad

NEPA Effects: Refer to Impact AQUA-5 under delta smelt and Impact AQUA-41 under Chinook salmon for a discussion of the effects of water operations on rearing habitat for American shad. The potential effects would be similar to those described there. The effects would not be adverse.

CEQA Conclusion: As described above the impacts on American shad rearing habitat would be less than significant.

Threadfin Shad

NEPA Effects: Refer to Impact AQUA-5 under delta smelt and Impact AQUA-41 under Chinook salmon for a discussion of the effects of water operations on rearing habitat for threadfin shad. The potential effects would be similar to those described there. The effects would not be adverse.

CEQA Conclusion: As described above the impacts on threadfin shad rearing habitat would be less than significant.

Largemouth Bass

Juveniles

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the April through November juvenile largemouth bass rearing period. Lower flows could reduce the quantity and quality of instream habitat (backwaters) available for juvenile rearing.

In the Sacramento River upstream of Red Bluff, flows under A1A_LLT would generally be similar to or greater than flows under NAA during April through July and October, with some exceptions (up to 14% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows under A1A_LLT during August, September, November, and July would be lower, by up to 42%, than NAA depending on month, water year type, and time period.

In the Trinity River below Lewiston Reservoir, flows under A1A_LLT would generally be similar to or greater than flows under NAA during the April through November period with some exceptions (up to 42% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Largemouth bass were not found in Trinity River screw trap data (Pinnix et al. 2010), but are apparently found in low numbers when washed down from upstream reservoirs (U.S. Fish and Wildlife Service and Hoopa Valley Tribe 1999).

In Clear Creek at Whiskeytown Dam, flows under A1A_LLT would generally be similar to or greater than NAA throughout the year, except in critical years during June and September (8% and 13% lower, respectively) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

In the Feather River at Thermalito Afterbay, flows under A1A_LLT would generally be lower than those under NAA during July through September (up to 86% lower) and generally greater during April through June and October through November (up to 219% greater), with some exceptions (up to 28% lower, respectively) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

In the American River at Nimbus Dam, flows under A1A_LLT would generally be lower than flows under NAA during July through September (up to 47% lower), greater during May, June, and October (up to 36% greater), and similar during April and November, with some exceptions (up to 17% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

Flow rates in the San Joaquin and Stanislaus rivers would be the same as described above for covered fish species under Alternative 1A (see Impacts AQUA-76 through 78 under Chinook salmon fall-/late-fall run ESU). That analysis indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months above the 88°F water temperature threshold for juvenile largemouth bass rearing during April through November was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Elevated water temperatures could lead to reduced quantity and quality of instream habitat available for juvenile rearing and increased stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures would not exceed 88°F under NAA or A1A_LLT in any of the rivers examined (Table 11-1A-96). As a result, there would be no difference in the percentage of months in which the 88°F water temperature threshold is exceeded between Alternative 1A and the NAA.

Table 11-1A-96. Difference and Percent Difference in the Percentage of Months during April–November in Which Water Temperatures Exceed the 88°F Water Temperature Threshold for Juvenile Largemouth Bass Rearing[a]

Location	Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Sacramento River upstream of Red Bluff	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
Trinity River below Lewiston Reservoir	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
Feather River below Thermalito Afterbay	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
American River below Nimbus Dam	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
Stanislaus River below New Melones Dam	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.

[a] A negative value indicates a benefit (reduction in percentage of months outside suitable range) of the alternative.

Adults

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during year-round adult largemouth bass rearing period. Lower flows could reduce the quantity and quality of instream habitat available for adult rearing.

In the Sacramento River upstream of Red Bluff, flows under A1A_LLT during August, September, and November would be lower than flows under NAA (up to 44% lower), and generally similar to or greater than flows under NAA during the rest of the year, with some exceptions (up to 11% lower). (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

In the Trinity River below Lewiston Reservoir, flows under A1A_LLT would generally be similar to or greater than flows under NAA with some exceptions (up to 11% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Largemouth bass were not found in Trinity River screw trap data (Pinnix et al. 2010), but are apparently found in low numbers when washed down from upstream reservoirs (U.S. Fish and Wildlife Service and Hoopa Valley Tribe 1999).

In Clear Creek at Whiskeytown Dam, flows under A1A_LLT would generally be similar to or greater than NAA throughout the year, except in critical years during June and September (8% and 13% lower, respectively) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

In the Feather River at Thermalito Afterbay, flows under A1A_LLT would generally be greater than those under NAA during October through June (up to 219% greater) and lower during July through September (up to 86% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

In the American River at Nimbus Dam, flows under A1A_LLT would generally be greater than flows under NAA during May, June, and October (up to 37% greater), generally lower during July through September (up to 47% lower), and generally similar during the remaining months (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

Flow rates in the San Joaquin and Stanislaus rivers would be the same as described above for covered fish species under Alternative 1A (see Impacts AQUA-76 through 78 under Chinook salmon fall-/late-fall run ESU). That analysis indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months above the 86°F water temperature threshold for year-round adult largemouth bass rearing period was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Elevated water temperatures could lead to reduced quantity and quality of adult rearing habitat and increased stress and mortality of rearing adults. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures would not exceed 88°F under NAA or A1A_LLT in any of the waterways examined (Table 11-1A-97). As a result, there would be no difference in the percentage of months in which the 86°F water temperature threshold is exceeded between Alternative 1A and the NAA.

Table 11-1A-97. Difference and Percent Difference in the Percentage of Months in Which Year-Round Water Temperatures Exceed the 86°F Water Temperature Threshold for Adult Largemouth Bass Survival[a]

Location	Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Sacramento River upstream of Red Bluff	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
Trinity River below Lewiston Reservoir	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
Feather River below Thermalito Afterbay	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
American River below Nimbus Dam	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
Stanislaus River below New Melones Dam	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.

[a] A negative value indicates a benefit (reduction in percentage of months outside suitable range) of the alternative.

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because Alternative 1A would not cause a substantial reduction in juvenile and adult rearing or spawning habitat. Flows in all rivers examined during the year under Alternative 1A are generally similar to or greater than flows under the NAA in most months. Flows in July through September are generally lower in the Feather River high flow channel and in the American River below Nimbus Dam, although these reductions would not be biologically meaningful to the largemouth bass population due to the high mobility and diverse distribution of largemouth bass in the Central Valley. The percentage of months outside all temperature thresholds in all locations examined under Alternative 1A are generally similar to or lower than under the NAA.

CEQA Conclusion: In general, Alternative 1A would reduce the quality and quantity of upstream habitat conditions for largemouth bass relative to Existing Conditions.

Juveniles

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the April through November juvenile largemouth bass rearing period. Lower flows could reduce the quantity and quality of instream habitat available for juvenile rearing.

In the Sacramento River upstream of Red Bluff, flows under A1A_LLT would generally be similar to or greater than flows under Existing Conditions in all months but July through September and November with some exceptions (up to 14% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows during July through September and November under A1A_LLT would be up to 24% lower than flows under Existing Conditions.

In the Trinity River below Lewiston Reservoir, flows under A1A_LLT during April through November would generally be similar to or greater than flows under Existing Conditions throughout the period with some exceptions (up to 42% lower), except during October and November (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows under A1A_LLT during October and November would be up to 25% lower than flows under Existing Conditions. Largemouth bass were not found in Trinity River screw trap data (Pinnix et al. 2010), but are apparently found in low numbers when washed down from upstream reservoirs (USFWS and Hoopa Valley Tribe 1999).

In Clear Creek at Whiskeytown Dam, flows under A1A_LLT would generally be similar to or greater than flows under Existing Conditions throughout the April through November period, except in critical years during August and September (17% to 38% lower, respectively) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

In the Feather River at Thermalito Afterbay, flows under A1A_LLT would generally be greater (up to 204% greater) than flows under Existing Conditions during April through June and October, lower (up to 56% lower) during July through September, and similar during November (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

In the American River at Nimbus Dam, flows under A1A_LLT would generally be similar to or greater than flows under Existing Conditions during April, June, and October, with some exceptions (up to 31% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows under A1A_LLT during the rest of the period would be lower by up to 53% and.

Flow rates in the San Joaquin and Stanislaus rivers would be the same as described above for covered fish species under Alternative 1A (see Impacts AQUA-76 through 78 under Chinook salmon fall-/late-fall run ESU). That analysis indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months above the 88°F water temperature threshold for juvenile largemouth bass rearing during April through November was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Elevated water temperatures could lead to reduced quantity and quality of instream habitat available for juvenile rearing and increased stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

The analysis indicates that there would be no temperature-related effects in in the Sacramento, Trinity, American, and Stanislaus rivers during the April through November period. Water temperatures would not exceed 88°F under Existing Conditions or A1A_LLT in all waterways examined (Table 11-1A-97). As a result, there would be no difference in the percentage of months in which the 88°F water temperature threshold is exceeded between Alternative 1A and Existing Conditions.

Adults

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the year-round adult largemouth bass rearing period. Lower flows could reduce the quantity and quality of instream habitat available for adult rearing.

In the Sacramento River upstream of Red Bluff, flows under A1A_LLT would generally be similar to or greater than flows under Existing Conditions during all months but July through September and November, except in wet years during May (14% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows under A1A_LLT during July through September and November would be lower than flows under Existing Conditions (up to 24% lower).

In the Trinity River below Lewiston Reservoir, flows under A1A_LLT would generally be similar to or greater than flows under Existing Conditions throughout the year with some exceptions (up to 42% lower), except during October through December when it would generally be lower (up to 25% lower during both months) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Largemouth bass were not found in Trinity River screw trap data (Pinnix et al. 2010), but are apparently found in low numbers when washed down from upstream reservoirs (USFWS and Hoopa Valley Tribe 1999).

In Clear Creek at Whiskeytown Dam, flows under A1A_LLT would generally be similar to or greater than flows under Existing Conditions throughout the year, except in critical years during August and September (17% and 38% lower, respectively) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

In the Feather River at Thermalito Afterbay, flows under A1A_LLT would generally be greater than those under Existing Conditions during February through June, October, and December (up to 204% greater), lower during July through September (up to 56% lower), and similar during November and January (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

In the American River at Nimbus Dam, flows under A1A_LLT would generally greater than flows under Existing Conditions during February, March, and October (up to 42% greater), lower during January, May, July through September, and November through December (up to 53% lower), and generally similar during the rest of the year (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

Flow rates in the San Joaquin and Stanislaus rivers would be the same as described above for covered fish species under Alternative 1A (see Impacts AQUA-76 through 78 under Chinook salmon fall-/late-fall run ESU). That analysis indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months above the 86°F water temperature threshold for year-round adult largemouth bass rearing period was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Elevated water temperatures could lead to reduced quantity and quality of adult rearing habitat and increased stress and mortality of rearing adults. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures would not exceed 86°F under Existing Conditions or A1A_LLT in all waterways examined (Table 11-1A-97). As a result, there would be no difference in the percentage of months in which the 86°F water temperature threshold is exceeded between Alternative 1A and Existing Conditions.

Collectively, the results of the Impact AQUA-202 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 1A could be significant because, under the CEQA baseline, the alternative could substantially reduce the amount of suitable habitat, contrary to the NEPA conclusion set forth above. There would be small to moderate flow-related effects and temperature-related effects of Alternative 1A on Sacramento tule perch in the American and Feather rivers. Flow reductions and increases in exceedances above temperature thresholds would have a biologically meaningful effect on the population. This impact is a result of the specific reservoir operations and resulting flows associated with this alternative. These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 1A does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 1A indicates that flows in the locations and during the months analyzed above would generally be similar between future conditions without BDCP and Alternative 1A. This indicates that the differences between Existing Conditions and Alternative 1A found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 1A, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on rearing habitat for Sacramento tule perch. This impact is found to be less than significant and no mitigation is required.

The NEPA and CEQA conclusions differ for this impact statement because they were determined using two unique baselines. The NEPA conclusion was based on the comparison of A1A_LLT with NAA and the CEQA conclusion was based on the comparison of A1A_LLT with Existing Conditions. These baselines differ in two ways. First, the NAA includes the Fall X2 standard in wet above normal water years whereas Existing Conditions do not. Second, the NAA is assumed to occur during the late long-term implementation period whereas the CEQA baseline is assumed to occur during existing climate conditions. Therefore, differences in model outputs between the CEQA baseline and the Alternative 1A are due primarily to both the alternative and future climate change.

Sacramento Tule Perch

NEPA Effects: Refer to Impact AQUA-5 under delta smelt and Impact AQUA-41 under Chinook salmon for a discussion of the effects of water operations on rearing habitat for Sacramento tule perch. The potential effects would be similar to those described there. The effects would not be adverse.

CEQA Conclusion: As described above the impacts on Sacramento tule perch rearing habitat would be less than significant.

Sacramento-San Joaquin Roach

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the year-round juvenile and adult Sacramento-San Joaquin roach rearing period. Lower flows could reduce the quantity and quality of instream habitat available for rearing. The Sacramento River and its large tributaries are most likely not the primary habitat of Sacramento-San Joaquin roach. It is more likely that they are washed into these bigger streams from smaller tributaries which would likely be warmer than the below dam releases that are made for salmonid fishes.

In the Sacramento River upstream of Red Bluff, flows under A1A_LLT during August, September, and November would be lower than flows under NAA (up to 44% lower), and generally similar to or greater than flows under NAA during the rest of the year, with some exceptions (up to 11% lower). (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

Sacramento-San Joaquin roach are not found in Trinity River screw trap data (Pinnix et al. 2010), or within the Klamath Province (Moyle 2002).

In Clear Creek at Whiskeytown Dam, flows under A1A_LLT would generally be similar to or greater than NAA throughout the year, except in critical years during June and September (8% and 13% lower, respectively) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

In the Feather River at Thermalito Afterbay, flows under A1A_LLT would generally be greater than those under NAA during October through June (up to 219% greater) and lower during July through September (up to 86% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

In the American River at Nimbus Dam, flows under A1A_LLT would generally be greater than flows under NAA during May, June, and October (up to 37% greater), generally lower during July through September (up to 47% lower), and generally similar during the remaining months (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

Flow rates in the San Joaquin and Stanislaus rivers would be the same as described above for covered fish species under Alternative 1A (see Impacts AQUA-76–through 78 under Chinook salmon fall-/late-fall run ESU). That analysis indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months above the 86°F water temperature threshold for year-round juvenile and adult Sacramento-San Joaquin roach rearing period was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Elevated water temperatures could lead to reduced rearing habitat quality and increased stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures would not exceed 86°F under NAA or A1A_LLT in any of the waterways examined (Table 11-1A-98). As a result, there would be no difference in the percentage of months in which the 86°F water temperature threshold is exceeded between Alternative 1A and NAA.

Table 11-1A-98. Difference and Percent Difference in the Percentage of Months in Which Year-Round Water Temperatures Exceed the 86°F Water Temperature Range for Sacramento-San Joaquin Roach Survival[a]

Location	Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Sacramento River upstream of Red Bluff	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
Trinity River below Lewiston Reservoir	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
Feather River below Thermalito Afterbay	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
American River below Nimbus Dam	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
Stanislaus River below New Melones Dam	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.

[a] A negative value indicates a benefit (reduction in percentage of months outside suitable range) of the alternative.

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because Alternative 1A would not cause a substantial reduction in spawning and juvenile and adult Sacramento-San Joaquin roach rearing habitat. Flows under Alternative 1A in all rivers examined throughout the year are generally similar to or greater than flows under the NAA, except during July through September are generally lower in the Feather River high flow channel and in the American River below Nimbus Dam, although these reductions would not be biologically meaningful to the roach population. The percentage of months outside temperature thresholds are generally similar to or lower under Alternative 1A than under NAA. In addition, Sacramento-San Joaquin roach occur primarily in tributary habitat areas, where there would be little or no effects from Alternative 1A water operations.

CEQA Conclusion: In general, Alternative 1A would reduce the quality and quantity of upstream habitat conditions for Sacramento-San Joaquin Roach relative to Existing Conditions.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the year-round juvenile and adult Sacramento-San Joaquin roach rearing period. Lower flows could reduce the quantity and quality of instream habitat available for rearing. The Sacramento River and its large tributaries are most likely not the primary habitat of Sacramento-San Joaquin roach. It is more likely that they are washed into these bigger streams from smaller tributaries which would likely be warmer than the below dam releases that are made for salmonid fishes.

In the Sacramento River upstream of Red Bluff, flows under A1A_LLT would generally be similar to or greater than flows under Existing Conditions during all months but July through September and November, except in wet years during May (14% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows under A1A_LLT during July through September and November would be lower than flows under Existing Conditions (up to 24% lower).

Sacramento-San Joaquin roach are not found in Trinity River screw trap data (Pinnix et al. 2010), or within the Klamath Province (Moyle 2002).

In Clear Creek at Whiskeytown Dam, flows under A1A_LLT would generally be similar to or greater than flows under Existing Conditions throughout the year, except in critical years during August and September (17% and 38% lower, respectively) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

In the Feather River at Thermalito Afterbay, flows under A1A_LLT would generally be greater than those under Existing Conditions during February through June, October, and December (up to 204% greater), lower during July through September (up to 56% lower), and similar during November and January (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

In the American River at Nimbus Dam, flows under A1A_LLT would generally greater than flows under Existing Conditions during February, March, and October (up to 42% greater), lower during January, May, July through September, and November through December (up to 53% lower), and generally similar during the rest of the year (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

Flow rates in the San Joaquin and Stanislaus rivers would be the same as described above for covered fish species under Alternative 1A (see Impacts AQUA-76–through 78 under Chinook salmon fall-/late-fall run ESU). That analysis indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months above the 86°F water temperature threshold for year-round juvenile and adult Sacramento-San Joaquin roach rearing period was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Elevated water temperatures could lead to reduced quantity and quality of adult rearing habitat and increased stress and mortality of rearing adults. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures would not exceed 86°F under Existing Conditions or A1A_LLT in any of the waterways examined (Table 11-1A-98). As a result, there would be no difference in the percentage of months in which the 86°F water temperature threshold is exceeded between Alternative 1A and Existing Conditions.

Collectively, these results indicate that the impact would not be significant because Alternative 1A would cause a substantial reduction in Sacramento-San Joaquin roach spawning habitat or juvenile and adult rearing habitat, as these occur primarily in tributary habitat areas. However, flows would be substantially lower during the majority of the year-round juvenile and adult rearing period in the American River and in one third of the period in the Feather River. Flows in other rivers would not have biologically meaningful effects.

Hardhead

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the year-round juvenile and adult hardhead rearing period. Lower flows could reduce the quantity and quality of instream habitat available for juvenile and adult rearing.

In the Sacramento River upstream of Red Bluff, flows under A1A_LLT during August, September, and November would be lower than flows under NAA (up to 44% lower), and generally similar to or greater than flows under NAA during the rest of the year, with some exceptions (up to 11% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

Hardhead are not found in Trinity River screw trap data (Pinnix et al. 2010), or within the Klamath Province (Moyle 2002).

In Clear Creek at Whiskeytown Dam). Flows under A1A_LLT would generally be similar to or greater than NAA throughout the year, except in critical years during June and September (8% and 13% lower, respectively) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

In the Feather River at Thermalito Afterbay, flows under A1A_LLT would generally be greater than those under NAA during October through June (up to 219% greater) and lower during July through September (up to 86% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

In the American River at Nimbus Dam, flows under A1A_LLT would generally be greater than flows under NAA during May, June, and October (up to 37% greater), generally lower during July through September (up to 47% lower), and generally similar during the remaining months (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

Flow rates in the San Joaquin and Stanislaus rivers would be the same as described above for covered fish species under Alternative 1A (see Impacts AQUA-76– through 78 under Chinook salmon fall-/late-fall run ESU). That analysis indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months outside of the 65°F to 82.4°F suitable water temperature range for juvenile and adult hardhead rearing was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced rearing habitat quality and increased stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

In the Sacramento River upstream of Red Bluff, the percentage of months under A1A_LLT outside the range would be similar to or lower than the percentage under NAA in all water year types (Table 11-1A-99).

Hardhead are not found in Trinity River screw trap data (Pinnix et al. 2010), or within the Klamath Province (Moyle 2002).

In the Feather River below Thermalito Afterbay, the percentage of months under A1A_LLT outside the range would be lower than the percentage under NAA in all water year types except below normal years (6% higher) (Table 11-1A-99).

In the American River below Nimbus Dam, the percentage of months under A1A_LLT outside the 59°F to 75°F water temperature range would be similar to or lower than the percentage under NAA in all water year types (Table 11-1A-99).

In the Stanislaus River below New Melones Dam, the percentage of months under A1A_LLT outside the range would be similar to the percentage under NAA in all water year types (Table 11-1A-99).

Table 11-1A-99. Difference and Percent Difference in the Percentage of Months in Which Year-Round Water Temperatures Are outside the 65°F to 82.4°F Water Temperature Range for Juvenile and Adult Hardhead Occurrence[a]

Location	Water Year Type	EXISTING CONDITIONS vs. A1A_LLT	NAA vs. A1A_LLT
Sacramento River upstream of Red Bluff	Wet	0 (0%)	0 (0%)
	Above Normal	-1 (-1%)	0 (0%)
	Below Normal	-1 (-1%)	-1 (-1%)
	Dry	-4 (-4%)	0 (0%)
	Critical	-14 (-15%)	-1 (-1%)
	All	-3 (-3%)	0 (0%)
Trinity River below Lewiston Reservoir	Wet	0 (0%)	0 (0%)
	Above Normal	0 (0%)	0 (0%)
	Below Normal	-1 (-1%)	0 (0%)
	Dry	-1 (-1%)	0 (0%)
	Critical	-9 (-9%)	-1 (-1%)
	All	-2 (-2%)	0 (0%)
Feather River below Thermalito Afterbay	Wet	-5 (-7%)	-2 (-3%)
	Above Normal	-9 (-13%)	-5 (-7%)
	Below Normal	-7 (-9%)	4 (6%)
	Dry	-7 (-10%)	0.5 (1%)
	Critical	-8 (-11%)	-1 (-1%)
	All	-7 (-9%)	-1 (-1%)
American River below Nimbus Dam	Wet	-20 (-25%)	1 (1%)
	Above Normal	-17 (-24%)	0 (0%)
	Below Normal	-17 (-24%)	1 (1%)
	Dry	-13 (-20%)	0 (-1%)
	Critical	-13 (-21%)	0 (0%)
	All	-17 (-23%)	0 (0%)
Stanislaus River below New Melones Dam	Wet	0 (0%)	0 (0%)
	Above Normal	0 (0%)	0 (0%)
	Below Normal	0 (0%)	0 (0%)
	Dry	0 (0%)	0 (0%)
	Critical	-1 (-1%)	0 (0%)
	All	0 (0%)	0 (0%)

[a] A negative value indicates a benefit (reduction in percentage of months outside suitable range) of the alternative.

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because Alternative 1A would not cause a substantial reduction in spawning and juvenile and adult hardhead rearing. Flows under Alternative 1A in all rivers examined throughout the year are generally similar to or greater than flows under the NAA, except during summer months in the Feather and half the year in the American rivers. These reductions in flows, however, would not cause an overall biologically meaningful effect on hardhead due to the high mobility and diverse distribution of hardhead in the Central Valley. The percentages of years outside all temperature thresholds in all locations examined under Alternative 1A are generally lower than under the NAA.

CEQA Conclusion: In general, Alternative 1A would reduce the quality and quantity of upstream habitat conditions for hardhead relative to Existing Conditions.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the year-round juvenile and adult hardhead rearing period. Lower flows could reduce the quantity and quality of instream habitat available for juvenile and adult rearing.

In the Sacramento River upstream of Red Bluff, flows under A1A_LLT would generally be similar to or greater than flows under Existing Conditions during all months but July through September and November, except in wet years during May (14% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows under A1A_LLT during July through September and November would be lower than flows under Existing Conditions (up to 24% lower).

Hardhead are not found in Trinity River screw trap data (Pinnix et al. 2010), or within the Klamath Province (Moyle 2002).

In Clear Creek at Whiskeytown Dam, flows under A1A_LLT would generally be similar to or greater than flows under Existing Conditions throughout the year, except in critical years during August and September (17% and 38% lower, respectively) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

In the Feather River at Thermalito Afterbay, flows under A1A_LLT would generally be greater than those under Existing Conditions during February through June, October, and December (up to 204% greater), lower during July through September (up to 56% lower), and similar during November and January (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

In the American River at Nimbus Dam, flows under A1A_LLT would generally greater than flows under Existing Conditions during February, March, and October (up to 42% greater), lower during January, May, July through September, and November through December (up to 53% lower), and generally similar during the rest of the year (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

Flow rates in the San Joaquin and Stanislaus rivers would be the same as described above for covered fish species under Alternative 1A (see Impacts AQUA-76 through 78 under Chinook salmon fall-/late-fall run ESU). That analysis indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months in which year-round in-stream temperatures would be outside of the 65°F to 82.4°F suitable water temperature range for juvenile and adult hardhead rearing was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced rearing habitat quality and increased stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

In the Sacramento River upstream of Red Bluff, the percentage of months under A1A_LLT outside the range would be similar to or lower than the percentage under Existing Conditions in all water year types (Table 11-1A-99).

Hardhead are not found in Trinity River screw trap data (Pinnix et al. 2010), or within the Klamath Province (Moyle 2002).

In the Feather River below Thermalito Afterbay, the percentage of months under A1A_LLT outside the range would be lower than the percentage under Existing Conditions in all water year types (Table 11-1A-99).

In the American River below Nimbus Dam, the percentage of months under A1A_LLT outside the range would be lower than the percentage under Existing Conditions in all water year types (Table 11-1A-99).

In the Stanislaus River below New Melones Dam, the percentage of months under A1A_LLT outside the range would be similar to the percentage under Existing Conditions in all water year types (Table 11-1A-99).

Collectively, these results indicate that the impact would be significant because Alternative 1A would cause a substantial reduction in hardhead habitat. Flows would be substantially lower during the majority of the year-round juvenile and adult rearing period in the American River and in one third of the period in the Feather River. Flows in other rivers would not have biologically meaningful effects on hardhead. The percentages of years outside the temperature thresholds are generally lower under Alternative 1A than under Existing Conditions, except for the 59–64°F spawning temperature range in the American River. This impact is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this impact to a less than significant level would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this impact is significant and unavoidable because there is no feasible mitigation available.

The NEPA and CEQA conclusions differ for this impact statement because they were determined using two unique baselines. The NEPA conclusion was based on the comparison of A1A_LLT with NAA and the CEQA conclusion was based on the comparison of A1A_LLT with Existing Conditions. These baselines differ in two ways. First, the NAA includes the Fall X2 standard in wet above normal water years whereas the CEQA Existing Conditions do not. Second, the NAA is assumed to occur during the late long-term implementation period whereas the CEQA baseline is assumed to occur during existing climate conditions. Therefore, differences in model outputs between the CEQA baseline and the Alternative 1A are due primarily to both the alternative and future climate change.

California Bay Shrimp

NEPA Effects: For California bay shrimp the overall flows and temperature within the estuary would be neutral or slightly improved with respect to rearing. These conditions would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of water operations on rearing conditions for California bay shrimp would not be significant and no mitigation is required.

Impact AQUA-204: Effects of Water Operations on Migration Conditions for Non-Covered Aquatic Species of Primary Management Concern

Striped Bass

NEPA Effects: Refer to Impact AQUA-6 under delta smelt and Impact AQUA-42 under Chinook salmon for a discussion of the effects of water operations on migration conditions for striped bass. The potential effects would be similar to those described there. The potential effects would be similar to those described, although the primary mechanisms of effect are likely to be changes in water flow, and related water temperatures, which could alter adult spawning migration timing. In addition, newly hatched larvae drift with the currents, so changes in flow would affect the rate of downstream movement, resulting in potential changes in food availability, predation rates, and available suitable habitat. The effects would not be adverse.

CEQA Conclusion: As described above the impacts on striped bass migration conditions would be less than significant.

American Shad

NEPA Effects: Refer to Impact AQUA-6 under delta smelt and Impact AQUA-42 under Chinook salmon for a discussion of the effects of water operations on migration conditions for American shad. The potential effects would be similar to those described there. The potential effects would be similar to those described, although the primary mechanism of effect would be changes in flow, which could affect adult and juvenile migration timing and migration rates. The effects would not be adverse.

CEQA Conclusion: As described above the impacts on American shad migration conditions would be less than significant.

Threadfin Shad

NEPA Effects: Threadfin shad are non-migratory fish within the Delta, so they do not use the Delta as migration habitat. Therefore, Alternative 1A would have no effect on their movements within the Delta.

CEQA Conclusion: As described above, threadfin shad are non-migratory, so flow changes under Alternative 1A would have no impact on their movements within the Delta. Therefore, no mitigation is required.

Largemouth Bass

NEPA Effects: Largemouth bass are non-migratory fish within the Delta. Therefore they do not use the Delta as migration habitat corridor. There would be no effect.

CEQA Conclusion: As described immediately above, flow changes under Alternative 1A would not affect largemouth movements within the Delta. No mitigation would be required.

Sacramento Tule Perch

NEPA Effects: Similar with largemouth bass, Sacramento tule perch are a non-migratory species and do not use the Delta as a migration corridor as they are a resident Delta species. There would be no effect.

CEQA Conclusion: As described immediately above, flow movements would not affect Sacramento tule perch movements within the Delta. No mitigation would be required.

Sacramento-San Joaquin Roach

NEPA Effects: Sacramento-San Joaquin roach are non-migratory, and the overall flows and temperature in upstream rivers during spawning would be similar to those described under Alternative 1A, Impact AQUA-202 for spawning. As described there, the flows would slightly improve the upstream spawning conditions relative to the NAA, but would have no effect on Sacramento-San Joaquin roach movement in the Delta.

CEQA Conclusion: As described immediately above, the impacts of water operations on migration conditions for Sacramento-San Joaquin roach would not be significant and no mitigation is required.

Hardhead

NEPA Effects: For hardhead the overall flows and temperature in upstream rivers during migration to their spawning grounds would be similar to those described under Alternative 1A, Impact AQUA-202 for spawning. As described there, the flows would slightly improve the upstream conditions relative to the NAA. These conditions would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of water operations on migration conditions for hardhead would not be significant and no mitigation is required.

California Bay Shrimp

NEPA Effects: For California bay shrimp the overall flows and temperature in the estuary associated with migration would be similar to those described under Alternative 1A, Impact AQUA-202 for spawning. As described there, the flows would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of water operations on migration conditions for California bay shrimp would not be significant and no mitigation is required.

Restoration Measures (Conservations Measures 2, 4–7, and 10)

The effects of restoration measures under Alternative 1A would be similar for all non-covered species; therefore, the analysis below is combined for all non-covered species instead of analyzed by individual species.

Impact AQUA-205: Effects of Construction of Restoration Measures on Non-Covered Aquatic Species of Primary Management Concern

NEPA Effects: Refer to Impact AQUA-7 under delta smelt a discussion of the effects of construction of restoration measures on non-covered species of primary management concern. The potential effects would be similar to those described there. These effects would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of the construction of restoration measures would be less than significant.

Impact AQUA-206: Effects of Contaminants Associated with Restoration Measures on Non-Covered Aquatic Species of Primary Management Concern

NEPA Effects: Refer to Impact AQUA-8 under delta smelt a discussion of the effects of contaminants associated with restoration measures on non-covered species of primary management concern. The potential effects would be similar to those described there. These effects would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of contaminants associated with restoration measures would be less than significant.

Impact AQUA-207: Effects of Restored Habitat Conditions on Non-Covered Aquatic Species of Primary Management Concern

NEPA Effects: Refer to Impact AQUA-9 under delta smelt a general discussion of the effects of restored habitat conditions on non-covered species of primary management concern. Although there are minor differences the effects are similar including for food production and export. Striped bass use Suisun Bay and the lower San Joaquin River so restored habitat in those locations would be of direct benefit. Largemouth bass do not use the Yolo Bypass and that restored habitat would have no direct benefit for them. Sacramento-San Joaquin roach do not use Yolo Bypass or the main river channels so those habitat improvements would not benefit them. Hardhead are primarily upstream of the Delta or in the lowermost main tributary channels so habitat improvements would have minimal benefit for them. Similarly, Sacramento perch would mainly benefit from restoration of tidal marsh habitat which would increase food resources. Threadfin shad use the estuarine zone so the increased acreage and improved quality of estuarine habitat would benefit them. California bay shrimp use the estuarine zone within Suisun Marsh so the increased acreage and improved quality of habitat would benefit them. Downstream transport of food resources into the Bay would also benefit California bay shrimp.

CEQA Conclusion: As described immediately above, the impacts of restored habitat conditions would range from no impact, to slightly beneficial, to beneficial.

Other Conservation Measures (CM12–CM19 and CM21)

The effects of other conservation measures under Alternative 1A would be similar for all non-covered species; therefore, the analysis below is combined for all non-covered species instead of analyzed by individual species.

Impact AQUA-208: Effects of Methylmercury Management on Non-Covered Aquatic Species of Primary Management Concern (CM12)

NEPA Effects: Refer to Impact AQUA-10 under delta smelt a discussion of the effects of methylmercury management on non-covered species of primary management concern The potential effects would be similar to those described there. These effects would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of methylmercury management would be less than significant.

Impact AQUA-209: Effects of Invasive Aquatic Vegetation Management on Non-Covered Aquatic Species of Primary Management Concern (CM13)

NEPA Effects: Refer to Impact AQUA-11 under delta smelt a discussion of the effects of invasive aquatic vegetation management on non-covered species of primary management concern. There are minor differences and the effects are similar except for predatory species (striped bass and largemouth bass) and Sacramento tule perch. Invasive aquatic vegetation provides staging habitat for predatory fish at intermediate abundance which improves their hunting success. Sacramento tule perch also use the cover of aquatic plants in the Sacramento and San Joaquin rivers and in Suisun marsh. Consequently, reducing large amounts of invasive aquatic habitat will lower predatory species hunting success rates and provide less cover for Sacramento tule perch. However, this control will not substantially reduce places for predatory species to hunt and there will still be many other habitats in which the predatory species can successfully hunt and in which Sacramento tule perch would find shelter from predators. The effect on them will not be adverse. Control of invasive aquatic vegetation would not occur within California bay shrimp habitat and there would be no effect on them.

CEQA Conclusion: Refer to Impact AQUA-11 under delta smelt a discussion of the effects of invasive aquatic vegetation management on non-covered species of primary management concern. There are minor differences and the effects are similar except for predatory species, California bay shrimp and Sacramento tule perch. Invasive aquatic vegetation provides staging habitat for predatory fish which improves their hunting success. Control of invasive aquatic vegetation would not occur within California bay shrimp habitat and there would be no effect on them. Sacramento tule perch also use the cover of aquatic plants in the Sacramento and San Joaquin rivers and in Suisun marsh. Consequently, reducing the amount of invasive aquatic habitat will lower predatory species hunting success rates and provide less cover for Sacramento tule perch. However, this control will not substantially reduce places for predatory species to hunt and there will still be many other habitats in which Sacramento tule perch would find shelter from predators. Therefore the effect on them will not be significant and no mitigation is required.

Impact AQUA-210: Effects of Dissolved Oxygen Level Management on Non-Covered Aquatic Species of Primary Management Concern (CM14)

NEPA Effects: Refer to Impact AQUA-12 under delta smelt a discussion of the effects of dissolved oxygen level management on non-covered species of primary management concern. The potential effects would be similar to those described there. California bay shrimp do not occur in this habitat and there would be no effect on them. These effects would be beneficial.

CEQA Conclusion: As described immediately above, the impacts of oxygen level management would be beneficial.

Impact AQUA-211: Effects of Localized Reduction of Predatory Fish on Non-Covered Aquatic Species of Primary Management Concern (CM15)

NEPA Effects: Refer to Impact AQUA-13 under delta smelt a discussion of the effects of predatory fish (striped bass and largemouth bass) and predator management on non-predatory fish. The purpose of predatory fish management is to reduce the numbers of predatory fish and to reduce their hunting success. To the extent that localized predator control efforts of *CM15 Localized Reduction of Predatory Fish* reduce the overall abundance of fish predators in the Delta, this management will have negative effects on predatory fish. However, the numbers of predatory fish are high and the extent of the habitats in which they hunt is extensive. Therefore the effects of this management will not be adverse. California bay shrimp do not occur in these habitats and there would be no effect on them.

CEQA Conclusion: Refer to Impact AQUA-13 under delta smelt a discussion of the effects of predatory fish and predator management on non-predatory fish. The purpose of predatory fish management is to reduce the numbers of predatory fish and to reduce their hunting success. To the extent that localized predator control efforts of *CM15 Localized Reduction of Predatory Fish* reduce the overall abundance of fish predators in the Delta, this management will have negative effects on predatory fish. However, the numbers of predatory fish are high and the extent of the habitats in which they hunt is extensive. Therefore the effects of this management will not be significant. No mitigation is required. California bay shrimp do not occur in these habitats and there would be no effect on them.

Impact AQUA-212: Effects of Nonphysical Fish Barriers on Non-Covered Aquatic Species of Primary Management Concern (CM16)

NEPA Effects: Refer to Impact AQUA-14 under delta smelt a discussion of the effects of nonphysical fish barriers on non-covered species of primary management concern. Although there are minor differences the effects are similar except for Sacramento-San Joaquin roach, hardhead, and Sacramento perch which are unlikely to be present in their vicinity. California bay shrimp do not occur in these habitats and there would be no effect on them. The effects would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of nonphysical fish barriers would be less than significant.

Impact AQUA-213: Effects of Illegal Harvest Reduction on Non-Covered Aquatic Species of Primary Management Concern (CM17)

NEPA Effects: Refer to Impact AQUA-15 under delta smelt a discussion of the effects of illegal harvest reduction on non-covered species of primary management concern. The potential effects would be similar to those described there. California bay shrimp do not occur in these habitats and there would be no effect on them. The effects would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of illegal harvest reduction would be less than significant.

Impact AQUA-214: Effects of Conservation Hatcheries on Non-Covered Aquatic Species of Primary Management Concern (CM18)

NEPA Effects: Refer to Impact AQUA-16 under delta smelt a discussion of the effects of conservation hatcheries on non-covered species of primary management concern. There would be no effect.

CEQA Conclusion: As described immediately above, conservation hatcheries would have not impact.

Impact AQUA-215: Effects of Urban Stormwater Treatment on Non-Covered Aquatic Species of Primary Management Concern (CM19)

NEPA Effects: Refer to Impact AQUA-17 under delta smelt a discussion of the effects of urban stormwater treatment on non-covered species of primary management concern. These effects would be beneficial.

CEQA Conclusion: As described immediately above, the impacts of stormwater management would be beneficial.

Impact AQUA-216: Effects of Removal/Relocation of Nonproject Diversions on Non-Covered Aquatic Species of Primary Management Concern (CM21)

NEPA Effects: Refer to Impact AQUA-18 under delta smelt a discussion of the effects of removal/relocation of nonproject diversion on non-covered species of primary management concern. Although there are minor differences the effects are similar except for Sacramento-San Joaquin roach, hardhead, and Sacramento perch which are unlikely to be present near these diversions. California bay shrimp do not occur in these habitats and there would be no effect on them. The effects would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of removal/relocation of nonproject diversions would be less than significant.

Upstream Reservoirs

Impact AQUA-217: Effects of Water Operations on Reservoir Coldwater Fish Habitat

As previously described under the methods for the reservoir coldwater fish habitat analysis (Section 11.3.2.7), Shasta Reservoir was analyzed first and that approach was then applied, in combination with CALSIM modeling and the selected minimum coldwater habitat volumes, to evaluate the effects of the alternatives on coldwater habitat for the other major CVP and SWP reservoirs.

The evaluation of the Shasta Reservoir coldwater habitat volume can be described in three basic steps: 1) describe the reservoir geometry (volume and surface area) as a function of elevation, 2) describe the seasonal (monthly) water temperatures as a function of the elevation, storage level and outlet elevation(s), and 3) determine the portion of the reservoir volume with temperatures less than 60°F for the full range of carryover storages simulated with CALSIM. The coldwater habitat assessment compares the number of years with carryover storage less than the selected minimum volume index corresponding to the minimum acceptable coldwater habitat volume between the NAA and the BDCP alternatives, for each reservoir.

The reservoir geometry (surface area and volume) as a function of the water elevation and the elevation of the reservoir outlets are the basic features that determine the coldwater habitat in each reservoir. Table 11-1A-100 gives a summary of the Shasta Reservoir area (acres) and volume (acre-feet) for 25-feet increments of elevation. Figure 11-1A-6 shows the Shasta Reservoir volume (thousand acre-feet [taf]) as a function of elevation. The bottom of Shasta Reservoir is at 630 feet msl, but there is very little storage volume (50 taf) below an elevation of 700 ft. The maximum elevation of about 1,065 corresponds to a maximum storage of about 4,550 taf. Figure 11-1A-6 shows the Shasta Reservoir surface area (acres) as a function of elevation. The bottom sediment area (where benthic food organisms live) is about the same as the water surface area (where photosynthesis and heat exchange occurs).

The elevations of the reservoir outlets are also important for understanding the coldwater pool. The coldest water at the bottom of the reservoir (below the outlet penstocks to the hydropower turbines) remains at nearly the same temperature during the stratified period. Shasta Dam has river outlets with gate sills (bottoms) located at elevation 742 feet and 942 feet (the river gate at 842 feet is no longer operational). The gates are about 8 feet high, so water comes from a zone approximately

20 feet high centered at about 750 feet and 950 feet (when they are used). The intakes for the 15-feet diameter penstocks to the hydropower turbines are located with a centerline elevation of 815 feet, so water is drawn from elevations of approximately 800 feet to 830 feet. The spillway crest elevation is at 1,037 feet. During the 1976–1977 and the 1987–1992 drought periods, when Shasta Reservoir storage was low and water temperatures released through the hydropower plant were greater than 55°F, the low-level river outlets (at 750 feet and 850 feet) were used to blend with the hydropower releases (from 800–830 feet) to provide cooler release temperatures at Keswick Dam for winter run spawning and egg incubation. Subsequently, to protect winter-run spawning and egg incubation temperatures and also make full hydropower releases, the temperature control device (TCD) was designed and constructed. The TCD, which began operating in 1998, allows all releases to be made through the hydropower penstocks. Three levels of louver "gates" allow the penstock water to be blended from three elevation zones. Higher level releases are used early in the summer to preserve as much of the cold water as possible; the open gate levels are adjusted towards the bottom gate during the summer. By preserving the coldest water for the early fall period (September and October), the cold water habitat in the reservoir is also protected through the summer months; however, use of the low level gate allows more of the cold water from the bottom of the reservoir to be released in September and October. Table 11-1A-100 indicates that the storage volume located below the penstocks (800 feet) is about 350 taf with a benthic area within this protected cold water habitat of about 5,000 acres.

Table 11-1A-100. Shasta Reservoir Geometry

Elevation (feet)	Surface Area (acres)	Volume (acre-feet)
1,075	30,908	4,792,000
1,050	27,654	4,068,649
1,025	24,633	3,388,333
1,000	21,800	2,830,000
975	19,200	2,345,000
950	16,600	1,860,000
925	14,300	1,505,000
900	12,000	1,150,000
875	10,100	907,500
850	8,200	665,000
825	6,617	490,624
800	5,080	342,000
775	3,800	233,333
750	2,800	150,000
725	1,914	85,714
700	1,200	50,000
675	771	18,750
650	343	3,437

The seasonal (monthly) reservoir release temperature and the vertical temperature profiles within the reservoir are directly linked and depend on the elevation of the outlets and the reservoir geometry and water surface elevation. The relationships between carryover storage and release temperatures for the major CVP and SWP reservoirs are shown and described in Appendix 29C

"Climate Change and Effects of Reservoir Operations on Water Temperatures." Release temperatures are relatively cool and stable until the fall months. The release temperatures increase and the remaining coldwater habitat volume decreases as the carryover reservoir storage is reduced in dry years. Only if the carryover storage is reduced below a specific volume (taf) are the release temperatures moderately increased. For storages below this threshold, the release temperature increases as the storage is reduced and the coldwater habitat volume is substantially reduced.

The cold water habitat of a reservoir is located below the vertical temperature gradient that develops in the spring months of April-June. Figure 11-1A-7 illustrates the seasonal development of surface warming and temperature stratification in Shasta Reservoir, and the fall cooling of surface temperatures in the fall and early winter months during 1995. These data were collected just upstream of Shasta Dam at depths corresponding to elevations of 650 feet to the surface in 25-feet increments. The water temperatures were never quite fully- mixed and isothermal (same temperatures) in 1995. The temperatures at the end of January and the end of February were about 45^{0}F at the bottom and 50^{0}F at the top (water surface elevation of 1,025 feet). Surface temperatures were less than 55^{0}F at the end of March and April, but increased to 65^{0}F at the end of May and June. The warmest surface temperatures (80^{0}F) were measured at the end of July, with slightly cooler surface temperatures of 75^{0}F at the end of August and September. At the end of October the surface temperatures were less than 65^{0}F and the surface cooling had caused the water to mix (isothermal) to a depth of about 100 feet. By the end of December the surface temperatures were less than 60^{0}F and the surface mixed layer had a depth of about 150 feet.

Warming of the reservoir below the surface heated layer is caused by water releases from the outlets; warmer water from above is drawn down to replace the water released from the penstock (elevation 800 feet) or the low-level river outlet (elevation 750 feet). The warming may also depend on the reservoir inflow and outflow during these summer months. Inflowing water will usually be cooler than the surface temperature and will enter the reservoir profile at the matching temperature; this will expand the depth of this temperature layer. The effects of inflowing water can be stronger during the fall, when the cooler inflow contributes to the deepening of the surface mixed layer.

The effects of reservoir storage drawdown on the coldwater habitat volume can be tracked by evaluating the coldwater habitat volume available through the year. Figure 11-1A-7 shows the entire reservoir was coldwater habitat (<60°F) from January through April. The surface layer was warmer than 60^{0}F in the summer months, but the reservoir volume below elevation 900 feet was less than 60^{0}F at the end of September and the volume below elevation 875 feet was less than 60^{0}F at the end of October. The minimum Shasta Reservoir storage at the end of September 1995 was about 3,400 taf (1,025 feet). The coldwater habitat volume would likely be more limited in years with a lower carryover storage volume. The end-of-September storage simulated with the CALSIM reservoir operation model will be used as the annual index for assessing coldwater habitat volume. A relationship between end of September storage and coldwater habitat volume was determined from the temperature profiles simulated with the Sacramento River Water Quality Model (SRWQM) developed for Reclamation by RMA. This model was used for each of the alternatives to simulate reservoir temperatures, release temperatures and downstream river temperatures. The model predicts reservoir profiles that were used to develop carryover storage-cold water habitat relationship for Shasta Reservoir.

Figure 11-1A-8 shows an example of the simulated relationship between reservoir storage and coldwater habitat (defined as less than 58°F in this example) for the No Action Baseline for 1922 to

2003. August was used in this example because September temperatures were not available in the coldwater habitat results. The SRWQM results show a strong relationship between August storage and coldwater habitat volume. The maximum coldwater habitat volume in August was about 1,500 taf (below elevation 925 feet) for <58^{0}F. The coldwater habitat volumes were reduced when the August storage volume was less than about 3,000 taf (below elevation 1,000 feet). Figure 11-1A-9 shows the SRWQM-simulated relationship between Shasta Reservoir volume and coldwater habitat volume for the end of August. The relationship between Shasta Reservoir storage and coldwater habitat volume can be used to assess the effects of reduced end-of-year storage on coldwater habitat volume.

The evaluation of the annual carryover storage effects on coldwater habitat volumes can be made using either a specified "threshold" for coldwater habitat impact for each reservoir, or using a "scale" for coldwater habitat effects that would vary with carryover volume for each reservoir. Impacts could then be measured as the increase in the number of years with storage below the selected threshold value, or as the reduction in the average coldwater habitat effects calculated from a baseline carryover storage sequence to an alternative sequence of carryover storage values. However, because a rating scale will provide the average coldwater habitat benefits rather than emphasizing the poor conditions in the lower storage years, large impacts in a few years will be masked by the generally suitable conditions. For this reason, the threshold storage method is preferred for impact evaluation. The impact evaluation of Shasta Reservoir operations on coldwater habitat volume was based on a specified threshold storage that would protect sufficient coldwater habitat volume for the fish populations in the reservoir.

Figure 11-1A-9 can be used as the basis for a specified threshold volume or for a specified "scaling" of carryover storage coldwater benefits. Assuming 60^{0}F as the upper limit for coldwater habitat, carryover storage of about 3,500 taf (maximum end-of September Shasta storage) would provide a coldwater habitat volume of 1,500 taf. Carryover storage of 2,500 taf would provide a coldwater habitat volume of about 750 taf, which is about half of the maximum coldwater habitat volume of 1,500 taf. Carryover storage of 2,000 taf would provide a coldwater habitat volume of about 500 taf, which is about 33% of the maximum coldwater habitat volume. Carryover storage of 1,500 taf would provide a coldwater habitat volume of about 250 taf, which is about 15% of the maximum coldwater habitat volume. Carryover storage of 1,000 taf would provide a coldwater habitat volume of about 50 taf, which is less than 5% of the maximum coldwater habitat volume. Because the minimum coldwater volume needed to protect the coldwater fish population in Shasta Reservoir is not known, the assessments for three carryover storage thresholds (2,500 taf, 2,000 taf, and 1,500 taf) were compared. Table 11-1A-101 shows the summary of the Shasta Reservoir coldwater habitat for three possible threshold values. The number of years with carryover storage less than the selected threshold (indicating a substantial reduction in coldwater habitat) for each alternative was compared to the number of years below the threshold storage for the baseline. As the carryover storage threshold is reduced, the likely impacts on coldwater habitat will be greater, but the impacts will be less frequent (measured as the number of years with carryover storage below the threshold). A coldwater habitat adverse effect determination was based on the number of additional years with carryover storage below the specified threshold value. An increase of greater than 5% of the years (5 more years) was selected as a substantial change in coldwater habitat conditions because these low storage conditions are expected infrequently during multi-year dry periods.

A comparison of the baseline cases shows the expected impacts on coldwater habitat from the effects of climate change shifts in hydrology as well as operational changes related to the Fall X2 requirements (USFWS BO) compared to the previous D-1641 Delta outflow criteria. The Shasta Reservoir carryover storage for the Existing Conditions baseline with no Fall X2 requirement (Existing Conditions) was less than 2,500 taf in 19 years, was less than 2,000 taf in 13 years and was less than 1,500 taf in 9 years (out of 82 years). The Shasta Reservoir carryover storage for the No Action Alternative (NAA) was less than 2,500 taf in 44 years, was less than 2,000 taf in 22 years and was less than 1,500 taf in 15 years. The increases for all of the storage thresholds would be judged adverse because an increase of greater than 5% of the years (5) was selected as the significance criteria. About 20–25% of the baseline carryover storage values should be less than the selected storage threshold, so that the threshold represents the lowest 20–25% of the years and so that the number of years with these impacted coldwater habitat conditions could be increased if the carryover storage values were reduced substantially by an alternative. The Shasta carryover storage threshold was selected to be 2,000 taf; the storage was less than this threshold in about 27% of the years (22/82) for the NAA.

Table 11-1A-101 indicates that using the 2,000 taf carryover storage threshold with a greater than 5% (5 year) increase criteria, none of the alternatives, including Alternative 1A, would have an adverse effect on Shasta Reservoir coldwater habitat in the late-long-term (LLT) when compared to the NAA. All of the alternatives would have Shasta Reservoir carryover storages of less than 2,000 taf in about the same number of years (19–23) as the baseline (22).

Evaluation of Effects on Coldwater Habitat in Other CVP and SWP Reservoirs

It is generally assumed that the availability of cold water can affect the success or sustainability of reservoir fish populations but specific management or biological criteria for defining this relationship for the major CVP and SWP reservoirs are not available. Based on the rationale presented above for Shasta Reservoir, carryover storage thresholds for each of the CVP and SWP reservoirs have been selected for this analysis for coldwater habitat conditions.

Table 11-1A-10 shows the summary of coldwater habitat evaluations for each of the six major CVP and SWP reservoirs. A single carryover storage threshold value was selected for each reservoir. Following the Shasta Reservoir example, this was based on a combination of available temperature profiles, hydropower penstock elevations, and minimum simulated storage values for each reservoir. Threshold carryover storage values were selected for each reservoir so that about 20–25% of the baseline carryover storage values would be less than the storage threshold; and assuming that greater than 5% more years (5 years) with less than the threshold storage would be an adverse effect on coldwater habitat conditions for each reservoir as a result of substantially less coldwater habitat being available during those years.

Trinity Reservoir has a maximum storage of about 2,500 taf and maximum carryover storage of 1,975 taf. The minimum simulated storage was about 250 taf, corresponding to the hydropower penstock intake. About 20% of CALSIM-simulated Trinity Reservoir carryover storages for the NAA baseline were less than 750 taf. The Trinity River Restoration Agreement required minimum carryover storages of 600 taf, and the 2009 NMFS BO requires "consultation" with Reclamation if the Trinity Reservoir carryover storage is expected to be less than 400 taf. The Trinity Reservoir carryover storage threshold was selected to be 750 taf, with a greater than 5% increase (5 years) impact criteria. Table 11-1A-102 indicates that none of the BDCP alternatives have adverse effects on the Trinity Reservoir coldwater habitat conditions. Figure 11-1A-10 shows the Trinity Reservoir carryover storages for the BDCP Alternatives (LLT) compared to the NAA carryover storages for 1922–2003. This provides a graphical description of the similarity of the Trinity Reservoir carryover storage sequences simulated with the CALSIM model for 1922–2003.

Shasta Reservoir has a maximum storage of about 4,500 taf and maximum carryover storage - of 3,400 taf. The minimum simulated storage is about 550 taf, corresponding to the hydropower penstock intake. About 27% of CALSIM-simulated Shasta Reservoir carryover storage for the NAA was below 2,000 taf. The 2009 NMFS BO requires “consultation” with Reclamation if the Shasta Reservoir carryover storage is expected to be less than 1,900 taf. The Shasta Reservoir carryover storage threshold was selected to be 2,000 taf, with a greater than 5% increase (5 years) impact criteria. Table 11-1A-102 indicates that none of the BDCP alternatives have adverse effects on the Shasta Reservoir coldwater habitat conditions. Figure 11-1A-11 shows the Shasta Reservoir carryover storages for the Alternatives (LLT) compared to the NAA carryover storages for 1922–2003. This provides a graphical description of the similarity of the Shasta Reservoir carryover storage sequences simulated with the CALSIM model for 1922–2003.

Oroville Reservoir has a maximum storage of about 3,500 taf and maximum carryover storage of 3,350 taf. The minimum simulated storage was about 500 taf, corresponding to the hydropower penstock intake. The 28% cumulative distribution of CALSIM-simulated Oroville Reservoir carryover storage for the NAA was about 1,000 taf. The Oroville target carryover storage is 1,000 taf; SWP deliveries are adjusted to maintain this minimum operational storage. The Oroville Reservoir carryover storage threshold was selected to be 1,000 taf, with a greater than 5% increase (5 years) impact criteria. Table 11-1A-102 indicates that none of the alternatives have adverse effects on the Oroville Reservoir coldwater habitat conditions. Figure 11-1A-12 shows the Oroville Reservoir carryover storages for the Alternatives (LLT) compared to the NAA carryover storages for 1922–2003. This provides a graphical description of the similarity of the Oroville Reservoir carryover storage sequences simulated with the CALSIM model for 1922–2003. Most of the alternatives would increase the carryover storage in Oroville Reservoir compared to the NAA; benefits for coldwater fish habitat in Oroville Reservoir are therefore expected for most alternatives.

Folsom Reservoir has a maximum storage of about 1,000 taf and maximum carryover storage of 650 taf. The minimum simulated storage is about 100 taf, corresponding to the hydropower penstock intake. The 18% cumulative distribution of CALSIM-simulated Folsom Reservoir carryover storage for the NAA was about 250 taf. The 2009 NMFS BO requires “consultation” with Reclamation if the Folsom Reservoir carryover storage is expected to be less than 250 taf. The Folsom Reservoir carryover storage threshold was selected to be 250 taf, with a greater than 5% increase (5 years) impact criteria. Table 11-1A-102 indicates that some of the alternatives may have adverse effects on the Folsom Reservoir coldwater habitat conditions. Figure 11-1A-13 shows the Folsom Reservoir carryover storages for the Alternatives (LLT) compared to the NAA carryover storages for 1922–2003. This provides a graphical description of the similarity of the Folsom Reservoir carryover storage sequences simulated with the CALSIM model for 1922–2003. Because Folsom Reservoir maximum storage is only 1,000 taf and the carryover storage is relatively low most years, there is not a major coldwater fish population (trout) in Folsom Reservoir; the potential impacts on coldwater habitat in Folsom Reservoir are somewhat less than for coldwater habitat in Trinity, Shasta, and Oroville Reservoirs.

New Melones Reservoir has a maximum storage of about 2,400 taf and maximum carryover storage of 2,000 taf. The minimum simulated storage is about 100 taf, corresponding to the hydropower penstock intake. About 26% of CALSIM-simulated New Melones Reservoir carryover storage for the NAA were less than 750 taf. The New Melones Reservoir carryover storage threshold was selected to be 750 taf, with a greater than 5% increase (5 years) impact criteria. Table 11-1A-102 indicates that none of the alternatives have adverse effects on the New Melones Reservoir coldwater habitat conditions. Figure 11-1A-14 shows the New Melones Reservoir carryover storages for the Alternatives (LLT) compared to the NAA baseline carryover storages for 1922–2003. This provides a graphical description of the similarity of the New Melones Reservoir carryover storage sequences simulated with the CALSIM model for 1922–2003. Because the New Melones Reservoir (and all other San Joaquin Basin Reservoirs) operations were only changed for the climate change hydrology, there were no simulated differences in the New Melones Reservoir operations for the alternatives. There were, therefore, no impacts on New Melones Reservoir coldwater habitat conditions.

San Luis Reservoir has a maximum storage of about 2,000 taf and maximum carryover storage of 1,725 taf. The minimum simulated storage is about 100 taf, corresponding to the hydropower penstock intake. About 26% of CALSIM-simulated San Luis Reservoir carryover storage for the NAA were less than 350 taf. The San Luis Reservoir carryover storage threshold was selected to be 350 taf, with a greater than 5% increase (5 years) impact criteria. Figure 11-1A-15 shows the San Luis Reservoir carryover storages for the Alternatives (LLT) compared to the NAA carryover storages for 1922–2003. This provides a graphical description of the differences in the San Luis Reservoir carryover storage sequences simulated with the CALSIM model for 1922–2003. Table 11-1A-102 indicates that several of the alternatives will reduce the San Luis carryover storage substantially, with more than 4 additional years with carryover storage of less than 350 taf. However, because San Luis Reservoir is an off-stream storage reservoir that is filled each year with water exported from the Delta, the temperature stratification in the reservoir is usually eliminated by the pumping of relatively warm water into the reservoir through the inlet that is located near the bottom of the reservoir. The releases from San Luis Reservoir are also made through the intake/outlet structure near the bottom of the reservoir so that the coldest water is released during the spring and summer. Therefore, there is no coldwater habitat in the reservoir; San Luis Reservoir is dominated by warm-water fish (largemouth bass and striped bass). Although the San Luis Reservoir carryover storage was reduced by most of the alternatives, there is no coldwater habitat in San Luis Reservoir during most years and therefore no impacts to the coldwater habitat.

NEPA Effects: In summary, this effect would not be adverse because coldwater fish habitat in the CVP and SWP upstream reservoirs under Alternative 1A would not be substantially reduced when compared to the No Action Alternative.

CEQA Conclusion: In general, Alternative 1A would reduce the quantity of coldwater fish habitat in the CVP and SWP as shown in Table 11-1A-102. There would be a greater than 5% increase (5 years) for several of the reservoirs when compared to Existing Conditions, which could result in a significant impact.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 1A does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. As a result, the CEQA conclusion regarding Alternative 1A, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on coldwater habitat in upstream reservoirs. This impact is found to be less than significant and no mitigation is required.

Table 11-1A-101. Evaluation of Coldwater Habitat Impacts for Shasta Reservoir Using Three Different Carryover Storage Thresholds (Years with Carryover Storage Less than Threshold, out of 82 Years)

Reservoir Threshold	Shasta <2,500	Shasta <2,000	Shasta <1,500
Baselines			
Existing Conditions	19	13	9
NAA	44	22	15
Alternatives			
Alt 1 LLT	44	23	16
Alt 2 LLT	48	22	14
Alt 3 LLT	44	20	15
Alt 4 LLT	49	23	14
Alt 5 LLT	51	22	14
Alt 6 LLT	35	19	14
Alt 7 LLT	43	22	16
Alt 8 LLT	41	22	12
Alt 9 LLT	43	23	14

Table 11-1A-102. Evaluation of Coldwater Habitat Effects (Years with Carryover Storage Less than Threshold) for CALSIM-Simulated Baselines and Alternatives for 1922–2003

Reservoir	Trinity		Shasta		Oroville		Folsom		New Melones		San Luis	
Threshold (taf)	<750		<2,000		<1,000		<2,50		<7,50		<350	
Existing	11	13%	13	16%	8	10%	5	6%	17	21%	9	11%
NAA	16	20%	22	27%	23	28%	15	18%	21	26%	21	26%
	Value	Difference	Value	Difference	Value	Difference	Value	Difference	Value	Difference	Value	Difference
Existing v. Alt 1 LLT	19	8	23	10	8	0	15	10	21	4	23	14
NAA v. Alt 1 LLT	19	3	23	1	8	-15	15	0	21	0	23	2
Existing v. Alt 2 LLT	19	8	22	9	14	6	20	15	21	4	45	36
NAA v. Alt 2 LLT	19	3	22	0	14	-9	20	5	21	0	45	24
Existing v. Alt 3 LLT	18	7	20	7	8	0	15	10	21	4	25	16
NAA v. Alt 3 LLT	18	2	20	-2	8	-15	15	0	21	0	25	4
Existing v. Alt 4 LLT	18	7	23	10	14	6	19	14	21	4	51	42
NAA v. Alt 4 LLT	18	2	23	1	14	-9	19	4	21	0	51	30
Existing v. Alt 5 LLT	18	7	22	9	14	6	18	13	21	4	37	28
NAA v. Alt 5 LLT	18	2	22	0	14	-9	18	3	21	0	37	16
Existing v. Alt 6 LLT	16	5	19	6	6	-2	14	9	21	4	70	61
NAA v. Alt 6 LLT	16	0	19	-3	6	-17	14	-1	21	0	70	49
Existing v. Alt 7 LLT	17	6	22	9	8	0	19	14	21	4	63	54
NAA v. Alt 7 LLT	17	1	22	0	8	-15	19	4	21	0	63	42
Existing v. Alt 8 LLT	15	4	22	9	16	8	21	16	21	4	76	67
NAA v. Alt 8 LLT	15	-1	22	0	16	-7	21	6	21	0	76	55
Existing v. Alt 9 LLT	18	7	23	10	18	10	13	8	21	4	39	30
NAA v. Alt 9 LLT	18	2	23	1	18	-5	13	-2	21	0	39	18

11.3.4.3 Alternative 1B—Dual Conveyance with East Alignment and Intakes 1–5 (15,000 cfs; Operational Scenario A)

Alternative 1B would be nearly identical to Alternative 1A except that the up to 15,000 cfs of water routed from the north Delta to the south Delta would be conveyed by gravity through a canal along the east side of the Delta instead of through pipelines/tunnels. While the five intakes would be located and constructed on the east bank of the Sacramento River identical to those under Alternative 1A, the difference in the type of conveyance facility (e.g., canal) results in different construction details to a limited extent as they relate to potential impacts on fish. Specifically, eight culvert and three tunnel siphons would be utilized to divert canal water beneath existing water courses and their construction would occur within those water courses. Alternative 1B would also have one barge landing and 19 bridge crossings compared to six barge landings and no bridge crossings for Alternative 1A. Approximately 4,500 barge trips would occur during construction. Besides the primary difference of utilizing a canal rather than a tunnel, Alternative 1B would have other structural differences such as inclusion of an intermediate pumping plant and elimination of the intermediate forebay. However, these latter differences would not affect fish resources and are not evaluated further in this chapter. Overall, construction impacts from Alternative 1B would be similar to Alternative 1A but with additional in-water work as described above. However, implementation of mitigation measures (described below) and environmental commitments (see Appendix 3B, *Environmental Commitments*) would reduce impacts as described under Alternative 1A.

Water supply and conveyance operations would follow the guidelines described as Scenario A, which is identical to those analyzed under Alternative 1A. CM2–CM22 would be implemented under this alternative, and these conservation measures would be identical to those under Alternative 1A. See Chapter 3, *Description of Alternatives*, for additional details on Alternative 1B.

Delta Smelt

Construction and Maintenance of CM1

The potential effects of construction and maintenance of water conveyance facilities on delta smelt and their designated critical habitat would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A (Impact AQUA-1 and AQUA-2), the effects described for delta smelt under Alternative 1A also appropriately characterize effects under Alternative 1B.

Impact AQUA-1: Effects of Construction of Water Conveyance Facilities on Delta Smelt

Impact AQUA-2: Effects of Maintenance of Water Conveyance Facilities on Delta Smelt

The potential effects of construction and maintenance of water conveyance facilities on delta smelt would be similar to those described under Alternative 1A, Impact AQUA-1 and AQUA-2. Unlike Alternative 1A, which would convey water from the north Delta to the south Delta through pipelines/tunnels, Alternative 1B would convey water through a surface canal. The surface canal conveyance in Alternative 1B would include an east-side canal with eight culvert siphons constructed below the following crossings: Stone Lake drain, Beaver Slough, Hog Slough, Sycamore Slough, White Slough, Disappointment Slough, BNSF Railroad, and Middle River.

Small numbers of delta smelt eggs, larvae, and adults could be present in the Delta in June and July during construction of intake facilities, barge landing, and invert culvert siphons.

As concluded in Alternative 1A, Impact AQUA-1 and AQUA-2, the effects will result in both temporary and permanent alteration of migration, spawning, and rearing habitats used by delta smelt. However, these effects are not expected to be adverse from a population standpoint, because local water quality conditions, very low electrical conductivity and typically low turbidity limit the suitability of this river reach for delta smelt (Werner et al. 2010). Moreover, any habitat losses will be offset by habitat restoration and beneficial operational effects on the Delta as a whole.

NEPA Effects: For the reasons described above, the construction and short-term maintenance activities would not be adverse for delta smelt.

CEQA Conclusion: As described in Impact AQUA-1 under Alternative 1A for delta smelt, the impact of the construction and maintenance of water conveyance facilities on delta smelt would not be significant except for construction noise associated with pile driving. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Alternative 1A, Impact AQUA-1.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Alternative 1A, Impact AQUA-1. Water Operations of CM1

Alternative 1B has the same diversion and conveyance operations as Alternative 1A. The primary difference between the two alternatives is that conveyance under Alternative 1B would be in a lined or unlined canal, instead of a pipeline. Because there would be no difference in conveyance capacity or operations, there would be no differences between these two alternatives in upstream of the Delta river flows or reservoir operations, Delta inflow, and hydrodynamics in the Delta. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A (Impact AQUA-3 through AQUA-6), the fish effects described for Alternative 1A also appropriately characterize effects under Alternative 1B.

The following impacts are those presented under Alternative 1A that are identical for Alternative 1B.

Impact AQUA-3: Effects of Water Operations on Entrainment of Delta Smelt

Impact AQUA-4: Effects of Water Operations on Spawning and Egg Incubation Habitat for Delta Smelt

Impact AQUA-5: Effects of Water Operations on Rearing Habitat for Delta Smelt

Impact AQUA-6: Effects of Water Operations on Migration Conditions for Delta Smelt

NEPA Effects: With the exception of Impact AQUA-5, the other impact mechanisms listed above would not be adverse to delta smelt under Alternative 1B. This is the same conclusion as described in detail under Alternative 1A, and is based on the expected overall limited or slightly beneficial impacts. However, the overall effect of Impact AQUA-5 on delta smelt rearing habitat would remain adverse because of the potential adverse change in the fall abiotic habitat and the uncertainty regarding BDCP restoration efforts (see Alternative 1A, AQUA-5 for details on expected effects).

CEQA Conclusion: The effects of all of the above listed impact mechanisms would be less than significant, or slightly beneficial to delta smelt, and no mitigation would be required. Detailed discussions regarding these conclusions are presented in Alternative 1A.

Restoration Measures (CM2, CM4–CM7, and CM10)

Alternative 1B has the same Restoration Measures as Alternative 1A. Because no substantial differences in restoration-related fish effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A, the fish effects of restoration measures described for Alternative 1A (Impact AQUA-7 through AQUA-9) also appropriately characterize effects under Alternative 1B.

The following impacts are those presented under Alternative 1A that are identical for Alternative 1B.

Impact AQUA-7: Effects of Construction of Restoration Measures on Delta Smelt

Impact AQUA-8: Effects of Contaminants Associated with Restoration Measures on Delta Smelt

Impact AQUA-9: Effects of Restored Habitat Conditions on Delta Smelt

NEPA Effects: Detailed discussions regarding the potential effects of these three impact mechanisms on delta smelt are the same for Alternative 1B, as those described under Alternatives 1A. The effects could be not adverse and/or generally beneficial. Specifically for AQUA-8, the effects of contaminants on delta smelt with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on delta smelt are uncertain.

CEQA Conclusion: All three of the impact mechanisms listed above would all be beneficial or less than significant, because they are intended to increase suitable habitat and habitat functions. Therefore, no mitigation is required.

Other Conservation Measures (CM12–CM19 and CM21)

Alternative 1B has the same Other Conservation Measures as Alternative 1A. Because no substantial differences in other conservation measure-related fish effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A, the fish effects of the other conservation measures described for Alternative 1A (Impact AQUA-10 through AQUA-18) also appropriately characterize effects under Alternative 1B.

The following impacts are those presented under Alternative 1A that are identical for Alternative 1B.

Impact AQUA-10: Effects of Methylmercury Management on Delta Smelt (CM12)

Impact AQUA-11: Effects of Invasive Aquatic Vegetation Management on Delta Smelt (CM13)

Impact AQUA-12: Effects of Dissolved Oxygen Level Management on Delta Smelt (CM14)

Impact AQUA-13: Effects of Localized Reduction of Predatory Fish on Delta Smelt (CM15)

Impact AQUA-14: Effects of Nonphysical Fish Barriers on Delta Smelt (CM16)

Impact AQUA-15: Effects of Illegal Harvest Reduction on Delta Smelt (CM17)

Impact AQUA-16: Effects of Conservation Hatcheries on Delta Smelt (CM18)

Impact AQUA-17: Effects of Urban Stormwater Treatment on Delta Smelt (CM19)

Impact AQUA-18: Effects of Removal/Relocation of Nonproject Diversions on Delta Smelt (CM21)

NEPA Effects: As described in Alternative 1A, none of these impact mechanisms (Impact AQUA 10 through 18) would be adverse to delta smelt, and some would be at least slightly beneficial.

CEQA Conclusion: All nine of the impact mechanisms listed above would be at least slightly beneficial, or less than significant, and no mitigation is required.

Longfin Smelt

The potential effects of construction and maintenance of water conveyance facilities on longfin smelt would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A (Impact AQUA-19 and AQUA-20), the effects described for longfin smelt under Alternative 1A also appropriately characterize effects for longfin smelt under Alternative 1B.

The following impacts on longfin smelt are those presented under Alternative 1A that are identical for Alternative 1B.

Impact AQUA-19: Effects of Construction of Water Conveyance Facilities on Longfin Smelt

Impact AQUA-20: Effects of Maintenance of Water Conveyance Facilities on Longfin Smelt

***NEPA Effects*:** These impact mechanisms would not be adverse to longfin smelt, although construction activities could result in adverse effects from impact pile driving activities. However, the implementation of the avoidance and minimization measures and Mitigation Measures AQUA-1a and AQUA-1b (described under Impact AQUA-1 in Alternative 1A for delta smelt) would minimize or eliminate adverse effects (e.g., injury or mortality).

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, Impact AQUA-19 could result in significant underwater noise effects from impact pile driving, although implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of water conveyance facility operations on longfin smelt would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1B compared to Alternative 1A (Impact AQUA-21 through AQUA-24), the effects described for longfin smelt under Alternatives 1A also appropriately characterize effects under Alternative 1B.

Impact AQUA-21: Effects of Water Operations on Entrainment of Longfin Smelt

Impact AQUA-22: Effects of Water Operations on Spawning, Egg Incubation, and Rearing Habitat for Longfin Smelt

Impact AQUA-23: Effects of Water Operations on Rearing Habitat for Longfin Smelt

Discussion provided above, under Impact AQUA-22

Impact AQUA-24: Effects of Water Operations on Migration Conditions for Longfin Smelt

Discussion provided above, under Impact AQUA-22

NEPA Effects: As discussed under Impact AQUA-21 through AQUA-24 in Alternative 1A, the effect of lower Delta winter-spring outflow under Alternative 1B on longfin smelt spawning and rearing has the potential to be adverse. This effect is a result of the specific reservoir operations, exports and resulting flows associated with this alternative. However, Alternative 1B includes an adaptive management plan that could be used to adjust spring operations as determined necessary through the adaptive management process. These adaptive management procedures are described in Mitigation Measures 22a through 22c, under Alternative 1A.

CEQA Conclusion: These impact mechanisms could result in significant effects to longfin smelt given the outflow-abundance relationship described by Kimmerer et al. (2009), although there are uncertainties regarding the outcome as a result of habitat restoration, and changes in winter-spring outflow. However, implementation of Mitigation Measures AQUA-22a through 22c, habitat restoration, and reduced larval entrainment would reduce this impact to less than significant, so no additional mitigation would be required.

Mitigation Measure AQUA-22a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Longfin Smelt to Determine Feasibility of Mitigation to Reduce Impacts to Spawning and Rearing Habitat

Please refer to Mitigation Measure AQUA-22a under Impact AQUA-22 of Alternative 1A.

Mitigation Measure AQUA-22b: Conduct Additional Evaluation and Modeling of Impacts on Longfin Smelt Rearing Habitat Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-22b under Impact AQUA-22 of Alternative 1A.

Mitigation Measure AQUA-22c: Consult with USFWS and CDFW to Identify and Implement Feasible Means to Minimize Effects on Longfin Smelt Rearing Habitat Consistent with CM1

Please refer to Mitigation Measure AQUA-22c under Impact AQUA-22 of Alternative 1A.

Restoration and Conservation Measures

The potential effects of restoration measures and other conservation measures on longfin smelt would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A (Impact AQUA-25 through AQUA-36), the effects described for longfin smelt under Alternative 1A also appropriately characterize effects for longfin smelt under Alternative 1B.

Impact AQUA-25: Effects of Construction of Restoration Measures on Longfin Smelt

Impact AQUA-26: Effects of Contaminants Associated with Restoration Measures on Longfin Smelt

Impact AQUA-27: Effects of Restored Habitat Conditions on Longfin Smelt

Impact AQUA-28: Effects of Methylmercury Management on Longfin Smelt (CM12)

Impact AQUA-29: Effects of Invasive Aquatic Vegetation Management on Longfin Smelt (CM13)

Impact AQUA-30: Effects of Dissolved Oxygen Level Management on Longfin Smelt (CM14)

Impact AQUA-31: Effects of Localized Reduction of Predatory Fish on Longfin Smelt (CM15)

Impact AQUA-32: Effects of Nonphysical Fish Barriers on Longfin Smelt (CM16)

Impact AQUA-33: Effects of Illegal Harvest Reduction on Longfin Smelt (CM17)

Impact AQUA-34: Effects of Conservation Hatcheries on Longfin Smelt (CM18)

Impact AQUA-35: Effects of Urban Stormwater Treatment on Longfin Smelt (CM19)

Impact AQUA-36: Effects of Removal/Relocation of Nonproject Diversions on Longfin Smelt (CM21)

NEPA Effects: The impact mechanisms listed above would range from no effect, to no adverse effect, or beneficial effects on longfin smelt for the reasons identified for Alternative 1A. Specifically for AQUA-26, the effects of contaminants on longfin smelt with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on longfin smelt are uncertain.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would range from no impact, to less than significant, or beneficial for longfin smelt for the reasons identified under Alternative 1A, and no mitigation would be required.

Winter-Run Chinook Salmon

Construction and Maintenance of CM1

The potential effects of construction and maintenance of water conveyance facilities on winter-run Chinook salmon would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A (Impact AQUA-37 and AQUA-38), the effects described for winter-run Chinook salmon under Alternative 1A also appropriately characterize effects for winter-run Chinook salmon under Alternative 1B.

Impact AQUA-37: Effects of Construction of Water Conveyance Facilities on Chinook Salmon (Winter-Run ESU)

Impact AQUA-38: Effects of Maintenance of Water Conveyance Facilities on Chinook Salmon (Winter-Run ESU)

NEPA Effects: These impact mechanisms would not be adverse to winter-run Chinook salmon. While construction activities (Impact AQUA-37) could result in adverse effects from impact pile driving activities, the implementation of Mitigation Measures AQUA-1a and AQUA-1b, would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality).

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, Impact AQUA-37 could result in significant underwater noise effects from impact pile driving, although implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of operations of water conveyance facilities on winter-run Chinook salmon would be similar to those described for Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A (Impacts AQUA-39 through AQUA-42), the effects described for winter-run Chinook salmon also appropriately characterize the effects under Alternative 1B.

Impact AQUA-39: Effects of Water Operations on Entrainment of Chinook Salmon (Winter-Run ESU)

Impact AQUA-40: Effects of Water Operations on Spawning and Egg Incubation Habitat for Chinook Salmon (Winter-Run ESU)

Impact AQUA-41: Effects of Water Operations on Rearing Habitat for Chinook Salmon (Winter-Run ESU)

Impact AQUA-42: Effects of Water Operations on Migration Conditions for Chinook Salmon (Winter-Run ESU)

NEPA Effects: Although analysis conducted as part of the EIR/EIS determined that Alternative 1B would have unavoidable adverse effects on winter-run Chinook salmon spawning, incubation, and/or rearing habitat, as well as overall migration conditions. This conclusion was based on the best available scientific information at the time and may prove to have been over- or understated. The effects are a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this effect to a level that is not adverse would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, these would be unavoidable adverse effects. The implementation of the mitigation measures listed below would reduce the severity of effects, although not necessarily to a not adverse level.

CEQA Conclusion: Similar to the discussion provided above, and for Alternative 1A, these impact mechanisms would have a significant effect on winter-run Chinook salmon spawning, incubation, and rearing habitat and/or migration conditions under Alternative 1B. The implementation of the mitigation measures listed below would reduce the severity of effects, although not necessarily to a less than significant level.

Upon the commencement of operations of CM1 and continuing through the life of the permit, the BDCP proponents will monitor potential effects on spawning, incubation, and rearing habitat to determine whether such effects would be as extensive as concluded at the time of preparation of this document and to determine any potentially feasible means of reducing the severity of such effects. This mitigation measure requires a series of actions to accomplish these purposes, consistent with the operational framework for Alternative 1B.

The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 1B operations only, and not effects of climate change or sea level rise. Development of mitigation actions for the incremental impact on winter-run Chinook salmon habitat attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 1B. The mitigation measures identified below would provide an adaptive management process, that may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6), for assessing impacts and developing appropriate minimization measures.

Mitigation Measure AQUA-40a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Winter-Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Spawning Habitat

Please refer to Mitigation Measure AQUA-40a under Alternative 1A (Impact AQUA-40) for winter-run Chinook salmon.

Mitigation Measure AQUA-40b: Conduct Additional Evaluation and Modeling of Impacts on Winter-Run Chinook Salmon Spawning Habitat Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-40b under Alternative 1A (Impact AQUA-40) for winter-run Chinook salmon.

Mitigation Measure AQUA-40c: Consult with USFWS and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Winter-Run Chinook Salmon Spawning Habitat Consistent with CM1

Please refer to Mitigation Measure AQUA-40c under Alternative 1A (Impact AQUA-40) for winter-run Chinook salmon.

Mitigation Measure AQUA-41a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Winter-Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Rearing Habitat

Please refer to Mitigation Measure AQUA-41a under Alternative 1A (Impact AQUA-41) for winter-run Chinook salmon.

Mitigation Measure AQUA-41b: Conduct Additional Evaluation and Modeling of Impacts on Winter-Run Chinook Salmon Rearing Habitat Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-41b under Alternative 1A (Impact AQUA-41) for winter-run Chinook salmon.

Mitigation Measure AQUA-41c: Consult with USFWS and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Winter-Run Chinook Salmon Rearing Habitat Consistent with CM1

Please refer to Mitigation Measure AQUA-41c under Alternative 1A (Impact AQUA-41) for winter-run Chinook salmon.

Mitigation Measure AQUA-42a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Winter-Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Migration Conditions

Please refer to Mitigation Measure AQUA-42a under Alternative 1A (Impact AQUA-41) for winter-run Chinook salmon.

Mitigation Measure AQUA-42b: Conduct Additional Evaluation and Modeling of Impacts on Winter-Run Chinook Salmon Migration Conditions Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-42b under Alternative 1A (Impact AQUA-41) for winter-run Chinook salmon.

Mitigation Measure AQUA-42c: Consult with USFWS, and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Winter-Run Chinook Salmon Migration Conditions Consistent with CM1

Please refer to Mitigation Measure AQUA-42c under Alternative 1A (Impact AQUA-41) for winter-run Chinook salmon.

Restoration and Conservation Measures

The potential effects of restoration measures and other conservation measures on winter-run Chinook salmon would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A (Impact AQUA-43 through AQUA-54), the effects described for winter-run Chinook salmon under Alternative 1A also appropriately characterize effects under Alternative 1B.

Impact AQUA-43: Effects of Construction of Restoration Measures on Chinook Salmon (Winter-Run ESU)

Impact AQUA-44: Effects of Contaminants Associated with Restoration Measures on Chinook Salmon (Winter-Run ESU)

Impact AQUA-45: Effects of Restored Habitat Conditions on Chinook Salmon (Winter-Run ESU)

Impact AQUA-46: Effects of Methylmercury Management on Chinook Salmon (Winter-Run ESU) (CM12)

Impact AQUA-47: Effects of Invasive Aquatic Vegetation Management on Chinook Salmon (Winter-Run ESU) (CM13)

Impact AQUA-48: Effects of Dissolved Oxygen Level Management on Chinook Salmon (Winter-Run ESU) (CM14)

Impact AQUA-49: Effects of Localized Reduction of Predatory Fish on Chinook Salmon (Winter-Run ESU) (CM15)

Impact AQUA-50: Effects of Nonphysical Fish Barriers on Chinook Salmon (Winter-Run ESU) (CM16)

Impact AQUA-51: Effects of Illegal Harvest Reduction on Chinook Salmon (Winter-Run ESU) (CM17)

Impact AQUA-52: Effects of Conservation Hatcheries on Chinook Salmon (Winter-Run ESU) (CM18)

Impact AQUA-53: Effects of Urban Stormwater Treatment on Chinook Salmon (Winter-Run ESU) (CM19)

Impact AQUA-54: Effects of Removal/Relocation of Nonproject Diversions on Chinook Salmon (Winter-Run ESU) (CM21)

NEPA Effects: As discussed in detail for Alternative 1A, these impact mechanisms would not be adverse, and would typically be beneficial to winter-run Chinook salmon. Specifically for AQUA-44, the effects of contaminants on winter-run Chinook salmon with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on winter-run Chinook salmon are uncertain.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, most of these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

Spring-Run Chinook Salmon

Construction and Maintenance of CM1

The potential effects of construction and maintenance of water conveyance facilities on spring-run Chinook salmon would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A (Impact AQUA-55 and AQUA-56), the effects described for spring-run Chinook salmon under Alternative 1A also appropriately characterize effects for spring-run Chinook salmon under Alternative 1B.

Impact AQUA-55: Effects of Construction of Water Conveyance Facilities on Chinook Salmon (Spring-Run ESU)

Impact AQUA-56: Effects of Maintenance of Water Conveyance Facilities on Chinook Salmon (Spring-Run ESU)

NEPA Effects: While construction activities (Impact AQUA-55) could result in adverse effects from impact pile driving activities, the implementation of Mitigation Measures AQUA-1a and AQUA-1b, would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality). The periodic and short-term maintenance activities would not be adverse.

CEQA Conclusion: Similar to the discussion provided above for Alternatives 1A, Impact AQUA-55 could result in significant underwater noise effects from impact pile driving, although implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of water conveyance facility operations on spring-run Chinook salmon would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A (Impact AQUA-57 and AQUA-60), the effects described for spring-run Chinook salmon under Alternative 1A also appropriately characterize effects under Alternative 1B.

Impact AQUA-57: Effects of Water Operations on Entrainment of Chinook Salmon (Spring-Run ESU)

Impact AQUA-58: Effects of Water Operations on Spawning and Egg Incubation Habitat for Chinook Salmon (Spring-Run ESU)

Impact AQUA-59: Effects of Water Operations on Rearing Habitat for Chinook Salmon (Spring-Run ESU)

Impact AQUA-60: Effects of Water Operations on Migration Conditions for Chinook Salmon (Spring-Run ESU)

NEPA Effects: As discussed in detail for Alternative 1A, the effects of Alternative 1B operations on entrainment, spawning and egg incubation habitat, and through-Delta migration conditions for spring-run Chinook salmon would be adverse due to predation and habitat loss associated with the five intakes of the north Delta facilities, and flow changes in the Feather River. However, the implementation of applicable conservation measures (CM6, *Channel Margin Enhancement* and CM15, *Predator Control*), as described in Chapter 3, Section 3.6, would minimize potential effects. In addition, the implementation of the mitigation measures listed below also has the potential to reduce the severity of the impact to migration conditions, although not necessarily to a not adverse level. These mitigation measures would provide an adaptive management process, that may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6), for assessing impacts and developing appropriate minimization measures.

CEQA Conclusion: As discussed above, and in detail for Alternative 1A, the effects of the impact mechanisms listed above (except for Impact AQUA-59) would be significant under Alternative 1B for spring-run Chinook salmon. However, differences between Alternative 1B (which is under LLT conditions that include future sea level rise and climate change) and Existing Conditions may therefore either overstate the effects of Alternative 1B, or suggest significant effects that are largely attributable to sea level rise and climate change rather than the alternative. Based on the overall assessment, Alternative 1B could result in a significant and unavoidable effect on migration conditions. While the mitigation measures listed below would reduce the severity of effects, they are likely to remain significant and unavoidable.

Mitigation Measure AQUA-58a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Spring-Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Spawning Habitat

Please refer to Mitigation Measure AQUA-58a under Alternative 1A (Impact AQUA-60) for spring-run Chinook salmon.

Mitigation Measure AQUA-58b: Conduct Additional Evaluation and Modeling of Impacts on Spring-Run Chinook Salmon Spawning Habitat Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-58b under Alternative 1A (Impact AQUA-60) for spring-run Chinook salmon.

Mitigation Measure AQUA-58c: Consult with USFWS and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Spring-Run Chinook Salmon Spawning Habitat Consistent with CM1

Please refer to Mitigation Measure AQUA-58c under Alternative 1A (Impact AQUA-60) for spring-run Chinook salmon.

Mitigation Measure AQUA-60a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Spring-Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Migration Conditions

Please refer to Mitigation Measure AQUA-60a under Alternative 1A (Impact AQUA-60) for spring-run Chinook salmon.

Mitigation Measure AQUA-60b: Conduct Additional Evaluation and Modeling of Impacts on Spring-Run Chinook Salmon Migration Conditions Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-60b under Alternative 1A (Impact AQUA-60) for spring-run Chinook salmon.

Mitigation Measure AQUA-60c: Consult with USFWS, and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Spring-Run Chinook Salmon Migration Conditions Consistent with CM1

Please refer to Mitigation Measure AQUA-60c under Alternative 1A (Impact AQUA-60) for spring-run Chinook salmon.

Restoration and Conservation Measures

The potential effects of restoration measures and other conservation measures on spring-run Chinook salmon would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A (Impact AQUA-61 through AQUA-72). Therefore, the effects on spring-run Chinook salmon under Alternative 1A also appropriately characterize effects under Alternative 1B.

Impact AQUA-61: Effects of Construction of Restoration Measures on Chinook Salmon (Spring-Run ESU)

Impact AQUA-62: Effects of Contaminants Associated with Restoration Measures on Chinook Salmon (Spring-Run ESU)

Impact AQUA-63: Effects of Restored Habitat Conditions on Chinook Salmon (Spring-Run ESU)

Impact AQUA-64: Effects of Methylmercury Management on Chinook Salmon (Spring-Run ESU) (CM12)

Impact AQUA-65: Effects of Invasive Aquatic Vegetation Management on Chinook Salmon (Spring-Run ESU) (CM13)

Impact AQUA-66: Effects of Dissolved Oxygen Level Management on Chinook Salmon (Spring-Run ESU) (CM14)

Impact AQUA-67: Effects of Localized Reduction of Predatory Fish on Chinook Salmon (Spring-Run ESU) (CM15)

Impact AQUA-68: Effects of Nonphysical Fish Barriers on Chinook Salmon (Spring-Run ESU) (CM16)

Impact AQUA-69: Effects of Illegal Harvest Reduction on Chinook Salmon (Spring-Run ESU) (CM17)

Impact AQUA-70: Effects of Conservation Hatcheries on Chinook Salmon (Spring-Run ESU) (CM18)

Impact AQUA-71: Effects of Urban Stormwater Treatment on Chinook Salmon (Spring-Run ESU) (CM19)

Impact AQUA-72: Effects of Removal/Relocation of Nonproject Diversions on Chinook Salmon (Spring-Run ESU) (CM21)

NEPA Effects: As discussed for Alternative 1A, the above listed impact mechanisms would not be adverse, and with the implementation of environmental commitments and conservation measures, the effects would typically be beneficial to spring-run Chinook salmon. Specifically for AQUA-62, the effects of contaminants on spring-run Chinook salmon with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on spring-run Chinook salmon are uncertain.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

Fall-/Late Fall–Run Chinook Salmon

Construction and Maintenance of CM1

The potential effects of construction and maintenance of water conveyance facilities on fall- and late fall-run Chinook salmon would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A (Impact AQUA-73 and AQUA-74), the fish effects described for fall- and late fall-run Chinook salmon under Alternative 1A also appropriately characterize effects under Alternative 1B.

Impact AQUA-73: Effects of Construction of Water Conveyance Facilities on Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-74: Effects of Maintenance of Water Conveyance Facilities on Chinook Salmon (Fall-/Late Fall–Run ESU)

NEPA Effects: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would not be adverse to fall- and late fall-run Chinook salmon. While construction activities (Impact

AQUA-73) could result in adverse effects from impact pile driving activities, the implementation of Mitigation Measures AQUA-1a and AQUA-1b, would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality).

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, Impact AQUA-73 could result in significant underwater noise effects from impact pile driving, although implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of water conveyance facility operations on fall- and late fall-run Chinook salmon would be similar to those described for Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A (Impacts AQUA-75 through AQUA-78), the effects described for fall- and late fall-run Chinook salmon also appropriately characterize the effects for Alternative 1B.

Impact AQUA-75: Effects of Water Operations on Entrainment of Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-76: Effects of Water Operations on Spawning and Egg Incubation Habitat for Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-77: Effects of Water Operations on Rearing Habitat for Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-78: Effects of Water Operations on Migration Conditions for Chinook Salmon (Fall-/Late Fall–Run ESU)

NEPA Effects: As indicated under Alternative 1A, the analysis results indicate that the effect of Alternative 1B is adverse because it has the potential to substantially interfere with the movement of fall-/late fall-run Chinook salmon. This would include adverse effects on fall-/late fall-run Chinook salmon through-delta migration conditions on the Sacramento River, relative to NAA, while through-Delta conditions on the San Joaquin River would be positive. The implementation of the conservation and mitigation measures listed below also has the potential to reduce the severity of the impact though not necessarily to a not adverse level.

CEQA Conclusion: The effects of Alternative 1B would be similar to those discussed above under Alternative 1A. The implementation of applicable conservation measures (CM6, *Channel Margin Enhancement* and CM15, *Predator Control*), as described in Chapter 3, Section 3.6, would minimize potential effects. In addition, the implementation of the mitigation measures listed below also has the potential to reduce the severity of the impact though not necessarily to a less-than-significant level. These mitigation measures would provide an adaptive management process, that could be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6), for assessing impacts and developing appropriate minimization measures.

Mitigation Measure AQUA-78a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Fall-/Late Fall–Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Migration Conditions

Please refer to Mitigation Measure AQUA-78a under Alternative 1A (Impact AQUA-78) for fall/late fall-run Chinook salmon.

Mitigation Measure AQUA-78b: Conduct Additional Evaluation and Modeling of Impacts on Fall-/Late Fall–Run Chinook Salmon Migration Conditions Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-78b under Alternative 1A (Impact AQUA-78) for fall/late fall-run Chinook salmon.

Mitigation Measure AQUA-78c: Consult with USFWS and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Fall-/Late Fall–Run Chinook Salmon Migration Conditions Consistent with CM1

Please refer to Mitigation Measure AQUA-78c under Alternative 1A (Impact AQUA-78) for fall/late fall-run Chinook salmon.

Restoration and Conservation Measures

Impact AQUA-79: Effects of Construction of Restoration Measures on Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-80: Effects of Contaminants Associated with Restoration Measures on Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-81: Effects of Restored Habitat Conditions on Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-82: Effects of Methylmercury Management on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM12)

Impact AQUA-83: Effects of Invasive Aquatic Vegetation Management on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM13)

Impact AQUA-84: Effects of Dissolved Oxygen Level Management on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM14)

Impact AQUA-85: Effects of Localized Reduction of Predatory Fish on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM15)

Impact AQUA-86: Effects of Nonphysical Fish Barriers on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM16)

Impact AQUA-87: Effects of Illegal Harvest Reduction on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM17)

Impact AQUA-88: Effects of Conservation Hatcheries on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM18)

Impact AQUA-89: Effects of Urban Stormwater Treatment on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM19)

Impact AQUA-90: Effects of Removal/Relocation of Nonproject Diversions on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM21)

NEPA Effects: As discussed in detail for Alternative 1A, these restoration and conservation commitment impact mechanisms (Impact AQUA-79 through AQUA-90),would not be adverse, and would typically be beneficial to fall- and late fall-run Chinook salmon. Specifically for AQUA-80, the effects of contaminants on fall- and late fall-run Chinook salmon with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on fall- and late fall-run Chinook salmon are uncertain.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

Steelhead

The potential effects of construction and maintenance of water conveyance facilities, operations of water conveyance facilities, restoration measures and other conservation measures on steelhead would be similar to those described under Alternatives 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance of water conveyance facilities on steelhead would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A (Impact AQUA-91 and AQUA-92), the fish effects described for steelhead under Alternative 1A also appropriately characterize effects under Alternative 1B.

Impact AQUA-91: Effects of Construction of Water Conveyance Facilities on Steelhead

Impact AQUA-92: Effects of Maintenance of Water Conveyance Facilities on Steelhead

NEPA Effects: These impact mechanisms would typically not be adverse to steelhead. While construction activities (Impact AQUA-91) could result in adverse effects from impact pile driving activities, the implementation of Mitigation Measures AQUA-1a and AQUA-1b, would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality).

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, Impact AQUA-91 could result in significant underwater noise effects from impact pile driving, although implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of` water conveyance facility operations on steelhead would be similar to those described above under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A (Impact AQUA-93 through AQUA-96), the effects described for steelhead under Alternative 1A also appropriately characterize effects under Alternative 1B.

Impact AQUA-93: Effects of Water Operations on Entrainment of Steelhead

Impact AQUA-94: Effects of Water Operations on Spawning and Egg Incubation Habitat for Steelhead

Impact AQUA-95: Effects of Water Operations on Rearing Habitat for Steelhead

Impact AQUA-96: Effects of Water Operations on Migration Conditions for Steelhead

NEPA Effects: As described in detail under Alternative 1A, these impact mechanisms would result in variable effects on steelhead, but the effects would not result in biologically meaningful reductions in overall survival of steelhead. Therefore, the effects would not be adverse to steelhead under Alternative 1B.

CEQA Conclusion: Collectively, the analysis indicates that the difference between the CEQA baseline and Alternative 1B could be significant because, under the CEQA baseline, the alternative could substantially reduce the amount of suitable habitat and interfere with steelhead migrations in some areas. Alternative 1B would also negatively affect juvenile and adult migration conditions in some areas. Despite the variability in effects of Alternative 1B, if adjusted to exclude sea level rise and climate change, the alternative would not in itself result in a significant impact on steelhead.

Restoration and Conservation Measures

The potential effects of restoration measures and other conservation measures on steelhead would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1B, compared to those described in detail for Alternative 1A (Impact AQUA-97 through AQUA-108), the effects described for steelhead under Alternative 1A also appropriately characterize the effects under Alternative 1B.

Impact AQUA-97: Effects of Construction of Restoration Measures on Steelhead

Impact AQUA-98: Effects of Contaminants Associated with Restoration Measures on Steelhead

Impact AQUA-99: Effects of Restored Habitat Conditions on Steelhead

Impact AQUA-100: Effects of Methylmercury Management on Steelhead (CM12)

Impact AQUA-101: Effects of Invasive Aquatic Vegetation Management on Steelhead (CM13)

Impact AQUA-102: Effects of Dissolved Oxygen Level Management on Steelhead (CM14)

Impact AQUA-103: Effects of Localized Reduction of Predatory Fish on Steelhead (CM15)

Impact AQUA-104: Effects of Nonphysical Fish Barriers on Steelhead (CM16)

Impact AQUA-105: Effects of Illegal Harvest Reduction on Steelhead (CM17)

Impact AQUA-106: Effects of Conservation Hatcheries on Steelhead (CM18)

Impact AQUA-107: Effects of Urban Stormwater Treatment on Steelhead (CM19)

Impact AQUA-108: Effects of Removal/Relocation of Nonproject Diversions on Steelhead (CM21)

NEPA Effects: As discussed for Alternative 1A, these impact mechanisms would not be adverse, and would typically be beneficial to steelhead. Specifically for AQUA-98, the effects of contaminants on steelhead with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on steelhead are uncertain.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

Sacramento Splittail

The potential effects of construction and maintenance of water conveyance facilities, operations of water conservation facilities, restoration measures and other conservation measures on Sacramento splittail would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance of water conveyance facilities would be similar to those described under Alternative 1A, because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A (Impact AQUA-109 and AQUA-110). Therefore, the effects described for Sacramento splittail under Alternative 1A also appropriately characterize effects for Sacramento splittail under Alternative 1B.

Impact AQUA-109: Effects of Construction of Water Conveyance Facilities on Sacramento Splittail

Impact AQUA-110: Effects of Maintenance of Water Conveyance Facilities on Sacramento Splittail

NEPA Effects: These impact mechanisms would generally not be adverse to Sacramento splittail. While construction activities (Impact AQUA-109) could result in adverse effects from impact pile driving activities, the implementation of Mitigation Measures AQUA-1a and AQUA-1b would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality).

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, Impact AQUA-109 could result in significant underwater noise effects from impact pile driving, although implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant. The effects of Impact AQUA-110 would be less than significant, so no additional mitigation would be required.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of water conveyance facility operations on Sacramento splittail would be similar to those described for Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1B, compared to those described in detail for Alternative 1A (Impacts AQUA-111 through AQUA-114), the effects described under Alternative 1A would also appropriately characterize the effects under Alternative 1B.

Impact AQUA-111: Effects of Water Operations on Entrainment of Sacramento Splittail

Impact AQUA-112: Effects of Water Operations on Spawning and Egg Incubation Habitat for Sacramento Splittail

Impact AQUA-113: Effects of Water Operations on Rearing Habitat for Sacramento Splittail

Impact AQUA-114: Effects of Water Operations on Migration Conditions for Sacramento Splittail

NEPA Effects: As discussed in detail for Alternative 1A, the operations impact mechanisms would not be adverse to Sacramento splittail.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would be less than significant, and no mitigation would be required.

Restoration and Conservation Measures

The potential effects of restoration measures and other conservation measures on Sacramento splittail would be similar to those described for Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A (Impacts AQUA-115 through AQUA-126), the fish effects described also appropriately characterize the effects under Alternative 1B.

Impact AQUA-115: Effects of Construction of Restoration Measures on Sacramento Splittail

Impact AQUA-116: Effects of Contaminants Associated with Restoration Measures on Sacramento Splittail

Impact AQUA-117: Effects of Restored Habitat Conditions on Sacramento Splittail

Impact AQUA-118: Effects of Methylmercury Management on Sacramento Splittail (CM12)

Impact AQUA-119: Effects of Invasive Aquatic Vegetation Management on Sacramento Splittail (CM13)

Impact AQUA-120: Effects of Dissolved Oxygen Level Management on Sacramento Splittail (CM14)

Impact AQUA-121: Effects of Localized Reduction of Predatory Fish on Sacramento Splittail (CM15)

Impact AQUA-122: Effects of Nonphysical Fish Barriers on Sacramento Splittail (CM16)

Impact AQUA-123: Effects of Illegal Harvest Reduction on Sacramento Splittail (CM17)

Impact AQUA-124: Effects of Conservation Hatcheries on Sacramento Splittail (CM18)

Impact AQUA-125: Effects of Urban Stormwater Treatment on Sacramento Splittail (CM19)

Impact AQUA-126: Effects of Removal/Relocation of Nonproject Diversions on Sacramento Splittail (CM21)

NEPA Effects: As discussed for Alternative 1A, the other impact mechanisms would not be adverse, and would typically be beneficial to Sacramento splittail. Specifically for AQUA-116, the effects of contaminants on Sacramento splittail with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on Sacramento splittail are uncertain.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, most of these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

Green Sturgeon

The potential effects of construction and maintenance of water conveyance facilities, operations of water conservation facilities, restoration measures and other conservation measures on green sturgeon would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance activities on green sturgeon would be similar to those described under Alternative 1A, because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A (Impact AQUA-127 and AQUA-128).,Therefore, the fish effects described for green sturgeon under Alternative 1A also appropriately characterize effects for green sturgeon under Alternative 1B.

Impact AQUA-127: Effects of Construction of Water Conveyance Facilities on Green Sturgeon

Impact AQUA-128: Effects of Maintenance of Water Conveyance Facilities on Green Sturgeon

NEPA Effects: Construction activities (Impact AQUA-127) could result in adverse effects from impact pile driving activities. However, the implementation of Mitigation Measures AQUA-1a and AQUA-1b, would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality). However, maintenance activities (Impact AQUQ-128) would not be adverse to green sturgeon.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, Impact AQUA-127 could result in significant underwater noise effects from impact pile driving, although implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant. The other impact mechanism would be less than significant, so no additional mitigation would be required.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of water conveyance operations on green sturgeon would be similar to those described for Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A (Impacts AQUA-129 through AQUA-132). Therefore, the effects described for green sturgeon under Alternative 1A, also appropriately characterize the effects under Alternative 1B.

Impact AQUA-129: Effects of Water Operations on Entrainment of Green Sturgeon

Impact AQUA-130: Effects of Water Operations on Spawning and Egg Incubation Habitat for Green Sturgeon

Impact AQUA-131: Effects of Water Operations on Rearing Habitat for Green Sturgeon

Impact AQUA-132: Effects of Water Operations on Migration Conditions for Green Sturgeon

NEPA Effects: As discussed for Alternative 1A, Impact AQUA-132 is expected to negatively affect green sturgeon migration habitat conditions under Alternative 1B. These effects are a result of the specific reservoir operations and resulting flows associated with this alternative. Therefore, while there is no feasible mitigation available, the implementation of the mitigation measures listed below has the potential to reduce the severity of the impact, but not necessarily to a level considered to be not adverse.

CEQA Conclusion: Similar to the discussion provided above, and for Alternative 1A, Impact AQUA-132 could result in significant, but unavoidable effects on water temperature, juvenile and adult green sturgeon migration habitat conditions, compared to Existing Conditions. Implementation of the mitigation measures listed below has the potential to reduce the severity of the impact though not necessarily to a less-than-significant level. These mitigation measures would provide an adaptive management process, that may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6), for assessing impacts and developing appropriate minimization measures.

Mitigation Measure AQUA-132a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Green Sturgeon to Determine Feasibility of Mitigation to Reduce Impacts to Migration Conditions

Please refer to Mitigation Measure AQUA-132a under Alternative 1A (Impact AQUA-132) for green sturgeon.

Mitigation Measure AQUA-132b: Conduct Additional Evaluation and Modeling of Impacts on Green Sturgeon Migration Conditions Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-132b under Alternative 1A (Impact AQUA-132) for green sturgeon.

Mitigation Measure AQUA-132c: Consult with USFWS and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Green Sturgeon Migration Conditions Consistent with CM1

Please refer to Mitigation Measure AQUA-132c under Alternative 1A (Impact AQUA-132) for green sturgeon.

Restoration and Conservation Measures

Alternative 1B has the same restoration and conservation measures as Alternative 1A. Because no substantial differences in fish effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A, the effects of the restoration and conservation measures would be similar.

The following impacts are those presented under Alternative 1A that are identical for Alternative 1B.

Impact AQUA-133: Effects of Construction of Restoration Measures on Green Sturgeon

Impact AQUA-134: Effects of Contaminants Associated with Restoration Measures on Green Sturgeon

Impact AQUA-135: Effects of Restored Habitat Conditions on Green Sturgeon

Impact AQUA-136: Effects of Methylmercury Management on Green Sturgeon (CM12)

Impact AQUA-137: Effects of Invasive Aquatic Vegetation Management on Green Sturgeon (CM13)

Impact AQUA-138: Effects of Dissolved Oxygen Level Management on Green Sturgeon (CM14)

Impact AQUA-139: Effects of Localized Reduction of Predatory Fish on Green Sturgeon (CM15)

Impact AQUA-140: Effects of Nonphysical Fish Barriers on Green Sturgeon (CM16)

Impact AQUA-141: Effects of Illegal Harvest Reduction on Green Sturgeon (CM17)

Impact AQUA-142: Effects of Conservation Hatcheries on Green Sturgeon (CM18)

Impact AQUA-143: Effects of Urban Stormwater Treatment on Green Sturgeon (CM19)

Impact AQUA-144: Effects of Removal/Relocation of Nonproject Diversions on Green Sturgeon (CM21)

NEPA Effects: These impact mechanisms would not be adverse, and with the implementation of environmental commitments and conservation measures, the effects would typically be beneficial to green sturgeon. Specifically for AQUA-134, the effects of contaminants on green sturgeon with respect to copper, ammonia and pesticides would not be adverse. The effects of methylmercury and selenium on green sturgeon are uncertain.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

White Sturgeon

The potential effects of construction and maintenance of water conveyance facilities, operations of water conservation facilities, restoration measures and other conservation measures on white sturgeon would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance activities on white sturgeon would be similar to those described under Alternative 1A, because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A (Impact AQUA-145 and AQUA-146). Therefore, the fish effects described for white sturgeon under Alternative 1A also appropriately characterize effects for white sturgeon under Alternative 1B.

Impact AQUA-145: Effects of Construction of Water Conveyance Facilities on White Sturgeon

Impact AQUA-146: Effects of Maintenance of Water Conveyance Facilities on White Sturgeon

NEPA Effects: As concluded for Alternative 1A (Impact AQUA-145 and AQUA-146), environmental commitments and mitigation measures would be available to avoid and minimize potential effects, so the effect would not be adverse for white sturgeon.

CEQA Conclusion: As described under Alternative 1A (Impact AQUA-145 and AQUA-146), the impact of the construction and maintenance of water conveyance facilities on white sturgeon would be less than significant except for construction noise associated with pile driving. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Alternative 1A, Impact AQUA-1.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Alternative 1A, Impact AQUA-1.

Water Operations of CM1

The potential effects of operations of water conveyance facilities on white sturgeon would be similar to those described for Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A (Impacts AQUA-147 through AQUA-150), the effects described for white sturgeon also appropriately characterize the effects under Alternative 1B.

Impact AQUA-147: Effects of Water Operations on Entrainment of White Sturgeon

Impact AQUA-148: Effects of Water Operations on Spawning and Egg Incubation Habitat for White Sturgeon

Impact AQUA-149: Effects of Water Operations on Rearing Habitat for White Sturgeon

Impact AQUA-150: Effects of Water Operations on Migration Conditions for White Sturgeon

NEPA Effects: As discussed above under Alternative 1A, the available information indicates that overall entrainment effects on white sturgeon populations, on available spawning, rearing or migration habitat conditions are not expected to substantially change under Alternative 1B compared to NAA. However, targeted investigations will be implemented to deal with scientific uncertainty regarding the mechanisms responsible for the positive correlation between year class strength and river/Delta flow. If upstream conditions are determined to be the primary mechanisms, then Alternative 1B would not be adverse, but if the positive correlation is related to in-Delta and through-Delta flow conditions, then Alternative 1B would be deemed adverse due to the magnitude of reductions in through-Delta flow conditions in Alternative 1B as compared to NAA.

CEQA Conclusion: As described for Alternative 1A, operational activities could result in a slight decrease in entrainment of white sturgeon, although the other impact mechanism could substantially reduce the amount of suitable habitat, contrary to the NEPA conclusion set forth above. There would also be small to moderate decreases in flows during most of the spawning and egg incubation period in some areas. However, Alternative 1B does not have the potential to substantially reduce the amount of suitable rearing habitat and substantially interfere with the movement of fish. Overall, the differences between Existing Conditions and Alternative 1B would generally be due to climate change, sea level rise, and future demand, and not the alternative. Therefore, this impact is found to be less than significant and no mitigation is required.

Restoration and Conservation Measures

Alternative 1B has the same restoration and conservation measures as Alternative 1A. Because no substantial differences in fish effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A, the effects of these measures described for white sturgeon under Alternative 1A (Impact AQUA-151 through Impact AQUA-162) also appropriately characterize effects under Alternative 1B.

Impact AQUA-151: Effects of Construction of Restoration Measures on White Sturgeon

Impact AQUA-152: Effects of Contaminants Associated with Restoration Measures on White Sturgeon

Impact AQUA-153: Effects of Restored Habitat Conditions on White Sturgeon

Impact AQUA-154: Effects of Methylmercury Management on White Sturgeon (CM12)

Impact AQUA-155: Effects of Invasive Aquatic Vegetation Management on White Sturgeon (CM13)

Impact AQUA-156: Effects of Dissolved Oxygen Level Management on White Sturgeon (CM14)

Impact AQUA-157: Effects of Localized Reduction of Predatory Fish on White Sturgeon (CM15)

Impact AQUA-158: Effects of Nonphysical Fish Barriers on White Sturgeon (CM16)

Impact AQUA-159: Effects of Illegal Harvest Reduction on White Sturgeon (CM17)

Impact AQUA-160: Effects of Conservation Hatcheries on White Sturgeon (CM18)

Impact AQUA-161: Effects of Urban Stormwater Treatment on White Sturgeon (CM19)

Impact AQUA-162: Effects of Removal/Relocation of Nonproject Diversions on White Sturgeon (CM21)

NEPA Effects: The restoration and conservation measure impact mechanisms have been determined to range from no effect, to no adverse effect, or beneficial effects on white sturgeon for NEPA purposes, for the reasons identified for Alternative 1A (Impact AQUA-151 through 162). Specifically for AQUA-152, the effects of contaminants on white sturgeon with respect to copper, ammonia and pesticides would not be adverse. The effects of methylmercury and selenium on white sturgeon are uncertain.

CEQA Conclusion: The restoration and conservation measure impact mechanisms would be considered to range from no impact, to less than significant, or beneficial on white sturgeon, for the reasons identified for Alternative 1A (Impact AQUA-151 through 162), and no mitigation is required.

Pacific Lamprey

The potential effects of construction and maintenance of water conveyance facilities, operations of water conservation facilities, restoration measures and other conservation measures on Pacific lamprey would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance of water conveyance facilities on Pacific lamprey would be similar to those described under Alternative 1A, because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A (Impact AQUA-163 through AQUA-180). Therefore, the effects described for Pacific lamprey under Alternative 1A also appropriately characterize effects for Pacific lamprey under Alternative 1B.

Impact AQUA-163: Effects of Construction of Water Conveyance Facilities on Pacific Lamprey

Impact AQUA-164: Effects of Maintenance of Water Conveyance Facilities on Pacific Lamprey

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-163 and AQUA-164, environmental commitments and mitigation measures would be available to avoid and minimize potential effects, and the effect would not be adverse for Pacific lamprey.

CEQA Conclusion: As described under Alternative 1A, Impact AQUA-163 and AQUA-164, the impact of the construction and maintenance of water conveyance facilities on Pacific lamprey would be less than significant except for construction noise associated with pile driving. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Alternative 1A, Impact AQUA-1.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Alternative 1A, Impact AQUA-1.

Water Operations of CM1

The potential effects of water conveyance facility operations on Pacific lamprey would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A (Impact AQUA-165 and Impact AQUA-168), the effects described for Pacific lamprey under Alternative 1A also appropriately characterize effects for Pacific lamprey under Alternative 1B.

Impact AQUA-165: Effects of Water Operations on Entrainment of Pacific Lamprey

Impact AQUA-166: Effects of Water Operations on Spawning and Egg Incubation Habitat for Pacific Lamprey

Impact AQUA-167: Effects of Water Operations on Rearing Habitat for Pacific Lamprey

Impact AQUA-168: Effects of Water Operations on Migration Conditions for Pacific Lamprey

NEPA Effects: Similar to the results discussed in detail under Alternative 1A, effects on entrainment of Pacific lamprey would not be adverse, and could be beneficial, due to design, installation, and operation of new screens in the north Delta. However, flow reductions would be expected to increase redd dewatering risk and exposure risk to egg cohorts in some areas, such as below Thermalito Afterbay. These effects would cause substantial reductions in habitat available for spawning and egg incubation in the Feather River, and reduce overall spawning success. While the implementation of the mitigation measures listed below (Mitigation Measures AQUA-166a through AQUA-166c) would reduce the severity of effects, this would not necessarily result in a not adverse determination. However, the changes in flow would not substantially interfere with the movement of fish. While the implementation of the mitigation measures listed below (Mitigation Measures AQUA-166a through AQUA-166c) would reduce the severity of effects, this would not necessarily result in a not adverse determination.

CEQA Conclusions: As concluded under Alternative 1A, Alternative 1B water operations could substantially reduce the number of fish as a result of increased exposure to redd dewatering and elevated water temperatures, which would reduce egg survival and increase ammocoete mortality. While the implementation of the mitigation measures listed below (Mitigation Measures AQUA-166a through AQUA-166c) would reduce the severity of effects, this would not necessarily result in a less than significant determination. Alternative 1A would also substantially reduce rearing habitat. However, if adjusted to exclude the effects of sea level rise and climate change, Alternative 1B would not in itself result in a significant impact on rearing habitat for Pacific lamprey. This impact is found to be less than significant and no mitigation is required.

Mitigation Measure AQUA-166a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Pacific Lamprey to Determine Feasibility of Mitigation to Reduce Impacts to Spawning Habitat

Please refer to Mitigation Measure AQUA-166a under Impact AQUA-166 of Alternative 1A.

Mitigation Measure AQUA-166b: Conduct Additional Evaluation and Modeling of Impacts on Pacific Lamprey Spawning Habitat Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-166b under Impact AQUA-166 of Alternative 1A.

Mitigation Measure AQUA-166c: Consult with USFWS and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Pacific Lamprey Spawning Habitat Consistent with CM1

Please refer to Mitigation Measure AQUA-166c under Impact AQUA-166 of Alternative 1A.

Restoration and Conservation Measures

Alternative 1B has the same restoration and conservation measures as Alternative 1A. Because no substantial differences in fish effects are anticipated anywhere in the affected environment under

Alternative 1B compared to those described in detail for Alternative 1A, the effects of these measures described for Pacific lamprey under Alternative 1A (Impact AQUA-169 through Impact AQUA-180) also appropriately characterize effects under Alternative 1B.

Impact AQUA-169: Effects of Construction of Restoration Measures on Pacific Lamprey

Impact AQUA-170: Effects of Contaminants Associated with Restoration Measures on Pacific Lamprey

Impact AQUA-171: Effects of Restored Habitat Conditions on Pacific Lamprey

Impact AQUA-172: Effects of Methylmercury Management on Pacific Lamprey (CM12)

Impact AQUA-173: Effects of Invasive Aquatic Vegetation Management on Pacific Lamprey (CM13)

Impact AQUA-174: Effects of Dissolved Oxygen Level Management on Pacific Lamprey (CM14)

Impact AQUA-175: Effects of Localized Reduction of Predatory Fish on Pacific Lamprey (CM15)

Impact AQUA-176: Effects of Nonphysical Fish Barriers on Pacific Lamprey (CM16)

Impact AQUA-177: Effects of Illegal Harvest Reduction on Pacific Lamprey (CM17)

Impact AQUA-178: Effects of Conservation Hatcheries on Pacific Lamprey (CM18)

Impact AQUA-179: Effects of Urban Stormwater Treatment on Pacific Lamprey (CM19)

Impact AQUA-180: Effects of Removal/Relocation of Nonproject Diversions on Pacific Lamprey (CM21)

NEPA Effects: As discussed for Alternative 1A, these impact mechanisms would not be adverse, and would typically be beneficial to Pacific lamprey.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

River Lamprey

The potential effects of construction and maintenance of water conveyance facilities, operations of water conservation facilities, restoration measures and other conservation measures on river lamprey would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance of water conveyance facilities on river lamprey would be similar to those described under Alternative 1A because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A (Impact AQUA-181 through AQUA-198), the fish effects described for river lamprey under Alternative 1A also appropriately characterize effects for river lamprey under Alternative 1B.

Impact AQUA-181: Effects of Construction of Water Conveyance Facilities on River Lamprey

Impact AQUA-182: Effects of Maintenance of Water Conveyance Facilities on River Lamprey

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-181 and AQUA-182, environmental commitments and mitigation measures would be available to avoid and minimize potential effects, and the effect would not be adverse for river lamprey.

CEQA Conclusion: As described under Alternative 1A, Impact AQUA-181 and AQUA-182, the impact of the construction and maintenance of water conveyance facilities on river lamprey would be less than significant except for construction noise associated with pile driving. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Alternative 1A, Impact AQUA-1.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Alternative 1A, Impact AQUA-1.

Water Operations of CM1

The potential effects of water conveyance facility operations on river lamprey would be similar to those described under Alternative 1A, for Impact AQUA-183 and Impact AQUA-186, which appropriately characterizes effects under Alternative 1B.

Impact AQUA-183: Effects of Water Operations on Entrainment of River Lamprey

Impact AQUA-184: Effects of Water Operations on Spawning and Egg Incubation Habitat for River Lamprey

Impact AQUA-185: Effects of Water Operations on Rearing Habitat for River Lamprey

Impact AQUA-186: Effects of Water Operations on Migration Conditions for River Lamprey

NEPA Effects: As discussed in detail for Alternative 1A, the effects of Alternative 1B on river lamprey entrainment and entrainment-related predation, spawning habitat, and migration conditions would not be adverse. However, Alternative 1B operations have the potential to substantially reduce river lamprey rearing habitat, and the number of fish as a result of ammocoete mortality. These effects would be due to increased exposure to critical water temperatures in the Sacramento, Feather, American, and Stanislaus Rivers and substantial increases in exposure to flow reductions that could lead to stranding in the American River. These effects on rearing habitat would be adverse. Implementation of the mitigation measures listed below has the potential to reduce the severity of the impact, although not necessarily to a not adverse level.

CEQA Conclusion: As described above, and in detail under Alternative 1A, the CEQA analyses indicate that Alternative 1B could have significant and unavoidable effects on river lamprey rearing habitat. However, the implementation of the mitigation measures listed below also has the potential to reduce the severity of the impact though not necessarily to a not adverse or a less-than-significant level. These mitigation measures would provide an adaptive management process, that may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6), for assessing impacts and developing appropriate minimization measures.

Mitigation Measure AQUA-185a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to River Lamprey to Determine Feasibility of Mitigation to Reduce Impacts to Rearing Habitat

Please refer to Mitigation Measure AQUA-185a under Alternative 1A (Impact AQUA-185) for river lamprey.

Mitigation Measure AQUA-185b: Conduct Additional Evaluation and Modeling of Impacts River Lamprey Rearing Habitat Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-185b under Alternative 1A (Impact AQUA-185) for river lamprey.

Mitigation Measure AQUA-185c: Consult with USFWS and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on River Lamprey Rearing Habitat Consistent with CM1

Please refer to Mitigation Measure AQUA-185c under Alternative 1A (Impact AQUA-185) for river lamprey.

Restoration and Conservation Measures

Alternative 1B has the same restoration and conservation measures as Alternative 1A. Because no substantial differences in fish effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A, the effects of these measures described for river lamprey under Alternative 1A (Impact AQUA-187 through Impact AQUA-198) also appropriately characterize effects under Alternative 1B.

Impact AQUA-187: Effects of Construction of Restoration Measures on River Lamprey

Impact AQUA-188: Effects of Contaminants Associated with Restoration Measures on River Lamprey

Impact AQUA-189: Effects of Restored Habitat Conditions on River Lamprey

Impact AQUA-190: Effects of Methylmercury Management on River Lamprey (CM12)

Impact AQUA-191: Effects of Invasive Aquatic Vegetation Management on River Lamprey (CM13)

Impact AQUA-192: Effects of Dissolved Oxygen Level Management on River Lamprey (CM14)

Impact AQUA-193: Effects of Localized Reduction of Predatory Fish on River Lamprey (CM15)

Impact AQUA-194: Effects of Nonphysical Fish Barriers on River Lamprey (CM16)

Impact AQUA-195: Effects of Illegal Harvest Reduction on River Lamprey (CM17)

Impact AQUA-196: Effects of Conservation Hatcheries on River Lamprey (CM18)

Impact AQUA-197: Effects of Urban Stormwater Treatment on River Lamprey (CM19)

Impact AQUA-198: Effects of Removal/Relocation of Nonproject Diversions on River Lamprey (CM21)

NEPA Effects: As discussed in detail for Alternative 1A, the restoration and conservation measure impact mechanisms (Impact AQUA-187 through AQUA-198) have been determined to range from no effect, not adverse, or beneficial to river lamprey for NEPA purposes.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

Non-Covered Aquatic Species of Primary Management Concern

The potential effects of construction and maintenance of water conveyance facilities, operations of water conservation facilities, restoration measures and other conservation measures on non-covered species would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance of water conveyance facilities on non-covered species would be similar to those described under Alternative 1A because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A (Impact AQUA-199 through AQUA-217), the fish effects described for river lamprey under Alternative 1A also appropriately characterize effects for river lamprey under Alternative 1B.

Impact AQUA-199: Effects of Construction of Water Conveyance Facilities on Non-Covered Aquatic Species of Primary Management Concern

Impact AQUA-200: Effects of Maintenance of Water Conveyance Facilities on Non-Covered Aquatic Species of Primary Management Concern

NEPA Effects: As concluded for Alternative 1A (Impact AQUA-199 and AQUA-200), environmental commitments and mitigation measures would be available to avoid and minimize potential effects, and the effect would not be adverse for non-covered aquatic species of primary management concern.

CEQA Conclusion: As described under Alternative 1A (Impact AQUA-199 and AQUA-200), the impact of the construction and maintenance of water conveyance facilities on non-covered aquatic species of primary management concern would be less than significant except potentially for construction noise associated with pile driving. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Alternative 1A, Impact AQUA-1.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Alternative 1A, Impact AQUA-1.

Water Operations of CM1

The potential effects of water conveyance facility operations on non-covered species would be similar to those described under Alternative 1A. As no differences in effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A (Impact AQUA-201 through Impact AQUA-204), the effects described for non-covered aquatic species of primary management concern under Alternative 1A also appropriately characterize effects for non-covered aquatic species of primary management concern under Alternative 1B.

Impact AQUA-201: Effects of Water Operations on Entrainment of Non-Covered Aquatic Species of Primary Management Concern

Impact AQUA-202: Effects of Water Operations on Spawning and Egg Incubation Habitat for Non-Covered Aquatic Species of Primary Management Concern

Impact AQUA-203: Effects of Water Operations on Rearing Habitat for Non-Covered Aquatic Species of Primary Management Concern

Impact AQUA-204: Effects of Water Operations on Migration Conditions for Non-Covered Aquatic Species of Primary Management Concern

NEPA Effects: These impact mechanisms would not be adverse to the non-covered species of primary management concern, and with the implementation of environmental commitments and conservation measures, the effects would typically be beneficial to non-covered fish species of primary management concern.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, Impact AQUA-203 and AQUA-204 could result in significant, but unavoidable effects on rearing habitat and migration habitat conditions for several fish species of primary management concern. These species include largemouth bass, Sacramento-San Joaquin roach, and hardhead. There are also no feasible mitigation measures available to mitigate for these impacts. The other impact mechanisms would be less than significant, or beneficial, so no additional mitigation would be required.

Restoration and Conservation Measures

Alternative 1B has the same restoration and conservation measures as Alternative 1A. Because no substantial differences in fish effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A, the effects of these measures described for non-covered aquatic species of primary management concern under

Alternative 1A (Impact AQUA-205 through Impact AQUA-216) also appropriately characterize effects under Alternative 1B.

Impact AQUA-205: Effects of Construction of Restoration Measures on Non-Covered Aquatic Species of Primary Management Concern

Impact AQUA-206: Effects of Contaminants Associated with Restoration Measures on Non-Covered Aquatic Species of Primary Management Concern

Impact AQUA-207: Effects of Restored Habitat Conditions on Non-Covered Aquatic Species of Primary Management Concern

Impact AQUA-208: Effects of Methylmercury Management on Non-Covered Aquatic Species of Primary Management Concern (CM12)

Impact AQUA-209: Effects of Invasive Aquatic Vegetation Management on Non-Covered Aquatic Species of Primary Management Concern (CM13)

Impact AQUA-210: Effects of Dissolved Oxygen Level Management on Non-Covered Aquatic Species of Primary Management Concern (CM14)

Impact AQUA-211: Effects of Localized Reduction of Predatory Fish on Non-Covered Aquatic Species of Primary Management Concern (CM15)

Impact AQUA-212: Effects of Nonphysical Fish Barriers on Non-Covered Aquatic Species of Primary Management Concern (CM16)

Impact AQUA-213: Effects of Illegal Harvest Reduction on Non-Covered Aquatic Species of Primary Management Concern (CM17)

Impact AQUA-214: Effects of Conservation Hatcheries on Non-Covered Aquatic Species of Primary Management Concern (CM18)

Impact AQUA-215: Effects of Urban Stormwater Treatment on Non-Covered Aquatic Species of Primary Management Concern (CM19)

Impact AQUA-216: Effects of Removal/Relocation of Nonproject Diversions on Non-Covered Aquatic Species of Primary Management Concern (CM21)

NEPA Effects: As discussed in detail under Alternative 1A and 6A, these impact mechanisms would not be adverse, and would typically be beneficial to non-covered fish species of primary management concern.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, most of these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

Upstream Reservoirs

Impact AQUA-217: Effects of Water Operations on Reservoir Coldwater Fish Habitat

NEPA Effects: Similar to the description for Alternative 1A, Impact AQUA-217 would not be adverse because coldwater fish habitat in the CVP and SWP upstream reservoirs under Alternative 1B would not be substantially reduced when compared to the No Action Alternative.

CEQA Conclusion: Similar to the description for Alternative 1A, Alternative 1B would reduce the quantity of coldwater fish habitat in the CVP and SWP. There would be a greater than 5% increase (5 years) for several of the reservoirs, which could result in a significant impact. However, if adjusted to exclude sea level rise and climate change, Alternative 1B would not in itself result in a significant impact on coldwater habitat in upstream reservoirs. Therefore, this impact mechanism is found to be less than significant and no mitigation is required.

11.3.4.4 Alternative 1C—Dual Conveyance with West Alignment and Intakes W1–W5 (15,000 cfs; Operational Scenario A)

Alternative 1C would be nearly identical to Alternative 1A except that up to 15,000 cfs of water routed from the north Delta to the south Delta would be conveyed by gravity through a canal along the west side of the Delta instead of through pipelines/tunnels. Alternative 1C water conveyance is similar except that the route is on the west side of the Delta. Under Alternative 1C the five intakes would be constructed on the west side of the Sacramento River rather than the east side as under Alternative 1A and Alternative 1B. Similar to Alternative 1B, while there would be the same types and number of intakes, the difference in the type of conveyance facility (e.g., canal) results in different construction details to a limited extent as they relate to potential impacts on fish. Specifically, nine culvert siphons would divert canal water beneath existing water courses and their construction would occur within those water courses. Alternative 1C would also have two barge landings and 16 bridge crossings compared to six barge landings and no bridge crossings for Alternative 1A and one barge landing and 19 bridge crossings for Alternative 1B. Approximately 3,000 barge trips would occur during construction. Besides the primary difference of utilizing a canal rather than a tunnel, Alternative 1C would have other structural differences such as inclusion of an intermediate pumping plant and elimination of the intermediate forebay. However, these latter differences would not affect fish resources and are not evaluated further in this chapter. Overall, construction impacts from Alternative 1C would be similar to Alternative 1A but with additional in-water work as described above. However, implementation of Mitigation Measures (described below) and Appendix 3B, *Environmental Commitments* would reduce impacts as described under Alternative 1A.

Water supply and conveyance operations would follow the guidelines described as Operational Scenario A, which is identical to those analyzed under Alternative 1A. CM2–CM22 would be implemented under this alternative, and these conservation measures would be identical to those under Alternative 1A. See Chapter 3, *Description of Alternatives*, for additional details on Alternative 1C.

Delta Smelt

Construction and Maintenance of CM1

The potential effects of construction and maintenance of the water conveyance facilities on delta smelt and their designated critical habitat would be similar to those described for Alternative 1A (Impact AQUA-1 and AQUA-2) except that Alternative 1C would include five intakes on the west side compared to five intakes on the east side under Alternative 1A. The five west side intakes would have slightly larger dimensions and slightly more impact than the east side intakes. This would convert about 13,550 lineal feet of existing shoreline habitat into intake facility structures and would require about 31.1 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging.

Impact AQUA-1: Effects of Construction of Water Conveyance Facilities on Delta Smelt

Impact AQUA-2: Effects of Maintenance of Water Conveyance Facilities on Delta Smelt

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-1 and AQUA-2, the effect would not be adverse for delta smelt.

CEQA Conclusion: As described in Impact AQUA-1 and AQUA-2 under Alternative 1A for delta smelt, the impact of the construction of water conveyance facilities on delta smelt would not be significant except for construction noise associated with pile driving. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Alternative 1A, Impact AQUA-1.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Alternative 1A, Impact AQUA-1.Water Operations of CM1

Alternative 1C has the same diversion and conveyance operations as Alternative 1A. The primary difference between the two alternatives is that conveyance under Alternative 1C would be in a lined or unlined canal, instead of a pipeline. Because there would be no difference in conveyance capacity or operations, there would be no differences between these two alternatives in upstream of the Delta river flows or reservoir operations, Delta inflow, and hydrodynamics in the Delta. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A (Impact AQUA-3 through AQUA-6), the fish effects described for Alternative 1A also appropriately characterize effects under Alternative 1C.

The following impacts are those presented under Alternative 1A that are identical for Alternative 1C.

Impact AQUA-3: Effects of Water Operations on Entrainment of Delta Smelt

Impact AQUA-4: Effects of Water Operations on Spawning and Egg Incubation Habitat for Delta Smelt

Impact AQUA-5: Effects of Water Operations on Rearing Habitat for Delta Smelt

Impact AQUA-6: Effects of Water Operations on Migration Conditions for Delta Smelt

NEPA Effects: With the exception of Impact AQUA-5, the other impact mechanisms listed above, would be beneficial or not adverse to delta smelt under Alternative 1C. This is the same conclusion as described in detail under Alternative 1A, and is based on the expected overall limited or slightly beneficial impacts. However, the overall effect of Impact AQUA-5 on delta smelt rearing habitat would remain adverse because there likely would still be a loss of suitable habitat even with BDCP restoration efforts (see Alternative 1A, AQUA-5 for details on expected effects).

CEQA Conclusion: The effects of three of the above listed impact mechanisms would be less than significant, or slightly beneficial to delta smelt, and no mitigation would be required. In addition, the effects of Impact AQUA-5 would also be considered less than significant, because it would not substantially reduce rearing habitat. Therefore, no mitigation would be required for any of the impact mechanisms listed above. Detailed discussions regarding these conclusions are presented in Alternative 1A.

Restoration and Conservation Measures

Alternative 1C has the same restoration and conservation measures as Alternative 1A. Because no substantial differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A, the effects described for Alternative 1A (Impact AQUA-7 through AQUA-18) also appropriately characterize effects under Alternative 1C.

The following impacts are those presented under Alternative 1A that are identical for Alternative 1C.

Impact AQUA-7: Effects of Construction of Restoration Measures on Delta Smelt

Impact AQUA-8: Effects of Contaminants Associated with Restoration Measures on Delta Smelt

Impact AQUA-9: Effects of Restored Habitat Conditions on Delta Smelt

Impact AQUA-10: Effects of Methylmercury Management on Delta Smelt (CM12)

Impact AQUA-11: Effects of Invasive Aquatic Vegetation Management on Delta Smelt (CM13)

Impact AQUA-12: Effects of Dissolved Oxygen Level Management on Delta Smelt (CM14)

Impact AQUA-13: Effects of Localized Reduction of Predatory Fish on Delta Smelt (CM15)

Impact AQUA-14: Effects of Nonphysical Fish Barriers on Delta Smelt (CM16)

Impact AQUA-15: Effects of Illegal Harvest Reduction on Delta Smelt (CM17)

Impact AQUA-16: Effects of Conservation Hatcheries on Delta Smelt (CM18)

Impact AQUA-17: Effects of Urban Stormwater Treatment on Delta Smelt (CM19)

Impact AQUA-18: Effects of Removal/Relocation of Nonproject Diversions on Delta Smelt (CM21)

NEPA Effects: As described in detail under Alternative 1A, none of these impact mechanisms (Impact AQUA-7 through AQUA-18) would be adverse to delta smelt, and most would be at least slightly beneficial. Specifically for AQUA-8, the effects of contaminants on delta smelt with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on delta smelt are uncertain.

CEQA Conclusion: All of the impact mechanisms listed above would be at least slightly beneficial, or less than significant, and no mitigation is required.

Longfin Smelt

The potential effects of construction and maintenance of water conveyance facilities, operations of water conservation facilities, restoration measures and other conservation measures on longfin smelt would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance of water conveyance facilities on longfin smelt would be similar to those described under Alternative 1A, because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A (Impact AQUA-19 and AQUA-20), the effects described for longfin smelt under Alternative 1A also appropriately characterize effects for longfin smelt under Alternative 1C.

The following impacts on longfin smelt are those presented under Alternative 1A that are identical for Alternative 1C.

Impact AQUA-19: Effects of Construction of Water Conveyance Facilities on Longfin Smelt

Impact AQUA-20: Effects of Maintenance of Water Conveyance Facilities on Longfin Smelt

NEPA Effects: These impact mechanisms would not be adverse to longfin smelt. While construction activities (Impact AQUA-19) could result in adverse effects from impact pile driving activities, the implementation of Mitigation Measures AQUA-1a and AQUA-1b, would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality).

CEQA Conclusion: Similar to the discussion provided above for Alternatives 1A, Impact AQUA-19 could result in significant underwater noise effects from impact pile driving, although implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of water conveyance facility operations on longfin smelt would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment for Impact AQUA-21 through AQUA-24, the effects described for longfin smelt under Alternatives 1A also appropriately characterize effects under Alternative 1C.

Impact AQUA-21: Effects of Water Operations on Entrainment of Longfin Smelt

Impact AQUA-22: Effects of Water Operations on Spawning, Egg Incubation, and Rearing Habitat for Longfin Smelt

Impact AQUA-23: Effects of Water Operations on Rearing Habitat for Longfin Smelt

Impact AQUA-24: Effects of Water Operations on Migration Conditions for Longfin Smelt

NEPA Effects: The potential effects of water operations on longfin smelt under Alternative 1C would be similar to those described above under Alternative 1A. As discussed in detail under Impact AQUA-22 (Alternative 1A), the effect of lower Delta winter-spring outflow on longfin smelt spawning and rearing has the potential to be adverse. This effect is a result of the specific reservoir operations, exports and resulting flows associated with this alternative. However, Alternative 1C also includes an adaptive management plan that could be used to adjust spring operations as determined necessary through the adaptive management process. These adaptive management procedures are described in Mitigation Measures 22a through 22c, under Alternative 1A. The other impact mechanisms would not be adverse, and would typically be beneficial to longfin smelt.

CEQA Conclusion: As described above under Alternatives 1A, water operations under Alternative 1C would generally reduce the quantity and quality of longfin smelt rearing habitat relative to Existing Conditions. The difference in rearing habitat could be significant because Delta outflows would be reduced in the spring, which would have the potential to contribute to substantial reductions in longfin smelt abundances. These effects are due to the specific reservoir operations and resulting flows associated with this alternative. However, the implementation of Mitigation Measures AQUA-22a through 22c, habitat restoration and reduced larval entrainment would reduce this impact to less than significant, so no additional mitigation would be required.

Mitigation Measure AQUA-22a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Longfin Smelt to Determine Feasibility of Mitigation to Reduce Impacts to Spawning and Rearing Habitat

Please refer to Mitigation Measure AQUA-22a under Impact AQUA-22 of Alternative 1A.

Mitigation Measure AQUA-22b: Conduct Additional Evaluation and Modeling of Impacts on Longfin Smelt Rearing Habitat Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-22b under Impact AQUA-22 of Alternative 1A.

Mitigation Measure AQUA-22c: Consult with USFWS and CDFW to Identify and Implement Feasible Means to Minimize Effects on Longfin Smelt Rearing Habitat Consistent with CM1

Please refer to Mitigation Measure AQUA-22c under Impact AQUA-22 of Alternative 1A.

Restoration and Conservation Measures

The potential effects of restoration measures and other conservation measures on longfin smelt would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A (Impact AQUA-25 through AQUA-36), the fish effects described for longfin smelt under Alternative 1A also appropriately characterize effects for longfin smelt under Alternative 1C.

Impact AQUA-25: Effects of Construction of Restoration Measures on Longfin Smelt

Impact AQUA-26: Effects of Contaminants Associated with Restoration Measures on Longfin Smelt

Impact AQUA-27: Effects of Restored Habitat Conditions on Longfin Smelt

Impact AQUA-28: Effects of Methylmercury Management on Longfin Smelt (CM12)

Impact AQUA-29: Effects of Invasive Aquatic Vegetation Management on Longfin Smelt (CM13)

Impact AQUA-30: Effects of Dissolved Oxygen Level Management on Longfin Smelt (CM14)

Impact AQUA-31: Effects of Localized Reduction of Predatory Fish on Longfin Smelt (CM15)

Impact AQUA-32: Effects of Nonphysical Fish Barriers on Longfin Smelt (CM16)

Impact AQUA-33: Effects of Illegal Harvest Reduction on Longfin Smelt (CM17)

Impact AQUA-34: Effects of Conservation Hatcheries on Longfin Smelt (CM18)

Impact AQUA-35: Effects of Urban Stormwater Treatment on Longfin Smelt (CM19)

Impact AQUA-36: Effects of Removal/Relocation of Nonproject Diversions on Longfin Smelt (CM21)

NEPA Effects: As described in Alternative 1A (Impact AQUA-25 through AQUA-36) these impact mechanisms have been determined to range from no effect, to not adverse, or beneficial to longfin smelt for NEPA purposes. Specifically for AQUA-26, the effects of contaminants on longfin smelt with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on longfin smelt are uncertain.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would be considered to range from no impact, to less than significant or beneficial for longfin smelt, and no mitigation would be required.

Winter-Run Chinook Salmon

The potential effects of construction and maintenance of water conveyance facilities, operations of water conservation facilities, restoration measures and other conservation measures on winter-run Chinook salmon would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance of water conveyance facilities on winter-run Chinook salmon would be similar to those described under Alternative 1A because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A (Impact AQUA-37 and AQUA-38), the fish effects described for winter-run Chinook salmon under Alternative 1A also appropriately characterize effects under Alternative 1C.

Impact AQUA-37: Effects of Construction of Water Conveyance Facilities on Chinook Salmon (Winter-Run ESU)

Impact AQUA-38: Effects of Maintenance of Water Conveyance Facilities on Chinook Salmon (Winter-Run ESU)

NEPA Effects: These impact mechanisms would not be adverse to winter-run Chinook salmon. While construction activities (Impact AQUA-37) could result in adverse effects from impact pile driving activities, the implementation of Mitigation Measures AQUA-1a and AQUA-1b, would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality).

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A and 6A, Impact AQUA-37 could result in significant underwater noise effects from impact pile driving, although implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of operations of water conveyance facilities on winter-run Chinook salmon would be similar to those described for Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A (Impacts AQUA-39 through AQUA-42).

Impact AQUA-39: Effects of Water Operations on Entrainment of Chinook Salmon (Winter-Run ESU)

Impact AQUA-40: Effects of Water Operations on Spawning and Egg Incubation Habitat for Chinook Salmon (Winter-Run ESU)

Impact AQUA-41: Effects of Water Operations on Rearing Habitat for Chinook Salmon (Winter-Run ESU)

Impact AQUA-42: Effects of Water Operations on Migration Conditions for Chinook Salmon (Winter-Run ESU)

NEPA Effects: As discussed for Alternative 1A, the impact mechanisms listed above would have significant and unavoidable adverse effects on winter-run Chinook salmon spawning, incubation, and/or rearing habitat, as well as overall migration conditions under Alternative 1C. These determinations are based on the best available scientific information at the time and may prove to have been over- or understated. The mitigation measures identified below would provide an adaptive management process, that may be conducted as a part of the Adaptive Management and

Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6), for assessing impacts and developing appropriate minimization measures. However, implementation of these measures would not necessarily result in a not adverse determination.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would result in significant and unavoidable effects on winter-run Chinook salmon spawning, rearing, and migration conditions under Alternative 1C. The mitigation measures identified below would provide an adaptive management process, that may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6), for assessing impacts and developing appropriate minimization measures. However, the result would not necessarily result in a less than significant determination.

Mitigation Measure AQUA-40a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Winter-Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Spawning Habitat

Please refer to Mitigation Measure AQUA-40a under Alternative 1A (Impact AQUA-40) for winter-run Chinook salmon.

Mitigation Measure AQUA-40b: Conduct Additional Evaluation and Modeling of Impacts on Winter-Run Chinook Salmon Spawning Habitat Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-40b under Alternative 1A (Impact AQUA-40) for winter-run Chinook salmon.

Mitigation Measure AQUA-40c: Consult with USFWS and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Winter-Run Chinook Salmon Spawning Habitat Consistent with CM1

Please refer to Mitigation Measure AQUA-40c under Alternative 1A (Impact AQUA-40) for winter-run Chinook salmon.

Mitigation Measure AQUA-41a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Winter-Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Rearing Habitat

Please refer to Mitigation Measure AQUA-41a under Alternative 1A (Impact AQUA-41) for winter-run Chinook salmon.

Mitigation Measure AQUA-41b: Conduct Additional Evaluation and Modeling of Impacts on Winter-Run Chinook Salmon Rearing Habitat Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-41b under Alternative 1A (Impact AQUA-41) for winter-run Chinook salmon.

Mitigation Measure AQUA-41c: Consult with USFWS and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Winter-Run Chinook Salmon Rearing Habitat Consistent with CM1

Please refer to Mitigation Measure AQUA-41c under Alternative 1A (Impact AQUA-41) for winter-run Chinook salmon.

Mitigation Measure AQUA-42a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Winter-Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Migration Conditions

Please refer to Mitigation Measure AQUA-42a under Alternative 1A (Impact AQUA-41) for winter-run Chinook salmon.

Mitigation Measure AQUA-42b: Conduct Additional Evaluation and Modeling of Impacts on Winter-Run Chinook Salmon Migration Conditions Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-42b under Alternative 1A (Impact AQUA-41) for winter-run Chinook salmon.

Mitigation Measure AQUA-42c: Consult with USFWS, and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Winter-Run Chinook Salmon Migration Conditions Consistent with CM1

Please refer to Mitigation Measure AQUA-42c under Alternative 1A (Impact AQUA-41) for winter-run Chinook salmon.

Restoration and Conservation Measures

The potential effects of restoration measures and other conservation measures on winter-run Chinook salmon would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A (Impact AQUA-43 through AQUA-54), the effects described for winter-run Chinook salmon under Alternative 1A also appropriately characterize effects under Alternative 1C.

Impact AQUA-43: Effects of Construction of Restoration Measures on Chinook Salmon (Winter-Run ESU)

Impact AQUA-44: Effects of Contaminants Associated with Restoration Measures on Chinook Salmon (Winter-Run ESU)

Impact AQUA-45: Effects of Restored Habitat Conditions on Chinook Salmon (Winter-Run ESU)

Impact AQUA-46: Effects of Methylmercury Management on Chinook Salmon (Winter-Run ESU) (CM12)

Impact AQUA-47: Effects of Invasive Aquatic Vegetation Management on Chinook Salmon (Winter-Run ESU) (CM13)

Impact AQUA-48: Effects of Dissolved Oxygen Level Management on Chinook Salmon (Winter-Run ESU) (CM14)

Impact AQUA-49: Effects of Localized Reduction of Predatory Fish on Chinook Salmon (Winter-Run ESU) (CM15)

Impact AQUA-50: Effects of Nonphysical Fish Barriers on Chinook Salmon (Winter-Run ESU) (CM16)

Impact AQUA-51: Effects of Illegal Harvest Reduction on Chinook Salmon (Winter-Run ESU) (CM17)

Impact AQUA-52: Effects of Conservation Hatcheries on Chinook Salmon (Winter-Run ESU) (CM18)

Impact AQUA-53: Effects of Urban Stormwater Treatment on Chinook Salmon (Winter-Run ESU) (CM19)

Impact AQUA-54: Effects of Removal/Relocation of Nonproject Diversions on Chinook Salmon (Winter-Run ESU) (CM21)

NEPA Effects: As discussed in detail for Alternative 1A, the impact mechanisms listed above would not be adverse, and would typically be beneficial to winter-run Chinook salmon. Specifically for AQUA-44, the effects of contaminants on winter-run Chinook salmon with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on winter-run Chinook salmon are uncertain.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would be less than significant, or beneficial, so no additional mitigation would be required.

Spring-Run Chinook Salmon

The potential effects of construction and maintenance of water conveyance facilities, operations of water conservation facilities, restoration measures and other conservation measures on spring-run Chinook salmon would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance of water conveyance facilities on spring-run Chinook salmon would be similar to those described under Alternative 1A, because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A (Impact AQUA-55 and AQUA-56), the fish effects described for spring-run Chinook salmon under Alternative 1A also appropriately characterize effects for spring-run Chinook salmon under Alternative 1C.

Impact AQUA-55: Effects of Construction of Water Conveyance Facilities on Chinook Salmon (Spring-Run ESU)

Impact AQUA-56: Effects of Maintenance of Water Conveyance Facilities on Chinook Salmon (Spring-Run ESU)

NEPA Effects: These impact mechanisms would not be adverse to spring-run Chinook salmon. While construction activities (Impact AQUA-55) could result in adverse effects from impact pile driving activities, the implementation of Mitigation Measures AQUA-1a and AQUA-1b, would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality).

CEQA Conclusion: Similar to the discussion provided above for Alternatives 1A, Impact AQUA-55 could result in significant underwater noise effects from impact pile driving, although implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of water conveyance facility operations on spring-run Chinook salmon would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C compared to Alternative 1A (Impact AQUA-57 through AQUA-60).

Impact AQUA-57: Effects of Water Operations on Entrainment of Chinook Salmon (Spring-Run ESU)

Impact AQUA-58: Effects of Water Operations on Spawning and Egg Incubation Habitat for Chinook Salmon (Spring-Run ESU)

Impact AQUA-59: Effects of Water Operations on Rearing Habitat for Chinook Salmon (Spring-Run ESU)

Impact AQUA-60: Effects of Water Operations on Migration Conditions for Chinook Salmon (Spring-Run ESU)

NEPA Effects: As discussed in detail for Alternative 1A, the impact mechanisms listed above (except for Impact AQUA-59) would be adverse under Alternative 1C for spring-run Chinook salmon. Adverse effects would occur because entrainment, spawning and egg incubation habitat, and migration conditions for juvenile spring-run Chinook salmon would be substantially reduced, and because it has the potential to substantially increase predation and remove important instream habitat as the result of the presence of five north Delta intake structures. The implementation of conservation and mitigation measures would reduce the severity of effects, although not necessarily to a not adverse level.

CEQA Conclusion: As discussed in detail for Alternative 1A, the effects of the impact mechanisms listed above (except for Impact AQUA-59) would be significant under Alternative 1C. The effects of Alternative 1C operations on would be adverse due to predation and habitat loss associated with the five intakes of the north Delta facilities, and flow changes in the Feather River.

While the effect of Alternative 1C on migration conditions is adverse, the implementation of applicable conservation measures (CM6, *Channel Margin Enhancement* and CM15, *Predator Control*), as described in Chapter 3 (Section 3.6) would minimize potential effects. In addition, the implementation of the mitigation measures listed below also has the potential to reduce the severity of the impact though not necessarily to a less-than-significant level. These mitigation measures would provide an adaptive management process, that may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6), for assessing impacts and developing appropriate minimization measures.

Mitigation Measure AQUA-58a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Spring-Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Spawning Habitat

Please refer to Mitigation Measure AQUA-58a under Alternative 1A (Impact AQUA-60) for spring-run Chinook salmon.

Mitigation Measure AQUA-58b: Conduct Additional Evaluation and Modeling of Impacts on Spring-Run Chinook Salmon Spawning Habitat Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-58b under Alternative 1A (Impact AQUA-60) for spring-run Chinook salmon.

Mitigation Measure AQUA-58c: Consult with USFWS and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Spring-Run Chinook Salmon Spawning Habitat Consistent with CM1

Please refer to Mitigation Measure AQUA-58c under Alternative 1A (Impact AQUA-60) for spring-run Chinook salmon.

Mitigation Measure AQUA-60a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Spring-Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Migration Conditions

Please refer to Mitigation Measure AQUA-60a under Alternative 1A (Impact AQUA-60) for spring-run Chinook salmon.

Mitigation Measure AQUA-60b: Conduct Additional Evaluation and Modeling of Impacts on Spring-Run Chinook Salmon Migration Conditions Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-60b under Alternative 1A (Impact AQUA-60) for spring-run Chinook salmon.

Mitigation Measure AQUA-60c: Consult with USFWS, and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Spring-Run Chinook Salmon Migration Conditions Consistent with CM1

Please refer to Mitigation Measure AQUA-60c under Alternative 1A (Impact AQUA-60) for spring-run Chinook salmon.

Restoration and Conservation Measures

The potential effects of restoration measures and other conservation measures on spring-run Chinook salmon would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A (Impact AQUA-61 through AQUA-72). Therefore, the effects on spring-run Chinook salmon under Alternative 1A also appropriately characterize effects under Alternative 1C.

Impact AQUA-61: Effects of Construction of Restoration Measures on Chinook Salmon (Spring-Run ESU)

Impact AQUA-62: Effects of Contaminants Associated with Restoration Measures on Chinook Salmon (Spring-Run ESU)

Impact AQUA-63: Effects of Restored Habitat Conditions on Chinook Salmon (Spring-Run ESU)

Impact AQUA-64: Effects of Methylmercury Management on Chinook Salmon (Spring-Run ESU) (CM12)

Impact AQUA-65: Effects of Invasive Aquatic Vegetation Management on Chinook Salmon (Spring-Run ESU) (CM13)

Impact AQUA-66: Effects of Dissolved Oxygen Level Management on Chinook Salmon (Spring-Run ESU) (CM14)

Impact AQUA-67: Effects of Localized Reduction of Predatory Fish on Chinook Salmon (Spring-Run ESU) (CM15)

Impact AQUA-68: Effects of Nonphysical Fish Barriers on Chinook Salmon (Spring-Run ESU) (CM16)

Impact AQUA-69: Effects of Illegal Harvest Reduction on Chinook Salmon (Spring-Run ESU) (CM17)

Impact AQUA-70: Effects of Conservation Hatcheries on Chinook Salmon (Spring-Run ESU) (CM18)

Impact AQUA-71: Effects of Urban Stormwater Treatment on Chinook Salmon (Spring-Run ESU) (CM19)

Impact AQUA-72: Effects of Removal/Relocation of Nonproject Diversions on Chinook Salmon (Spring-Run ESU) (CM21)

NEPA Effects: These impact mechanisms would not be adverse, and with the implementation of environmental commitments and conservation measures, the effects would typically be beneficial to spring-run Chinook salmon. Specifically for AQUA-62, the effects of contaminants on spring-run Chinook salmon with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on spring-run Chinook salmon are uncertain.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, most of these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

Fall-/Late Fall–Run Chinook Salmon

The potential effects of construction and maintenance of water conveyance facilities, operations of water conservation facilities, restoration measures and other conservation measures on fall- and late fall-run Chinook salmon would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance of water conveyance facilities on fall- and late fall-run Chinook salmon would be similar to those described under Alternative 1A because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A (Impact AQUA-73 and AQUA-74), the fish effects described for fall- and late fall-run Chinook salmon under Alternative 1A also appropriately characterize effects for fall- and late fall-run Chinook salmon under Alternative 1C.

Impact AQUA-73: Effects of Construction of Water Conveyance Facilities on Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-74: Effects of Maintenance of Water Conveyance Facilities on Chinook Salmon (Fall-/Late Fall–Run ESU)

NEPA Effects: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would not be adverse to fall- and late fall-run Chinook salmon. While construction activities (Impact AQUA-73) could result in adverse effects from impact pile driving activities, the implementation of Mitigation Measures AQUA-1a and AQUA-1b, would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality).

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, Impact AQUA-73 could result in significant underwater noise effects from impact pile driving, although implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of water conveyance facility operations on fall- and late fall-run Chinook salmon would be similar to those described for Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 6A (Impacts AQUA-75 through AQUA-78).

Impact AQUA-75: Effects of Water Operations on Entrainment of Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-76: Effects of Water Operations on Spawning and Egg Incubation Habitat for Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-77: Effects of Water Operations on Rearing Habitat for Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-78: Effects of Water Operations on Migration Conditions for Chinook Salmon (Fall-/Late Fall–Run ESU)

NEPA Effects: Overall, the effects of water operations vary by location. Similar to effects described in detail under Alternative 1A, Alternative 1C would have an adverse effect on fall-/late fall-run Chinook salmon juvenile survival because it has the potential to substantially interfere with the movement of fall-/late fall-run Chinook salmon. This would include adverse effects on fall-/late fall-run Chinook salmon through-delta migration conditions on the Sacramento River, relative to NAA, while through-Delta conditions on the San Joaquin River would be positive. The implementation of the conservation and mitigation measures listed below also has the potential to reduce the severity of the impact though not necessarily to a not adverse level.

CEQA Conclusion: Although the CEQA analyses indicate some significant effects of water operations on juvenile fall-/late fall-run Chinook salmon survival through the Delta. The implementation of applicable conservation measures (CM6, *Channel Margin Enhancement* and CM15, *Predator Control*), as described in Chapter 3 (Section 3.6) would minimize potential effects. In addition, the implementation of the mitigation measures listed below also would have the potential to reduce the severity of the effects, although not necessarily to a less-than-significant level. These mitigation measures would provide an adaptive management process, that may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6), for assessing impacts and developing appropriate minimization measures.

Mitigation Measure AQUA-78a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Fall-/Late Fall–Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Migration Conditions

Please refer to Mitigation Measure AQUA-78a under Alternative 1A (Impact AQUA-78) for fall/late fall-run Chinook salmon.

Mitigation Measure AQUA-78b: Conduct Additional Evaluation and Modeling of Impacts on Fall-/Late Fall–Run Chinook Salmon Migration Conditions Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-78b under Alternative 1A (Impact AQUA-78) for fall/late fall-run Chinook salmon.

Mitigation Measure AQUA-78c: Consult with USFWS and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Fall-/Late Fall–Run Chinook Salmon Migration Conditions Consistent with CM1

Please refer to Mitigation Measure AQUA-78c under Alternative 1A (Impact AQUA-78) for fall/late fall-run Chinook salmon.

Restoration and Conservation Measures

Impact AQUA-79: Effects of Construction of Restoration Measures on Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-80: Effects of Contaminants Associated with Restoration Measures on Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-81: Effects of Restored Habitat Conditions on Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-82: Effects of Methylmercury Management on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM12)

Impact AQUA-83: Effects of Invasive Aquatic Vegetation Management on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM13)

Impact AQUA-84: Effects of Dissolved Oxygen Level Management on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM14)

Impact AQUA-85: Effects of Localized Reduction of Predatory Fish on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM15)

Impact AQUA-86: Effects of Nonphysical Fish Barriers on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM16)

Impact AQUA-87: Effects of Illegal Harvest Reduction on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM17)

Impact AQUA-88: Effects of Conservation Hatcheries on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM18)

Impact AQUA-89: Effects of Urban Stormwater Treatment on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM19)

Impact AQUA-90: Effects of Removal/Relocation of Nonproject Diversions on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM21)

NEPA Effects: As discussed for Alternative 1A, the other impact mechanisms would not be adverse, and would typically be beneficial to fall- and late fall-run Chinook salmon. Specifically for AQUA-80, the effects of contaminants on fall- and late fall-run Chinook salmon with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on fall- and late fall-run Chinook salmon are uncertain.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would generally be beneficial or less than significant, and no mitigation would be required.

Steelhead

The potential effects of construction and maintenance of water conveyance facilities, operations of water conservation facilities, restoration measures and other conservation measures on steelhead would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance of water conveyance facilities because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A (Impact AQUA-91 and AQUA-92), the fish effects described for steelhead under Alternative 1A also appropriately characterize effects for steelhead under Alternative 1C.

Impact AQUA-91: Effects of Construction of Water Conveyance Facilities on Steelhead

Impact AQUA-92: Effects of Maintenance of Water Conveyance Facilities on Steelhead

NEPA Effects: These impact mechanisms would typically not be adverse to steelhead. While construction activities (Impact AQUA-91) could result in adverse effects from impact pile driving activities, the implementation of Mitigation Measures AQUA-1a and AQUA-1b, would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality).

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, Impact AQUA-91 could result in significant underwater noise effects from impact pile driving, although implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of` water conveyance facility operations on steelhead would be similar to those described above under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A (Impact AQUA-93 through AQUA-96).

Impact AQUA-93: Effects of Water Operations on Entrainment of Steelhead

Impact AQUA-94: Effects of Water Operations on Spawning and Egg Incubation Habitat for Steelhead

Impact AQUA-95: Effects of Water Operations on Rearing Habitat for Steelhead

Impact AQUA-96: Effects of Water Operations on Migration Conditions for Steelhead

NEPA Effects: Collectively, these results indicate that effect is not adverse because it would not substantially reduce the amount of suitable habitat or substantially interfere with the movement of fish. Flows under Alternative 1A in each waterway examined would not be reduced enough or in high enough frequency relative to NAA to affect steelhead migration. As described in detail under Alternative 1A, these impact mechanisms would result in variable effects on steelhead, but the effects would not result in biologically meaningful reductions in overall survival of steelhead. Therefore, the effects would not be adverse to steelhead under Alternative 1C.

CEQA Conclusion: Collectively, the analysis indicates that the difference between the CEQA baseline and Alternative 1C could be significant because, under the CEQA baseline, the alternative could substantially reduce the amount of suitable habitat and interfere with steelhead migrations in some areas. Despite the variability in effects of Alternative 1C, if adjusted to exclude sea level rise and climate change, the alternative would not in itself result in a significant impact on steelhead.

Restoration and Conservation Measures

The potential effects of restoration and conservation measures on steelhead would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C, compared to those described in detail for Alternative 1A (Impact AQUA-97 through AQUA-108), the effects described for steelhead also appropriately characterize the effects under Alternative 1C.

Impact AQUA-97: Effects of Construction of Restoration Measures on Steelhead

Impact AQUA-98: Effects of Contaminants Associated with Restoration Measures on Steelhead

Impact AQUA-99: Effects of Restored Habitat Conditions on Steelhead

Impact AQUA-100: Effects of Methylmercury Management on Steelhead (CM12)

Impact AQUA-101: Effects of Invasive Aquatic Vegetation Management on Steelhead (CM13)

Impact AQUA-102: Effects of Dissolved Oxygen Level Management on Steelhead (CM14)

Impact AQUA-103: Effects of Localized Reduction of Predatory Fish on Steelhead (CM15)

Impact AQUA-104: Effects of Nonphysical Fish Barriers on Steelhead (CM16)

Impact AQUA-105: Effects of Illegal Harvest Reduction on Steelhead (CM17)

Impact AQUA-106: Effects of Conservation Hatcheries on Steelhead (CM18)

Impact AQUA-107: Effects of Urban Stormwater Treatment on Steelhead (CM19)

Impact AQUA-108: Effects of Removal/Relocation of Nonproject Diversions on Steelhead (CM21)

NEPA Effects: As discussed for Alternative 1A, the other impact mechanisms would not be adverse, and would typically be beneficial to steelhead. Specifically for AQUA-98, the effects of contaminants on steelhead with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on steelhead are uncertain.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

Sacramento Splittail

The potential effects of construction and maintenance of water conveyance facilities, operations of water conservation facilities, restoration measures and other conservation measures on Sacramento splittail would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance of water conveyance facilities on Sacramento splittail would be similar to those described under Alternative 1A, because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A (Impact AQUA-109 and AQUA-110), the fish effects described for Sacramento splittail under Alternative 1A also appropriately characterize effects for Sacramento splittail under Alternative 1C.

Impact AQUA-109: Effects of Construction of Water Conveyance Facilities on Sacramento Splittail

Impact AQUA-110: Effects of Maintenance of Water Conveyance Facilities on Sacramento Splittail

NEPA Effects: These impact mechanisms would generally not be adverse to Sacramento splittail. While construction activities (Impact AQUA-109) could result in adverse effects from impact pile driving activities, the implementation of Mitigation Measures AQUA-1a and AQUA-1b would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality).

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, Impact AQUA-109 could result in significant underwater noise effects from impact pile driving, although implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant. The effects of Impact AQUA-110 would be less than significant, so no additional mitigation would be required.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of water conveyance facility operations on Sacramento splittail would be similar to those described for Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C, compared to those described in detail for Alternative 6A (Impacts AQUA-111 through AQUA-114).

Impact AQUA-111: Effects of Water Operations on Entrainment of Sacramento Splittail

Impact AQUA-112: Effects of Water Operations on Spawning and Egg Incubation Habitat for Sacramento Splittail

Impact AQUA-113: Effects of Water Operations on Rearing Habitat for Sacramento Splittail

Impact AQUA-114: Effects of Water Operations on Migration Conditions for Sacramento Splittail

NEPA Effects: As discussed in detail for Alternative 1A, the operations impact mechanisms would not be adverse to Sacramento splittail.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would be less than significant, and no mitigation would be required.

Restoration and Conservation Measures

The potential effects of restoration measures and other conservation measures on Sacramento splittail would be similar to those described for Alternative 1A, because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A (Impacts AQUA-115 through AQUA-126).

Impact AQUA-115: Effects of Construction of Restoration Measures on Sacramento Splittail

Impact AQUA-116: Effects of Contaminants Associated with Restoration Measures on Sacramento Splittail

Impact AQUA-117: Effects of Restored Habitat Conditions on Sacramento Splittail

Impact AQUA-118: Effects of Methylmercury Management on Sacramento Splittail (CM12)

Impact AQUA-119: Effects of Invasive Aquatic Vegetation Management on Sacramento Splittail (CM13)

Impact AQUA-120: Effects of Dissolved Oxygen Level Management on Sacramento Splittail (CM14)

Impact AQUA-121: Effects of Localized Reduction of Predatory Fish on Sacramento Splittail (CM15)

Impact AQUA-122: Effects of Nonphysical Fish Barriers on Sacramento Splittail (CM16)

Impact AQUA-123: Effects of Illegal Harvest Reduction on Sacramento Splittail (CM17)

Impact AQUA-124: Effects of Conservation Hatcheries on Sacramento Splittail (CM18)

Impact AQUA-125: Effects of Urban Stormwater Treatment on Sacramento Splittail (CM19)

Impact AQUA-126: Effects of Removal/Relocation of Nonproject Diversions on Sacramento Splittail (CM21)

NEPA Effects: As discussed for Alternative 1A, the other impact mechanisms would not be adverse, and would typically be beneficial to Sacramento splittail. Specifically for AQUA-116, the effects of contaminants on Sacramento splittail with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on Sacramento splittail are uncertain.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

Green Sturgeon

The potential effects of construction and maintenance of water conveyance facilities, operations of water conservation facilities, restoration measures and other conservation measures on green sturgeon would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance of water conveyance facilities on green sturgeon would be similar to those described under Alternative 1A, because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A (Impact AQUA-127 through AQUA-144).

Impact AQUA-127: Effects of Construction of Water Conveyance Facilities on Green Sturgeon

Impact AQUA-128: Effects of Maintenance of Water Conveyance Facilities on Green Sturgeon

NEPA Effects: While the maintenance impact mechanism (Impact AQUA-128) would not be adverse to green sturgeon, construction activities (Impact AQUA-127) could result in adverse effects from impact pile driving activities. However, the implementation of Mitigation Measures AQUA-1a and AQUA-1b, would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality).

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, Impact AQUA-127 could result in significant underwater noise effects from impact pile driving, although implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant. The other impact mechanism would be less than significant, so no additional mitigation would be required.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of operations of water conveyance facilities on green sturgeon would be similar to those described for Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A (Impacts AQUA-129 through AQUA-132), the effects described for green sturgeon also appropriately characterize the effects under Alternative 1C.

Impact AQUA-129: Effects of Water Operations on Entrainment of Green Sturgeon

Impact AQUA-130: Effects of Water Operations on Spawning and Egg Incubation Habitat for Green Sturgeon

Impact AQUA-131: Effects of Water Operations on Rearing Habitat for Green Sturgeon

Impact AQUA-132: Effects of Water Operations on Migration Conditions for Green Sturgeon

NEPA Effects: As discussed for Alternative 1A, Impact AQUA-132 is expected to negatively affect green sturgeon migration conditions under Alternative 1C. These effects are a result of the specific reservoir operations and resulting flows associated with this alternative. The implementation of the mitigation measures listed below has the potential to reduce the severity of the impact, although not necessarily to a level considered not adverse.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, Impact AQUA-132, the migration habitat conditions under Alternative 1C would be negatively affected, compared to Existing Conditions. The implementation of the mitigation measures listed below has the potential to reduce the severity of the impact, although not necessarily to a less-than-significant level. These mitigation measures would provide an adaptive management process, that may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6), for assessing impacts and developing appropriate minimization measures.

Mitigation Measure AQUA-132a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Green Sturgeon to Determine Feasibility of Mitigation to Reduce Impacts to Migration Conditions

Please refer to Mitigation Measure AQUA-132a under Alternative 1A (Impact AQUA-132) for green sturgeon.

Mitigation Measure AQUA-132b: Conduct Additional Evaluation and Modeling of Impacts on Green Sturgeon Migration Conditions Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-132b under Alternative 1A (Impact AQUA-132) for green sturgeon.

Mitigation Measure AQUA-132c: Consult with USFWS and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Green Sturgeon Migration Conditions Consistent with CM1

Please refer to Mitigation Measure AQUA-132c under Alternative 1A (Impact AQUA-132) for green sturgeon.

Restoration and Conservation Measures

Alternative 1C has the same restoration and conservation measures as Alternative 1A. Because no substantial differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A, the effects of the restoration and conservation measures described for green sturgeon under Alternative 1A (Impact AQUA-133 through Impact AQUA-144) also appropriately characterize effects under Alternative 1C.

Impact AQUA-133: Effects of Construction of Restoration Measures on Green Sturgeon

Impact AQUA-134: Effects of Contaminants Associated with Restoration Measures on Green Sturgeon

Impact AQUA-135: Effects of Restored Habitat Conditions on Green Sturgeon

Impact AQUA-136: Effects of Methylmercury Management on Green Sturgeon (CM12)

Impact AQUA-137: Effects of Invasive Aquatic Vegetation Management on Green Sturgeon (CM13)

Impact AQUA-138: Effects of Dissolved Oxygen Level Management on Green Sturgeon (CM14)

Impact AQUA-139: Effects of Localized Reduction of Predatory Fish on Green Sturgeon (CM15)

Impact AQUA-140: Effects of Nonphysical Fish Barriers on Green Sturgeon (CM16)

Impact AQUA-141: Effects of Illegal Harvest Reduction on Green Sturgeon (CM17)

Impact AQUA-142: Effects of Conservation Hatcheries on Green Sturgeon (CM18)

Impact AQUA-143: Effects of Urban Stormwater Treatment on Green Sturgeon (CM19)

Impact AQUA-144: Effects of Removal/Relocation of Nonproject Diversions on Green Sturgeon (CM21)

NEPA Effects: As discussed for Alternative 1A, these impact mechanisms would not be adverse, and with the implementation of environmental commitments and conservation measures, the effects would typically be beneficial to green sturgeon. Specifically for AQUA-134, the effects of contaminants on green sturgeon with respect to copper, ammonia and pesticides would not be adverse. The effects of methylmercury and selenium on green sturgeon are uncertain.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

White Sturgeon

The potential effects of construction and maintenance of water conveyance facilities, operations of water conservation facilities, restoration measures and other conservation measures on white sturgeon would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance of water conveyance facilities on white sturgeon would be similar to those described under Alternative 1A, because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A (Impact AQUA-145 and AQUA-146). Therefore, the effects described for white sturgeon under Alternative 1A also appropriately characterize effects for white sturgeon under Alternative 1C.

Impact AQUA-145: Effects of Construction of Water Conveyance Facilities on White Sturgeon

Impact AQUA-146: Effects of Maintenance of Water Conveyance Facilities on White Sturgeon

NEPA Effects: As concluded for Alternative 1A (Impact AQUA-145 and AQUA-146), environmental commitments and mitigation measures would be available to avoid and minimize potential effects, so the effect would not be adverse for white sturgeon.

CEQA Conclusion: As described under Alternative 1A (Impact AQUA-145 and AQUA-146), the impact of the construction and maintenance of water conveyance facilities on white sturgeon would be less than significant except for construction noise associated with pile driving. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Alternative 1A, Impact AQUA-1.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Alternative 1A, Impact AQUA-1.

Water Operations of CM1

The potential effects of operations of water conveyance facilities on white sturgeon would be similar to those described for Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A (Impacts AQUA-147 through AQUA-150), the effects described for white sturgeon also appropriately characterize the effects under Alternative 1C.

Impact AQUA-147: Effects of Water Operations on Entrainment of White Sturgeon

Impact AQUA-148: Effects of Water Operations on Spawning and Egg Incubation Habitat for White Sturgeon

Impact AQUA-149: Effects of Water Operations on Rearing Habitat for White Sturgeon

Impact AQUA-150: Effects of Water Operations on Migration Conditions for White Sturgeon

NEPA Effects: As described in detail under Alternatives 1A, the effects of water operations on white sturgeon would generally not be adverse. However, uncertainty regarding the mechanisms responsible for the positive correlation between year class strength and high river/Delta flow would be addressed through targeted research and monitoring, prior to the initiation of north Delta facilities operations. If these targeted investigations determine that the primary mechanism behind the positive correlation are related to in-Delta and through-Delta flow conditions, Alternative 1C operations would be considered to be adverse.

CEQA Conclusion: While the effects of Alternative 1C would not be significant for entrainment and spawning habitat, the results of the Impact AQUA-149 and AQUA-150 analyses indicate that the difference between the CEQA baseline and Alternative 1C could be significant, but the differences would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 1C, if adjusted to exclude sea level rise and climate change would be less than significant, and no mitigation is required.

Restoration and Conservation Measures

Alternative 1C has the same restoration and conservation measures as Alternative 1A. Because no substantial differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C, compared to those described in detail for Alternative 1A, the effects of these measures described for white sturgeon under Alternative 1A (Impact AQUA-151 through Impact AQUA-162) also appropriately characterize effects under Alternative 1C.

Impact AQUA-151: Effects of Construction of Restoration Measures on White Sturgeon

Impact AQUA-152: Effects of Contaminants Associated with Restoration Measures on White Sturgeon

Impact AQUA-153: Effects of Restored Habitat Conditions on White Sturgeon

Impact AQUA-154: Effects of Methylmercury Management on White Sturgeon (CM12)

Impact AQUA-155: Effects of Invasive Aquatic Vegetation Management on White Sturgeon (CM13)

Impact AQUA-156: Effects of Dissolved Oxygen Level Management on White Sturgeon (CM14)

Impact AQUA-157: Effects of Localized Reduction of Predatory Fish on White Sturgeon (CM15)

Impact AQUA-158: Effects of Nonphysical Fish Barriers on White Sturgeon (CM16)

Impact AQUA-159: Effects of Illegal Harvest Reduction on White Sturgeon (CM17)

Impact AQUA-160: Effects of Conservation Hatcheries on White Sturgeon (CM18)

Impact AQUA-161: Effects of Urban Stormwater Treatment on White Sturgeon (CM19)

Impact AQUA-162: Effects of Removal/Relocation of Nonproject Diversions on White Sturgeon (CM21)

NEPA Effects: As described for Alternative 1A, these impact mechanisms would not be adverse to white sturgeon. Specifically for AQUA-152, the effects of contaminants on white sturgeon with respect to copper, ammonia and pesticides would not be adverse. The effects of methylmercury and selenium on white sturgeon are uncertain.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

Pacific Lamprey

The potential effects of construction and maintenance of water conveyance facilities, operations of water conservation facilities, restoration measures and other conservation measures on Pacific lamprey would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance of water conveyance facilities because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A (Impact AQUA-163 and AQUA-164), the effects described for Pacific lamprey under Alternative 1A also appropriately characterize effects for Pacific lamprey under Alternative 1C.

Impact AQUA-163: Effects of Construction of Water Conveyance Facilities on Pacific Lamprey

Impact AQUA-164: Effects of Maintenance of Water Conveyance Facilities on Pacific Lamprey

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-163 and AQUA-164, environmental commitments and mitigation measures would be available to avoid and minimize potential effects, and the effect would not be adverse for Pacific lamprey.

CEQA Conclusion: As described under Alternative 1A, Impact AQUA-163 and AQUA-164, the impact of the construction and maintenance of water conveyance facilities on Pacific lamprey would be less than significant except for construction noise associated with pile driving. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Alternative 1A, Impact AQUA-1.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Alternative 1A, Impact AQUA-1.

Water Operations of CM1

The potential effects of water conveyance facility operations on Pacific lamprey would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A (Impact AQUA-165 and Impact AQUA-168)

Impact AQUA-165: Effects of Water Operations on Entrainment of Pacific Lamprey

Impact AQUA-166: Effects of Water Operations on Spawning and Egg Incubation Habitat for Pacific Lamprey

Impact AQUA-167: Effects of Water Operations on Rearing Habitat for Pacific Lamprey

Impact AQUA-168: Effects of Water Operations on Migration Conditions for Pacific Lamprey

NEPA Effects: Similar to the results discussed in detail under Alternative 1A, effects on entrainment of Pacific lamprey would not be adverse, and could be beneficial, due to design, installation, and operation of new screens in the north Delta. However, flow reductions are expected to cause substantial reductions in habitat available for spawning and egg incubation in the Feather River, and reduce overall spawning success. While the implementation of the mitigation measures listed below (Mitigation Measures AQUA-166a through AQUA-166c) would reduce the severity of effects, this would not necessarily result in a not adverse determination. However, the changes in flow would not substantially interfere with the movement of fish.

CEQA Conclusions: As concluded under Alternative 1A, Alternative 1C water operations could substantially reduce the number of fish as a result of increased exposure to redd dewatering and elevated water temperatures, which would reduce egg survival and increase ammocoete mortality. While the implementation of the mitigation measures listed below (Mitigation Measures AQUA-166a through AQUA-166c) would reduce the severity of effects, this would not necessarily result in a less than significant determination.

Mitigation Measure AQUA-166a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Pacific Lamprey to Determine Feasibility of Mitigation to Reduce Impacts to Spawning Habitat

Please refer to Mitigation Measure AQUA-166a under Impact AQUA-166 of Alternative 1A.

Mitigation Measure AQUA-166b: Conduct Additional Evaluation and Modeling of Impacts on Pacific Lamprey Spawning Habitat Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-166b under Impact AQUA-166 of Alternative 1A.

Mitigation Measure AQUA-166c: Consult with USFWS and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Pacific Lamprey Spawning Habitat Consistent with CM1

Please refer to Mitigation Measure AQUA-166c under Impact AQUA-166 of Alternative 1A.

Restoration and Conservation Measures

Alternative 1C has the same restoration and conservation measures as Alternative 1A. Because no substantial differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A, the effects of these measures described for Pacific lamprey under Alternative 1A (Impact AQUA-169 through Impact AQUA-180) also appropriately characterize effects under Alternative 1C.

Impact AQUA-169: Effects of Construction of Restoration Measures on Pacific Lamprey

Impact AQUA-170: Effects of Contaminants Associated with Restoration Measures on Pacific Lamprey

Impact AQUA-171: Effects of Restored Habitat Conditions on Pacific Lamprey

Impact AQUA-172: Effects of Methylmercury Management on Pacific Lamprey (CM12)

Impact AQUA-173: Effects of Invasive Aquatic Vegetation Management on Pacific Lamprey (CM13)

Impact AQUA-174: Effects of Dissolved Oxygen Level Management on Pacific Lamprey (CM14)

Impact AQUA-175: Effects of Localized Reduction of Predatory Fish on Pacific Lamprey (CM15)

Impact AQUA-176: Effects of Nonphysical Fish Barriers on Pacific Lamprey (CM16)

Impact AQUA-177: Effects of Illegal Harvest Reduction on Pacific Lamprey (CM17)

Impact AQUA-178: Effects of Conservation Hatcheries on Pacific Lamprey (CM18)

Impact AQUA-179: Effects of Urban Stormwater Treatment on Pacific Lamprey (CM19)

Impact AQUA-180: Effects of Removal/Relocation of Nonproject Diversions on Pacific Lamprey (CM21)

NEPA Effects: As discussed for Alternative 1A, these impact mechanisms would not be adverse, and would typically be beneficial to Pacific lamprey.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

River Lamprey

The potential effects of construction and maintenance of water conveyance facilities, operations of water conservation facilities, restoration measures and other conservation measures on river lamprey would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance of water conveyance facilities on river lamprey would be similar to those described under Alternative 1A because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A (Impact AQUA-181 and AQUA-182)., As a result, the fish effects described for river lamprey under Alternative 1A also appropriately characterize effects for river lamprey under Alternative 1C.

Impact AQUA-181: Effects of Construction of Water Conveyance Facilities on River Lamprey

Impact AQUA-182: Effects of Maintenance of Water Conveyance Facilities on River Lamprey

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-181 and AQUA-182, environmental commitments and mitigation measures would be available to avoid and minimize potential effects, and the effect would not be adverse for river lamprey.

CEQA Conclusion: As described under Alternative 1A, Impact AQUA-181 and AQUA-182, the impact of the construction and maintenance of water conveyance facilities on river lamprey would be less than significant except for construction noise associated with pile driving. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Alternative 1A, Impact AQUA-1.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Alternative 1A, Impact AQUA-1.

Water Operations of CM1

The potential effects of water conveyance facility operations on river lamprey would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C, compared to those described in detail for Alternative 1A (Impact AQUA-183 through Impact AQUA-186). Therefore, the effects described for river lamprey under Alternative 6A also appropriately characterize effects under Alternative 1C.

Impact AQUA-183: Effects of Water Operations on Entrainment of River Lamprey

Impact AQUA-184: Effects of Water Operations on Spawning and Egg Incubation Habitat for River Lamprey

Impact AQUA-185: Effects of Water Operations on Rearing Habitat for River Lamprey

Impact AQUA-186: Effects of Water Operations on Migration Conditions for River Lamprey

NEPA Effects: As discussed in detail for Alternative 1A, the effects of water operations under Alternative 1C has the potential to substantially reduce river lamprey rearing habitat, and substantially reduce the number of fish as a result of ammocoete mortality. However, the implementation of the mitigation measures listed below has the potential to reduce the severity of the impact, although not necessarily to a not adverse level. Therefore, the impact is considered adverse.

CEQA Conclusion: As described in detail under Alternative 1A, the CEQA analyses indicate that water operations under Alternative 1C has the potential to significantly reduce river lamprey rearing habitat, as well as the number of fish as a result of ammocoete mortality. While the implementation of the mitigation measures listed below has the potential to reduce the severity of the impact, it would not necessarily reduce it to a less-than-significant level. These mitigation measures would provide an adaptive management process, that may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6), for assessing impacts and developing appropriate minimization measures.

Mitigation Measure AQUA-185a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to River Lamprey to Determine Feasibility of Mitigation to Reduce Impacts to Rearing Habitat

Please refer to Mitigation Measure AQUA-185a under Alternative 1A (Impact AQUA-185) for river lamprey.

Mitigation Measure AQUA-185b: Conduct Additional Evaluation and Modeling of Impacts River Lamprey Rearing Habitat Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-185b under Alternative 1A (Impact AQUA-185) for river lamprey.

Mitigation Measure AQUA-185c: Consult with USFWS and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on River Lamprey Rearing Habitat Consistent with CM1

Please refer to Mitigation Measure AQUA-185c under Alternative 1A (Impact AQUA-185) for river lamprey.

Restoration and Conservation Measures

Alternative 1C has the same restoration and conservation measures as Alternative 1A. Because no substantial differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A, the effects of the measures described for river lamprey under Alternative 1A (Impact AQUA-187 through Impact AQUA-198) also appropriately characterize effects under Alternative 1C.

Impact AQUA-187: Effects of Construction of Restoration Measures on River Lamprey

Impact AQUA-188: Effects of Contaminants Associated with Restoration Measures on River Lamprey

Impact AQUA-189: Effects of Restored Habitat Conditions on River Lamprey

Impact AQUA-190: Effects of Methylmercury Management on River Lamprey (CM12)

Impact AQUA-191: Effects of Invasive Aquatic Vegetation Management on River Lamprey (CM13)

Impact AQUA-192: Effects of Dissolved Oxygen Level Management on River Lamprey (CM14)

Impact AQUA-193: Effects of Localized Reduction of Predatory Fish on River Lamprey (CM15)

Impact AQUA-194: Effects of Nonphysical Fish Barriers on River Lamprey (CM16)

Impact AQUA-195: Effects of Illegal Harvest Reduction on River Lamprey (CM17)

Impact AQUA-196: Effects of Conservation Hatcheries on River Lamprey (CM18)

Impact AQUA-197: Effects of Urban Stormwater Treatment on River Lamprey (CM19)

Impact AQUA-198: Effects of Removal/Relocation of Nonproject Diversions on River Lamprey (CM21)

NEPA Effects: As discussed for Alternative 1A, the other impact mechanisms would not be adverse, and would typically be beneficial to river lamprey.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

Non-Covered Aquatic Species of Primary Management Concern

The potential effects of construction and maintenance of water conveyance facilities, operations of water conservation facilities, restoration measures and other conservation measures on non-covered species would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance activities on non-covered aquatic species of primary management concern would be similar to those described under Alternative 1A because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A (Impact AQUA-199 through AQUA-217). Therefore, the fish effects described for non-covered aquatic species of primary management concern under Alternative 1A also appropriately characterize effects for river lamprey under Alternative 1C.

Impact AQUA-199: Effects of Construction of Water Conveyance Facilities on Non-Covered Aquatic Species of Primary Management Concern

Impact AQUA-200: Effects of Maintenance of Water Conveyance Facilities on Non-Covered Aquatic Species of Primary Management Concern

NEPA Effects: As concluded for Alternative 1A (Impact AQUA-199 and AQUA-200), environmental commitments and mitigation measures would be available to avoid and minimize potential effects, and the effect would not be adverse for non-covered aquatic species of primary management concern.

CEQA Conclusion: As described under Alternative 1A (Impact AQUA-199 and AQUA-200), the impact of the construction and maintenance of water conveyance facilities on non-covered aquatic species of primary management concern would be less than significant except potentially for construction noise associated with pile driving. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Alternative 1A, Impact AQUA-1.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Alternative 1A, Impact AQUA-1.

Water Operations of CM1

The potential effects of water conveyance facility operations on non-covered aquatic species of primary management concern would be similar to those described under Alternative 1A, because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A (Impact AQUA-201 through Impact AQUA-204).

Impact AQUA-201: Effects of Water Operations on Entrainment of Non-Covered Aquatic Species of Primary Management Concern

Impact AQUA-202: Effects of Water Operations on Spawning and Egg Incubation Habitat for Non-Covered Aquatic Species of Primary Management Concern

Impact AQUA-203: Effects of Water Operations on Rearing Habitat for Non-Covered Aquatic Species of Primary Management Concern

Impact AQUA-204: Effects of Water Operations on Migration Conditions for Non-Covered Aquatic Species of Primary Management Concern

NEPA Effects: These impact mechanisms would not be adverse to the non-covered species of primary management concern, as well as with the implementation of environmental commitments and conservation measures, the effects would typically be beneficial.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would generally be less than significant. However, Impact AQUA-203 and AQUA-204 could result in significant, but unavoidable effects on rearing habitat and migration habitat conditions for several fish species. These species include largemouth bass, Sacramento-San Joaquin roach, and hardhead. There are also no feasible mitigation measures available to mitigate for these impacts. The other impact mechanisms would be less than significant, or beneficial, so no additional mitigation would be required.

Restoration and Conservation Measures

Alternative 1C has the same restoration and conservation measures as Alternative 1A. Because no substantial differences in fish effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A, the effects of these measures described for non-covered aquatic species of primary management concern under Alternative 1A (Impact AQUA-205 through Impact AQUA-216) also appropriately characterize effects under Alternative 1C.

Impact AQUA-205: Effects of Construction of Restoration Measures on Non-Covered Aquatic Species of Primary Management Concern

Impact AQUA-206: Effects of Contaminants Associated with Restoration Measures on Non-Covered Aquatic Species of Primary Management Concern

Impact AQUA-207: Effects of Restored Habitat Conditions on Non-Covered Aquatic Species of Primary Management Concern

Impact AQUA-208: Effects of Methylmercury Management on Non-Covered Aquatic Species of Primary Management Concern (CM12)

Impact AQUA-209: Effects of Invasive Aquatic Vegetation Management on Non-Covered Aquatic Species of Primary Management Concern (CM13)

Impact AQUA-210: Effects of Dissolved Oxygen Level Management on Non-Covered Aquatic Species of Primary Management Concern (CM14)

Impact AQUA-211: Effects of Localized Reduction of Predatory Fish on Non-Covered Aquatic Species of Primary Management Concern (CM15)

Impact AQUA-212: Effects of Nonphysical Fish Barriers on Non-Covered Aquatic Species of Primary Management Concern (CM16)

Impact AQUA-213: Effects of Illegal Harvest Reduction on Non-Covered Aquatic Species of Primary Management Concern (CM17)

Impact AQUA-214: Effects of Conservation Hatcheries on Non-Covered Aquatic Species of Primary Management Concern (CM18)

Impact AQUA-215: Effects of Urban Stormwater Treatment on Non-Covered Aquatic Species of Primary Management Concern (CM19)

Impact AQUA-216: Effects of Removal/Relocation of Nonproject Diversions on Non-Covered Aquatic Species of Primary Management Concern (CM21)

NEPA Effects: As discussed in detail under Alternative 1A, these impact mechanisms would not adversely affect the aquatic species of primary management concern, and with the implementation of environmental commitments and conservation measures, the effects would typically be beneficial.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

Upstream Reservoirs

Impact AQUA-217: Effects of Water Operations on Reservoir Coldwater Fish Habitat

NEPA Effects: As discussed in detail under Alternative 1A, this effect would not be adverse because coldwater fish habitat in the CVP and SWP upstream reservoirs under Alternative 1C would not be substantially reduced when compared to the No Action Alternative.

CEQA Conclusion: In general, as discussed under Alternative 1A, Alternative 1C would reduce the quantity of coldwater fish habitat in the CVP and SWP compared to Existing Conditions, which could result in a significant impact. However, if adjusted to exclude sea level rise and climate change, Alternative 1C would not in itself result in a significant impact on coldwater habitat in upstream reservoirs. Therefore, this impact is found to be less than significant and no mitigation is required.

11.3.4.5 Alternative 2A—Dual Conveyance with Pipeline/Tunnel and Five Intakes (15,000 cfs; Operational Scenario B)

Like Alternative 1A, Alternative 2A would consist of pipelines and tunnels generally located in the central Delta with an intermediate forebay; however, Alternative 2A could potentially entail two different intake and intake pumping plant locations. Currently, as an alternative to Intakes 1–5, intake locations 1, 2, 3, 6, and 7 are being considered. Selection of intake locations 6 and 7 would entail construction in the same general region (north Delta), although about 5 and 6 miles farther downstream from the Intake 5 location, respectively. Thus, the same types of construction effects on fish species would occur, as those discussed for Alternative 1A. In addition, some of the conveyance pipelines and the initial tunnel (Tunnel 1) between the intake pumping plants and the intermediate forebay would be adjusted depending on the intake locations. This alternative would convey water from five fish-screened intakes between Clarksburg and Walnut Grove (Intakes 6 and 7, if selected, would be downstream of Sutter and Steamboat Sloughs) to a new Byron Tract Forebay adjacent to CCF. Construction effects for all fish species would be similar to those described for Alternative 1A.

Like Alternative 1A, the Alternative 2A facilities could convey up to 15,000 cfs from the north Delta, although Alternative 2A water conveyance operational criteria (Operational Scenario B) would be modified from those described for Alternative 1A (Operational Scenario A). Unlike Operational Scenario A, Operational Scenario B includes incorporation of Fall X2 guidelines, more restrictive (less negative) south Delta OMR flows, and an operable barrier at the head of Old River (see Section 3.6.4.2, *North Delta and South Delta Water Conveyance Operational Criteria*). Operational Scenario B also includes north Delta diversion bypass flow criteria, south Delta export/inflow ratio, flow criteria over Fremont Weir into Yolo Bypass, Delta inflow and outflow criteria, DCC gate operations, Rio Vista minimum instream flow criteria, operations for Delta water quality and residence criteria, and water quality criteria for agricultural and municipal/industrial diversions.

Delta Smelt

Construction and Maintenance of CM1

Small numbers of delta smelt eggs, larvae, and/or adults could be present in the Delta in June and July during construction of intake facilities and the barge landings (see Table 11-6). The construction and maintenance sites also occur entirely within designated delta smelt critical habitat.

Impact AQUA-1: Effects of Construction of Water Conveyance Facilities on Delta Smelt

The potential effects of construction of the water conveyance facilities on delta smelt or designated critical habitat would be similar to those described for Alternative 1A (Impact AQUA-1) except that Alternative 2A could potentially include two different intakes than under Alternative 1A. This would convert about 11,350 lineal feet of existing shoreline habitat into intake facility structures and would require about 26 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. The effects related to temporary increases in turbidity, accidental spills, underwater noise, in-water work activities, and disturbance of contaminated sediments would be similar to Alternative 1A and the same environmental commitments and mitigation measures (described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*) would be available to avoid and minimize potential effects.

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-1, the effect would not be adverse for delta smelt or designated critical habitat.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-1, the impact of the construction of water conveyance facilities on delta smelt and critical habitat would be less than significant with the implementation measures described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*, except for construction noise associated with pile driving. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Alternative 1A, Impact AQUA-1.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Alternative 1A, Impact AQUA-1.

Impact AQUA-2: Effects of Maintenance of Water Conveyance Facilities on Delta Smelt

NEPA Effects: The potential effects of the maintenance of water conveyance facilities under Alternative 2A would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-2). As concluded in Alternative 1A, Impact AQUA-2, with the implementation measures described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*, the effect would not be adverse for delta smelt.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-2, with the implementation measures described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*, the impact of the maintenance of water conveyance facilities on delta smelt would be less than significant and no mitigation is required.

Water Operations of CM1

Impact AQUA-3: Effects of Water Operations on Entrainment of Delta Smelt

Water Exports from SWP/CVP South Delta Facilities

Overall, operational activities under Alternative 2A would benefit delta smelt by reducing average proportional entrainment at the south Delta facilities. Average juvenile proportional entrainment (March–June) would be 0.14 (i.e., 14% of the juvenile population) under Alternative 2A, which would be reduced 0.008(a 5% relative decrease) compared to baseline (0.15 NAA) (Figure 11-2A-1, Table 11-2A-1). As described under Alternative 1A (Impact AQUA-3), the greatest relative reductions in larval/juvenile proportional entrainment would be in wetter years (24% to 33% relative decrease compared to NAA). Average adult proportional entrainment (December–March) for all water year types would be reduced under Alternative 2A by 0.02 (a 27% relative decrease) under Alternative 2A compared to NAA (Figure 11-2A-2, Table 11-2A-1).

Table 11-2A-1. Differences in Proportional Entrainment of Delta Smelt at SWP/CVP South Delta Facilities

Water Year Type	Proportional Entrainment[a] Difference in Proportions (Relative Change in Proportions) EXISTING CONDITIONS vs. A2A	NAA vs. A2A
Total Population		
Wet	-0.034 (-31%)	-0.059 (-44%)
Above Normal	-0.028 (-17%)	-0.056 (-29%)
Below Normal	0.016 (7%)	-0.013 (-5%)
Dry	0.017 (6%)	-0.002 (-1%)
Critical	0.010 (3%)	0.010 (3%)
All Years	-0.007 (-3%)	-0.028 (-13%)
Juvenile Delta Smelt (March–June)		
Wet	0.005 (13%)	-0.021 (-33%)
Above Normal	0.002 (3%)	-0.027 (-24%)
Below Normal	0.030 (22%)	-0.001 (-1%)
Dry	0.026 (14%)	0.005 (3%)
Critical	0.017 (7%)	0.012 (5%)
All Years	0.015 (12%)	-0.008 (-5%)
Adult Delta Smelt[b] (December–March)		
Wet	-0.039 (-56%)	-0.038 (-55%)
Above Normal	-0.030 (-37%)	-0.029 (-36%)
Below Normal	-0.014 (-17%)	-0.012 (-15%)
Dry	-0.009 (-11%)	-0.007 (-9%)
Critical	-0.007 (-9%)	-0.002 (-2%)
All Years	-0.022 (-29%)	-0.020 (-27%)

Shading indicates >5% or more increased entrainment.

Note: Negative values indicate lower entrainment loss under Alternative 2A than under EXISTING CONDITIONS.

[a] Proportional entrainment index (U.S. Fish and Wildlife Service 2008a).

[b] Adult proportional entrainment adjusted according to Kimmerer (2011).

Water Exports from SWP/CVP North Delta Intake Facilities

As described for Alternative 1A (Impact AQUA-3 for delta smelt), delta smelt would face potential entrainment and impingement at the proposed north Delta diversion facilities. The exposure to potential entrainment would be low, however, because only a very small proportion of the population occurs at this location. The intakes would be screened to exclude fish larger than 15 mm SL, which would include juvenile delta smelt. There would be potential negative effects from entrainment of smaller life stages (eggs and larvae) and potential impingement and screen contact by juveniles and adults (Appendix B, *Entrainment*, Section B.6.2.3).

Water Export with a Dual Conveyance for the SWP North Bay Aqueduct

As described for Alternative 1A, potential entrainment and impingement risks at the north Delta intakes would be limited since delta smelt rarely occur in the vicinity of the proposed intake site. Potential larval smelt entrainment as modeled by PTM would be minimal (less than 2% under Alternative 2A) and similar to NAA. The intake would be screened to exclude fish larger than 15 mm SL.

Water Export with a Dual Conveyance for the SWP North Bay Aqueduct

Potential entrainment of larval delta smelt at the NBA, as estimated by particle-tracking models was low, averaging 1.3% under Alternative 2A compared to 2.0% under NAA, a 35% reduction in relative terms (Table 11-2A-2).

Table 11-2A-2. Average Percentage (and Difference) of Particles Representing Larval Delta Smelt Entrained by the North Bay Aqueduct under Alternative 2A and Baseline Scenarios

Average Percent Particles Entrained at NBA			Difference (and Relative Difference)	
EXISTING CONDITIONS	NAA	A2A_LLT	A2A_LLT vs. EXISTING CONDITIONS	A2A_LLT vs. NAA
2.1	2.0	1.3	-0.81 (-39%)	-0.71 (-35%)

Note: 60-day DSM2-PTM simulation. Negative difference indicates lower entrainment under the alternative compared to the baseline scenario.

Predation Associated with Entrainment

As described in Impact AQUA-3 for Alternative 1A, pre-screen losses of delta smelt at the SWP/CVP facilities are believed to be high and are typically attributed to predation and other unfavorable conditions near the pumps (Castillo et al. 2012). Under Alternative 2, pre-screen losses at the south Delta facilities would decrease commensurate with entrainment reductions described above. Structures associated with the proposed north Delta intakes could attract piscivorous fish, potentially increasing localized predation risk. However few delta smelt would be expected to occur in the vicinity of the north Delta intakes, thus limiting their exposure to the predation risk. Predatory fish could potentially occur along NPBs, which could potentially increase predation risk at those times of year delta smelt are in that region of the south Delta (December–June). The effect would be beneficial for delta smelt because fewer delta smelt would be lost to predation across all SWP/CVP facilities.

NEPA Effects: Under Alternative 2A, overall potential entrainment of delta smelt would be reduced at the south Delta SWP/CVP facilities. Entrainment and impingement could potentially occur at the proposed north Delta intakes, but the risk would be low due to the location, design and operation of intakes, and offset by reduced entrainment at the south Delta facilities. Furthermore, any potential effects would be reduced by monitoring and adaptive management by the Real-Time Response Team. Overall, Alternative 2A would not have an adverse effect and may be beneficial to delta smelt due to a small reduction in entrainment and associated predation losses at the south Delta facilities, and minimizing entrainment at the north Delta facilities and NBA intakes.

CEQA Conclusion: As described above, operations under Alternative 2A would reduce average adult proportional entrainment by 0.022 (a 29% relative decrease) compared to Existing Conditions.

Larval/juvenile entrainment would increase by 0.015 (12% relative increase) on average, and increase by 0.030 (22% relative increase) in below normal years compared to Existing Conditions (Table 11-2A-1). However, this would affect a small proportion of the population (1.5% on average, 3% in below normal years).

This CEQA interpretation of the biological modeling differs from the NEPA analysis, which is likely attributable to different modeling assumptions (as described fully in Section 11.3.3 and Alternative 1A Impact AQUA-3). Because the action alternative modeling does not partition the effects of implementation of the alternative from the effects of sea level rise, climate change and future water demands, the comparison to Existing Conditions may not offer a clear understanding of the impact of the alternative on the environment. Note that the analysis for larvae and juveniles includes both OMR flows and X2 as predictors of proportional entrainment; primarily because of sea level rise assumptions, X2 would be further upstream in the ELT and LLT even with similar water operations, so that the comparison of the action alternative in the ELT and LLT to Existing Conditions is confounded.

Therefore, the impact analysis is better informed by the results from the NEPA analysis presented above, which accounts for sea level rise by considering the NAA in the LLT. When climate change is factored in, larval-juvenile delta smelt proportional entrainment is reduced 0.008 (5% relative decrease) on average compared to conditions without BDCP, and is similar in below normal years (Table 11-2A-1).

The risk of entrainment and impingement at the proposed north Delta intakes is low due to the low abundance of delta smelt in the vicinity, and would be further minimized by fish screens. Potential entrainment of larvae would be slightly decreased (~1%) at the NBA (Table 11-2A-2).

Overall, Alternative 2A would not significantly increase entrainment and associated predation losses at the south Delta facilities, and would minimize entrainment at the north Delta facilities and NBA intakes. Furthermore, any potential impacts would be reduced by monitoring and adaptive management by the Real-Time Response Team. The impact is considered to be less than significant, and no mitigation would be required.

Impact AQUA-4: Effects of Water Operations on Spawning and Egg Incubation Habitat for Delta Smelt

NEPA Effects: The effects of operations under Alternative 2A on abiotic spawning habitat would be about the same as described for Alternative 1A (Impact AQUA-4). Flow reductions below the north Delta intakes would not reduce available spawning habitat. In-Delta water temperatures, which can affect spawning timing, would not change across Alternatives, because they would be in thermal equilibrium with atmospheric conditions and not strongly influenced by the flow changes. The effect of Alternative 2A operations on spawning would not be adverse, because there would be little change in abiotic spawning conditions for delta smelt.

CEQA Conclusion: As described above, operations under Alternative 2A would not reduce abiotic spawning habitat availability or change spawning temperatures for delta smelt. Consequently, the impact would be less than significant, and no mitigation is required.

Impact AQUA-5: Effects of Water Operations on Rearing Habitat for Delta Smelt

As described for Alternative 1A (Impact AQUA-5 for delta smelt), rearing habitat conditions for juvenile delta smelt were evaluated using the fall abiotic habitat index (Feyrer et al. 2011) with and without the assumption that habitat benefits are realized. Unlike Alternative 1A, Alternative 2A includes the BiOp Fall X2 requirements. The abiotic habitat index under Alternative 2A without restoration would be similar to NAA (Table 11-2A-3, Figure 11-2A-3). However, Alternative 2A is expected to further benefit delta smelt by habitat restoration (*CM2 Yolo Bypass Fisheries Enhancement and CM4 Tidal Natural Communities Restoration*), particularly in the Suisun Marsh, West Delta, and Cache Slough ROAs, which are closer to delta smelt's main areas of occurrence. Habitat restoration, similar in scale to that under Alternative 1A, is expected to increase spawning and rearing habitat and is intended to supplement food production and export to rearing areas.

NEPA Effects: Assuming BDCP habitat benefits are realized, Alternative 2A could result in an increase in the abiotic habitat index of up to 30% (compared to NAA), averaged across all water years and assuming 100% habitat occupancy (Table 11-2A-3). These effects are due to the inundation of new areas of the Delta resulting from habitat restoration effects, which will open up additional habitat for delta smelt. However, since delta smelt are pelagic, they would not be expected to occupy habitats shallower than about 3-6 feet deep in significant numbers. When analyzing effects by water years, the relative increase in abiotic habitat index would be at least 25% for all years combined, and greatest in dry years (37% NAA) and below normal years (34% NAA), with restoration. If conservation measures to restore habitat do not realize expected benefits, there would be only minor changes in abiotic habitat index.

Table 11-2A-3. Differences in Delta Smelt Fall Abiotic Index (hectares) between Alternative 2A and Existing Biological Conditions Scenarios, with Habitat Restoration, Averaged by Prior Water Year Type

	Without Restoration		With Restoration	
Water Year	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
All	992 (25%)	106 (2%)	2,325 (58%)	1,439 (30%)
Wet	2,178 (46%)	-18 (0%)	4,065 (86%)	1,869 (27%)
Above Normal	1,729 (45%)	61 (1%)	3,243 (85%)	1,575 (29%)
Below Normal	60 (1%)	208 (5%)	1,192 (29%)	1,340 (34%)
Dry	195 (5%)	286 (8%)	1,186 (33%)	1,278 (37%)
Critical	28 (1%)	28 (1%)	743 (25%)	743 (25%)

Note: Negative values indicate lower habitat indices under preliminary proposal scenarios. Water year 1922 was omitted because water year classification for prior year was not available.

CEQA Conclusion: As discussed under Alternative 1A, Alternative 2A would not result in less rearing habitat area (based on the Feyrer et al. 2011 abiotic habitat index), compared to Existing Conditions. Averaged across all water year types, Alternative 2A would result in an overall increase in the abiotic habitat index by 25% without restoration and up to 58% with restoration compared Existing Conditions (which do not include Fall X2 criteria) (Table 11-2A-3). Without BDCP habitat restoration efforts, the fall abiotic habitat index would be similar to baseline in drier years (5% more), but would increase 45–46% in above normal and wet years, when Fall X2 requirements are met. As described above, habitat restoration under Alternative 2A would further increase the delta smelt fall abiotic habitat index, resulting in up to 25–33% increase in drier years and up to 85–86% increase in wetter years, optimistically assuming 100% habitat occupancy (Figure 11-2A-3).

Note that the CEQA analysis predicts a greater increase in the abiotic habitat index relative to baseline than the NEPA analysis. It is unclear whether this increase under Alternative 2A compared to Existing Conditions is a function of Project operations, or attributable to differences in modeling assumptions (Existing Conditions does not include Fall X2). The NEPA analysis is a better approach for isolating the effect of the Alternative from the effects of sea level rise, climate change, future water demands, and implementation of required actions under the BiOps such as the Fall X2 requirement. When compared to the NAA and informed by the NEPA analysis, the average delta smelt abiotic habitat index under Alternative 2A would be similar to NAA without restoration, and 30% greater with restoration (Table 11-2A-3).

Overall, there would be a minor beneficial impact on the species compared to existing conditions without Fall X2, primarily from implementation of habitat restoration. The benefits of restored habitat for this species will depend on the success of restoration in creating physical habitat for smelt and in fostering ecological conditions that favor good feeding conditions and production of food upon which smelt can feed. The magnitude of restored habitat benefits is uncertain. As such, restoration success will have to be assessed empirically during the term of the BDCP permit. BDCP water operations will be subject to adjustment via adaptive management, in order to ensure the impacts of water operations on rearing habitat for delta smelt are not significant and to support a contribution to recovery of this species. The Adaptive Management Program will evaluate the effects of water operations and habitat restoration on the delta smelt population, including adjustments as appropriate to improve water supply reliability. In conclusion, the impact of Alternative 2A would be less than significant and would likely provide a benefit to the species because of the increase in available habitat. No mitigation is required.

Impact AQUA-6: Effects of Water Operations on Migration Conditions for Delta Smelt

From December to March, many mature delta smelt migrate upstream from brackish rearing areas in and around Suisun Bay and the confluence of the Sacramento and San Joaquin Rivers (U.S. Fish and Wildlife Service 2008a; Sommer et al. 2011). The initiation of migration is associated with pulses of freshwater inflow, which are turbid, cool, and less saline (Grimaldo et al. 2009). Changes in flow under Alternative2A could change turbidity, but is not expected to result in changes in water temperatures or pulses of local rainwater into the Delta. As described above in Impact AQUA-4, in-Delta water temperatures would not change in response to Alternative 2A flows. The modeling results indicate no biologically meaningful changes in water temperature within the Delta under Alternative2A and no substantial changes in the number of stressful or lethal condition days for juveniles.

Turbid water is an important habitat characteristic for delta smelt (Nobriga et al. 2008; Feyrer et al. 2011), and has been correlated to long-term changes in delta smelt abundance or survival either by itself or in combination with other factors (Thomson et al. 2010; Miller et al. 2012). Therefore, it is assumed that turbidity is an attribute of critical importance to delta smelt larvae, juveniles, and adults. Operation of the north Delta intakes (*CM1 Water Facilities and Operation*) is estimated to result in around 8 to 9% less sediment entering the Plan Area from the Sacramento River, the main source of sediment for the Delta and downstream subregions. In addition, sediment could be accreted (captured) in the ROAs (*CM4 Tidal Natural Communities Restoration*). Notching the Fremont Weir (*CM2 Yolo Bypass Fisheries Enhancements)* will also direct more Sacramento River water and sediment into the Bypass. These actions could limit sediment supply to areas currently important to delta smelt, such as Suisun Bay, which would result in less seasonal deposition of sediment that could be resuspended by wind-wave action to make/keep the overlying water column turbid. Therefore, there is a potential for a slight increase in water clarity, and a corresponding reduction in habitat quality for delta smelt. However, Alternative 2A is not expected to affect suspended sediment concentration during the first flush of precipitation that cues delta smelt migration. As such, turbidity cues associated with adult delta smelt migration should not change. With regard to suspended sediment concentrations at other times of the year, any effect will be minimized through the reintroduction of sediment collected at the north Delta intakes into tidal natural communities restoration projects (CM4), consistent with the Environmental Commitment addressing Disposal and Reuse of Spoils, Reusable Tunnel Material (RTM), and Dredged Material.

NEPA Effects: Alternative 2 may decrease sediment supply to the estuary by 8 to 9 percent, with the potential for decreased habitat suitability for delta smelt in some locations.

CEQA Conclusion: As described above, operations under Alternative 2A would not substantially alter the turbidity cues associated with winter flush events that may initiate the adult delta smelt migration. Additionally there would be no appreciable changes in water temperatures under Alternative 2A. Consequently, the impact on adult delta smelt migration conditions would be less than significant, and no mitigation is required.

Restoration and Conservation Measures

Alternative 2A has the same restoration and conservation measures as Alternative 1A. Because no substantial differences in fish effects are anticipated anywhere in the affected environment under Alternative 2A compared to those described in detail for Alternative 1A, the effects described for delta smelt under Alternative 1A (Impact AQUA-7 through AQUA-18) also appropriately characterize effects under Alternative 2A.

The following impacts are those presented under Alternative 1A that are identical for Alternative 2A.

Impact AQUA-7: Effects of Construction of Restoration Measures on Delta Smelt

Impact AQUA-8: Effects of Contaminants Associated with Restoration Measures on Delta Smelt

Impact AQUA-9: Effects of Restored Habitat Conditions on Delta Smelt

Impact AQUA-10: Effects of Methylmercury Management on Delta Smelt (CM12)

Impact AQUA-11: Effects of Invasive Aquatic Vegetation Management on Delta Smelt (CM13)

Impact AQUA-12: Effects of Dissolved Oxygen Level Management on Delta Smelt (CM14)

Impact AQUA-13: Effects of Localized Reduction of Predatory Fish on Delta Smelt (CM15)

Impact AQUA-14: Effects of Nonphysical Fish Barriers on Delta Smelt (CM16)

Impact AQUA-15: Effects of Illegal Harvest Reduction on Delta Smelt (CM17)

Impact AQUA-16: Effects of Conservation Hatcheries on Delta Smelt (CM18)

Impact AQUA-17: Effects of Urban Stormwater Treatment on Delta Smelt (CM19)

Impact AQUA-18: Effects of Removal/Relocation of Nonproject Diversions on Delta Smelt (CM21)

NEPA Effects: All of these restoration and conservation measure impact mechanisms have been determined to result in no adverse effects on delta smelt for the reasons identified for Alternative 1A. Specifically for AQUA-8, the effects of contaminants on delta smelt with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on delta smelt are uncertain.

CEQA Conclusion: All of these restoration and conservation measure impact mechanisms would be considered less than significant, for the reasons identified for Alternative 1A, and no mitigation would be required.

Longfin Smelt

Construction and Maintenance of CM1

Impact AQUA-19: Effects of Construction of Water Conveyance Facilities on Longfin Smelt

Longfin smelt are not expected to be present in the project construction zones during the expected in-water construction window (June 1–October 31) (see Table 11-6). Therefore, there is a very low potential risk of effects from construction activities. In addition, longfin smelt are pelagic species and are less likely to be present in the construction zones than other fish species.

The potential effects of construction of the water conveyance facilities on longfin smelt would be similar to those described for Alternative 1A (Impact AQUA-19) except that Alternative 2A could potentially include two different intakes than under Alternative 1A. This would convert about 11,350 lineal feet of existing shoreline habitat into intake facility structures and would require about 26 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. The effects related to temporary increases in turbidity, accidental spills, underwater noise, in-water work activities, and disturbance of contaminated sediments would be similar to Alternative 1A and the same environmental commitments and mitigation measures (described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*) would be available to avoid and minimize potential effects.

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-19, environmental commitments and mitigation measures would be available to avoid and minimize potential effects, and the effect would not be adverse for longfin smelt.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-19, the impact of the construction of water conveyance facilities on longfin smelt would be less than significant except for construction noise associated with pile driving. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1.

Impact AQUA-20: Effects of Maintenance of Water Conveyance Facilities on Longfin Smelt

NEPA Effects: The potential effects of the maintenance of water conveyance facilities under Alternative 2A would be about the same as those described for Alternative 1A (see Impact AQUA-20). As concluded in Alternative 1A, Impact AQUA-20, the effect would not be adverse for longfin smelt.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-20, the impact of the maintenance of water conveyance facilities on longfin smelt would be less than significant and no mitigation is required.

Water Operations of CM1

Impact AQUA-21: Effects of Water Operations on Entrainment of Longfin Smelt

Water Exports from SWP/CVP South Delta Facilities

For larval longfin smelt, particle tracking model simulations indicate that overall the magnitude of entrainment risk is low under all hydrologic conditions and starting geographic distributions (wetter and drier). Average entrainment loss under Alternative 2A with the wetter starting distribution was 0.8% compared to 1.6% under NAA, a 54% relative decrease (Table 11-2A-4). Average entrainment loss with the drier starting distribution was 1.0% for Alternative 1A compared to 2.2% under NAA, a 57% decline in relative terms. The risk of entrainment would be greater during years when outflows during late winter and spring are low (generally in dry years, as modeled by drier distribution), with reduced entrainment under Alternative 2A compared to baseline conditions. Overall, larval entrainment would be reduced under Alternative 2A relative to NAA.

Table 11-2A-4. Percentage of Particles (and Difference) Representing Longfin Smelt Larvae Entrained by the South Delta Facilities under Alternative 2A and Baseline Scenarios

	Percent Particles Entrained			Difference (and Relative Difference)	
Starting Distribution	EXISTING CONDITIONS	NAA	A2A_LLT	A2A_LLT vs. EXISTING CONDITIONS	A2A_LLT vs. NAA
Wetter	1.9	1.6	0.8	-1.09 (-58%)	-0.91 (-54%)
Drier	2.5	2.2	1.0	-1.56 (-62%)	-1.29 (-57%)

Note: 60-day runs of PTM. Negative difference values indicate lower entrainment under the alternative compared to the baseline scenario.

Juvenile and adult longfin smelt entrainment at the south Delta facilities is calculated by normalizing salvage data against fall midwater trawl abundance indices. Entrainment under Alternative 2A would be reduced compared to NAA. Entrainment averaged across all water year types would be reduced for juvenile longfin smelt by 54% compared to NAA; entrainment would decrease for adults by 66% compared to NAA (Table 11-2A-5). As discussed for Alternative 1A (Impact AQUA-21 for longfin smelt), entrainment would be highest in dry and critical years. Under Alternative 2A, entrainment in dry and critical years would be reduced 21–24% for juveniles and 25% for adults, compared to NAA. This reflects substantial reductions in reverse OMR flows under Alternative 2A for December to March.

Table 11-2A-5. Longfin Smelt Entrainment Index (March–June) at the SWP and CVP Salvage Facilities and Differences (Absolute and Percentage) between Model Scenarios

		Absolute Difference (Percent Difference)	
Life Stage	Water Year Types	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Juvenile (March–June)	Wet	-52,640 (-83%)	-58,082 (-84%)
	Above Normal	-2,383 (-53%)	-2,673 (-55%)
	Below Normal	-637 (-21%)	-845 (-26%)
	Dry	-62,687 (-12%)	-120,994 (-21%)
	Critical	-191,393 (-34%)	-117,523 (-24%)
	All Years	-132,302 (-49%)	-157,314 (-54%)
Adult (December–March)	Wet	-98 (-76%)	-102 (-77%)
	Above Normal	-431 (-66%)	-471 (-68%)
	Below Normal	-917 (-47%)	-840 (-45%)
	Dry	-348 (-29%)	-282 (-25%)
	Critical	-7,724 (-32%)	-5,590 (-25%)
	All Years	-2,393 (-66%)	-2,357 (-66%)
	Shading indicates >5% increase in entrainment index.		

Water Exports from SWP/CVP North Delta Intake Facilities

The proposed new north Delta intakes would increase entrainment potential in this area, but entrainment of longfin smelt and potential exposure to predators at the diversion structures would be extremely low because this species is rarely encountered in surveys this far upstream (California Department of Fish and Game 2012a; 2012b; 2013b).

Water Export with a Dual Conveyance for the SWP North Bay Aqueduct

Larval entrainment to NBA was assessed by particle tracking modeling of particles, using starting distributions emulating longfin smelt distribution in wetter years (i.e., greater outflow, smelt spawn further west) and drier years (i.e., longfin smelt spawning occurs further east and deeper into the Delta). Particle entrainment at the NBA was low for both starting distributions (wetter and drier), averaging 0.13–0.16% under Alternative 2A, which was 0.05–0.06% less than NAA, or 55–64% lower in relative terms (Table 11-2A-6).

Table 11-2A-6. Average Percentage (and Difference) of Particles Representing Larval Longfin Smelt Entrained by the North Bay Aqueduct under Alternative 2A and Baseline Scenarios

	Percent Particles Entrained			Difference (and Relative Difference)	
Distribution	EXISTING CONDITIONS	NAA	A2A_LLT	A2A_LLT vs. EXISTING CONDITIONS	A2A_LLT vs. NAA
Wetter	0.20	0.08	0.13	-0.07 (-35.3%)	0.05 (64.0%)
Drier	0.25	0.11	0.16	-0.08 (-33.2%)	0.06 (55.1%)

Note: 60-day runs of PTM. Negative difference values indicate lower entrainment under the alternative compared to the baseline scenario.

Entrainment to the NBA under Alternative 2A would be increased slightly (<0.1% net change) relative to NAA.

In summary, under Alternative 2A potential entrainment of longfin smelt would be reduced at the SWP/CVP south Delta facilities and the NBA. Entrainment loss of longfin smelt at the proposed north Delta intakes would be rare because longfin smelt are not expected to occur in that area of the Sacramento River, and the intakes would be screened. NPBs would be designed to deter salmonids, but their potential ability to reduce entrainment for longfin smelt is uncertain.

Predation Associated with Entrainment

Pre-screen loss of longfin smelt at the south Delta facilities is typically attributed to predation (as described for Impact AQUA-3 for Alternative 1). Under Alternative 2A, pre-screen loss is expected to decrease commensurate with entrainment reductions. Predation loss at the proposed north Delta intakes and the alternate NBA intake would be limited because longfin smelt rarely occur that far upstream. ***NEPA Effects***: The effect and conclusion for the risk of predation associated with the NPB structures would be the same as described for Alternative 1A. In conclusion, the effect on entrainment and entrainment-related predation loss under Alternative 2A would be beneficial because of the substantial reduction in entrainment and predation loss at the south Delta facilities.

CEQA Conclusion: As described above, entrainment loss of longfin smelt would be reduced under Alternative 2A. Entrainment and associated predation loss at the south Delta facilities under Alternative 2A would decrease 49% for juveniles and 66% for adults compared to Existing Conditions. Based on particle tracking simulations, entrainment of larval longfin smelt to the SWP NBA, agricultural diversions, and the south delta facilities would be expected to be less than baseline under most scenarios Predation loss at the proposed north Delta intakes and the alternate NBA intake would be limited because longfin smelt rarely occur that far upstream

The impact under Alternative 2A would be beneficial to the species because of the reduction in entrainment and predation loss for both juveniles and adults.

Impact AQUA-22: Effects of Water Operations on Spawning, Egg Incubation, and Rearing Habitat for Longfin Smelt

Adult longfin smelt inhabit primarily brackish water and marine areas in San Pablo and San Francisco Bays and nearshore coastal marine waters. Prespawning adult longfin smelt use the Delta for staging and spawning. The planktonic larvae are transported downstream after hatching; within the Plan Area, the early juvenile life stages rear in the low-salinity areas of the West Delta and

Suisun Bay subregions. Juvenile and adult longfin smelt occupying the Plan Area during fall through spring migrate westward into San Francisco Bay during the summer.

Longfin smelt spawn in the late winter and early spring months when water temperatures in the lower rivers and Delta are seasonally cool. Longfin smelt spawn adhesive eggs that are thought to be deposited on sand and gravel and possibly other hard substrates. Spawning occurs in the lower reaches of the Sacramento River in the vicinity of Cache Slough and Rio Vista, although some spawning occurs in the lower San Joaquin River based on presence of early larval and adult longfin smelt in CDFW larval trawl samples (California Department of Fish and Game 2009b). Spawning also occurs in Suisun Marsh and the Napa River.

Immediately after hatching from the incubating eggs, longfin smelt larvae are planktonic and drift passively with water flows; older larvae use a variety of behaviors to help retain themselves in favorable habitats (Bennett et al. 2002). Larvae are typically present in the Delta during the late winter and early spring months. Juvenile longfin smelt rear in the spring (approximately March to June) in the Suisun Bay and the West Delta subregions before migrating downstream of the Plan Area into San Pablo and San Francisco Bays and nearshore coastal marine waters, where they continue to rear for a year or more. Larval and early juvenile longfin smelt could be affected by covered activities when they are present in the Plan Area during the winter and spring months.

NEPA Effects: The indices of abundance of longfin smelt based on the Fall Midwater, Bay Otter, and Bay Midwater trawl indices have been correlated to outflow (expressed as the location of X2) in the preceding winter and spring months, when longfin smelt spawning and rearing occurs (January through June) (Kimmerer 2002a; Kimmerer et al. 2009; Rosenfield and Baxter 2007; Mac Nally et al. 2010; Thomson et al. 2010). Modeling results based on Kimmerer et al. (2009) predict longfin smelt Fall Midwater and Bay Otter Trawl indices would decrease for most water year types, relative to NAA, based on changes in winter-spring flow alone (Table 11-2A-7). Alternative 2A operations would be expected to result in 5–6% lower longfin smelt abundance compared to NAA, for all years combined.

Table 11-2A-7. Estimated Differences between Scenarios for Longfin Smelt Relative Abundance in the Fall Midwater Trawl or Bay Otter Trawl

	Fall Midwater Trawl Relative Abundance		Bay Otter Trawl Relative Abundance	
Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
All	-1,665 (-32%)	-188 (-5%)	-5,336 (-37%)	-581 (-6%)
Wet	-6,317 (-35%)	48 (0.4%)	-25,962 (-40%)	186 (0.5%)
Above Normal	-3,557 (-41%)	-725 (-13%)	-12,475 (-47%)	-2,430 (-15%)
Below Normal	-1,508 (-35%)	-209 (-7%)	-4,639 (-41%)	-619 (-8%)
Dry	-616 (-29%)	-123 (-8%)	-1,658 (-34%)	-321 (-9%)
Critical	-158 (-17%)	-24 (-3%)	-369 (-20%)	-55 (-3%)
	Shading indicates greater than 10% decrease in relative abundance.			

During the period of longfin smelt rearing from January–June, Delta outflows would be similar (<10% difference) to NAA in all months except April, when flows would be reduced 11%.

Longfin smelt may also benefit from habitat restoration actions (*CM2 Yolo Bypass Fisheries Enhancement and CM4 Tidal Natural Communities Restoration*, which are intended to provide additional food production and export to longfin smelt rearing areas in Suisun Marsh, West Delta, and Cache Slough ROAs.

CEQA Conclusion: Average Delta outflow under Alternative 2 would be similar (less than 5% difference) to Existing Conditions in winter (January, February, March) and decreased in spring (13% in April, 22% in May, 17% in June). Relative longfin smelt abundance based on Kimmerer et al. 2009 decreased 32–37% on average compared to Existing Conditions (Table 11-2A-6), with greatest reductions in above normal water years (41–47% lower under Alternative 2A). Average juvenile longfin smelt relative abundance, based on Kimmerer et al. 2009, decreased 31–36% compared to Existing Conditions (Table 11-2A-6).

Contrary to the NEPA conclusion set forth above, these results indicate that the difference between Existing Conditions and Alternative 2 could be significant because the alternative could substantially reduce relative abundance based on Kimmerer et al. 2009. However, as discussed earlier (Alternative 1A, Impact AQUA-22), this interpretation of the biological modeling results is likely attributable to different modeling assumptions for four factors: sea level rise, climate change, future water demands, and implementation of the alternative. As discussed above (Section 11.3.3), because of differences between the CEQA and NEPA baselines, it is sometimes possible for CEQA and NEPA significance conclusions to vary between one another under the same impact discussion. The baseline for the CEQA analysis is Existing Conditions at the time the NOP was prepared. Both the action alternative and the NEPA baseline (NAA) models anticipated future conditions that would occur in 2060 (LLT implementation period), including the projected effects of climate change (precipitation patterns), sea level rise and future water demands, as well as implementation of required actions under the 2008 USFWS BiOp and the 2009 NMFS BiOp. Because the action alternative modeling does not partition the effects of implementation of the alternative from the effects of sea level rise, climate change and future water demands, the comparison to Existing Conditions may not offer a clear understanding of the impact of the alternative on the environment. This suggests that the NEPA analysis, which compares results between the alternative and NAA, is a better approach because it isolates the effect of the alternative from those of sea level rise, climate change, and future water demands.

When compared to NAA and informed by the NEPA analysis above, longfin smelt relative abundance, based on Kimmerer et al. (2009), decreased 5% to 6% on average relative to conditions without BDCP (Table 11-2A-6). These results represent the increment of change attributable to the alternative and address the limitations of the comparison the CEQA baseline (Existing Conditions). Therefore, operations under Alternative 2A would not in itself result in a significant impact on longfin smelt rearing.

This impact is found to be less than significant, and no mitigation is required. Furthermore, as described above, other measures such as habitat restoration (CM4) could improve the quality of spawning and rearing habitat for longfin smelt, although there is some uncertainty of the outcome related to habitat restoration.

Impact AQUA-23: Effects of Water Operations on Rearing Habitat for Longfin Smelt

The analysis, NEPA Effects and CEQA Conclusion for effects of water operations on rearing habitat for longfin smelt is included in *Impact AQUA-22: Effects of Water Operations on Spawning, Egg Incubation, and Rearing Habitat for Longfin Smelt.*

Impact AQUA-24: Effects of Water Operations on Migration Conditions for Longfin Smelt

The analysis, NEPA Effects and CEQA Conclusion for effects of water operations on migration conditions for longfin smelt is included in *Impact AQUA-22: Effects of Water Operations on Spawning, Egg Incubation, and Rearing Habitat for Longfin Smelt.*

Restoration and Conservation Measures

Alternative 2A has the same restoration and conservation measures as Alternative 1A. Because no substantial differences in fish effects are anticipated anywhere in the affected environment under Alternative 2A compared to those described in detail for Alternative 1A, the effects described for longfin smelt under Alternative 1A (Impact AQUA-25 through AQUA-36) also appropriately characterize effects under Alternative 2A.

The following impacts are those presented under Alternative 1A that are identical for Alternative 2A.

Impact AQUA-25: Effects of Construction of Restoration Measures on Longfin Smelt

Impact AQUA-26: Effects of Contaminants Associated with Restoration Measures on Longfin Smelt

Impact AQUA-27: Effects of Restored Habitat Conditions on Longfin Smelt

Impact AQUA-28: Effects of Methylmercury Management on Longfin Smelt (CM12)

Impact AQUA-29: Effects of Invasive Aquatic Vegetation Management on Longfin Smelt (CM13)

Impact AQUA-30: Effects of Dissolved Oxygen Level Management on Longfin Smelt (CM14)

Impact AQUA-31: Effects of Localized Reduction of Predatory Fish on Longfin Smelt (CM15)

Impact AQUA-32: Effects of Nonphysical Fish Barriers on Longfin Smelt (CM16)

Impact AQUA-33: Effects of Illegal Harvest Reduction on Longfin Smelt (CM17)

Impact AQUA-34: Effects of Conservation Hatcheries on Longfin Smelt (CM18)

Impact AQUA-35: Effects of Urban Stormwater Treatment on Longfin Smelt (CM19)

Impact AQUA-36: Effects of Removal/Relocation of Nonproject Diversions on Longfin Smelt (CM21)

NEPA Effects: These restoration and conservation measure impact mechanisms have been determined to range from no effect, to not adverse, or beneficial effects on longfin smelt for NEPA purposes, for the reasons identified for Alternative 1A. Specifically for AQUA-26, the effects of contaminants on longfin smelt with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on longfin smelt are uncertain.

CEQA Conclusion: These restoration and conservation measure impact mechanisms would be considered to range from no impact, be less than significant, or beneficial on longfin smelt, for the reasons identified for Alternative 1A, and no mitigation is required.

Winter-Run Chinook Salmon

Impact AQUA-37: Effects of Construction of Water Conveyance Facilities on Chinook Salmon (Winter-Run ESU)

The potential effects of construction of the water conveyance facilities on Chinook salmon would be similar to those described for Alternative 1A (Impact AQUA-37) except that Alternative 2A could potentially include two different intakes than under Alternative 1A. This would convert about 11,350 lineal feet of existing shoreline habitat into intake facility structures and would require about 26 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. The effects related to temporary increases in turbidity, accidental spills, underwater noise, in-water work activities, and disturbance of contaminated sediments would be similar to Alternative 1A and the same environmental commitments and mitigation measures (described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*) would be available to avoid and minimize potential effects.

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-37, environmental commitments and mitigation measures would be available to avoid and minimize potential effects, and the effect would not be adverse for Chinook salmon.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-37 for Chinook salmon, the impact of the construction of water conveyance facilities on Chinook salmon would be less than significant except for construction noise associated with pile driving. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1.

Impact AQUA-38: Effects of Maintenance of Water Conveyance Facilities on Chinook Salmon (Winter-Run ESU)

NEPA Effects: The potential effects of the maintenance of water conveyance facilities under Alternative 2A would be about the same as those described for Alternative 1A (see Impact AQUA-38). As concluded in Alternative 1A, Impact AQUA-38, the impact would not be adverse for Chinook salmon.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-38 for Chinook salmon, the impact of the maintenance of water conveyance facilities on Chinook salmon would be less than significant and no mitigation is required.

Water Operations of CM1

Impact AQUA-39: Effects of Water Operations on Entrainment of Chinook Salmon (Winter-Run ESU)

Water Exports from SWP/CVP South Delta Facilities

Entrainment losses would be reduced under Alternative 2A (A2A_LLT) at the south Delta facilities. Losses for all years combined would decrease by approximately 5,000 fish (67–68%) compared to NAA (Table 11-2A-8). Entrainment would be reduced in all water year types, ranging from moderate reductions in critical water years (18% fewer fish compared to NAA) to significant reductions in wet years (90% fewer fish entrained) (Table 11-2A-8). Pre-screen losses, typically attributed to predation, would be expected to decrease commensurate with decreased entrainment at the south Delta facilities.

The proportion of the annual winter-run Chinook population (assumed to be 500,000 juveniles approaching the Delta) lost at the south Delta facilities across all years is very small, averaging 1.4% under NAA and decreasing to 0.4% under Alternative 2A

Table 11-2A-8. Juvenile Winter-Run Chinook Salmon Annual Entrainment Index at the SWP and CVP Salvage Facilities—Differences between Model Scenarios for Alternative 2A

	Absolute Difference (Percent Difference)[a]	
Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wet	-10,144 (-89%)	-10,565 (-90%)
Above Normal	-5,399 (-81%)	-5,523 (-82%)
Below Normal	-3,751 (-52%)	-3,327 (-49%)
Dry	-1,175 (-31%)	-868 (-25%)
Critical	-347 (-27%)	-208 (-18%)
All Years	-4,598 (-68%)	-4,539 (-67%)
	Shading indicates10% or greater increased entrainment.	

[a] Estimated annual number of fish lost, based on normalized data.

Water Exports from SWP/CVP North Delta Intake Facilities

The effect of Alternative 2A on entrainment and impingement at the North Delta facilities would be the same as described for Alternative 1A (Impact AQUA-39) because both alternatives would have state-of-the-art screens installed to prevent entrainment and be designed to minimize impingement.

Water Export with a Dual Conveyance for the SWP North Bay Aqueduct

The effect would be the same as described for Alternative 1A (Impact AQUA-39). Entrainment and impingement effects would be minimal for Alternative 2A because intakes would have state-of-the-art screens installed.

Predation Associated with Entrainment

Pre-screen loss of juvenile Chinook salmon at the south Delta facilities is typically attributed to predation, and is expected to decrease under Alternative 2A, commensurate with entrainment reductions. Predation loss at the proposed north Delta intakes and the alternate NBA intake would be limited because of the state-of-the-art, positive barrier screens installed.

NEPA Effects: Due to reduced entrainment at the south Delta facilities, the effect of Alternative 2A water operations on winter-run Chinook entrainment would be beneficial.

CEQA Conclusion: As described above, entrainment losses of juvenile Chinook salmon at the south Delta facilities would decrease under Alternative 2A (A2A_LLT) compared to Existing Conditions (Table 11-2A-8). At the north Delta facilities and the alternate NBA intake, the screened intakes as designed would exclude this species, although there is some potential for impingement or contact by smaller fish with the screen. Overall impacts of Alternative 2A water operations on entrainment of Chinook salmon (winter-run ESU) would be beneficial due to a reduction in entrainment and no mitigation would be required.

Impact AQUA-40: Effects of Water Operations on Spawning and Egg Incubation Habitat for Chinook Salmon (Winter-Run ESU)

In general, Alternative 2A would reduce the quantity and quality of spawning and egg incubation habitat for winter-run Chinook salmon relative to NAA

Flows in the Sacramento River between Keswick and upstream of Red Bluff Diversion Dam were examined during the May through September winter-run spawning period (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Lower flows can reduce the instream area available for spawning and egg incubation. Flows under A2A_LLT during May and June would generally be similar to or greater than flows under NAA. Flows under A2A_LLT during July, August, and September would generally be lower than flows under NAA by up to 20%. These results indicate that there would be intermittent negligible-to-small flow-related effects of Alternative 2A on spawning and egg incubation habitat.

Shasta Reservoir storage volume at the end of May influences flow rates below the dam during the May through September winter-run spawning and egg incubation period. May Shasta storage volume under A2A_LLT would be similar to or greater than storage under NAA for all water year types (Table 11-2A-9).

Table 11-2A-9. Difference and Percent Difference in May Water Storage Volume (thousand acre-feet) in Shasta Reservoir for Model Scenarios

Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wet	-19 (0%)	15 (0%)
Above Normal	-89 (-2%)	-3 (0%)
Below Normal	-102 (-2%)	96 (2%)
Dry	-230 (-6%)	214 (6%)
Critical	-218 (-9%)	366 (20%)

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the May through September winter-run spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no substantial differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period at either location.

The number of days on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month (May through September) and year of the 82-year modeling period (Table 11-2A-10). The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern" as defined in Table 11-2A-11. Differences between baselines and Alternative 2A in the highest level of concern across all months and all 82 modeled years are presented in Table 11-2A-12. There would be no difference in levels of concern between NAA and Alternative 2A.

Table 11-2A-10. Maximum Water Temperature Criteria for Covered Salmonids and Sturgeon Provided by NMFS and Used in the BDCP Effects Analysis

Location	Period	Maximum Water Temperature (°F)	Purpose
Upper Sacramento River			
Bend Bridge	May–Sep	56	Winter- and spring-run spawning and egg incubation
		63	Green sturgeon spawning and egg incubation
Red Bluff	Oct–Apr	56	Spring-, fall-, and late fall–run spawning and egg incubation
Hamilton City	Mar–Jun	61 (optimal), 68 (lethal)	White sturgeon spawning and egg incubation
Feather River			
Robinson Riffle (RM 61.6)	Sep–Apr	56	Spring-run and steelhead spawning and incubation
	May–Aug	63	Spring-run and steelhead rearing
Gridley Bridge	Oct–Apr	56	Fall- and late fall–run spawning and steelhead rearing
	May–Sep	64	Green sturgeon spawning, incubation, and rearing
American River			
Watt Avenue Bridge	May–Oct	65	Juvenile steelhead rearing

Table 11-2A-11. Number of Days per Month Required to Trigger Each Level of Concern for Water Temperature Exceedances in the Sacramento River for Covered Salmonids and Sturgeon Provided by NMFS and Used in the BDCP Effects Analysis

Exceedance above Water Temperature Threshold (°F)	Level of Concern			
	None	Yellow	Orange	Red
1	0-9 days	10-14 days	15-19 days	≥20 days
2	0-4 days	5-9 days	10-14 days	≥15 days
3	0 days	1-4 days	5-9 days	≥10 days

Table 11-2A-12. Differences between Baseline and Alternative 2A Scenarios in the Number of Years in Which Water Temperature Exceedances above 56°F Are within Each Level of Concern, Sacramento River at Bend Bridge, May through September

Level of Concern[a]	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Red	33 (67%)	0 (0%)
Orange	-14 (-100%)	0 (NA)
Yellow	-16 (-100%)	0 (NA)
None	-3 (-100%)	0 (NA)

NA = could not be calculated because the denominator was 0.
[a] For definitions of levels of concern, see Table 11-2A-11.

Total degree-days exceeding 56°F at Bend Bridge were summed by month and water year type during May through September (Table 11-2A-13). Total degree-days under Alternative 2A would be up to 12% lower than under NAA during May and June and up to 16% higher during July through September.

Table 11-2A-13. Differences between Baseline and Alternative 2A Scenarios in Total Degree-Days (°F-Days) by Month and Water Year Type for Water Temperature Exceedances above 56°F in the Sacramento River at Bend Bridge, May through September

Month	Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
May	Wet	987 (262%)	-215 (-14%)
	Above Normal	213 (100%)	-142 (-25%)
	Below Normal	431 (197%)	-32 (-5%)
	Dry	235 (126%)	-179 (-30%)
	Critical	477 (216%)	67 (11%)
	All	2,344 (193%)	-500 (-12%)
June	Wet	391 (102%)	-320 (-29%)
	Above Normal	48 (32%)	-181 (-48%)
	Below Normal	304 (219%)	-48 (-10%)
	Dry	554 (295%)	20 (3%)
	Critical	628 (157%)	78 (8%)
	All	1,926 (153%)	-450 (-12%)
July	Wet	757 (146%)	151 (13%)
	Above Normal	374 (462%)	104 (30%)
	Below Normal	670 (456%)	214 (35%)
	Dry	1,295 (459%)	367 (30%)
	Critical	1,873 (227%)	87 (3.3%)
	All	4,968 (268%)	922 (16%)
August	Wet	2,187 (314%)	224 (8%)
	Above Normal	901 (221%)	242 (23%)
	Below Normal	1,279 (483%)	244 (19%)
	Dry	2,098 (313%)	488 (21%)
	Critical	2,764 (186%)	145 (4%)
	All	9,229 (262%)	1,342 (12%)
September	Wet	833 (113%)	124 (9%)
	Above Normal	559 (78%)	159 (14%)
	Below Normal	1,572 (211%)	426 (23%)
	Dry	2,585 (202%)	-11 (0%)
	Critical	1,971 (95%)	80 (2%)
	All	7,523 (135%)	778 (6%)

NA = could not be calculated because the denominator was 0.

The Reclamation egg mortality model predicts that winter-run Chinook salmon egg mortality in the Sacramento River under A2A_LLT would be lower or similar to mortality under NAA except in below normal and dry water years (82% and 20%, respectively). The increase in the percent of winter-run population subject to mortality would be 1% in both below normal and dry years. Therefore, the increase in mortality of 1% from NAA to A2A_LLT, although relatively large, would be negligible at an absolute scale to the winter-run population (Table 11-2A-14). These results indicate that climate change would cause the majority of the increase in winter-run egg mortality.

Table 11-2A-14. Difference and Percent Difference in Percent Mortality of Winter-Run Chinook Salmon Eggs in the Sacramento River (Egg Mortality Model)

Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wet	1 (252%)	-0.1 (-7%)
Above Normal	2 (339%)	-0.1 (-3%)
Below Normal	2 (239%)	1 (82%)
Dry	7 (477%)	1 (20%)
Critical	42 (157%)	-2 (-3%)
All	9 (189%)	0.3 (2%)

SacEFT predicts that there would be a 31% decrease in the percentage of years with good spawning availability, measured as weighted usable area, under A2A_LLT relative to NAA (Table 11-2A-15). SacEFT predicts that the percentage of years with good (lower) redd scour risk under A2A_LLT would be similar to the percentage of years under NAA. SacEFT predicts that the percentage of years with good egg incubation conditions under A2A_LLT would be similar to that under NAA. SacEFT predicts that the percentage of years with good (lower) redd dewatering risk under A2A_LLT would be similar to NAA. These results indicate that there would be a small negative effect of Alternative 2A on spawning habitat.

The biological significance of a reduction in available suitable spawning habitat varies at the population level in response to a number of factors, including adult escapement. For those years when adult escapement is less than the carrying capacity of the spawning habitat, a reduction in area would have little or no population level effect. In years when escapement exceeds carrying capacity of the reduced habitat, competition among spawners for space (e.g., increased redd superimposition) would increase, resulting in reduced reproductive success. The reduction in the frequency of years in which spawning habitat availability is considered to be good by SacEFT could result in reduced reproductive success and abundance of winter-run Chinook salmon if the number of spawners is limited by spawning habitat quantity.

Table 11-2A-15. Difference and Percent Difference in Percentage of Years with "Good" Conditions for Winter-Run Chinook Salmon Habitat Metrics in the Upper Sacramento River (from SacEFT)

Metric	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Spawning WUA	-36 (-62%)	-10 (-31%)
Redd Scour Risk	0 (0%)	0 (0%)
Egg Incubation	-26 (-27%)	-3 (-4%)
Redd Dewatering Risk	4 (16%)	0 (0%)
Juvenile Rearing WUA	-24 (-48%)	1 (4%)
Juvenile Stranding Risk	-3 (-15%)	-14 (-45%)

WUA = Weighted Usable Area.

NEPA Effects: Considering the range of results presented here for winter-run Chinook salmon spawning and egg incubation, this effect would be adverse because it has the potential to substantially reduce suitable spawning habitat and substantially reduce the number of fish as a result of egg mortality. There would be small to moderate reductions in flow during a substantial portion (3 of 5 months) of the spawning and egg incubation period that would reduce spawning and egg incubation conditions for winter-run Chinook salmon. Further, SacEFT predicts that the extent of winter-run spawning habitat would be reduced by 31% under Alternative 2A (Table 11-2A-15). This effect is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this effect to a level that is not adverse would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this would be an unavoidable adverse effect because there is no feasible mitigation available. Even so, proposed mitigation (Mitigation Measure AQUA-40a through AQUA-40c) has the potential to reduce the severity of impact, although not necessarily to a not adverse level.

CEQA Conclusion: In general, Alternative 2A would reduce the quantity and quality of spawning and egg incubation habitat for winter-run Chinook salmon relative to the Existing Conditions.

CALSIM flows in the Sacramento River between Keswick and upstream of Red Bluff were examined during the May through September winter-run spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions during May and June and generally lower by up to 27% during July, August, and September.

Shasta Reservoir storage volume at the end of May under A2A_LLT would be similar to Existing Conditions in wet, above normal, and below normal water years, but lower by 6% to 9% in dry and critical water years, respectively (Table 11-2A-9). This indicates that there would be a small to moderate effect of Alternative 2A on flows during the spawning and egg incubation period.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the May through September winter-run spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 2A during May and June. Mean monthly water temperature would be up to 12% higher under Alternative 2A in July through September depending on month, water year type, and location.

The number of days on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month (May through September) and year of the 82-year modeling period (Table 11-2A-10). The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern" as defined in Table 11-2A-11. The number of years classified as "red" would increase by 67% under Alternative 2A relative to Existing Conditions (Table 11-2A-12).

Total degree-days exceeding 56°F at Bend Bridge were summed by month and water year type during May through September (Table 11-2A-13). Total degree-days under Alternative 2A would be 135% to 313% higher than that under Existing Conditions depending on month throughout the period.

The Reclamation egg mortality model predicts that winter-run Chinook salmon egg mortality in the Sacramento River under A2A_LLT would be 157–477% greater than mortality under Existing Conditions depending on water year type (Table 11-2A-14). These increases would only affect the winter-run population during dry and critical years, in which the absolute percent increase of the winter-run population would be 7 and 42%, respectively. These results indicate that Alternative 2A would cause increased winter-run Chinook salmon egg mortality in the Sacramento River.

SacEFT predicts that there would be a 62% decrease in the percentage of years with good spawning availability, measured as weighted usable area, under A2A_LLT relative to Existing Conditions (Table 11-2A-15). SacEFT predicts that the percentage of years with good (lower) redd scour risk under A2A_LLT would be similar to the percentage of years under Existing Conditions. SacEFT predicts that the percentage of years with good egg incubation conditions under A2A_LLT would be 27% lower than under Existing Conditions. SacEFT predicts that the percentage of years with good (lower) redd dewatering risk under A2A_LLT would be 16% greater than the percentage of years under Existing Conditions. These results indicate that Alternative 2A would cause small to moderate reductions in spawning WUA and egg incubation conditions.

Collectively, these results indicate that the impact would be significant because it has the potential to substantially reduce suitable spawning habitat and substantially reduce the number of fish as a result of egg mortality. Exceedances of NMFS temperature thresholds would be substantially greater under Alternative 2A. Egg mortality in drier years, during which winter-run Chinook salmon would already be stressed due to reduced flows and increased temperatures, would be up to 42% greater due to Alternative 2A compared to the Existing Conditions (Table 11-2A-14). Further, the extent of spawning habitat would be 62% lower due to Alternative 2A compared to the Existing Conditions (Table 11-2A-15), which represents a substantial reduction in spawning habitat and, therefore, in adult spawner and redd carrying capacity. This impact is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this impact to a less-than-significant level would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this impact is significant and unavoidable because there is no feasible mitigation available. Even so, proposed below is mitigation that has the potential to reduce the severity of impact though not necessarily to a less-than-significant level.

Mitigation Measure AQUA-40a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Winter-Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Spawning Habitat

Although analysis conducted as part of the EIR/EIS determined that Alternative 2A would have significant and unavoidable adverse effects on spawning habitat, this conclusion was based on the best available scientific information at the time and may prove to have been overstated. Upon the commencement of operations of CM1 and continuing through the life of the permit, the BDCP proponents will monitor effects on spawning habitat in order to determine whether such effects would be as extensive as concluded at the time of preparation of this document and to determine any potentially feasible means of reducing the severity of such effects. This mitigation measure requires a series of actions to accomplish these purposes, consistent with the operational framework for Alternative 2A.

The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 2A operations only. Development of mitigation actions for the incremental impact on spawning habitat attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 2A.

Mitigation Measure AQUA-40b: Conduct Additional Evaluation and Modeling of Impacts on Winter-Run Chinook Salmon Spawning Habitat Following Initial Operations of CM1

Following commencement of initial operations of CM1 and continuing through the life of the permit, the BDCP proponents will conduct additional evaluations to define the extent to which modified operations could reduce impacts to spawning habitat under Alternative 2A. The analysis required under this measure may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6).

Mitigation Measure AQUA-40c: Consult with NMFS, USFWS, and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Winter-Run Chinook Salmon Spawning Habitat Consistent with CM1

In order to determine the feasibility of reducing the effects of CM1 operations on winter-run Chinook salmon habitat, the BDCP proponents will consult with NMFS, USFWS and CDFW to identify and implement any feasible operational means to minimize effects on spawning habitat. Any such action will be developed in conjunction with the ongoing monitoring and evaluation of habitat conditions required by Mitigation Measure AQUA-40a.

If feasible means are identified to reduce impacts on spawning habitat consistent with the overall operational framework of Alternative 2A without causing new significant adverse impacts on other covered species, such means shall be implemented. If sufficient operational flexibility to reduce effects on winter-run Chinook salmon habitat is not feasible under Alternative 2A operations, achieving further impact reduction pursuant to this mitigation measure would not be feasible under this Alternative, and the impact on winter-run Chinook salmon would remain significant and unavoidable.

Impact AQUA-41: Effects of Water Operations on Rearing Habitat for Chinook Salmon (Winter-Run ESU)

In general, Alternative 2A would reduce the quantity and quality of rearing habitat for fry and juvenile winter-run Chinook salmon relative to NAA.

Sacramento River flows upstream of Red Bluff were examined for the juvenile winter-run Chinook salmon rearing period (August through December) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Lower flows can lead to reduced extent and quality of fry and juvenile rearing habitat. Flows under A2A_LLT would generally be lower than flows under NAA by up to 17% during August and November, and similar to or greater than flows under NAA during September, October, and December.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the August through December winter-run juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period at either location.

SacEFT predicts that the percentage of years with good juvenile rearing habitat availability, measured as weighted usable area, under A2A_LLT would not be different from the percentage of years under NAA (Table 11-2A-14). In addition, the percentage of years with good (low) juvenile stranding risk under A2A_LLT is predicted to be 45% (14% on an absolute scale) lower than under

NAA. This indicates that the quantity and quality of juvenile rearing habitat in the Sacramento River would be lower under A2A_LLT relative to NAA.

SALMOD predicts that winter-run smolt equivalent habitat-related mortality under A2A_LLT would have a negligible difference (<5%) in habitat-related mortality with NAA.

NEPA Effects: Collectively, these results indicate that the effect is adverse because it has the potential to substantially reduce the amount of suitable habitat and substantially interfere with the movement of fish. There would be no substantial effects of Alternative 2A on flows or water temperatures. However, effects on juvenile stranding risk are substantial (45% increase) relative to NAA. This effect is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this effect to a level that is not adverse would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this would be an unavoidable adverse effect because there is no feasible mitigation available. Even so, proposed mitigation (Mitigation Measure AQUA-41a through AQUA-41c) has the potential to reduce the severity of impact though not necessarily to not adverse level.

CEQA Conclusion: In general, Alternative 2A would reduce the quantity and quality of fry and juvenile rearing habitat for winter-run Chinook salmon relative to the Existing Conditions.

Sacramento River flows upstream of Red Bluff were examined for the juvenile winter-run Chinook salmon rearing period (August through December) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions during October and December, but up to 24% lower than Existing Conditions during August, September, and November.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the August through December winter-run rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperature would be up to 14% higher under Alternative 2A in July through October depending on month, water year type, and location. There would be no differences (<5%) between Existing Conditions and Alternative 2A in mean monthly water temperature during November and December at either location.

SacEFT predicts that the percentage of years with good juvenile rearing habitat availability, measured as weighted usable area, under A2A_LLT would be 48% lower than under Existing Conditions (Table 11-2A-15). In addition, the percentage of years with good (low) juvenile stranding risk under A2A_LLT is predicted to be 15% lower than under Existing Conditions. This indicates that the quantity and quality of juvenile rearing habitat in the Sacramento River would be lower under A2A_LLT relative to Existing Conditions.

SALMOD predicts that winter-run smolt equivalent habitat-related mortality under A2A_LLT would be 15% higher than under Existing Conditions.

These results indicate that the impact would be significant because it has the potential to substantially reduce the amount of suitable habitat and substantially interfere with the movement of fish. Differences in flows are moderately large during the majority of months and water years types. Further, a 48% reduction in rearing habitat quantity and 15% increase in stranding risk would reduce upstream habitat conditions for winter-run fry and juveniles. Water temperatures would be higher than those under NAA in the Sacramento River during a substantial portion of the winter-run rearing period. This impact is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this impact to a less-than-significant level would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this impact is significant and unavoidable because there is no feasible mitigation available. Even so, proposed below is mitigation that has the potential to reduce the severity of impact though not necessarily to a less-than-significant level.

Mitigation Measure AQUA-41a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Winter-Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Rearing Habitat

Although analysis conducted as part of the EIR/EIS determined that Alternative 2A would have significant and unavoidable adverse effects on rearing habitat, this conclusion was based on the best available scientific information at the time and may prove to have been overstated. Upon the commencement of operations of CM1 and continuing through the life of the permit, the BDCP proponents will monitor effects on rearing habitat in order to determine whether such effects would be as extensive as concluded at the time of preparation of this document and to determine any potentially feasible means of reducing the severity of such effects. This mitigation measure requires a series of actions to accomplish these purposes, consistent with the operational framework for Alternative 2A.

The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 2A operations only. Development of mitigation actions for the incremental impact on rearing habitat attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 2A.

Mitigation Measure AQUA-41b: Conduct Additional Evaluation and Modeling of Impacts on Winter-Run Chinook Salmon Rearing Habitat Following Initial Operations of CM1

Following commencement of initial operations of CM1 and continuing through the life of the permit, the BDCP proponents will conduct additional evaluations to define the extent to which modified operations could reduce impacts to rearing habitat under Alternative 2A. The analysis required under this measure may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6).

Mitigation Measure AQUA-41c: Consult with NMFS, USFWS, and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Winter-Run Chinook Salmon Rearing Habitat Consistent with CM1

In order to determine the feasibility of reducing the effects of CM1 operations on winter-run Chinook salmon habitat, the BDCP proponents will consult with NMFS, USFWS and CDFW to identify and implement any feasible operational means to minimize effects on rearing habitat. Any such action will be developed in conjunction with the ongoing monitoring and evaluation of habitat conditions required by Mitigation Measure AQUA-41a.

If feasible means are identified to reduce impacts on rearing habitat consistent with the overall operational framework of Alternative 2A without causing new significant adverse impacts on other covered species, such means shall be implemented. If sufficient operational flexibility to reduce effects on winter-run Chinook salmon habitat is not feasible under Alternative 2A operations, achieving further impact reduction pursuant to this mitigation measure would not be feasible under this Alternative, and the impact on winter-run Chinook salmon would remain significant and unavoidable.

Impact AQUA-42: Effects of Water Operations on Migration Conditions for Chinook Salmon (Winter-Run ESU)

In general, Alternative 2A would affect migration conditions for winter-run Chinook salmon relative to NAA.

Upstream of the Delta

Flows in the Sacramento River upstream of Red Bluff were examined for the July through November juvenile emigration period. A reduction in flow may reduce the ability of juvenile winter-run Chinook salmon to migrate effectively down the Sacramento River. Flows under A2A_LLT would generally be similar to flows under NAA, except during August and November, in which flows would be up to 17% lower under A2A_LLT. These flow reductions would not be of a high enough magnitude to have biologically meaningful effects on juvenile emigration conditions.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the July through November winter-run Chinook salmon juvenile emigration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period at either location.

Flows in the Sacramento River upstream of Red Bluff were examined during the adult winter-run Chinook salmon upstream migration period (December through August). A reduction in flows may reduce the olfactory cues needed by adults to return to natal spawning grounds in the upper Sacramento River. Flows under A2A_LLT would generally be similar to or greater than those under NAA except for wet water years during August, in which flows would be up to 14% lower under A2A_LLT. These reductions would not be large or frequent enough to cause biologically meaningful effects on adult migration conditions.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the December through August winter-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period at either location.

Migration flows and water temperatures would not differ substantially between Alternative 2A and NAA.

Through-Delta

The effects of Alternative 2A on through-Delta migration were evaluated using the approach described in Alternative 1A, Impact AQUA-42.

Juveniles

During the juvenile winter-run Chinook salmon emigration period (November to early May), mean monthly flows downstream of the north Delta diversion facility under Alternative 2A would be reduced up to 25% depending on the month compared to NAA.

The north Delta export facilities would replace aquatic habitat and likely attract piscivorous fish around the intake structures. The predation effects of Alternative 2A would be the same as those described for Alternative 1A (see details in Impact AQUA-42), since there are five intakes for both alternatives. The five NDD intakes would remove or modify habitat along that portion of the migration corridor (22 acres aquatic habitat and 11,900 linear feet of shoreline). Potential predation losses at the north Delta intakes, as estimated by the bioenergetics model with median density of predators (119 striped bass per 1,000 feet of intake), would be less than 2% compared to the annual production estimated for the Sacramento Valley (Table 11-1A-17). A conservative assumption of 5% loss per intake would yield a cumulative loss of 18.5% of juvenile winter-run Chinook that reach the north Delta. This assumption is uncertain and represents an upper bound estimate.

Through-Delta survival to Chipps Island by emigrating juvenile winter-run Chinook salmon was modeled by the DPM. Average survival under Alternative 2A would be 33% across all years, 26% in drier years, and 45% in wetter years (Table 11-2A-16). Compared to NAA, juvenile survival would decrease 1.2% across all year (a 4% relative decrease) and decrease 1.5% (5% relative decrease) in drier years.

Table 11-2A-16. Through-Delta Survival (%) of Emigrating Juvenile Winter-Run Chinook Salmon under Alternative 2A

	Percentage Survival			Difference in Percentage Survival (Relative Difference)	
Year Type	EXISTING CONDITIONS	NAA	A2A_LLT	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wetter Years	46.3	46.1	45.2	-1.1 (-3%)	-0.9 (-2%)
Drier Years	28.0	27.1	25.7	-2.3 (-8%)	-1.5 (-5%)
All Years	34.9	34.2	33.0	-1.9 (-5%)	-1.2 (-4%)

Note: Delta Passage Model results for survival to Chipps Island.
Wetter = Wet and above normal water years (6 years).
Drier = Below normal, dry and critical water years (10 years).

Adults

Attraction flow, as estimated by the percentage of Sacramento River water at Collinsville, declined under Alternative 2A by no more than 10% during the December through June migration period for winter-run adults (Table 11-2A-17). The reductions in percentage are small in comparison with the magnitude of change in dilution reported to cause a significant change in migration by Fretwell (1989) and, therefore, are not expected to affect winter-run migration. However, uncertainty remains with regard to adult salmon behavioral response to anticipated changes in lower Sacramento River flow percentages. For further discussion of the topic see the analysis for Alternative 1A.

Table 11-2A-17. Percentage (%) of Water at Collinsville that Originated in the Sacramento River and San Joaquin River during the Adult Chinook Migration Period for Alternative 2A

	Percentage of Water			Difference	
Month	EXISTING CONDITIONS	NAA	A2A_LLT	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Sacramento River					
September	60	65	78	18	13
October	60	68	67	7	-1
November	60	66	62	2	-4
December	67	66	65	-2	-1
January	76	75	73	-3	-2
February	75	72	67	-8	-5
March	78	76	67	-11	-9
April	77	75	65	-12	-10
May	69	65	59	-10	-6
San Joaquin River					
September	0.3	0.1	1.3	1.0	1.2
October	0.2	0.3	3.6	3.4	3.3
November	0.4	1.0	5.4	5.0	4.4
December	0.9	1.0	3.0	2.1	2.0
January	1.6	1.7	3.2	1.6	1.5
February	1.4	1.5	3.8	2.4	2.3
March	2.6	2.8	6.1	3.5	3.3
April	6.3	6.6	10.6	4.3	4.0
	Shading indicates a difference of 10% or greater in flow proportion.				

NEPA Effects: Overall, the results indicate that the effect of Alternative 2A is adverse due to the cumulative effects associated with five north Delta intake facilities, including mortality related to near-field effects (e.g. impingement and predation) and far-field effects (reduced survival due to reduced flows downstream of the intakes) associated with the five NDD intakes.

Upstream of the Delta, Alternative 2A would not affect migration conditions for winter-run Chinook salmon, as migration flows and water temperatures would not differ substantially between Alternative 2A and NAA.

Adult attraction flows under Alternative 2A would be lower than those under NAA, but adult attraction flows are expected to be adequate to provide olfactory cues for migrating adults.

Near-field effects of Alternative 2A NDD on winter-run Chinook salmon related to impingement and predation associated with five new intakes could result in substantial effects on juvenile migrating winter-run Chinook salmon, although there is high uncertainty regarding the potential effects. Estimates within the effects analysis range from very low levels of effects (<1% mortality) to very significant effects (~ 19% mortality above current baseline levels). CM15 would be implemented with the intent of providing localized and temporary reductions in predation pressure at the NDD. Additionally, several pre-construction surveys to better understand how to minimize losses associated with the five new intake structures will be implemented as part of the final NDD screen design effort. Alternative 2A also includes an Adaptive Management Program and Real-Time Operational Decision-Making Process to evaluate and make limited adjustments intended to provide adequate migration conditions for winter-run Chinook. However, at this time, due to the absence of comparable facilities anywhere in the lower Sacramento River/Delta, the degree of mortality expected from near-field effects at the NDD remains highly uncertain.

Two recent studies (Newman 2003 and Perry 2010) indicate that far-field effects associated with the new intakes could cause a reduction in smolt survival in the Sacramento River downstream of the NDD intakes due to reduced flows in this area. The analyses of other elements of Alternative 2A predict improvements in smolt condition and survival associated with increased access to the Yolo Bypass, reduced interior Delta entry, and reduced south Delta entrainment. The overall magnitude of each of these factors and how they might interact and/or offset each other in affecting salmonid survival through the plan area is uncertain, and remains an area of active investigation for the BDCP.

The DPM is a flow-based model being developed for BDCP which attempts to combine the effects of all of these elements of BDCP operations and conservation measures to predict smolt migration survival throughout the entire Plan Area. The current draft of this model predicts that smolt migration survival under Alternative 2A would be similar to survival rates estimated for NAA. Further refinement and testing of the DPM, along with several ongoing and planned studies related to salmonid survival at and downstream of the NDD are expected to be completed in the foreseeable future. These efforts are expected to improve our understanding of the relationships and interactions among the various factors affecting salmonid survival, and reduce the uncertainty around the potential effects of BDCP implementation on migration conditions for Chinook salmon. Until these efforts are completed and their results are fully analyzed, the overall effect of Alternative 2A on winter-run Chinook salmon through-Delta survival remains uncertain.

Therefore, primarily as a result of reduced upstream migration habitat conditions for winter-run Chinook salmon due to reduced flows along with unacceptable levels of uncertainty regarding the cumulative impacts of near-field and far-field effects associated with the presence and operation of the five intakes on winter-run Chinook salmon, this effect is adverse. While implementation of the conservation and mitigation measures listed below would address these impacts, these are not anticipated to reduce the impacts to a level considered not adverse.

CEQA Conclusion: In general, Alternative 2A would reduce migration conditions for winter-run Chinook salmon relative to the Existing Conditions.

Upstream of the Delta

Flows in the Sacramento River upstream of Red Bluff were examined during the July through November juvenile emigration period. Flows under A2A_LLT for juvenile migrants would generally be similar to flows under Existing Conditions, except during August and November, in which flows would be up to 24% lower (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*. These reductions would not be large or frequent enough to cause biologically meaningful effects on juvenile emigration conditions.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the July through November winter-run juvenile emigration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperature would be up to 14% higher under Alternative 2A in July through October depending on month, water year type, and location. There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 2A during November.

Flows under A2A_LLT in the Sacramento River upstream of Red Bluff during December through August would generally be similar to flows under Existing Conditions, except during May and June, in which flows under A2A_LLT would be up to 21% greater, and during August, in which flows would be up to 24% lower. These reductions in flow would not be frequent enough to cause biologically meaningful effects on adult migration conditions.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the December through August winter-run upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 2A during December through June. Mean monthly water temperature would be up to 14% higher under Alternative 2A in July and August depending on month, water year type, and location.

Through-Delta

As described above, predation losses of migrating juvenile winter-run Chinook would increase at the five north Delta intakes, hypothetically ranging from less than 1% up to 12% that reach the north Delta. Through-Delta survival of emigrating juvenile winter-run Chinook salmon averaged across all years would decrease slightly compared to Existing Conditions (1.9% lower, a 5% relative decrease for all years) (Table 11-2A-16).

For migrating adults, olfactory cues, based on the proportion of Sacramento River flows, would be similar (<10% difference) to Existing Conditions during the winter-run Chinook salmon migration period December to February (Table 11-2A-17). For further discussion of this topic see the analysis for Alternative 1A.

Summary of CEQA Conclusion

Overall, Alternative 2A would significantly affect the migration conditions for juvenile or adult winter-run Chinook salmon, relative to the Existing Conditions. Alternative 2A would cause higher water temperatures in the Sacramento River upstream of the Delta relative to the Existing Conditions during a substantial portion of winter-run Chinook salmon juvenile and adult migration periods. There would be no effect of Alternative 2A on flows during the juvenile or adult winter-run Chinook salmon migration periods. Through-Delta survival of emigrating juveniles is expected to be substantially reduced, compared to Existing Conditions. There would be no effect of Alternative 2A on adult olfactory cues in the Delta.

Implementation of CM6 and CM15 would address these impacts, but are not anticipated to reduce them to a level considered less than significant. Although implementation of *CM6 Channel Margin Enhancement* would provide habitat similar to that which would be lost, it would not necessarily be located near the intakes and therefore would not fully compensate for the lost habitat. Additionally, implementation of this measure would not fully address predation losses. *CM15 Localized Reduction of Predatory Fishes (Predator Control)* has substantial uncertainties associated with its effectiveness such that it is considered to have no demonstrable effect. Conservation measures that address habitat and predation losses, therefore, would potentially minimize impacts to some extent but not to a less than significant level. Consequently, as a result of these changes in migration conditions, this impact is significant and unavoidable.

Applicable conservation measures are briefly described below and full descriptions are found in Chapter 3, Section 3.6.2.5 Channel Margin Enhancement (CM6) and Section 3.6.3.4 Localized Reduction of Predatory Fishes (Predator Control) (CM15).

CM6 Channel Margin Enhancement. CM6 would entail restoration of 20 linear miles of channel margin by improving channel geometry and restoring riparian, marsh, and mudflat habitats on the waterside side of levees along channels that provide rearing and outmigration habitat for juvenile salmonids. Linear miles of enhancement would be measured along one side or the other of a given channel segment (e.g., if both sides of a channel are enhanced for a length of 1 mile, this would account for a total of 2 miles of channel margin enhancement). At least 10 linear miles would be enhanced by year 10 of Plan implementation; enhancement would then be phased in 5-mile increments at years 20 and 30, for a total of 20 miles at year 30. Channel margin enhancement would be performed only along channels that provide rearing and outmigration habitat for juvenile salmonids. These include channels that are protected by federal project levees—including the Sacramento River between Freeport and Walnut Grove among several others.

CM15 Localized Reduction of Predatory Fishes (Predator Control). CM15 would seek to reduce populations of predatory fishes at specific locations or modify holding habitat at selected locations of high predation risk (i.e., predation "hotspots"). This conservation measure seeks to benefit covered salmonids by reducing mortality rates of juvenile migratory life stages that are particularly vulnerable to predatory fishes. Predators are a natural part of the Delta ecosystem. Therefore, this conservation measure is not intended to entirely remove predators at any location, or substantially alter the abundance of predators at the scale of the Delta system. This conservation measure would also not remove piscivorous birds. Because of uncertainties regarding treatment methods and efficacy, implementation of CM15 would involve discrete pilot projects and research actions coupled with an adaptive management and monitoring program to evaluate effectiveness. Effects would be temporary, as new individuals would be expected to occupy vacated areas; therefore, removal activities would need to be continuous during periods of concern. CM15 also recognizes that the NDD intakes would create new predation hotspots.

This impact is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this impact to a less-than-significant level would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this impact is significant and unavoidable because there is no feasible mitigation available. Even so, proposed below is mitigation that has the potential to reduce the severity of the impact though not necessarily to a less-than-significant level.

Mitigation Measure AQUA-42a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Winter-Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Migration Conditions

Although analysis conducted as part of the EIR/EIS determined that Alternative 2A would have significant and unavoidable adverse effects on migration habitat, this conclusion was based on the best available scientific information at the time and may prove to have been over- or understated. Upon the commencement of operations of CM1 and continuing through the life of the permit, the BDCP proponents will monitor effects on migration habitat in order to determine whether such effects would be as extensive as concluded at the time of preparation of this document and to determine any potentially feasible means of reducing the severity of such effects. This mitigation measure requires a series of actions to accomplish these purposes, consistent with the operational framework for Alternative 2A.

The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 2A operations only. Development of mitigation actions for the incremental impact on migration habitat attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 2A.

Mitigation Measure AQUA-42b: Conduct Additional Evaluation and Modeling of Impacts on Winter-Run Chinook Salmon Migration Conditions Following Initial Operations of CM1

Following commencement of initial operations of CM1 and continuing through the life of the permit, the BDCP proponents will conduct additional evaluations to define the extent to which modified operations could reduce impacts to migration habitat under Alternative 2A. The analysis required under this measure may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6).

Mitigation Measure AQUA-42c: Consult with USFWS, and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Winter-Run Chinook Salmon Migration Conditions Consistent with CM1

In order to determine the feasibility of reducing the effects of CM1 operations on winter-run Chinook salmon habitat, the BDCP proponents will consult with FWS and the Department of Fish and Wildlife to identify and implement any feasible operational means to minimize effects on migration habitat. Any such action will be developed in conjunction with the ongoing monitoring and evaluation of habitat conditions required by Mitigation Measure AQUA-42a.

If feasible means are identified to reduce impacts on migration habitat consistent with the overall operational framework of Alternative 2A without causing new significant adverse impacts on other covered species, such means shall be implemented. If sufficient operational flexibility to reduce effects on winter-run Chinook salmon habitat is not feasible under Alternative 2A operations, achieving further impact reduction pursuant to this mitigation measure would not be feasible under this Alternative, and the impact on winter-run Chinook salmon would remain significant and unavoidable.

Restoration and Conservation Measures

Alternative 2A has the same restoration and conservation measures as Alternative 1A. Because no substantial differences in effects are anticipated anywhere in the affected environment under Alternative 2A compared to those described in detail for Alternative 1A, the effects described for winter-run Chinook salmon under Alternative 1A (Impact AQUA-43 through AQUA-54) also appropriately characterize effects under Alternative 2A.

The following impacts are those presented under Alternative 1A that are identical for Alternative 2A.

Impact AQUA-43: Effects of Construction of Restoration Measures on Chinook Salmon (Winter-Run ESU)

Impact AQUA-44: Effects of Contaminants Associated with Restoration Measures on Chinook Salmon (Winter-Run ESU)

Impact AQUA-45: Effects of Restored Habitat Conditions on Chinook Salmon (Winter-Run ESU)

Impact AQUA-46: Effects of Methylmercury Management on Chinook Salmon (Winter-Run ESU) (CM12)

Impact AQUA-47: Effects of Invasive Aquatic Vegetation Management on Chinook Salmon (Winter-Run ESU) (CM13)

Impact AQUA-48: Effects of Dissolved Oxygen Level Management on Chinook Salmon (Winter-Run ESU) (CM14)

Impact AQUA-49: Effects of Localized Reduction of Predatory Fish on Chinook Salmon (Winter-Run ESU) (CM15)

Impact AQUA-50: Effects of Nonphysical Fish Barriers on Chinook Salmon (Winter-Run ESU) (CM16)

Impact AQUA-51: Effects of Illegal Harvest Reduction on Chinook Salmon (Winter-Run ESU) (CM17)

Impact AQUA-52: Effects of Conservation Hatcheries on Chinook Salmon (Winter-Run ESU) (CM18)

Impact AQUA-53: Effects of Urban Stormwater Treatment on Chinook Salmon (Winter-Run ESU) (CM19)

Impact AQUA-54: Effects of Removal/Relocation of Nonproject Diversions on Chinook Salmon (Winter-Run ESU) (CM21)

NEPA Effects: The nine impact mechanisms have been determined to range from no effect, to no adverse effect, or beneficial effects on winter-run Chinook salmon for NEPA purposes, for the reasons identified for Alternative 1A. Specifically for AQUA-44, the effects of contaminants on winter-run Chinook salmon with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on winter-run Chinook salmon are uncertain.

CEQA Conclusion: The nine impact mechanisms would be considered to range from no impact, to less than significant, or beneficial on winter-run Chinook salmon, for the reasons identified for Alternative 1A, and no mitigation is required.

Spring-Run Chinook Salmon

Construction and Maintenance of CM1

Impact AQUA-55: Effects of Construction of Water Conveyance Facilities on Chinook Salmon (Spring-Run ESU)

The potential effects of construction of the water conveyance facilities on spring-run Chinook salmon would be similar to those described for Alternative 1A (Impact AQUA-55) except that Alternative 2A could potentially include two different intakes than under Alternative 1A. This would convert about 11,350 lineal feet of existing shoreline habitat into intake facility structures and would require about 26 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. The effects related to temporary increases in turbidity, accidental spills, underwater noise, in-water work activities, and disturbance of contaminated sediments would be similar to Alternative 1A and the same environmental commitments and mitigation measures (described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*) would be available to avoid and minimize potential effects.

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-55, environmental commitments and mitigation measures would be available to avoid and minimize potential effects, and the effect would not be adverse for spring-run Chinook salmon.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-55, the impact of the construction of water conveyance facilities on spring-run Chinook salmon would not be significant except for construction noise associated with pile driving. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in the discussion of Alternative 1A.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in the discussion of Alternative 1A.

Impact AQUA-56: Effects of Maintenance of Water Conveyance Facilities on Chinook Salmon (Spring-Run ESU)

The maintenance-related effects of Alternative 2A would be identical for all four Chinook salmon ESUs. Accordingly, for a discussion of the impacts listed below, please refer to the discussion of these effects for winter-run Chinook for Alternative 1A (Impact AQUA-38). Therefore, the impact would not be adverse for spring-run Chinook salmon.

Water Operations of CM1

Impact AQUA-57: Effects of Water Operations on Entrainment of Chinook Salmon (Spring-Run ESU)

Water Exports from SWP/CVP South Delta Facilities

Losses under Alternative 2A would decrease by approximately 54% compared to NAA averaged across all years (Table 11-2A-8). Annual average loss of juvenile spring-run Chinook salmon under Alternative 2A would be approximately 18,000 fish for the combined SWP and CVP south Delta facilities. Losses would be greatest in dry (~16,000 fish) and wet years (~12,800 fish), and lowest in below normal years (~5,200 fish). Entrainment reductions under Alternative 2A would be greater in wetter years, ranging from a 5% decrease in dry years up to 86% decrease in wet years compared to Existing Conditions (Table 11-2A-18). Pre-screen losses, typically attributed to predation, would also decrease commensurate with entrainment reductions.

The proportion of the annual spring-run Chinook population (assumed to be 750,000 juveniles approaching the Delta) lost at the south Delta facilities across all years averaged 5.1–5.3% under NAA, and would decrease to 2.4% under Alternative 2A.

Table 11-2A-18. Juvenile Spring-Run Chinook Salmon Annual Entrainment Index at the SWP and CVP Salvage Facilities—Differences between Model Scenarios for Alternative 2A

	Absolute Difference (Percent Difference)[a]	
Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wet	-79,450 (-86%)	-78,649 (-86%)
Above Normal	-19,700 (-66%)	-16,431 (-62%)
Below Normal	-1,919 (-27%)	-1,105 (-17%)
Dry	-1,760 (-10%)	-848 (-5%)
Critical	-916 (-9%)	-2,311 (-20%)
All Years	-21,554 (-55%)	-20,586 (-54%)

Shading indicates 10% or greater increased entrainment.

[a] Estimated annual number of fish lost, based on normalized data.

Water Exports from SWP/CVP North Delta Intake Facilities

The impacts from the proposed SWP/CVP north Delta intakes on spring-run Chinook salmon would be the same as described for Impact AQUA-57 for spring-run Chinook Salmon under Alternative 1A. State-of-the-art fish screens operated with an adaptive management plan would be expected to eliminate entrainment risk for juvenile spring-run Chinook salmon to these intakes.

Water Export with a Dual Conveyance for the SWP North Bay Aqueduct

The effects would be the same as described in Impact AQUA-39 for Alternative 1A. Entrainment and impingement effects on juvenile spring-run Chinook salmon would be minimal for Alternative 2A because intakes would have state-of-the-art screens installed.

NEPA Effects: Under Alternative 2A, entrainment of juvenile spring-run Chinook salmon at the south Delta facilities was estimated to be similar to or somewhat lower than NAA across all water years (considering the all-year salvage density results). Therefore, the effect would not be adverse.

CEQA Conclusion: As described above, operational activities associated with water exports from SWP/CVP south Delta facilities would result in an overall decrease in entrainment for juvenile spring-run Chinook salmon, although there is substantial variation among water year types (Table 11-2A-8). However, with the added entrainment risks at the proposed north Delta facilities the overall entrainment rates are expected to be similar for Alternative 2A as Existing Conditions. Consequently, the impact of water operations on entrainment of juvenile Chinook salmon (spring-run ESU) is considered less than significant, and no mitigation would be required.

Impact AQUA-58: Effects of Water Operations on Spawning and Egg Incubation Habitat for Chinook Salmon (Spring-Run ESU)

In general, the effects of Alternative 2A on spawning and egg incubation habitat for spring-run Chinook salmon relative to NAA are uncertain.

Sacramento River

Flows in the Sacramento River upstream of Red Bluff during the spring-run Chinook salmon spawning and incubation period (September through January) under A2A_LLT would be greater than, similar to, and lower than those under NAA depending on month and water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT during December and January would be greater than or similar to those under NAA regardless of water year type. Flows during September would be up to 17% greater than or similar to those under NAA in wet, dry, and critical years, up to 15% lower in above normal and below normal years, but similar when all years are combined. Flows during October would not be different from those under NAA in all water years except below normal years, when flows are 6% lower. Flows in November would be similar or lower (up to -17%) depending on water year type.

Shasta Reservoir storage volume at the end of September influences flows downstream of the dam during the spring-run spawning and egg incubation period (September through January). Storage under A2A_LLT would be similar to, or greater than storage under NAA in all water year types (Table 11-2A-19).

Table 11-2A-19. Difference and Percent Difference in September Water Storage Volume (thousand acre-feet) in Shasta Reservoir for Model Scenarios

Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wet	-286 (-9%)	226 (8%)
Above Normal	-346 (-11%)	269 (10%)
Below Normal	-229 (-8%)	125 (5%)
Dry	-172 (-7%)	339 (17%)
Critical	-137 (-12%)	245 (30%)

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the September through January spring-run Chinook salmon spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results* *utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period at either location.

The number of days on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month (May through September at Bend Bridge and October through April at Red Bluff) and year of the 82-year modeling period (Table 11-2A-10). The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern" as defined in Table 11-2A-11. Differences between baselines and Alternative 2A in the highest level of concern across all months and all 82 modeled years are presented in Table 11-2A-12 for Bend Bridge and in Table 11-2A-20 for Red Bluff. There would be no difference in levels of concern between NAA and Alternative 2A at Bend Bridge. At Red Bluff, there would be 1 (2%) and 4 (24%) more years with a "red" and "orange" level of concern, respectively, under Alternative 2A. There would be 5 (71%) fewer years with a "yellow" level of concern.

Table 11-2A-20. Differences between Baseline and Alternative 2A Scenarios in the Number of Years in Which Water Temperature Exceedances above 56°F Are within Each Level of Concern, Sacramento River at Red Bluff, October through April

Level of Concern[a]	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Red	37 (308%)	1 (2%)
Orange	11 (183%)	4 (24%)
Yellow	-6 (-46%)	-5 (-71%)
None	-42 (-82%)	0 (0%)

[a] For definitions of levels of concern, see Table 11-2A-11.

Total degree-days exceeding 56°F were summed by month and water year type at Bend Bridge during May through September and at Red Bluff during October through April. At Bend Bridge, total degree-days under Alternative 2A would be up to 12% lower than those under NAA during May and June and up to 16% higher during July through September (Table 11-2A-13). At Red Bluff, total degree-days under Alternative 2A would differ from those under NAA during October, November, and March (6%, 8%, and 9% higher, respectively), 5% lower during April, and similar during remaining months, for all years combined (Table 11-2A-21).

Table 11-2A-21. Differences between Baseline and Alternative 2A Scenarios in Total Degree-Days (°F-Days) by Month and Water Year Type for Water Temperature Exceedances above 56°F in the Sacramento River at Red Bluff, October through April

Month	Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
October	Wet	1,277 (497%)	108 (8%)
	Above Normal	526 (202%)	49 (7%)
	Below Normal	825 (395%)	119 (13%)
	Dry	1,153 (235%)	82 (5%)
	Critical	909 (152%)	-14 (-1%)
	All	4,690 (258%)	344 (6%)
November	Wet	97 (9,700%)	7 (8%)
	Above Normal	75 (NA)	14 (23%)
	Below Normal	59 (NA)	11 (23%)
	Dry	163 (2,038%)	12 (8%)
	Critical	105 (2,625%)	-5 (-4%)
	All	499 (3,838%)	39 (8%)
December	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
January	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
February	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
March	Wet	9 (NA)	0 (0%)
	Above Normal	5 (NA)	1 (25%)
	Below Normal	36 (400%)	15 (50%)
	Dry	63 (450%)	-1 (-1%)
	Critical	25 (2,500%)	-2 (-7%)
	All	138 (575%)	13 (9%)
April	Wet	260 (226%)	-1 (0%)
	Above Normal	208 (149%)	-21 (-6%)
	Below Normal	228 (289%)	-2 (-1%)
	Dry	261 (140%)	-59 (-12%)
	Critical	152 (1,267%)	1 (1%)
	All	1,109 (208%)	-82 (-5%)

NA = could not be calculated because the denominator was 0.

The Reclamation egg mortality model predicts that spring-run Chinook salmon egg mortality in the Sacramento River under A2A_LLT would be similar to mortality under NAA in dry and critical years, but greater in wet (13% greater), above normal (9% greater), and below normal (28% greater) water years (Table 11-2A-22). Absolute scale increases of 3% of the spring-run population under wet and above normal water years would be negligible to the overall population. However, the 12% increase in mortality in below normal years would be a small negative effect on the spring-run population. Combining all water years, there would be no effect of Alternative 2A on egg mortality (3% absolute change).

Table 11-2A-22. Difference and Percent Difference in Percent Mortality of Spring-Run Chinook Salmon Eggs in the Sacramento River (Egg Mortality Model)

Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wet	18 (178%)	3 (13%)
Above Normal	25 (188%)	3 (9%)
Below Normal	41 (345%)	12 (28%)
Dry	56 (287%)	0 (0%)
Critical	22 (30%)	0 (0%)
All	32 (143%)	3 (7%)

SacEFT predicts that there would be a minimal (<5%) difference in the percentage of years with good spawning availability, measured as weighted useable area, between A2A_LLT and NAA (Table 11-2A-23). SacEFT predicts that there would be no difference in the percentage of years with good (lower) redd scour risk under A2A_LLT relative to NAA (Table 11-2A-23). SacEFT predicts that there would be a 26% decrease (9% decrease on absolute scale) in the percentage of years with good (lower) egg incubation conditions under A2A_LLT relative to NAA. SacEFT predicts that there would be a 6% decrease (2% decrease on absolute scale) in the percentage of years with good (lower) redd dewatering risk under A2A_LLT relative to NAA.

Table 11-2A-23. Difference and Percent Difference in Percentage of Years with "Good" Conditions for Spring-Run Chinook Salmon Habitat Metrics in the Upper Sacramento River (from SacEFT)

Metric	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Spawning WUA	-22 (-31%)	-1 (-2%)
Redd Scour Risk	0 (0%)	0 (0%)
Egg Incubation	-61 (-71%)	-9 (-26%)
Redd Dewatering Risk	-17 (-35%)	-2 (-6%)
Juvenile Rearing WUA	1 (5%)	1 (5%)
Juvenile Stranding Risk	-8 (-42%)	-3 (-21%)
WUA = Weighted Usable Area.		

There is an apparent discrepancy in results of the SacEFT model and Reclamation egg mortality model with regard to conditions for spring-run salmon eggs. SacEFT predicts that egg incubation habitat would decrease (9% absolute scale decrease) and the Reclamation egg mortality model predicts that overall egg mortality would be unaffected by Alternative 2A, except in below normal water years. The SacEFT uses mid-August through early March as the egg incubation period, based on Vogel and Marine (1991), and the reach between ACID Dam and Battle Creek for redd locations. The Reclamation egg mortality model uses the number of days after Julian week 33 (mid-August) that it takes to accumulate 750 temperature units to hatching and another 750 temperature units to emergence. Temperatures units are calculated by subtracting 32°F from daily river temperature and are computed on a daily basis. As a result, egg incubation duration is generally mid-August through January, but is dependent on river temperature. The Reclamation model uses the reach between ACID Dam and Jelly's Ferry (approximately 5 river miles downstream of Battle Creek), which includes 95% of Sacramento River spawning locations based on 2001–2004 redd survey data (Reclamation 2008). These differences in egg incubation period and location likely account for the difference between model results. Although the SacEFT model has been peer-reviewed, the Reclamation egg mortality model has been extensively reviewed and used in prior biological assessments and BiOps. Therefore, both results are considered valid and were considered in drawing conclusions about spring-run egg mortality in the Sacramento River.

Clear Creek

Flows in Clear Creek were examined during the spring-run Chinook salmon spawning and egg incubation period (September through January). Flows under A2A_LLT would be similar to or greater than flows under NAA throughout the period for all water year types (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

The potential risk of spring-run Chinook salmon redd dewatering in Clear Creek was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in September when spawning is assumed to occur. The greatest reduction in flows under A2A_LLT would be the same as that under NAA in all water year types (Table 11-2A-24).

Water temperatures were not modeled in Clear Creek.

Table 11-2A-24. Difference and Percent Difference in Greatest Monthly Reduction (Percent Change) in Instream Flow in Clear Creek below Whiskeytown Reservoir during the September through January Spawning and Egg Incubation Period[a]

Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wet	0 (NA)	0 (NA)
Above Normal	-27 (NA)	0 (0%)
Below Normal	53 (100%)	0 (NA)
Dry	-67 (NA)	0 (0%)
Critical	-33 (-50%)	0 (0%)

NA = could not be calculated because the denominator was 0.

[a] Redd dewatering risk not applicable for months when flows during the egg incubation period were at or greater than flows in September, when spawning is assumed to occur. A negative value indicates that the greatest monthly reduction would be of greater magnitude (worse) under the alternative than under the baseline.

Feather River

Flows were examined in the Feather River low-flow channel (upstream of Thermalito Afterbay) where spring-run Chinook primarily spawn during September through January (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would not differ from

NAA because minimum Feather River flows are included in the FERC settlement agreement and would be met for all model scenarios (California Department of Water Resources 2006).

Oroville Reservoir storage volume at the end of September influence flows downstream of the dam during the spring-run spawning and egg incubation period. Storage volume at the end of September under A2A_LLT would be similar to or up to 16% greater than storage under NAA depending on water year type (Table 11-2A-25).

Table 11-2A-25. Difference and Percent Difference in September Water Storage Volume (thousand acre-feet) in Oroville Reservoir for Model Scenarios

Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wet	-929 (-32%)	85 (5%)
Above Normal	-859 (-36%)	-68 (-4%)
Below Normal	-559 (-28%)	50 (4%)
Dry	-192 (-14%)	161 (16%)
Critical	-71 (-7%)	117 (15%)

The potential risk of redd dewatering in the Feather River low-flow channel was evaluated by comparing the magnitude of flow reduction each month over the egg incubation period compared to the flow in September when spawning is assumed to occur. Minimum flows in the low-flow channel during October through January were identical among A2A_LLT and NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Therefore, there would be no effect of Alternative 2A on redd dewatering in the Feather River low-flow channel.

Mean monthly water temperatures were examined in the Feather River low-flow channel (upstream of Thermalito Afterbay) during September through January (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

The percent of months exceeding the 56°F temperature threshold in the Feather River above Thermalito Afterbay (low-flow channel) was evaluated during September through January (Table 11-2A-26). The percent of months exceeding the threshold under Alternative 2A would generally be lower (up to 11% lower on an absolute scale) than the percent under NAA during September, October and November and similar during other months.

Table 11-2A-26. Differences between Baseline and Alternative 2A Scenarios in Percent of Months during the 82-Year CALSIM Modeling Period during Which Water Temperatures in the Feather River above Thermalito Afterbay Exceed the 56°F Threshold, September through January

	Degrees Above Threshold				
Month	>1.0	>2.0	>3.0	>4.0	>5.0
EXISTING CONDITIONS vs. A2A_LLT					
September	0 (0%)	0 (0%)	6 (7%)	17 (24%)	35 (85%)
October	53 (239%)	51 (683%)	48 (780%)	44 (1,800%)	31 (1,250%)
November	54 (2,200%)	47 (3,800%)	41 (3,300%)	27 (NA)	14 (NA)
December	4 (NA)	1 (NA)	0 (NA)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
NAA vs. A2A_LLT					
September	0 (0%)	-1 (-1%)	-1 (-1%)	-6 (-6%)	-7 (-9%)
October	-11 (-13%)	-7 (-11%)	-1 (-2%)	-2 (-5%)	-6 (-16%)
November	-10 (-15%)	-11 (-19%)	-7 (-15%)	-5 (-15%)	-11 (-45%)
December	0 (0%)	0 (0%)	-1 (-100%)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.

Total degree-days exceeding 56°F were summed by month and water year type above Thermalito Afterbay (low-flow channel) during September through January (Table 11-2A-27). Total degree-months would be similar between NAA and Alternative 2A during September and January, lower during October and November, and 20% higher during December.

Table 11-2A-27. Differences between Baseline and Alternative 2A Scenarios in Total Degree-Months (°F-Months) by Month and Water Year Type for Water Temperature Exceedances above 56°F in the Feather River above Thermalito Afterbay, September through January

Month	Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
September	Wet	29 (27%)	4 (3%)
	Above Normal	14 (33%)	4 (8%)
	Below Normal	39 (65%)	8 (9%)
	Dry	70 (101%)	-18 (-11%)
	Critical	50 (77%)	-12 (-9%)
	All	202 (59%)	-14 (-2%)
October	Wet	84 (1,680%)	-12 (-12%)
	Above Normal	31 (310%)	-4 (-9%)
	Below Normal	52 (743%)	-2 (-3%)
	Dry	83 (1,186%)	3 (3%)
	Critical	33 (413%)	-8 (-16%)
	All	282 (762%)	-24 (-7%)
November	Wet	56 (NA)	0 (0%)
	Above Normal	24 (800%)	-1 (-4%)
	Below Normal	26 (2,600%)	-8 (-23%)
	Dry	48 (NA)	-3 (-6%)
	Critical	24 (NA)	-4 (-14%)
	All	177 (4,425%)	-17 (-9%)
December	Wet	1 (NA)	0 (0%)
	Above Normal	2 (NA)	1 (100%)
	Below Normal	3 (NA)	0 (0%)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	6 (NA)	1 (20%)
January	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.

NEPA Effects: Available analytical tools show conflicting results regarding the temperature effects of relatively small changes in predicted summer and fall flows in the Sacramento River. Several models (CALSIM, SRWQM, and Reclamation Egg Mortality Model) generally show no change in upstream conditions as a result of Alternative 2A. However, one model, SacEFT, shows adverse effects under some conditions. After extensive investigation of these results, they appear to be a function of high model sensitivity to relatively small changes in estimated upstream conditions, which may or may not accurately predict adverse effects. The new NDD structures allow for spring time deliveries of water south of the Delta that are currently constrained under the NAA. For this reason, additional spring storage criteria may be necessary to ensure Shasta Reservoir operations similar to what was modeled. These discussions will occur in the Section 7 consultation with Reclamation on Shasta

Reservoir and system-wide operations, which is outside the scope of BDCP. In conclusion, Alternative 2A modeling results support a finding that effects are uncertain. Modeled results are mixed and operations that match the CALSIM modeling are not assured. Model results will be submitted to independent peer review to confirm that adverse effects are not reasonably anticipated to occur.

There would be no effects of Alternative 2A on spawning and egg incubation conditions in Clear Creek and no or beneficial effects in the Feather River.

CEQA Conclusion: In general, Alternative 2A would not affect spawning and egg incubation habitat for spring-run Chinook salmon relative to the Existing Conditions.

Sacramento River

Flows in the Sacramento River upstream of Red Bluff were examined during the spring-run Chinook salmon spawning and incubation period (September through January). Flows during September would be up to 55% greater than or similar to those under Existing Conditions in wet, above normal, and critical years and up to 17% lower than those under Existing Conditions in below normal and dry water years (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT during October and January would be up to 10% greater than or similar to those under Existing Conditions depending on water year type. Flows during November would be 3% to 13% lower than those under Existing Conditions depending on water year type. Flows during December would be up to 7% greater than or similar to those under Existing Conditions in all water years except wet year, in which flows are 8% lower than under Existing Conditions.

Shasta Reservoir Storage volume at the end of September would be 7% to 12% lower under A2A_LLT relative to Existing Conditions (Table 11-2A-19).

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the September through January spring-run Chinook salmon spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). At Keswick, temperatures under Alternative 2A during September and October would be up to 10% and 7% greater, respectively, than those under Existing Conditions, but not different in other months during the period. At Bend Bridge, temperatures under Alternative 2A during September and October would be up to 9% and 6% greater, respectively, than those under Existing Conditions, but not different in other months during the period.

The number of days on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month (May through September at Bend Bridge and October through April at Red Bluff) and year of the 82-year modeling period (Table 11-2A-10). The combination of number of days and degrees above the 56°F threshold were further assigned a “level of concern” as defined in Table 11-2A-11. Differences between baselines and Alternative 2A in the highest level of concern across all months and all 82 modeled years are presented in Table 11-2A-12 for Bend Bridge and in Table 11-2A-20 for Red Bluff. At Bend Bridge, there would be a 67% increase in the number of years with a “red” level of concern under Alternative 2A relative to Existing Conditions. At Red Bluff, there would be 308% and 183% increases in the number of years with “red” and “orange” levels of concern, respectively, under Alternative 2A relative to Existing Conditions.

Total degree-days exceeding 56°F were summed by month and water year type at Bend Bridge during May through September and at Red Bluff during October through April. At Bend Bridge, total degree-days under Alternative 2A would be up to 1135% to 313% higher than those under Existing

Conditions depending on the month (Table 11-2A-13). At Red Bluff, total degree-days under Alternative 2A would be 208% to 3838% higher than those under Existing Conditions during October, November, March, and April, and similar during December through February (Table 11-2A-21).

The Reclamation egg mortality model predicts that spring-run Chinook salmon egg mortality in the Sacramento River under A2A_LLT would be 30% to 345% greater than mortality under Existing Conditions depending on water year type (Table 11-2A-22).

SacEFT predicts that there would be a 31% decrease in the percentage of years with good spawning availability, measured as weighted usable area, under A2A_LLT relative to Existing Conditions (Table 11-2A-23). SacEFT predicts that there would be no difference in the percentage of years with good (lower) redd scour risk under A2A_LLT relative to Existing Conditions. SacEFT predicts that there would be a 71% decrease in the percentage of years with good (lower) egg incubation conditions under A2A_LLT relative to Existing Conditions, respectively. SacEFT predicts that there would be a 35% decrease in the percentage of years with good (lower) redd dewatering risk under A2A_LLT relative to Existing Conditions. These results indicate that spawning and egg incubation conditions for spring-run Chinook salmon would be poor relative to Existing Conditions.

Clear Creek

Flows in Clear Creek during the spring-run Chinook salmon spawning and egg incubation period (September through January) under A2A_LLT would generally be similar to or greater than flows under Existing Conditions except in critical years during September through November (6% to 29% reduction) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

The potential risk of spring-run Chinook salmon redd dewatering in Clear Creek was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in September when spawning is assumed to occur. The greatest reduction in flows under A2A_LLT would be similar to or lower magnitude than that under Existing Conditions in wet and below normal water years (Table 11-2A-24). The greatest reduction in flows under A2A_LLT would be 27% to 67% lower (more negative) than Existing Conditions in above normal, dry, and critical years.

Water temperatures were not modeled in Clear Creek.

Feather River

Flows in the Feather River low-flow channel under A2A_LLT are not different from Existing Conditions during the spring-run spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in October through January (800 cfs) would be equal to or greater than the spawning flows in September (773 cfs) for all model scenarios.

Oroville Reservoir storage volume at the end of September would be 7% to 36% lower under A2A_LLT relative to Existing Conditions depending on water year type (Table 11-2A-25).

The potential risk of redd dewatering in the Feather River low-flow channel was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in September when spawning is assumed to occur. Minimum flows in the low-flow channel during October through January were identical between A2A_LLT and Existing Conditions

(Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Therefore, there would be no effect of Alternative 2A on redd dewatering in the Feather River low-flow channel.

Mean monthly water temperatures were examined in the Feather River low-flow channel (upstream of Thermalito Afterbay) during September through January (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Temperatures under Alternative 2A would be 6% to 11% greater than those under Existing Conditions in all months during the period.

The percent of months exceeding the 56°F temperature threshold in the Feather River above Thermalito Afterbay (low-flow channel) was evaluated during September through January (Table 11-2A-26). The percent of months exceeding the threshold under Alternative 2A would be similar to or up to 54% higher (absolute scale) than under Existing Conditions during September through November. There would be little to no difference in the percent of months exceeding the threshold between Existing Conditions and Alternative 2A during December and January.

Total degree-days exceeding 56°F were summed by month and water year type above Thermalito Afterbay (low-flow channel) during September through January (Table 11-2A-27). Total degree-months exceeding the threshold under Alternative 2A would be 59% to 4425% greater than those under Existing Conditions during September through November. There would be minimal to no difference in total degree-months between Existing Conditions and Alternative 2A during December and January.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-58 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 2A could be significant because, when compared to the CEQA baseline, the alternative could substantially reduce suitable spawning habitat and substantially reduce the number of fish as a result of egg mortality, contrary to the NEPA conclusion set forth above, which is directly related to the inclusion of climate change effects in Alternative 2A. There are biologically meaningful flow reductions and temperature increases in the Sacramento River under Alternative 2A, relative to Existing Conditions, that would lead to increased egg mortality and overall reduced habitat conditions in spring-run spawning and egg incubation habitat conditions. Flows in the Feather River low-flow channel do not differ between Alternative 2A and Existing Conditions. However, water temperature analyses in the Feather River low-flow channel using NMFS thresholds indicate that there would be substantial negative effects on temperature conditions during spring-run Chinook salmon spawning and egg incubation.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 2A does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow and reservoir storage outputs between Existing Conditions in the late long-term implementation period and Alternative 2A indicates that flows and reservoir storage in the locations and during the months analyzed above would generally be similar between future conditions without the BDCP (NAA) and Alternative 2A. This indicates that the differences between Existing Conditions and Alternative 2A found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 2A, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on spawning and egg incubation habitat for spring-run Chinook salmon. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-59: Effects of Water Operations on Rearing Habitat for Chinook Salmon (Spring-Run ESU)

In general, Alternative 2A would not affect the quantity and quality of rearing habitat for fry and juvenile spring-run Chinook salmon relative to NAA.

Sacramento River

Flows were evaluated during the November through March larval and juvenile spring-run Chinook salmon rearing period in the Sacramento River between Keswick Dam and just upstream of Red Bluff (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows between December and March under A2A_LLT would generally be similar to or greater than those under NAA. Flows during November would be up to 17% lower under A2A_LLT than under NAA.

As reported in Impact AQUA-40, May Shasta storage volume under A2A_LLT would be similar to or greater than storage under NAA for all water year types (Table 11-2A-9).

As reported in Impact AQUA-58, September Shasta storage volume would be similar to or greater than storage under NAA in all water year types (Table 11-2A-19).

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the year-round spring-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period at either location.

SacEFT predicts that the percentage of years with good juvenile rearing WUA conditions under A2A_LLT would be similar to that under NAA (Table 11-2A-23). However, the percentage of years with good (lower) juvenile stranding risk conditions under A2A_LLT would be 21% lower than under NAA, although this would be a 3% difference on an absolute scale.

SALMOD predicts that spring-run smolt equivalent habitat-related mortality would be 6% lower under A2A_LLT than NAA.

Clear Creek

Flows in Clear Creek below Whiskeytown during the November through March spring-run rearing period under A2A_LLT would generally be similar to or greater than flows under NAA, except for critical years in February and below normal years in March in which flows would be 6% to 8% lower (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Water temperatures were not modeled in Clear Creek.

Feather River

Flows in the Feather River both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) during November through June were reviewed to determine flow-related effects on larval and juvenile spring-run rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Relatively constant flows in the low flow channel throughout this period under A2A_LLT would not differ from those under NAA. In the high flow channel, flows under A2A_LLT would be mostly similar to or greater than flows under NAA during November through June with few exceptions during which flows would be up to 12% lower under A2A_LLT.

May Oroville storage under A2A_LLT would be similar to storage under NAA (Table 11-2A-28).

As reported in Impact AQUA-58, September Oroville storage volume would be similar to or up to 5% lower than under NAA depending on water year type (Table 11-2A-25).

Table 11-2A-28. Difference and Percent Difference in May Water Storage Volume (thousand acre-feet) in Oroville Reservoir for Model Scenarios

Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wet	-78 (-2%)	-32 (-1%)
Above Normal	-205 (-6%)	-49 (-1%)
Below Normal	-404 (-12%)	-51 (-2%)
Dry	-576 (-21%)	-56 (-3%)
Critical	-272 (-15%)	44 (3%)

Mean monthly water temperatures in the Feather River both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were evaluated during November through June (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period at either location.

The percent of months exceeding the 63°F temperature threshold in the Feather River above Thermalito Afterbay (low-flow channel) was evaluated during May through August (Table 11-2A-29). The percent of months exceeding the threshold under Alternative 2A would generally be similar to or lower (up to 23% lower on an absolute scale) than the percent under NAA.

Table 11-2A-29. Differences between Baseline and Alternative 2A Scenarios in Percent of Months during the 82-Year CALSIM Modeling Period during Which Water Temperatures in the Feather River above Thermalito Afterbay Exceed the 63°F Threshold, May through August

	Degrees Above Threshold				
Month	>1.0	>2.0	>3.0	>4.0	>5.0
EXISTING CONDITIONS vs. A2A_LLT					
May	2 (NA)	2 (NA)	0 (NA)	0 (NA)	0 (NA)
June	26 (47%)	27 (100%)	23 (475%)	7 (NA)	1 (NA)
July	0 (0%)	0 (0%)	1 (1%)	25 (34%)	48 (122%)
August	0 (0%)	12 (14%)	36 (62%)	51 (178%)	40 (400%)
NAA vs. A2A_LLT					
May	-4 (-60%)	0 (0%)	-1 (-100%)	0 (NA)	0 (NA)
June	-7 (-8%)	-23 (-30%)	-19 (-39%)	-14 (-65%)	-4 (-75%)
July	0 (0%)	0 (0%)	0 (0%)	-1 (-1%)	-6 (-7%)
August	0 (0%)	0 (0%)	-5 (-5%)	-2 (-3%)	-7 (-13%)

Total degree-days exceeding 63°F were summed by month and water year type above Thermalito Afterbay (low-flow channel) during May through August (Table 11-2A-30). Total degree-months under Alternative 2A would be similar to or lower than those under NAA depending on the month except for July when it would be 3% higher.

Table 11-2A-30. Differences between Baseline and Alternative 2A Scenarios in Total Degree-Months (°F-Months) by Month and Water Year Type for Water Temperature Exceedances above 63°F in the Feather River above Thermalito Afterbay, May through August

Month	Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
May	Wet	1 (NA)	0 (0%)
	Above Normal	1 (NA)	0 (0%)
	Below Normal	0 (NA)	0 (NA)
	Dry	2 (NA)	0 (0%)
	Critical	3 (NA)	-1 (-25%)
	All	7 (NA)	-1 (-13%)
June	Wet	24 (160%)	-5 (-11%)
	Above Normal	12 (86%)	-5 (-16%)
	Below Normal	17 (131%)	-5 (-14%)
	Dry	30 (130%)	-3 (-5%)
	Critical	20 (333%)	-5 (-16%)
	All	104 (146%)	-22 (-11%)
July	Wet	44 (37%)	3 (2%)
	Above Normal	20 (45%)	0 (0%)
	Below Normal	28 (47%)	0 (0%)
	Dry	41 (58%)	5 (5%)
	Critical	38 (73%)	6 (7%)
	All	171 (49%)	14 (3%)
August	Wet	43 (48%)	10 (8%)
	Above Normal	21 (84%)	3 (7%)
	Below Normal	31 (82%)	2 (3%)
	Dry	47 (118%)	-6 (-6%)
	Critical	32 (76%)	-8 (-10%)
	All	174 (74%)	1 (0.2%)

NA = could not be calculated because the denominator was 0.

NEPA Effects: Collectively, these results indicate that the effect is not adverse because habitat would not be substantially reduced. There would be no substantial effects of Alternative 2A on rearing habitat for spring-run Chinook salmon in the Sacramento and Feather Rivers or in Clear Creek. Biological models, including SacEFT and SALMOD, support these findings.

CEQA Conclusion: In general, under Alternative 2A water operations, the quantity and quality of rearing habitat for fry and juvenile spring-run Chinook salmon would not be affected relative to Existing Conditions (the CEQA baseline).

Sacramento River

Flows were evaluated during the November through March larval and juvenile spring-run Chinook salmon rearing period in the Sacramento River between Keswick Dam and just upstream of Red Bluff (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows between December and March under A2A_LLT would be generally similar to or greater than those under Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows during November would be lower under A2A_LLT than under Existing Conditions.

As reported in Impact AQUA-40, Shasta Reservoir storage volume at the end of May under A2A_LLT would be similar to Existing Conditions in wet, above normal, and below normal water years, but lower by 6% to 9% in dry and critical water years (Table 11-2A-9). As reported in Impact AQUA-58, storage volume at the end of September under A2A_LLT would be 7% to 12% lower relative to Existing Conditions (Table 11-2A-19).

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the year-round spring-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). At both locations, there would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 2A in most months, except for 5% to 14% increases during July through October.

SacEFT predicts that the percentage of years with good juvenile rearing WUA conditions under A2A_LLT would be greater than that under Existing Conditions (Table 11-2A-23). The percentage of years with good (lower) juvenile stranding risk conditions under A2A_LLT would be 42% lower than under Existing Conditions.

SALMOD predicts that spring-run smolt equivalent habitat-related mortality under A2A_LLT would be 165% higher than under Existing Conditions.

Clear Creek

Flows in Clear Creek during the November through March rearing period under A2A_LLT would generally be similar to or greater than flows under Existing Conditions, except for critical years in November and December in which flows would be 6% lower (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Water temperatures were not modeled in Clear Creek.

Feather River

Relatively constant flows in the low flow channel throughout the November through June period under A2A_LLT would not differ from those under Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). In the high flow channel (at Thermalito Afterbay), flows under A2A_LLT would be mostly lower (up to 45%) during November, December, and February and both higher and lower depending on water year type during March.

May Oroville storage volume under A2A_LLT would be lower than Existing Conditions by 6% to 21% depending on water year type, except in wet years, in which storage would be similar to Existing Conditions (Table 11-2A-28).

As reported in Impact AQUA-58, September Oroville storage volume would be 7% to 36% lower under A2A_LLT relative to Existing Conditions depending on water year type (Table 11-2A-25).

Mean monthly water temperatures in the Feather River both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were evaluated during the November through June juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Water temperature under Alternative 2A would be 5% to 10% greater than those under Existing Conditions during November through March, but similar (<5% difference) during April through June.

The percent of months exceeding the 63°F temperature threshold in the Feather River above Thermalito Afterbay (low-flow channel) was evaluated during May through August (Table 11-2A-29). The percent of months exceeding the threshold under Alternative 2A would be similar to those under Existing Conditions during May, but up to 51% greater during June through August.

Total degree-days exceeding 63°F were summed by month and water year type above Thermalito Afterbay (low-flow channel) during May through August (Table 11-2A-30). Total degree-months under Alternative 2A would be similar to those under Existing Conditions during May, but 49% to 146% higher during June through August.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-59 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 2A could be significant because, under the CEQA baseline, the alternative could substantially reduce rearing habitat, contrary to the NEPA conclusion set forth above. Flows and temperatures in the Sacramento River would generally be unchanged under Alternative 2A relative to Existing Conditions, both SacEFT and SALMOD predict negative effects on juvenile rearing habitat. There would be no effects of Alternative 2A on flows in Clear Creek. Flows in the low-flow channel would be unchanged by Alternative 2A. However, flows in the high-flow channel would be mostly lower by up to 44% during the half of the fry and juvenile rearing period. Temperatures in both portions of the Feather River would experience increased water temperatures during substantial portions of the rearing period under Alternative 2A and NMFS temperature thresholds would be exceeded at a substantially higher frequency.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 2A does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 2A indicates that flows and reservoir storage in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 2A. This indicates that the differences between Existing Conditions and Alternative 2A found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 2A, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on rearing habitat for spring-run Chinook salmon. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-60: Effects of Water Operations on Migration Conditions for Chinook Salmon (Spring-Run ESU)

In general, Alternative 2A would reduce migration conditions for spring-run Chinook salmon relative to NAA.

Upstream of the Delta

Sacramento River

Flows in the Sacramento River upstream of Red Bluff were evaluated during the December through May juvenile Chinook salmon spring-run migration period. Flows under A2A_LLT during December through May would always be similar to or greater than flows under NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the December through May juvenile Chinook salmon spring-run emigration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

Flows in the Sacramento River upstream of Red Bluff were evaluated during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would generally be similar to or greater than flows under NAA except during July and August (up to 15% lower depending on month and water year type).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

Clear Creek

Flows in Clear Creek during the November through May juvenile Chinook salmon spring-run migration period under A2A_LLT would generally be similar to or greater than flows under NAA except in critical years during February (6% lower), and in below normal years in March (6% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flows in Clear Creek during the April through August adult spring-run Chinook salmon upstream migration period under A2A_LLT would generally be similar to or greater than flows under NAA with exceptions in critical water years during June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Water temperatures were not modeled in Clear Creek.

Feather River

Flows in the Feather River at the confluence with the Sacramento River were examined during the November through May juvenile Chinook salmon spring-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would be similar to or greater than flows under NAA in all months and water years except during November in above normal years (8% lower).

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the November through May juvenile spring-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

Flows in the Feather River at the confluence with the Sacramento River were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT during April through June would be similar to or greater than flows under NAA. Flows under A2A_LLT during July and August would generally be lower than flows under NAA by up to 44%.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

Through-Delta

The effects of Alternative 2A on through-Delta migration were evaluated using the approach described in Alternative 1A, Impact AQUA-42.

Juveniles

Flows under Alternative 2A would generally decrease up to 25% depending on month downstream of the north Delta facilities compared to baseline conditions (NAA). The intake structures would replace aquatic habitat and likely attract piscivorous fish around the intake structures. As described for Alternative 1A, the five NDD intakes would remove or modify habitat along that portion of the migration corridor (22 acres aquatic habitat and 11,900 linear feet of shoreline). Potential predation losses at the north Delta intakes, as estimated by the bioenergetics model with median density of predators (119 striped bass per 1,000 feet of intake), would be less than 2% compared to the annual production estimated for the Sacramento Valley (Table 11-1A-17). A conservative assumption of 5% loss per intake would yield a cumulative loss of 19.2% of juvenile spring-run Chinook that reach the north Delta. This assumption is uncertain and represents an upper bound estimate.

Through-Delta survival to Chipps Island (DPM) by emigrating juvenile spring-run Chinook salmon under Alternative 2A would average 29% across all years, 24% in drier years, and 38% in wetter years (Table 11-2A-31). Compared to NAA, juvenile survival would decrease slightly, 1.4% lower across all years (a 5% relative decrease) and 2.7% lower (7% relative decrease) in wetter years.

Table 11-2A-31. Through-Delta Survival (%) of Emigrating Juvenile Spring-Run Chinook Salmon under Alternative 2A

	Percentage Survival			Difference in Percentage Survival (Relative Difference)	
Year Type	EXISTING CONDITIONS	NAA	A2A_LLT	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wetter Years	42.1	40.4	37.8	-4.4 (-10%)	-2.7 (-7%)
Drier Years	24.8	24.3	23.7	-1.1 (-4%)	-0.6 (-3%)
All Years	31.3	30.3	29.0	-2.3 (-7%)	-1.4 (-5%)

Note: Delta Passage Model results for survival to Chipps Island.
Wetter = Wet and above normal water years (6 years).
Drier = Below normal, dry and critical water years (10 years).

Adults

When climate change effects are accounted for (NAA), during the overall spring-run upstream migration from March-June the proportion of Sacramento River water would decrease 6% to 10% compared to NAA (Table 11-2A-17). Although Sacramento River attraction flows would be reduced during these months relative to Existing Conditions, the Sacramento River would still represent 59% to 67% of Delta flows. For a discussion of the topic see the analysis for Alternative 1A. Overall the impact on adult winter-run salmon upstream migration would be less than significant. No mitigation would be required.

NEPA Effects: Overall, the results indicate that the effect of Alternative 2A is adverse due to the cumulative effects associated with five north Delta intake facilities, including mortality related to near-field effects (e.g. impingement and predation) and far-field effects (reduced survival due to reduced flows downstream of the intakes) associated with the five NDD intakes.

Upstream of the Delta migration conditions for spring-run Chinook salmon under Alternative 2A would not be adverse because flow and temperature conditions would generally be similar to those under the NEPA baseline.

Adult attraction flows under Alternative 2A would be lower than those under NAA, but adult attraction flows are expected to be adequate to provide olfactory cues for migrating adults.

Near-field effects of Alternative 2A NDD on spring-run Chinook salmon related to impingement and predation associated with five new intakes could result in substantial effects on juvenile migrating spring-run Chinook salmon, although there is high uncertainty regarding the potential effects. Estimates within the effects analysis range from very low levels of effects (<1% mortality) to very significant effects (~ 19% mortality above current baseline levels). CM15 would be implemented with the intent of providing localized and temporary reductions in predation pressure at the NDD. Additionally, several pre-construction surveys to better understand how to minimize losses associated with the five new intake structures will be implemented as part of the final NDD screen design effort. Alternative 2A also includes an Adaptive Management Program and Real-Time Operational Decision-Making Process to evaluate and make limited adjustments intended to provide adequate migration conditions for spring-run Chinook salmon. However, at this time, due to the absence of comparable facilities anywhere in the lower Sacramento River/Delta, the degree of mortality expected from near-field effects at the NDD remains highly uncertain.

Two recent studies (Newman 2003 and Perry 2010) indicate that far-field effects associated with the new intakes could cause a reduction in smolt survival in the Sacramento River downstream of the NDD intakes due to reduced flows in this area. The analyses of other elements of Alternative 2A predict improvements in smolt condition and survival associated with increased access to the Yolo Bypass, reduced interior Delta entry, and reduced south Delta entrainment. The overall magnitude of each of these factors and how they might interact and/or offset each other in affecting salmonid survival through the plan area is uncertain, and remains an area of active investigation for the BDCP.

The DPM is a flow-based model being developed for BDCP which attempts to combine the effects of all of these elements of BDCP operations and conservation measures to predict smolt migration survival throughout the entire Plan Area. The current draft of this model predicts that smolt migration survival under Alternative 2A would be similar to survival rates estimated for NAA. Further refinement and testing of the DPM, along with several ongoing and planned studies related to salmonid survival at and downstream of the NDD are expected to be completed in the foreseeable future. These efforts are expected to improve our understanding of the relationships and interactions among the various factors affecting salmonid survival, and reduce the uncertainty around the potential effects of BDCP implementation on migration conditions for Chinook salmon. Until these efforts are completed and their results are fully analyzed, the overall effect of Alternative 2A on spring-run Chinook salmon through-Delta survival remains uncertain.

Therefore, primarily as a result of reduced upstream migration habitat conditions for spring-run Chinook salmon due to unacceptable levels of uncertainty regarding the cumulative impacts of near-field and far-field effects associated with the presence and operation of the five intakes on spring-run Chinook salmon, this effect is adverse. While implementation of the conservation and mitigation measures listed below would address these impacts, these are not anticipated to reduce the impacts to a level considered not adverse.

CEQA Conclusion:

Upstream of the Delta

In general, Alternative 2A would affect migration conditions for spring-run Chinook salmon relative to the Existing Conditions.

Sacramento River

Flows in the Sacramento River upstream of Red Bluff during December through May juvenile spring-run Chinook salmon migration period under A2A_LLT would generally be similar to or greater than flows under Existing Conditions except during December in wet water years (8% decrease), during March in below normal water years (10% decrease), and during May in wet water years (15% decrease) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the December through May juvenile Chinook salmon spring-run emigration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 2A in any month or water year type throughout the period

Flows in the Sacramento River upstream of Red Bluff during the April through August adult spring-run Chinook salmon upstream migration period under A2A_LLT would generally be similar to or greater than Existing Conditions except during May in wet years (15% decrease), July in critical years (13% decrease), and August in wet (7% decrease), dry (11% decrease) and critical (24% decrease) water years.

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 2A during April through June. Mean monthly water temperatures under Alternative 2A would be higher in dry and critical years during July (6% and 9% higher, respectively), and up to 12% greater relative to Existing Conditions during August.

Clear Creek

Flows in Clear Creek during the November through May juvenile Chinook salmon spring-run migration period under A2A_LLT would generally be similar to or greater than flows under Existing Conditions except in critical years during November (6% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flows in Clear Creek during the April through August adult spring-run Chinook salmon upstream migration period under A2A_LLT would generally be similar to or greater than flows under Existing Conditions with exceptions during August of critical water years (17% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Water temperatures were not modeled in Clear Creek.

Feather River

Flows were examined for the Feather River at the confluence with the Sacramento River during the November through May juvenile Chinook salmon spring-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows during November and December under A2A_LLT would generally be lower than flows under Existing Conditions by up to 31%. Flows during January through May would generally be similar to or greater than flows under Existing Conditions, with few exceptions.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the November through May juvenile spring-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Water temperatures under Alterative 2A would be 5% to 6% greater than those under Existing Conditions in November and December, but similar during January through May.

Flows were examined for the Feather River at the confluence with the Sacramento River during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows during April through June under A2A_LLT would generally be similar to or greater than flows under Existing Conditions with exceptions during which flows would be up to 24% lower. Flows during July and August under A2A_LLT would generally be lower by up to 53% than flows under Existing Conditions.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation*

Temperature Model Results utilized in the Fish Analysis). Water temperatures under Alternative 2A would be 5% to 8% higher than those under Existing Conditions during July and August, and similar during April through June.

Through-Delta

Through Delta survival by emigrating juvenile spring-run Chinook salmon would decrease 2.3% (7% relative decrease) under Alternative 2A across all years compared to Existing Conditions (Table 11-2A-31). Losses due to predation at the five north Delta intakes could hypothetically range from less than 2% up to 19.2% of juvenile spring-run Chinook that reach the north Delta, as calculated for Impact AQUA-60 for Alternative 1A.

Attraction flow, as estimated by the percentage of Sacramento River water at Collinsville, declined 10% to 12% during the April and May migration period for spring-run adults under Alternative 2A compared to Existing Conditions (Table 11-2A-17). The reductions in percentage are small in comparison with the magnitude of change in dilution reported to cause a significant change in migration by Fretwell (1989) and, therefore, are not expected to significantly impact adult migration. Sacramento River attraction flows would still represent 59% to 67% of Delta flows. However, uncertainty remains with regard to adult salmon behavioral response to anticipated changes in lower Sacramento River flow percentages. This topic is discussed further in Impact AQUA-42 in Alternative 1A.

Summary of CEQA Conclusion

Migration conditions throughout most of the Plan Area would generally decline for emigrating juvenile spring-run Chinook salmon. Through Delta survival would be reduced under Alternative 2A. Attraction flows would be slightly lower compared to Existing Conditions during the adult migration period. Potential predation losses would increase at the five intake structures, ranging hypothetically from 2% to 19.2% of juveniles that reach the Delta. This impact is significant.

Upstream of the Delta, the results indicate that the effect would be less than significant because it would not substantially reduce the suitability of migration habitat or interfere with the movement of fish. Flows in the Sacramento River and Clear Creek and water temperatures in the Sacramento and Feather Rivers would generally not be affected by Alternative 2A. Flows would be lower in 2 months of the 7-month juvenile migration period and in 2 months of the 5-month adult migration period, although there would be no other flow reductions in the Feather River.

With respect to the NDD intakes, implementation of CM6 and CM15 and Mitigation Measures AQUA-60a through AQUA-60c would address these impacts, but are not anticipated to reduce them to a level considered less than significant. Although implementation of *CM6 Channel Margin Enhancement* would provide habitat similar to that which would be lost, it would not necessarily be located near the intakes and therefore would not fully compensate for the lost habitat. Additionally, implementation of this measure would not fully address predation losses. *CM15 Localized Reduction of Predatory Fishes (Predator Control)* has substantial uncertainties associated with its effectiveness such that it is considered to have no demonstrable effect. Conservation measures that address habitat and predation losses, therefore, would potentially minimize impacts to some extent but not to a less than significant level. Consequently, as a result of these changes in migration conditions, this impact is significant and unavoidable.

Applicable conservation measures are briefly described below and full descriptions are found in Chapter 3, Section 3.6.2.5 Channel Margin Enhancement (CM6) and Section 3.6.3.4 Localized Reduction of Predatory Fishes (Predator Control) (CM15).

CM6 Channel Margin Enhancement. CM6 would entail restoration of 20 linear miles of channel margin by improving channel geometry and restoring riparian, marsh, and mudflat habitats on the waterside side of levees along channels that provide rearing and outmigration habitat for juvenile salmonids. Linear miles of enhancement would be measured along one side or the other of a given channel segment (e.g., if both sides of a channel are enhanced for a length of 1 mile, this would account for a total of 2 miles of channel margin enhancement). At least 10 linear miles would be enhanced by year 10 of Plan implementation; enhancement would then be phased in 5-mile increments at years 20 and 30, for a total of 20 miles at year 30. Channel margin enhancement would be performed only along channels that provide rearing and outmigration habitat for juvenile salmonids. These include channels that are protected by federal project levees—including the Sacramento River between Freeport and Walnut Grove among several others.

CM15 Localized Reduction of Predatory Fishes (Predator Control). CM15 would seek to reduce populations of predatory fishes at specific locations or modify holding habitat at selected locations of high predation risk (i.e., predation "hotspots"). This conservation measure seeks to benefit covered salmonids by reducing mortality rates of juvenile migratory life stages that are particularly vulnerable to predatory fishes. Predators are a natural part of the Delta ecosystem. Therefore, this conservation measure is not intended to entirely remove predators at any location, or substantially alter the abundance of predators at the scale of the Delta system. This conservation measure would also not remove piscivorous birds. Because of uncertainties regarding treatment methods and efficacy, implementation of CM15 would involve discrete pilot projects and research actions coupled with an adaptive management and monitoring program to evaluate effectiveness. Effects would be temporary, as new individuals would be expected to occupy vacated areas; therefore, removal activities would need to be continuous during periods of concern. CM15 also recognizes that the NDD intakes would create new predation hotspots.

In addition to the conservation measures, the mitigation measures identified below would provide an adaptive management process, that may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6), for assessing impacts and developing appropriate minimization measures. However, this would not necessarily result in a less than significant determination.

Mitigation Measure AQUA-60a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Spring-Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Migration Conditions

Please refer to Mitigation Measure AQUA-60a under Alternative 1A (Impact AQUA-60) for spring-run Chinook salmon.

Mitigation Measure AQUA-60b: Conduct Additional Evaluation and Modeling of Impacts on Spring-Run Chinook Salmon Migration Conditions Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-60b under Alternative 1A (Impact AQUA-60) for spring-run Chinook salmon.

Mitigation Measure AQUA-60c: Consult with USFWS, and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Spring-Run Chinook Salmon Migration Conditions Consistent with CM1

Please refer to Mitigation Measure AQUA-60c under Alternative 1A (Impact AQUA-60) for spring-run Chinook salmon.

Restoration and Conservation Measures

Alternative 2A has the same restoration and conservation measures as Alternative 1A. Because no substantial differences in fish effects are anticipated anywhere in the affected environment under Alternative 2A compared to those described in detail for Alternative 1A, the effects described for spring-run Chinook salmon under Alternative 1A (Impact AQUA-61 through AQUA-72) also appropriately characterize effects under Alternative 2A.

The following impacts are those presented under Alternative 1A that are identical for Alternative 2A.

Impact AQUA-61: Effects of Construction of Restoration Measures on Chinook Salmon (Spring-Run ESU)

Impact AQUA-62: Effects of Contaminants Associated with Restoration Measures on Chinook Salmon (Spring-Run ESU)

Impact AQUA-63: Effects of Restored Habitat Conditions on Chinook Salmon (Spring-Run ESU)

Impact AQUA-64: Effects of Methylmercury Management on Chinook Salmon (Spring-Run ESU) (CM12)

Impact AQUA-65: Effects of Invasive Aquatic Vegetation Management on Chinook Salmon (Spring-Run ESU) (CM13)

Impact AQUA-66: Effects of Dissolved Oxygen Level Management on Chinook Salmon (Spring-Run ESU) (CM14)

Impact AQUA-67: Effects of Localized Reduction of Predatory Fish on Chinook Salmon (Spring-Run ESU) (CM15)

Impact AQUA-68: Effects of Nonphysical Fish Barriers on Chinook Salmon (Spring-Run ESU) (CM16)

Impact AQUA-69: Effects of Illegal Harvest Reduction on Chinook Salmon (Spring-Run ESU) (CM17)

Impact AQUA-70: Effects of Conservation Hatcheries on Chinook Salmon (Spring-Run ESU) (CM18)

Impact AQUA-71: Effects of Urban Stormwater Treatment on Chinook Salmon (Spring-Run ESU) (CM19)

Impact AQUA-72: Effects of Removal/Relocation of Nonproject Diversions on Chinook Salmon (Spring-Run ESU) (CM21)

NEPA Effects: These impact mechanisms have been determined to range from no effect, to no adverse effect, or beneficial effects on spring-run Chinook salmon for NEPA purposes, for the reasons identified for Alternative 1A. Specifically for AQUA-62, the effects of contaminants on spring-run Chinook salmon with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on spring-run Chinook salmon are uncertain.

CEQA Conclusion: These impact mechanisms would be considered to range from no impact, to less than significant, or beneficial on spring-run Chinook salmon, for the reasons identified for Alternative 1A, and no mitigation is required.

Fall-/Late Fall–Run Chinook Salmon

Construction and Maintenance of CM1

The construction- and maintenance-related effects of Alternative 2A would be identical for all four Chinook salmon ESUs. Accordingly, for a discussion of the impacts listed below, please refer to the discussion of these effects for winter-run Chinook (Impact AQUA-43 and Impact AQUA-44).

Impact AQUA-73: Effects of Construction of Water Conveyance Facilities on Chinook Salmon (Fall-/Late Fall–Run ESU)

The potential effects of construction of the water conveyance facilities on fall-/late fall–run Chinook salmon would be similar to those described for Alternative 1A (Impact AQUA-73) except that Alternative 2A could potentially include two different intakes than under Alternative 1A. This would convert about 11,350 lineal feet of existing shoreline habitat into intake facility structures and would require about 26 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. The effects related to temporary increases in turbidity, accidental spills, underwater noise, in-water work activities, and disturbance of contaminated sediments would be similar to Alternative 1A and the same environmental commitments and mitigation measures (described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*) would be available to avoid and minimize potential effects.

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-73, environmental commitments and mitigation measures would be available to avoid and minimize potential effects, and the effect would not be adverse for fall-/late fall–run Chinook salmon.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-73, the impact of construction of the water conveyance facilities on fall-/late fall–run Chinook salmon would not be significant except for construction noise associated with pile driving. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in the discussion of Alternative 1A.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in the discussion of Alternative 1A.

Impact AQUA-74: Effects of Maintenance of Water Conveyance Facilities on Chinook Salmon (Fall-/Late Fall–Run ESU)

The construction-related effects of Alternative 2A would be identical for all four Chinook salmon ESUs. Accordingly, for a discussion of the impacts listed below, please refer to the discussion of these effects for winter-run Chinook (Alternative 2A, Impact AQUA-38).

Water Operations of CM1

Impact AQUA-75: Effects of Water Operations on Entrainment of Chinook Salmon (Fall-/Late Fall–Run ESU)

Water Exports from SWP/CVP South Delta Facilities

Alternative 2A (A2A_LLT) would decrease entrainment of fall-run Chinook salmon by approximately 58% and late fall–run Chinook salmon by approximately 41% compared to NAA (Table 11-2A-32). Entrainment reductions under Alternative 2A would be greater in wetter years, ranging from a 8% decrease in dry years up to 84% decrease compared to Existing Conditions.

Table 11-2A-32. Juvenile Chinook Salmon Annual Entrainment Index at the SWP and CVP Salvage Facilities—Differences between Model Scenarios for Alternative 2A

	Absolute Difference (Percent Difference)[a]	
Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Fall-Run Chinook Salmon		
Wet	-107,545 (-84%)	-112,297 (-84%)
Above Normal	-22,439 (-67%)	-21,191 (-66%)
Below Normal	-5,003 (-36%)	-4,247 (-32%)
Dry	-3,371 (-16%)	-1,612 (-8%)
Critical	-7,610 (-21%)	-10,686 (-28%)
All Years	-31,474 (-57%)	-31,940 (-58%)
Late Fall–Run Chinook Salmon		
Wet	-3,829 (-65%)	-4,006 (-66%)
Above Normal	-307 (-55%)	-315 (-55%)
Below Normal	-22 (-41%)	-26 (-46%)
Dry	-26 (-22%)	-37 (-28%)
Critical	-37 (-25%)	-50 (-31%)
All Years	-692 (-37%)	-811 (-41%)
	Shading indicates 10% or greater increased entrainment.	

[a] Estimated annual number of fish lost, based on normalized data.

For juvenile late fall-run Chinook salmon, entrainment under Alternative 2A would decrease by 41% compared to NAA averaged across all years (Table 11-2A-32). Entrainment reductions would be substantially greater in wetter years, ranging from approximately 28% decrease in dry years to 66% decrease in wet years compared to Existing Conditions.

The proportion of the annual juvenile population (assumed to be 23 million fall-run juveniles and 1 million late fall–run juveniles) lost at the south Delta facilities is very low under baseline conditions (<0.25% for both runs), and would be reduced under Alternative 2A.

Water Exports from SWP/CVP North Delta Intake Facilities

Impacts from the proposed north Delta intake facilities for fall-/late fall–run Chinook salmon, such as impingement and predation exposure risks, would be expected to be similar to those described above for winter-run Chinook salmon. Impacts would also be the same as described for Alternative 1A. State-of-the-art fish screens would be expected to eliminate entrainment risk for juvenile fall-/late fall–run Chinook salmon to these intakes.

Water Exports with a Dual Conveyance for the SWP North Bay Aqueduct

The effects would be the same as described for Impact AQUA-39 under Alternative 1A. Entrainment and impingement effects on fall-/late fall–run Chinook salmon would be minimal for Alternative 2A because intakes would have state-of-the-art screens installed.

NEPA Effects: Under Alternative 2A potential entrainment of juvenile Chinook salmon of all races (winter, spring, fall and late fall–run) would be similar or reduced compared to baseline at the SWP/CVP south delta facilities and the NBA. Entrainment of Chinook salmon at the proposed SWP/CVP north Delta intakes would not be expected to occur due to the state-of-the-art fish screens; there would be a potential for impingement, but this risk would be minimized due to the design and operation of the facilities. Therefore the effect on fall-/late fall–run Chinook salmon entrainment from Alternative 2A would not be adverse.

CEQA Conclusion: As described above, entrainment of juvenile Chinook salmon of all races (winter, spring, fall and late fall–run) would be similar or reduced compared to baseline at the SWP/CVP south delta facilities, agricultural diversions, and the NBA. Entrainment of Chinook salmon at the proposed SWP/CVP north delta intakes would not be expected to occur due to the state-of-the-art fish screens; there would be a potential for impingement, but this risk would be minimized due to the design and operation of the facilities. Overall, impacts of water operations on entrainment of juvenile Chinook salmon (fall-/late fall–run ESU) would be beneficial due to a general reduction in entrainment and no mitigation would be required.

Impact AQUA-76: Effects of Water Operations on Spawning and Egg Incubation Habitat for Chinook Salmon (Fall-/Late Fall–Run ESU)

In general, Alternative 2A would not affect spawning and egg incubation habitat for fall-/late fall–run Chinook salmon relative to NAA.

Sacramento River

Fall-Run

Sacramento River flows upstream of Red Bluff were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would be greater than or similar to flows under NAA in October, December, and January. Flows under A2A_LLT would generally be greater than or similar to NAA during October, December, and January, except in below normal years during October. During November, flows under A2A_LLT would be 5% to 17% lower than under NAA depending on water year type.

Shasta Reservoir storage at the end of September would affect flows during the fall-run spawning and egg incubation period. As reported in Impact AQUA-58 for spring-run Chinook salmon, end of September Shasta Reservoir storage would be similar to or greater than storage under NAA in all water year types (Table 11-2A-19).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

The number of days at Red Bluff on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month during October through April and year of the 82-year modeling period (Table 11-2A-10). The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern" as defined in Table 11-2A-11. Differences between baselines and Alternative 2A in the highest level of concern across all months and all 82 modeled years are presented in Table 11-2A-20. There would be 1 (2%) and 4 (24%) more years with "red" and "orange" level of concern under Alternative 2A. There would be 5 (71%) fewer years with a "yellow" level of concern under Alternative 2A.

Total degree-days exceeding 56°F were summed by month and water year type at Red Bluff during October through April. Total degree-days under Alternative 2A would be 6% higher than those under NAA during October, 8% higher during November, 9% higher during March, 5% lower during April, and similar during remaining months (Table 11-2A-21).

The Reclamation egg mortality model predicts that fall-run Chinook salmon egg mortality in the Sacramento River under A2A_LLT would be lower than or similar to mortality under NAA in all water year types including below normal years (up to 10% greater relative to NAA, but absolute increase of 2% of fall-run population) (Table 11-2A-33).

Table 11-2A-33. Difference and Percent Difference in Percent Mortality of Fall-Run Chinook Salmon Eggs in the Sacramento River (Egg Mortality Model)

Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wet	11 (110%)	1 (6%)
Above Normal	12 (109%)	1 (4%)
Below Normal	13 (126%)	2 (10%)
Dry	17 (120%)	1 (2%)
Critical	9 (31%)	-0.5 (-1%)
All	13 (90%)	1 (4%)

SacEFT predicts that there would be a 46% increase in the percentage of years with good spawning availability for fall-run Chinook salmon, measured as weighted usable area, under A2A_LLT relative to NAA (Table 11-2A-34). SacEFT predicts that there would be a 12% reduction in the percentage of years with good (lower) redd scour risk under A2A_LLT relative to NAA. SacEFT predicts that there would be no difference between A2A_LLT and NAA. SacEFT predicts that there would be a 19% increase in the percentage of years with good (lower) redd dewatering risk under A2A_LLT relative to NAA.

Table 11-2A-34. Difference and Percent Difference in Percentage of Years with "Good" Conditions for Fall-Run Chinook Salmon Habitat Metrics in the Upper Sacramento River (from SacEFT)

Metric	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Spawning WUA	3 (6%)	16 (46%)
Redd Scour Risk	-3 (-5%)	-8 (-12%)
Egg Incubation	-25 (-27%)	0 (0%)
Redd Dewatering Risk	5 (19%)	5 (19%)
Juvenile Rearing WUA	5 (15%)	-2 (-5%)
Juvenile Stranding Risk	-9 (-29%)	2 (10%)

WUA = Weighted Usable Area.

Late Fall-Run

Sacramento River flows upstream of Red Bluff were examined for the February through May late fall–run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would be greater than or similar to flows under NAA throughout the period.

Shasta Reservoir storage at the end of September would affect flows during the late fall–run spawning and egg incubation period. As reported in Impact AQUA-58 for spring-run Chinook salmon, end of September Shasta Reservoir storage would be similar to or greater than storage under NAA in all water year types (Table 11-2A-19).

The Reclamation egg mortality model predicts that late fall-run Chinook salmon egg mortality in the Sacramento River under A2A_LLT would be similar to mortality under NAA in all water years, including below normal water years in which, although there would be an 11% relative increase, the absolute increase would be 1% of the late fall-run population (Table 11-2A-35).

Table 11-2A-35. Difference and Percent Difference in Percent Mortality of Late Fall–Run Chinook Salmon Eggs in the Sacramento River (Egg Mortality Model)

Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wet	4 (182%)	-1 (-9%)
Above Normal	4 (151%)	-1 (-13%)
Below Normal	5 (313%)	1 (11%)
Dry	4 (163%)	-0.5 (-6%)
Critical	3 (148%)	0.1 (1%)
All	4 (183%)	-0.3 (-5%)

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the February through May late fall–run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

The number of days at Red Bluff on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month during October through April and year of the 82-year modeling period (Table 11-2A-10). The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern" as defined in Table 11-2A-11. Differences between baselines and Alternative 2A in the highest level of concern across all months and all 82 modeled years are presented in Table 11-2A-20. There would be 1 (2%) and 4 (24%) more years with "red" and "orange" level of concern under Alternative 2A. There would be 5 (71%) fewer years with a "yellow" level of concern under Alternative 2A. The level of concern in these years would be reduced to an "none" (from "yellow") level.

Total degree-days exceeding 56°F were summed by month and water year type at Red Bluff during October through April. Total degree-days under Alternative 2A would be 6% higher than those under NAA during October, 8% higher during November, 9% higher during March, 5% lower during April, and similar during remaining months (Table 11-2A-21).

SacEFT predicts that there would be a 4% decrease in the percentage of years with good spawning availability for late fall–run Chinook salmon, measured as weighted usable area, under A2A_LLT relative to NAA (Table 11-2A-36). SacEFT predicts that there would be a negligible (<5%) difference in the percentage of years with good (lower) egg incubation conditions and redd dewatering risk between A2A_LLT and NAA.

Table 11-2A-36. Difference and Percent Difference in Percentage of Years with "Good" Conditions for Late Fall–Run Chinook Salmon Habitat Metrics in the Upper Sacramento River (from SacEFT)

Metric	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Spawning WUA	-6 (-12%)	-2 (-4%)
Redd Scour Risk	-6 (-7%)	0 (0%)
Egg Incubation	0 (0%)	0 (0%)
Redd Dewatering Risk	-3 (-5%)	2 (4%)
Juvenile Rearing WUA	-5 (-11%)	-23 (-37%)
Juvenile Stranding Risk	-27 (-38%)	-1 (-2%)

WUA = Weighted Usable Area.

Clear Creek

No water temperature modeling was conducted in Clear Creek.

Fall-Run

Clear Creek flows below Whiskeytown Reservoir were examined for the September through February fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would be similar to or greater than flows under NAA in all water year types.

The potential risk of redd dewatering in Clear Creek was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in September when spawning is assumed to occur. The greatest monthly reduction in Clear Creek flows during September through February under A2A_LLT would be similar to or lower magnitude than the reduction under NAA for all water year types (Table 11-2A-37).

Table 11-2A-37. Difference and Percent Difference in Greatest Monthly Reduction (Percent Change) in Instream Flow in Clear Creek below Whiskeytown Reservoir during the September through February Spawning and Egg Incubation Period[a]

Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wet	0 (NA)	0 (NA)
Above Normal	-27 (NA)	0 (0%)
Below Normal	53 (100%)	0 (NA)
Dry	-67 (NA)	0 (0%)
Critical	-33 (-50%)	0 (0%)

NA = could not be calculated because the denominator was 0.

[a] Redd dewatering risk not applicable for months when flows during the egg incubation period were at or greater than flows in September, when spawning is assumed to occur. A negative value indicates that the greatest monthly reduction would be of greater magnitude (worse) under the alternative than under the baseline.

Feather River

Fall-Run

Flows in the Feather River in the low flow and high flow channels were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in the low-flow channel under A2A_LLT would be identical to those under NAA. Flows in the high-flow channel under A2A_LLT generally be similar to or greater than those under NAA, except in above normal years during November and December and in wet an critical years during January (7% to 12% lower).

The potential risk of redd dewatering in the Feather River low-flow channel was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in October when spawning is assumed to occur. Minimum flows in the low-flow channel during November through January were identical between A2A_LLT and NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Therefore, there would be no effect of Alternative 2A on redd dewatering in the Feather River low-flow channel.

Mean monthly water temperatures in the Feather River above Thermalito Afterbay (low-flow channel) and below Thermalito Afterbay (high-flow channel) were examined during the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period at either location.

The percent of months exceeding the 56°F temperature threshold in the Feather River at Gridley was evaluated during October through April (Table 11-2A-38). The percent of months exceeding the threshold under Alternative 2A would similar to or up to 40% lower (absolute scale for greater than 2.0 through greater than 5.0 degrees C above the threshold) than the percent under NAA.

Table 11-2A-38. Differences between Baseline and Alternative 2A Scenarios in Percent of Months during the 82-Year CALSIM Modeling Period during Which Water Temperatures in the Feather River at Gridley Exceed the 56°F Threshold, October through April

	Degrees Above Threshold				
Month	>1.0	>2.0	>3.0	>4.0	>5.0
EXISTING CONDITIONS vs. A2A_LLT					
October	2 (3%)	14 (16%)	25 (34%)	43 (106%)	52 (280%)
November	49 (1,333%)	31 (2,500%)	21 (NA)	11 (NA)	5 (NA)
December	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	1 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
March	27 (367%)	17 (467%)	6 (500%)	6 (NA)	2 (NA)
April	12 (18%)	17 (30%)	35 (112%)	33 (193%)	21 (189%)
NAA vs. A2A_LLT					
October	0 (0%)	0 (0%)	1 (1%)	-5 (-6%)	-7 (-10%)
November	-9 (-14%)	-9 (-21%)	-11 (-35%)	-7 (-40%)	-1 (-20%)
December	-1 (-100%)	-1 (-100%)	0 (NA)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	-2 (-67%)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
March	-10 (-22%)	-7 (-26%)	-4 (-33%)	-1 (-17%)	-1 (-33%)
April	-7 (-8%)	-6 (-8%)	-7 (-10%)	-9 (-15%)	-6 (-16%)

NA = could not be calculated because the denominator was 0.

Total degree-months exceeding 56°F were summed by month and water year type at Gridley during October through April (Table 11-2A-39). Total degree-months would be similar between NAA and Alternative 2A for all months except December, in which degree-months 50% lower under Alternative 2A and February in which degree-months would be 33% higher.

Table 11-2A-39. Differences between Baseline and Alternative 2A Scenarios in Total Degree-Months (°F-Months) by Month and Water Year Type for Water Temperature Exceedances above 56°F in the Feather River at Gridley, October through April

Month	Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
October	Wet	99 (136%)	-3 (-2%)
	Above Normal	33 (75%)	-3 (-4%)
	Below Normal	49 (89%)	0 (0%)
	Dry	73 (138%)	2 (2%)
	Critical	41 (100%)	-3 (-4%)
	All	295 (111%)	-7 (-1%)
November	Wet	37 (NA)	0 (0%)
	Above Normal	19 (950%)	0 (0%)
	Below Normal	19 (1,900%)	-2 (-9%)
	Dry	26 (NA)	-5 (-16%)
	Critical	19 (1,900%)	1 (5%)
	All	120 (3,000%)	-6 (-5%)
December	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	1 (NA)	-1 (-50%)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	1 (NA)	-1 (-50%)
January	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
February	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	2 (NA)	1 (100%)
	Dry	1 (NA)	1 (NA)
	Critical	2 (NA)	0 (0%)
	All	4 (NA)	1 (33%)
March	Wet	5 (NA)	0 (0%)
	Above Normal	2 (200%)	0 (0%)
	Below Normal	19 (1,900%)	-2 (-9%)
	Dry	23 (575%)	0 (0%)
	Critical	18 (450%)	1 (5%)
	All	67 (670%)	-1 (-1%)
April	Wet	37 (264%)	-1 (-2%)
	Above Normal	26 (113%)	-1 (-2%)
	Below Normal	22 (55%)	-3 (-5%)
	Dry	38 (78%)	-3 (-3%)
	Critical	31 (107%)	0 (0%)
	All	153 (99%)	-9 (-3%)

NA = could not be calculated because the denominator was 0.

The Reclamation egg mortality model predicts that fall-run Chinook salmon egg mortality in the Feather River under A2A_LLT would be similar to or lower than mortality under NAA in all water years, including critical water years in which, although there would be a 10% relative increase, the absolute increase would be 3% of the late fall-run population (Table 11-2A-40).

Table 11-2A-40. Difference and Percent Difference in Percent Mortality of Fall-Run Chinook Salmon Eggs in the Feather River (Egg Mortality Model)

Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wet	17 (1,253%)	-2 (-8%)
Above Normal	14 (1,210%)	1 (10%)
Below Normal	14 (768%)	1 (4%)
Dry	19 (843%)	-0.2 (-1%)
Critical	20 (418%)	-3 (-10%)
All	17 (800%)	-1 (-4%)

American River

Fall-Run

Flows in the American River at the confluence with the Sacramento River were examined during the October through January fall-run spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would generally be similar to or greater than flows under NAA, except for wet and above normal water years during October (7% and 10% lower, respectively) and critical water years during November (9% lower).

Mean monthly water temperatures in the American River at the Watt Avenue Bridge were examined during the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

The percent of months exceeding the 56°F temperature threshold in the American River at the Watt Avenue Bridge was evaluated during November through April (Table 11-2A-41). The percent of months exceeding the threshold under Alternative 2A would similar to or up to 11% lower (absolute scale) than the percent under NAA.

Table 11-2A-41. Differences between Baseline and Alternative 2A Scenarios in Percent of Months during the 82-Year CALSIM Modeling Period during Which Water Temperatures in the American River at the Watt Avenue Bridge Exceed the 56°F Threshold, November through April

	Degrees Above Threshold				
Month	>1.0	>2.0	>3.0	>4.0	>5.0
EXISTING CONDITIONS vs. A2A_LLT					
November	43 (95%)	48 (177%)	52 (382%)	43 (1,750%)	32 (2,600%)
December	1 (NA)	1 (NA)	0 (NA)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	1 (NA)	1 (NA)	0 (NA)	0 (NA)	0 (NA)
March	27 (220%)	16 (217%)	11 (450%)	10 (800%)	5 (NA)
April	25 (35%)	25 (40%)	27 (59%)	31 (96%)	25 (91%)
NAA vs. A2A_LLT					
November	-4 (-4%)	-10 (-12%)	-9 (-12%)	-11 (-20%)	-7 (-18%)
December	0 (0%)	0 (0%)	0 (NA)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	-2 (-67%)	0 (0%)	0 (NA)	0 (NA)	0 (NA)
March	-10 (-20%)	-9 (-27%)	-2 (-15%)	-1 (-10%)	0 (0%)
April	-1 (-1%)	-6 (-7%)	-7 (-9%)	-9 (-12%)	-5 (-9%)

NA = could not be calculated because the denominator was 0.

Total degree-months exceeding 56°F were summed by month and water year type at the Watt Avenue Bridge during November through April (Table 11-2A-42). Total degree-months would be similar between NAA and Alternative 2A for all months.

Table 11-2A-42. Differences between Baseline and Alternative 2A Scenarios in Total Degree-Months (°F-Months) by Month and Water Year Type for Water Temperature Exceedances above 56°F in the American River at the Watt Avenue Bridge, November through April

Month	Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
November	Wet	76 (304%)	-6 (-6%)
	Above Normal	33 (300%)	-3 (-6%)
	Below Normal	44 (550%)	1 (2%)
	Dry	47 (362%)	-4 (-6%)
	Critical	36 (225%)	-2 (-4%)
	All	235 (322%)	-15 (-5%)
December	Wet	1 (NA)	1 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	2 (NA)	0 (0%)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	3 (NA)	1 (50%)
January	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
February	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	4 (NA)	0 (0%)
	All	4 (NA)	0 (0%)
March	Wet	10 (500%)	-2 (-14%)
	Above Normal	9 (NA)	0 (0%)
	Below Normal	10 (333%)	-1 (-7%)
	Dry	25 (625%)	0 (0%)
	Critical	19 (190%)	-1 (-3%)
	All	74 (389%)	-3 (-3%)
April	Wet	57 (204%)	-1 (-1%)
	Above Normal	33 (150%)	-1 (-2%)
	Below Normal	39 (108%)	-2 (-3%)
	Dry	41 (54%)	-4 (-3%)
	Critical	36 (61%)	1 (1%)
	All	207 (94%)	-6 (-1%)

NA = could not be calculated because the denominator was 0.

The potential risk of redd dewatering in the American River at Nimbus Dam was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in October when spawning is assumed to occur. The greatest monthly reduction in American

River flows during November through January under A2A_LLT be 60% to 65% greater in magnitude than under NAA in below normal, dry, and critical water years and 11% to 30% lower in magnitude than NAA in wet and above normal water years (Table 11-2A-43).

Table 11-2A-43. Difference and Percent Difference in Greatest Monthly Reduction (Percent Change) in Instream Flow in the American River at Nimbus Dam during the October through January Spawning and Egg Incubation Period[a]

Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wet	-20 (-91%)	5 (11%)
Above Normal	2 (7%)	12 (30%)
Below Normal	-58 (-301%)	-30 (-65%)
Dry	-25 (-54%)	-27 (-61%)
Critical	-12 (-24%)	-24 (-60%)

NA = could not be calculated because the denominator was 0.

[a] Redd dewatering risk not applicable for months when flows during the egg incubation period were at or greater than flows in October, when spawning is assumed to occur. A negative value indicates that the greatest monthly reduction would be of greater magnitude (worse) under the alternative than under the baseline.

The Reclamation egg mortality model predicts that fall-run Chinook salmon egg mortality in the American River under A2A_LLT would be similar to mortality under NAA in all water years (Table 11-2A-44).

Table 11-2A-44. Difference and Percent Difference in Percent Mortality of Fall-Run Chinook Salmon Eggs in the American River (Egg Mortality Model)

Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wet	24 (159%)	0.4 (1%)
Above Normal	22 (206%)	-1 (-3%)
Below Normal	22 (175%)	-1 (-2%)
Dry	16 (99%)	0 (0%)
Critical	9 (43%)	-1 (-3%)
All	19 (128%)	-0.2 (-1%)

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would be similar to flows under NAA throughout the period.

Water temperatures throughout the Stanislaus River would be similar under NAA and Alternative 2A throughout the October through January period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

San Joaquin River

Flows in the San Joaquin River at Vernalis were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would be similar to flows under NAA throughout the period.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Flows in the Mokelumne River at the Delta were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would be similar to flows under NAA throughout the period.

Water temperature modeling was not conducted in the Mokelumne River.

NEPA Effects: Collectively, it is concluded that the effect is not adverse because spawning and egg incubation habitat conditions are not substantially reduced. There are no reductions in flows under Alternative 2A or increases in temperatures that would translate into adverse biological effects on fall-/late fall-run Chinook salmon spawning and egg incubation habitat. Further, the Reclamation egg mortality model predicts no effects of Alternative 2A on fall-/late fall-run Chinook salmon spawning and egg incubation habitat in the Sacramento, Feather, and American Rivers and SacEFT predicts generally negligible or beneficial impacts on spawning and egg incubation habitat in the Sacramento River.

CEQA Conclusion: In general, Alternative 2A would not affect spawning and egg incubation habitat for fall-/late fall–run Chinook salmon relative to the Existing Conditions.

Sacramento River

Fall-Run

Flows in the Sacramento River upstream of Red Bluff under A2A_LLT would generally be greater than or similar to Existing Conditions during October, December, and January, except in wet years during December (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). During November, flows under A2_LLT would be 3% to 13% lower than under Existing Conditions depending on water year type.

Storage volume at the end of September would be 7% to 12% lower under A2A_LLT relative to Existing Conditions (Table 11-2A-19).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 2A during the period, except during October, in which temperatures would be 6% higher under Alternative 2A.

The number of days at Red Bluff on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month during October through April and year of the 82-year modeling period (Table 11-2A-10). The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern" as defined in Table 11-2A-11. Differences between baselines and Alternative 2A in the highest level of concern across all months and all 82 modeled years are presented in Table 11-2A-20. There would be 308% and 183% increases in the number of years with "red" and "orange" levels of concern under Alternative 2A relative to Existing Conditions.

Total degree-days exceeding 56°F were summed by month and water year type at Red Bluff during October through April. Total degree-days under Alternative 2A would be 9% to 3838% higher than those under Existing Conditions during October, November, March, and April, and similar during December through February (Table 11-2A-21).

The Reclamation egg mortality model predicts that fall-run Chinook salmon egg mortality in the Sacramento River under A2A_LLT would be 31% to 126% greater than mortality under Existing Conditions, which is a 9% to 17% increase on an absolute scale (Table 11-2A-33).

SacEFT predicts that there would be a 6% increase in the percentage of years with good spawning availability, measured as weighted usable area, under A2A_LLT relative to Existing Conditions (Table 11-2A-34). SacEFT predicts that there would be a 5% reduction in the percentage of years with good (lower) redd scour risk under A2A_LLT relative to Existing Conditions. SacEFT predicts that there would be a 27% decrease in the percentage of years with good (lower) egg incubation conditions under A2A_LLT relative to Existing Conditions. SacEFT predicts that there would be a 35% decrease in the percentage of years with good (lower) redd dewatering risk under A2A_LLT relative to Existing Conditions.

Late Fall–Run

Flows in the Sacramento River upstream of Red Bluff were examined during the February through May late fall–run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would generally be greater than or similar to flows under Existing Conditions, except in below normal years during March (6% lower) and wet years during May (15% lower).

Storage volume at the end of September would be 7% to 12% lower under A2A_LLT relative to Existing Conditions (Table 11-2A-19).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the February through May late fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 2A in any month or water year type throughout the period.

The number of days at Red Bluff on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month during October through April and year of the 82-year modeling period (Table 11-2A-10). The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern" as defined in Table 11-2A-11. Differences between baselines and Alternative 2A in the highest level of concern across all months and all 82 modeled years are presented in Table 11-2A-20. There would be 308% and 183% increases in the number of years with "red" and "orange" levels of concern under Alternative 2A relative to Existing Conditions.

Total degree-days exceeding 56°F were summed by month and water year type at Red Bluff during October through April. Total degree-days under Alternative 2A would be 9% to 3838% higher than those under Existing Conditions during October, November, March, and April, and similar during December through February (Table 11-2A-21).

The Reclamation egg mortality model predicts that late fall–run Chinook salmon egg mortality in the Sacramento River under A2A_LLT would be 148% to 313% greater than mortality under Existing Conditions (Table 11-2A-35). However, absolute differences in the percent of the late-fall population subject to mortality would be minimal in all but below normal years, in which there is a 5% increase.

SacEFT predicts that there would be a 12% decrease in the percentage of years with good spawning availability, measured as weighted usable area, under A2A_LLT relative to Existing Conditions (Table 11-2A-36). SacEFT predicts that there would be a 7% decrease in the percentage of years with good (lower) redd scour risk under A2A_LLT relative to Existing Conditions. SacEFT predicts that there would be no difference in the percentage of years with good (lower) egg incubation conditions under A2A_LLT relative to Existing Conditions. SacEFT predicts that there would be a 5% decrease in the percentage of years with good (lower) redd dewatering risk under A2A_LLT relative to Existing Conditions.

Clear Creek

No water temperature modeling was conducted in Clear Creek.

Fall-Run

Flows in Clear Creek below Whiskeytown Reservoir under A2A_LLT during the September through February fall-run spawning and egg incubation period would generally be similar to or greater than flows under Existing Conditions, except in critical water years during October and November (7% and 6% lower, respectively).

The potential risk of redd dewatering in Clear Creek was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in September when spawning occurred. The greatest monthly reduction in Clear Creek flows during October through February under A2A_LLT would be similar to or lower magnitude than those under Existing Conditions in wet and below normal water years, but the reduction would be 27%, 67%, and 33% greater (absolute, not relative, differences) under A2A_LLT in above normal, dry, and critical water years, respectively (Table 11-2A-37).

Feather River

Fall-Run

Flows in the low-flow channel during October through January under A2A_LLT would be identical to those under Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis* Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in the high-flow channel under A2A_LLT would generally be lower by up to 44% than flows under Existing Conditions.

The potential risk of redd dewatering in the Feather River low-flow channel was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in October when spawning is assumed to occur. Minimum flows in the low-flow channel were identical between A2A_LLT and Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized* *in the Fish Analysis*). Therefore, there would be no effect of Alternative 2A on redd dewatering in the Feather River low-flow channel.

The Reclamation egg mortality model predicts that fall-run Chinook salmon egg mortality in the Feather River under A2A_LLT would be 418% to 1,253% greater than mortality under Existing Conditions (Table 11-2A-40).

Mean monthly water temperatures in the Feather River above Thermalito Afterbay (low-flow channel) and below Thermalito Afterbay (high-flow channel) were examined during the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures would be under Alternative 2A relative to Existing Conditions by 6% to 11% higher in the low-flow channel and 5% to 9% higher in the high-flow channel depending on month.

The percent of months exceeding the 56°F temperature threshold in the Feather River at Gridley was evaluated during October through April (Table 11-2A-38). The percent of months exceeding the threshold under Alternative 2A would similar to or up to 52% higher (absolute scale) than the percent under Existing Conditions during all months except December through February, during which there would be no difference in the percent of months exceeding the threshold.

Total degree-months exceeding 56°F were summed by month and water year type at Gridley during October through April (Table 11-2A-39). Total degree-months under Alternative 2A would be 99% to 3000% higher than total degree-months under Existing Conditions, except during December through February, in which there would be no difference between Existing Conditions and Alternative 2A in total degree-months exceeding the 56°F threshold.

American River

Fall-Run

Flows in the American River at the confluence with the Sacramento River were examined during the October through January fall-run spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions during October, but generally lower by up to 33% than flows under NAA during November through January.

Mean monthly water temperatures in the American River at the Watt Avenue Bridge were examined during the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly temperatures under Alternative 2A would be 5% to 13% greater than those under Existing Conditions depending on month.

The percent of months exceeding the 56°F temperature threshold in the American River at the Watt Avenue Bridge was evaluated during November through April (Table 11-2A-41). The percent of months exceeding the threshold under Alternative 2A would be up to 52% greater (absolute scale) than the percent under Existing Conditions during November, March, and April and similar to the percent under Existing Conditions during December through February.

Total degree-months exceeding 56°F were summed by month and water year type at the Watt Avenue Bridge during November through April (Table 11-2A-42). Total degree-months under

Alternative 2A would be 94% to 322% greater than total degree-months under Existing Conditions during November, March and April and similar to total degree months under Existing Conditions during December through February.

The potential risk of redd dewatering in the American River at Nimbus Dam was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in October when spawning is assumed to occur. The greatest monthly reduction in American River flows during November through January under A2A_LLT would be up to 301% greater magnitude than those under Existing Conditions in all years except above normal (7% lower magnitude) (Table 11-2A-43).

The Reclamation egg mortality model predicts that fall-run Chinook salmon egg mortality in the American River under A2A_LLT would be 43% to 206% greater than mortality under Existing Conditions (Table 11-2A-44).

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the October through January fall-run spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would be similar to Existing Conditions during October, November and December and mixed in January being similar in wet and dry years, higher in above normal years (8% higher) and lower in below normal and critical years (up to 11% lower) than those under Existing Conditions.

Water temperatures in the Stanislaus River at the confluence with the San Joaquin River were examined during the October through January fall-run spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under Alternative 2A would not be different from those under Existing Conditions during October, except for wet and critical years when they would be 5% higher, and up to 7% higher during November through January.

San Joaquin River

Flows in the San Joaquin River at Vernalis were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would be up to 8% lower than Existing Conditions during October, and generally similar to or higher than Existing Conditions during November through January.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Flows in the Mokelumne River at the Delta were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would be up to 14% lower than flows under Existing Conditions during October and November, and generally higher than Existing Conditions during December and January (up to 18% greater.

Water temperature modeling was not conducted in the Mokelumne River.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-76 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 2A could be significant because, when compared to the CEQA baseline, the alternative could substantially reduce suitable spawning habitat and substantially reduce the number of fish as a result of egg mortality, contrary to the NEPA conclusion set forth above. There would be flow reductions in all waterways except Clear Creek and the San Joaquin River and increases in the exceedances of NMFS temperature thresholds in the Sacramento, Feather, and American Rivers that would substantially affect the fall-/late fall-run population. Further, the Reclamation egg mortality model predicts moderate to substantial negative impacts of Alternative 2A on fall-/late fall-run Chinook salmon in the Sacramento, Feather, and American Rivers and SacEFT predicts substantially reduced spawning and egg incubation habitat conditions in the Sacramento River.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 2A does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 2A indicates that flows and reservoir storage in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 2A. This indicates that the differences between Existing Conditions and Alternative 2A found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 2A, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on spawning and egg incubation habitat for fall-run Chinook salmon. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-77: Effects of Water Operations on Rearing Habitat for Chinook Salmon (Fall-/Late Fall–Run ESU)

In general, Alternative 2A would not affect the quantity and quality of larval and juvenile rearing habitat for fall-/late fall–run Chinook salmon relative to NAA.

Sacramento River

Fall-Run

Sacramento River flows upstream of Red Bluff were examined for the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish*

Analysis). Flows under A2A_LLT would be greater than or similar to flows under NAA throughout the period.

Shasta Reservoir storage at the end of September would affect flows during the fall-run larval and juvenile rearing period. As reported in Impact AQUA-59 for spring-run Chinook salmon, end of September Shasta Reservoir storage would be similar to or greater than storage under NAA in all water year types (Table 11-2A-19).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

SacEFT predicts that there would be a 5% decrease in the percentage of years with good juvenile rearing availability for fall-run Chinook salmon, measured as weighted usable area, under A2A_LLT relative to NAA (Table 11-2A-34). SacEFT predicts that there would be a 10% increase in the percentage of years with "good" (lower) juvenile stranding risk under A2A_LLT relative to NAA.

SALMOD predicts that fall-run smolt equivalent habitat-related mortality under A2A_LLT would be similar to mortality under NAA.

Late Fall-Run

Year-round Sacramento River flows upstream of Red Bluff were examined for the late fall–run Chinook salmon juvenile rearing period of March through July (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows during March through June under A2A_LLT were generally similar to or greater than those under NAA (up to 105% greater). Flows during July were up to 41% lower under A2A_LLT than under NAA.

Shasta Reservoir storage at the end of September and May would affect flows during the late fall–run larval and juvenile rearing period. As reported in Impact AQUA-156, end of September Shasta Reservoir storage would be similar to or greater than storage under NAA in all water year types (Table 11-2A-19).

As reported in Impact AQUA-59, Shasta storage at the end of May under A2A_LLT would be similar to or greater than storage under NAA for all water year types (Table 11-2A-9).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the March through July late fall–run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

SacEFT predicts that there would be a 37% decrease in the percentage of years with good juvenile rearing availability for late fall–run Chinook salmon, measured as weighted usable area, under A2A_LLT relative to NAA (Table 11-2A-36). SacEFT predicts that there would be a 2% reduction in the percentage of years with "good" (lower) juvenile stranding risk under A2A_LLT relative to NAA.

SALMOD predicts that late fall–run smolt equivalent habitat-related mortality under A2A_LLT would be similar to mortality under NAA.

Clear Creek

No water temperature modeling was conducted in Clear Creek.

Fall-Run

Flows in Clear Creek below Whiskeytown Reservoir were examined the January through May fall-run Chinook salmon rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would generally be similar to or greater than flows under NAA, except in critical years during February (6% reduction) and in below normal years during March (6% reduction).

Feather River

Fall-Run

Flows in the Feather River both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) during December through June were reviewed to determine flow-related effects on larval and juvenile fall-run rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Relatively constant flows in the low flow channel throughout this period under A2A_LLT would not differ from those under NAA. In the high flow channel, flows under A2A_LLT would be mostly similar to or greater than flows under NAA during December through June with few exceptions during which flows would be up to 12% lower under A2A_LLT.

As reported in Impact AQUA-59 for spring-run Chinook salmon, May Oroville storage volume under A2A_LLT would be similar to storage under NAA, indicating that the difference is primarily a result of climate change (Table 11-2A-28).

As reported in Impact AQUA-59 for spring-run Chinook salmon, September Oroville storage volume would be similar to or up to 5% lower than under NAA depending on water year type (Table 11-2A-25).

Mean monthly water temperatures in the Feather River in both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were examined during the December through June fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis).* There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period at either location.

American River

Fall-Run

Flows in the American River at the confluence with the Sacramento River were examined for the January through May fall-run larval and juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT generally be similar to or greater than flows under NAA except in dry and critical years (6% and 7% lower, respectively) during March.

Mean monthly water temperatures in the American River at the Watt Avenue Bridge were examined during the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the*

Fish Analysis). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River for Alternative 2A are not different from those under NAA, for the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures throughout the Stanislaus River would be similar between NAA and Alternative 2A throughout the January through May fall-run rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

San Joaquin River

Flows in the San Joaquin River at Vernalis for Alternative 2A are not different from those under NAA, for the January through May fall-run larval and juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Flows in the Mokelumne River at the Delta for Alternative 2A are not different from those under NAA, for the January through May fall-run larval and juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Water temperature modeling was not conducted in the Mokelumne River.

NEPA Effects: Taken together, these results indicate that the effect is not adverse because it does not have the potential to substantially reduce the amount of suitable habitat of fish. SacEFT predicts that there would be a 37% decrease in the percentage of years with good juvenile rearing availability for late fall-run, although the number of years with good juvenile stranding risk as predicted by SacEFT would not differ between Alternative 2A and the NEPA baseline, nor would late fall–run smolt equivalent habitat-related mortality as predicted by SALMOD. Despite the reduction in late fall-run rearing availability, there are no effects of Alternative 2A on fall-run or late fall-run in other waterways that would rise to the level of adverse.

CEQA Conclusion: In general, Alternative 2A would not affect the quantity and quality of larval and juvenile rearing habitat for fall-/late fall–run Chinook salmon relative to the Existing Conditions.

Sacramento River

Fall-Run

Sacramento River flows upstream of Red Bluff were examined for the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would generally be greater than or similar to flows under Existing Conditions, except in below normal years during March (10% lower) and wet years during May (15% lower).

As reported in Impact AQUA-59, end of September Shasta Reservoir storage would be 7% to 12% lower under A2A_LLT relative to Existing Conditions depending on water year type (Table 11-2A-19).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 2A in any month or water year type throughout the period.

SacEFT predicts that there would be an 15% increase in the percentage of years with good juvenile rearing availability for fall-run Chinook salmon, measured as weighted usable area, under A2A_LLT relative to Existing Conditions (Table 11-2A-34). SacEFT predicts that there would be a 29% reduction in the percentage of years with "good" (lower) juvenile stranding risk under A2A_LLT relative to Existing Conditions.

SALMOD predicts that fall-run smolt equivalent habitat-related mortality under A2A_LLT would be 11% lower than mortality under Existing Conditions.

Late Fall–Run

Year-round Sacramento River flows upstream of Red Bluff were examined for the late fall–run Chinook salmon juvenile March through July rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows during March through June under A2A_LLT were generally similar to or greater than those under Existing Conditions. Flows during July were generally lower under A2A_LLT than under Existing Conditions.

As reported in Impact AQUA-59, end of September Shasta Reservoir storage would be 7% to 12% lower under A2A_LLT relative to Existing Conditions depending on water year type (Table 11-2A-19).

As reported in Impact AQUA-41, end of May Shasta storage under A2A_LLT would be similar to Existing Conditions in wet, above normal, and below normal water years, but lower by 6% to 9% in dry and critical water years (Table 11-2A-9).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the March through July late fall–run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 2A in any month or water year type throughout the period except for dry and critical years in July (6% and 9% higher, respectively.

SacEFT predicts that there would be an 11% reduction in the percentage of years with good juvenile rearing availability for late fall–run Chinook salmon, measured as weighted usable area, under A2A_LLT relative to Existing Conditions (Table 11-2A-36). SacEFT predicts that there would be a 38% reduction in the percentage of years with "good" (lower) juvenile stranding risk under A2A_LLT relative to Existing Conditions.

SALMOD predicts that late fall–run smolt equivalent habitat-related mortality under A2A_LLT would be 8% higher than mortality under Existing Conditions.

Clear Creek

No temperature modeling was conducted in Clear Creek.

Fall-Run

Flows in Clear Creek below Whiskeytown Reservoir were examined the January through May fall-run Chinook salmon rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would be similar to or greater than flows under Existing Conditions for the entire period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Feather River

Fall-Run

Flows in the Feather River both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) during December through June were reviewed to determine flow-related effects on larval and juvenile fall-run rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Relatively constant flows in the low flow channel throughout the period under A2A_LLT would not differ from those under Existing Conditions. In the high flow channel, flows under A2A_LLT would be mostly lower (up to 45%) during December and February and mostly similar to or greater than flows under Existing Conditions during January and March through June with few exceptions during which flows would be up to 46% lower under A2A_LLT.

As reported under in Impact AQUA-59, May Oroville storage volume under A2A_LLT would be lower than Existing Conditions by 6% to 21% depending on water year type, except in wet years, in which storage would be similar to Existing Conditions (Table 11-2A-25).

As reported in Impact AQUA-59, September Oroville storage volume would be 7% to 36% lower under A2A_LLT relative to Existing Conditions depending on water year type (Table 11-2A-28).

Mean monthly water temperatures in the Feather River in both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were examined during the December through June fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). In the low-flow channel, mean monthly water temperatures under Alternative 2A would be 5% to 11% higher than those under Existing Conditions during December through March, but not different from those under Existing Conditions during April through June. In the high-flow channel, mean monthly water temperatures under Alternative 2A would be 6% to 10% higher than those under Existing Conditions during December through February, but not different from those under Existing Conditions during March through June.

American River

Fall-Run

Flows in the American River at the confluence with the Sacramento River were examined for the January through May fall-run larval and juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions, except during January in below normal, dry and critical years (16% to 18% lower) and in critical years during February and March (14% and 10%, respectively).

Mean monthly water temperatures in the American River at the Watt Avenue Bridge were examined during the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under Alternative 2A would be 5% to 7% higher than those under Existing Conditions during January through March and May, but not different during April.

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the October through January fall-run spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would generally similar to those under Existing Conditions from October through December and 11% lower during January.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were examined during the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under Alternative 2A would be 6% higher than those under Existing Conditions in all months during the period.

San Joaquin River

Flows in the San Joaquin River at Vernalis were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would be up to 8% lower than Existing Conditions in most water years during October, similar to Existing Conditions in November through January.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Flows in the Mokelumne River at the Delta were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would be up to 14% lower than flows under Existing Conditions during October and up to 18% greater than flows under Existing Conditions during November through January.

Water temperature modeling was not conducted in the Mokelumne River.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-77 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 2A could be significant because, when compared to the CEQA baseline, the alternative could substantially reduce suitable rearing habitat, contrary to the NEPA conclusion set forth above. Late fall–run Chinook salmon in the Sacramento River experience small to moderate reductions in flow during August and November in most water year types relative to the Existing Conditions. SacEFT predicts that there would be a 29% reduction in years with low juvenile stranding risk, indicating that flows would be more variable during the rearing period. Flows in the Feather River for fall-run Chinook salmon would be up to 45% lower than the Existing Conditions in the majority of water years during December and February. Water temperatures would be similar between Alternative 2A and Existing Conditions in the Sacramento River, although temperatures would be higher in the Feather, American, and Stanislaus Rivers under Alternative 2A. Both SacEFT and SALMOD predict reduced rearing habitat conditions under Alternative 2A relative to Existing Conditions.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 2A does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 2A indicates that flows and reservoir storage in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 2A. This indicates that the differences between Existing Conditions and Alternative 2A found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 2A, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on rearing habitat for fall-run Chinook salmon. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-78: Effects of Water Operations on Migration Conditions for Chinook Salmon (Fall-/Late Fall–Run ESU)

Upstream of the Delta

In general, Alternative 2A would reduce migration conditions for fall-/late fall–run Chinook salmon relative to NAA.

Sacramento River

Fall-Run

Flows in the Sacramento River upstream of Red Bluff for juvenile fall-run migrants during February through May under A2A_LLT would be similar to or greater than flows under NAA throughout the February through May juvenile fall-run migration period in all water year types (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

Flows in the Sacramento River upstream of Red Bluff during the adult fall-run Chinook salmon upstream migration period (September through October) under A2A_LLT would generally be similar to or greater than those under NAA except during above normal years during September (5% lower) and below normal years during September and October (15% and 6% lower, respectively) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the September through October adult fall-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

Late Fall-Run

Flows in the Sacramento River upstream of Red Bluff for juvenile late fall-run migrants (January through March) under A2A_LLT would generally be similar to or greater than flows under NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the January through March juvenile late fall-run Chinook salmon emigration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

Flows in the Sacramento River upstream of Red Bluff during the adult late fall-run Chinook salmon upstream migration period (December through February) under A2A_LLT would be similar to or greater than those under NAA regardless of water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the December through February adult late fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

Clear Creek

Water temperature modeling was not conducted in Clear Creek.

Fall-Run

Flows in the Clear Creek below Whiskeytown Reservoir were examined for juvenile fall-run migrants during February through May. Flows under A2A_LLT would be similar to or greater than flows under NAA, except in critical years during February and below normal years during March (6% lower for both) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flows in Clear Creek below Whiskeytown Reservoir during the adult fall-run Chinook salmon upstream migration period (September through October) under A2A_LLT would be similar to or greater than those under NAA throughout the period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Feather River

Fall-Run

Flows in the Feather River at the confluence with the Sacramento River during the fall-run juvenile migration period (February through May) under A2A_LLT would generally be similar to or greater than flows under NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

Flows in the Feather River at the confluence with the Sacramento River during the September through October fall-run Chinook salmon adult migration period under A2A_LLT would generally be lower by up to 33% lower than flows under NAA in September but similar to or greater than flows under NAA in October (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the September through October fall-run Chinook salmon adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

American River

Fall-Run

Flows in the American River at the confluence with the Sacramento River were examined during the February through May juvenile Chinook salmon fall-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would be generally similar to or greater than flows under NAA, except for dry and critical years during March (6% and 7% lower, respectively).

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

Flows in the American River at the confluence with the Sacramento River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under Alternative 2A during September would be 10% to 19% lower than those under NAA in wet, above normal, and below normal years and flows during October would be 7% to 10% lower in wet and above normal years. Flows in other water years would be similar to or greater than those under NAA.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under Alternative 2A would be similar to those under NAA throughout the year. Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

San Joaquin River

Flows in the San Joaquin River at Vernalis were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under Alternative 2A would be similar to those under NAA throughout the year.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Flows in the Mokelumne River at the Delta were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under Alternative 2A would be similar to those under NAA throughout the year.

Water temperature modeling was not conducted in the Mokelumne River.

Through-Delta

Sacramento River

The effects of Alternative 2A on through-Delta migration were evaluated using the approach described in Alternative 1A, Impact AQUA-42.

Fall-Run

Juveniles

Juvenile salmonids migrating down the Sacramento River would generally experience lower flows below the north Delta intakes compared to Existing Conditions. The predation effects of Alternative 2A would be the same as those described for Alternative 1A, since there are five intakes for both alternatives. Estimates of potential predation losses ranged from 1.8% (bioenergetics model, Table

11-1A-17) up to 20.3% (conservative assumption of 5% loss per intake) of fall-run annual production.

Through-Delta survival by juvenile fall-run Chinook salmon under Alternative 2A averaged across years would be 24.3% from the Sacramento River and 16.4% from the Mokelumne River, which is not much different from NAA (Table 11-2A-45). In wetter years, mean survival would be 2.5% lower from the Sacramento (8% relative decrease) and 1.5% greater (9% relative increase) from the Mokelumne.

Overall, Alternative 2A would have a negative effect on fall-run Chinook salmon juvenile survival due to habitat and predation losses at the NDD intakes.

Table 11-2A-45. Through-Delta Survival (%) of Emigrating Juvenile Fall-Run Chinook Salmon under Alternative 2A

	Percentage Survival			Difference in Percentage Survival (Relative Difference)	
Year Type	EXISTING CONDITIONS	NAA	A2A	EXISTING CONDITIONS vs. A2A	NAA vs. A2A
Sacramento River					
Wetter Years	34.5	31.1	28.6	-5.9 (-17%)	-2.5 (-8%)
Drier Years	20.6	20.8	21.7	1.1 (5%)	0.9 (4%)
All Years	25.8	24.7	24.3	-1.5 (-6%)	-0.3 (-1%)
Mokelumne River					
Wetter Years	17.2	15.7	17.2	0.0 (0%)	1.5 (9%)
Drier Years	15.6	15.9	15.9	0.3 (2%)	-0.1 (<-1%)
All Years	16.2	15.9	16.4	0.2 (1%)	0.5 (3%)
San Joaquin River					
Wetter Years	19.3	20.3	16.6	-2.7 (-14%)	-3.6 (-18%)
Drier Years	10.0	9.5	10.9	1.0 (10%)	1.4 (14%)
All Years	13.5	13.6	13.1	-0.4 (-3%)	-0.5 (-4%)

Note: Delta Passage Model results for survival to Chipps Island.
Wetter = Wet and above normal water years (6 years).
Drier = Below normal, dry and critical water years (10 years).

Adults

Attraction flow for fall-run adults, as estimated by the percentage of Sacramento River water at Collinsville, increased 13% in September and decreased 1% to 4% October to December under Alternative 2A compared to NAA (Table 11-2A-17). The Sacramento River would still represent a substantial proportion (62% to 78%) of Delta outflows. The reductions in percentage are small in comparison with the magnitude of change in dilution (20% or more) reported to cause a significant change in migration by Fretwell (1989) and, therefore, are not expected to affect adult Chinook salmon migration. However, uncertainty remains with regard to adult salmon behavioral response to anticipated changes in lower Sacramento River flow percentages. This topic is discussed further in Impact AQUA-42 in Alternative 1A.

Late Fall–Run

Juveniles

Juvenile salmonids migrating down the Sacramento River would generally experience lower flows below the north Delta intakes compared to Existing Conditions. Through-Delta survival by emigrating juvenile late fall–run Chinook salmon under Alternative 2A (A2A_LLT) would average 23% across all years, ranging from 20% in drier years to 27% in wet years. Juvenile survival would decrease slightly in wetter (0.6% less survival, or 2% less in relative percentage) and similar in drier years (0.3% greater survival, or 1% more in relative percentage) compared to NAA (Table 11-2A-46). Overall, Alternative 2A would not have an adverse effect on late fall–run Chinook salmon juvenile survival due an increase in survival during all water year types.

Table 11-2A-46. Through-Delta Survival (%) of Emigrating Juvenile Late Fall–Run Chinook Salmon under Alternative 2A

	Percentage Survival			Difference in Percentage Survival (Relative Difference)	
Year Type	EXISTING CONDITIONS	NAA	A2A_LLT	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wetter Years	28.8	27.3	26.7	-2.1 (-7%)	-0.6 (-2%)
Drier Years	18.8	20.2	20.5	1.7 (9%)	0.3 (1%)
All Years	22.5	22.9	22.8	0.3 (1%)	-0.1 (<-1%)

Note: Delta Passage Model results for survival to Chipps Island.
Wetter = Wet and above normal water years (6 years).
Drier = Below normal, dry and critical water years (10 years).

Adults

The adult late fall–run migration is from November through March, peaking in January through March. The proportion of Sacramento River water in the Delta would be similar (<10% difference) to NAA throughout the adult late fall–run migration (Table 11-2A-17). Alternative 2A would not have an adverse effect on late fall–run adult migration. However, uncertainty remains with regard to adult salmon behavioral response to anticipated changes in lower Sacramento River flow percentages. This topic is discussed further in Impact AQUA-42 in Alternative 1A.

San Joaquin River

Fall-Run

Juveniles

The only changes on San Joaquin River flows at Vernalis would result from the modeled effects of climate change on inflows to the river downstream of Friant Dam and reduced tributary inflows. There are no flow changes associated with the alternatives. Through-Delta survival by emigrating juvenile fall-run Chinook salmon under Alternative 2A (A2A_LLT) would average 13% across all years (Table 11-2A-46). Juveniles from the San Joaquin River would experience 3.6% lower survival in wetter years (18% less in relative percentage) and 1.4% greater survival in drier years (14% more in relative percentage). Across all years, survival would be similar under Alternative 2A relative to the baseline (0.5% less, or 4% relative decrease). Overall, Alternative 2A would not have an adverse effect on fall-run Chinook salmon juvenile survival due to minor differences in survival.

Adults

Alternative 2A would slightly increase the proportion of San Joaquin River water in the Delta in September through December by 1.1 to 4.4% compared to NAA). The proportion of San Joaquin River water would be similar (<5% change) to NAA (Table 11-2A-47). Therefore migration conditions under Alternative 2A would be similar to those described for Alternative 1A. The effect of Alternative 2A would not be adverse on the fall-run adult migration.

Table 11-2A-47. Percentage (%) of Water at Collinsville that Originated in the Sacramento River and San Joaquin River during the Adult Chinook Migration Period for Alternative 2A

	Percentage of Water			Difference	
Month	EXISTING CONDITIONS	NAA	A2A_LLT	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Sacramento River					
September	60	65	78	18	13
October	60	68	67	7	-1
November	60	66	62	2	-4
December	67	66	65	-2	-1
January	76	75	73	-3	-2
February	75	72	67	-8	-5
March	78	76	67	-11	-9
April	77	75	65	-12	-10
May	69	65	59	-10	-6
San Joaquin River					
September	0.3	0.1	1.3	1.0	1.2
October	0.2	0.3	3.6	3.4	3.3
November	0.4	1.0	5.4	5.0	4.4
December	0.9	1.0	3.0	2.1	2.0
January	1.6	1.7	3.2	1.6	1.5
February	1.4	1.5	3.8	2.4	2.3
March	2.6	2.8	6.1	3.5	3.3
April	6.3	6.6	10.6	4.3	4.0
	Shading indicates a difference of 10% or greater in flow proportion.				

NEPA Effects:

Overall, the results indicate that the effect of Alternative 2A is adverse because it has the potential to substantially decrease fall- and late fall-run Chinook salmon migration habitat conditions upstream of the Delta. In addition, this alternative is adverse due to the cumulative effects associated with five north Delta intake facilities, including mortality related to near-field effects (e.g. impingement and predation) and far-field effects (reduced survival due to reduced flows downstream of the intakes) associated with the five NDD intakes.

Upstream of the Delta, flows in the Feather and American rivers would be up to 33% lower during at least one of the two months of the fall-run Chinook salmon adult migration period. These reductions in flow may impact the ability of adult fall-run Chinook salmon to migrate upstream successfully. There would be no other effects of Alternative 2A on upstream flows or water temperatures during the juvenile or adult migration periods for fall- and late fall-run Chinook salmon.

Adult attraction flows under Alternative 2A would be lower than those under NAA, but adult attraction flows are expected to be adequate to provide olfactory cues for migrating adults.

Near-field effects of Alternative 2A NDD on fall- and late fall-run Chinook salmon related to impingement and predation associated with five new intakes could result in substantial effects on juvenile migrating fall- and late fall-run Chinook salmon, although there is high uncertainty regarding the potential effects. Estimates within the effects analysis range from very low levels of effects (<2% mortality) to very significant effects (~ 20% mortality above current baseline levels). CM15 would be implemented with the intent of providing localized and temporary reductions in predation pressure at the NDD. Additionally, several pre-construction surveys to better understand how to minimize losses associated with the five new intake structures will be implemented as part of the final NDD screen design effort. Alternative 2A also includes an Adaptive Management Program and Real-Time Operational Decision-Making Process to evaluate and make limited adjustments intended to provide adequate migration conditions for fall- and late fall-run Chinook salmon. However, at this time, due to the absence of comparable facilities anywhere in the lower Sacramento River/Delta, the degree of mortality expected from near-field effects at the NDD remains highly uncertain.

Two recent studies (Newman 2003 and Perry 2010) indicate that far-field effects associated with the new intakes could cause a reduction in smolt survival in the Sacramento River downstream of the NDD intakes due to reduced flows in this area. The analyses of other elements of Alternative 2A predict improvements in smolt condition and survival associated with increased access to the Yolo Bypass, reduced interior Delta entry, and reduced south Delta entrainment. The overall magnitude of each of these factors and how they might interact and/or offset each other in affecting salmonid survival through the plan area is uncertain, and remains an area of active investigation for the BDCP.

The DPM is a flow-based model being developed for BDCP which attempts to combine the effects of all of these elements of BDCP operations and conservation measures to predict smolt migration survival throughout the entire Plan Area. The current draft of this model predicts that smolt migration survival under Alternative 2A would be similar to survival rates estimated for NAA. Further refinement and testing of the DPM, along with several ongoing and planned studies related to salmonid survival at and downstream of the NDD are expected to be completed in the foreseeable future. These efforts are expected to improve our understanding of the relationships and interactions among the various factors affecting salmonid survival, and reduce the uncertainty around the potential effects of BDCP implementation on migration conditions for Chinook salmon. Until these efforts are completed and their results are fully analyzed, the overall effect of Alternative 2A on fall- and late fall-run Chinook salmon through-Delta survival remains uncertain.

Therefore, due to unacceptable levels of uncertainty regarding the cumulative impacts of near-field and far-field effects associated with the presence and operation of the five intakes on fall- and late fall-run Chinook salmon, this effect is adverse.

While the implementation of the conservation and mitigation measures described below would reduce the effects on migration conditions, these reductions would not necessarily result in a not adverse determination. Therefore, the overall effect is adverse.

CEQA Conclusion:

Upstream of the Delta

In general, Alternative 2A would affect migration conditions for fall-/late fall–run Chinook salmon relative to the Existing Conditions.

Sacramento River

Fall-Run

Flows in the Sacramento River upstream of Red Bluff for juvenile fall-run migrants during February through May under A2A_LLT would generally be similar to or greater than those under Existing Conditions, except in below normal water years during March (10% lower) and in wet water years during May (15% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 2A in any month or water year type throughout the period.

Flows in the Sacramento River upstream of Red Bluff during the adult fall-run Chinook salmon upstream migration period (September through October) under A2A_LLT would generally be similar to or greater than those under Existing Conditions except for below normal and dry years during September (13% and 16% lower, respectively) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the September through October adult fall-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under Alternative 2A would be 9% and 6% greater than those under Existing Conditions during September and October, respectively.

Late Fall-Run

Flows in the Sacramento River upstream of Red Bluff for juvenile late fall-run migrants (January through March) under A2A_LLT would generally be similar to or greater than flows under Existing Conditions, except in below normal water years during March (10% reduction) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the January through March juvenile late fall-run Chinook salmon emigration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 2A in any month or water year type throughout the period.

Flows in the Sacramento River upstream of Red Bluff during the adult late fall-run Chinook salmon upstream migration period (December through February) under A2A_LLT would generally be similar to or greater than those under Existing Conditions, except in wet years during December (8% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the December through February adult late fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 2A in any month or water year type throughout the period.

Clear Creek

Water temperature modeling was not conducted in Clear Creek.

Fall-Run

Flows in Clear Creek below Whiskeytown Reservoir during the juvenile fall-run Chinook salmon upstream migration period (February through May) under A2A_LLT would be similar to or greater than those under Existing Conditions throughout the period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flows in Clear Creek below Whiskeytown Reservoir during the adult fall-run Chinook salmon upstream migration period (September through October) under A2A_LLT would generally be similar to or greater than those under Existing Conditions except in critical years (29% and 7% lower during September and October, respectively) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Feather River

Fall-Run

Flows in the Feather River at the confluence with the Sacramento River during the fall-run juvenile migration period (February through May) under A2A_LLT would generally be similar to or greater than flows under Existing Conditions, except in below normal years during February and March (11% and 18% lower, respectively) and in wet years during May (24% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 2A in any month or water year type throughout the period.

Flows in the Feather River at the confluence with the Sacramento River during the September through October fall-run Chinook salmon adult migration period under A2A_LLT would generally be greater than flows under Existing Conditions, except in below normal and dry years during September (24% and 28% lower, respectively) and in wet and below normal water years during October (8% and 12% lower, respectively).

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the September through October fall-run Chinook salmon adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperature differences (>5%) would be higher in below normal, dry and critical years during September (6%, 6% and 5% higher, respectively) and in wet and dry years during October (5% higher in both years).

American River

Fall-Run

Flows in the American River at the confluence with the Sacramento River were examined during the February through May juvenile Chinook salmon fall-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT during February and March would generally be similar to or greater than flows under Existing Conditions, except for critical years (14% an 10% lower in February and March, respectively). Flows under A2A_LLT during May would be mostly lower by up to 26% than flows under Existing Conditions.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under Alternative 2A would be 5% to 7% higher than under Existing Conditions although April would equal or exceed 5% only in wet and above normal years.

Flows in the American River at the confluence with the Sacramento River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT during September would be 28% to 56% lower than flows under Existing Conditions. Flows under A2A_LLT during October would generally be similar to or greater than those under Existing Conditions in except in wet and above normal water years (16% and 6% lower, respectively).

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under Alternative 2A would be 6% and 12% higher than those under Existing Conditions during September and October, respectively.

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under Alternative 2A would be 8% to 13% lower than those under Existing Conditions throughout the period.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under Alternative 2A would be 6% higher than those under Existing Conditions in every month of the period.

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under Alternative 2A would be 10% and 7% lower during September and October, respectively, than those under Existing Conditions

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under Alternative 2A would be 6% higher than those under Existing Conditions during September and 5% higher in critical years during October but there would be no difference in mean monthly water temperatures between Alternative 2A and Existing Conditions in the other water years during October.

San Joaquin River

Flows in the San Joaquin River at Vernalis were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under Alternative 2A would generally be similar to those under Existing Conditions during February, but up to 15% lower during the remainder of the period, particularly in drier water years.

Flows in the San Joaquin River at Vernalis were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under Alternative 2A would be 5% and 8% lower than those under Existing Conditions during September and October, respectively.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Flows in the Mokelumne River at the Delta were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under Alternative 2A would be similar to or greater than those under Existing Conditions during February and March and 8% and 12% lower than those under Existing Conditions during April and May, respectively.

Flows in the Mokelumne River at the Delta were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under Alternative 2A would be similar to those under Existing Conditions during both months.

Water temperature modeling was not conducted in the Mokelumne River.

Through-Delta

Through-Delta survival as modeled by DPM was similar or slightly reduced for Alternative 2A compared to Existing Conditions, and therefore the impact would be less than significant. Based on the proportion of Sacramento River flows, olfactory cues would be similar (<10% difference) to Existing Conditions for nearly all months of the year. The proportion of flows would decrease slightly in March and April by 11 to 12%. The 11% decrease in March would affect the last month of the late fall-run adult migration. An increase in the proportion of Sacramento River flows in September by 18% though would benefit the pre-peak fall-run adult upstream migration. Through the Delta, Sacramento River flows below the NDD would be reduced compared to baseline conditions during adult and juvenile migration periods. Modeled juvenile survival is expected to be similar or slightly lower in all water year types (6% relative decrease across all years). Estimated predation losses of juveniles migrating past the five intakes could hypothetically range from 2% to 20% of annual production, although the latter estimate is a conservative upper bound. The adaptive management program would provide a mechanism for making adjustments to minimize this effect to some extent. In addition, *CM15 Localized Reduction of Predatory Fishes* could be implemented to reduce potential effects. However, the benefits of these actions are uncertain. As a result of changes in predation and habitat associated with five NDD structures, this impact is substantial.

Summary of CEQA Conclusion

There would be substantial reductions in flows and increases in temperatures in multiple upstream waterways under Alternative 2A relative to Existing Conditions that would slow or inhibit migration of juveniles and adult fall-/late fall-run Chinook salmon or increase thermal stress on migrants. In addition, Alternative 2A has the potential to substantially increase predation and remove important instream habitat in the Delta as the result of the presence of five NDD structures. Through-Delta survival of emigrating juveniles is expected to be substantially reduced, compared to Existing Conditions. Implementation of CM6 and CM15 and Mitigation Measures AQUA-78a through AQUA-78c would address these impacts, but are not anticipated to reduce them to a level considered less than significant. Although implementation of *CM6 Channel Margin Enhancement* would provide habitat similar to that which would be lost, it would not necessarily be located near the intakes and therefore would not fully compensate for the lost habitat. Additionally, implementation of this measure would not fully address predation losses. *CM15 Localized Reduction of Predatory Fishes (Predator Control)* has substantial uncertainties associated with its effectiveness such that it is considered to have no demonstrable effect. Conservation measures that address habitat and predation losses, therefore, would potentially minimize impacts to some extent but not to a less than significant level. Consequently, as a result of these changes in migration conditions, this impact is significant and unavoidable.

Applicable conservation measures are briefly described below and full descriptions are found in Chapter 3, Section 3.6.2.5 Channel Margin Enhancement (CM6) and Section 3.6.3.4 Localized Reduction of Predatory Fishes (Predator Control) (CM15).

CM6 Channel Margin Enhancement. CM6 would entail restoration of 20 linear miles of channel margin by improving channel geometry and restoring riparian, marsh, and mudflat habitats on the waterside side of levees along channels that provide rearing and outmigration habitat for juvenile salmonids. Linear miles of enhancement would be measured along one side or the other of a given channel segment (e.g., if both sides of a channel are enhanced for a length of 1 mile, this would account for a total of 2 miles of channel margin enhancement). At least 10 linear miles would be enhanced by year 10 of Plan implementation; enhancement would then be phased in 5-mile increments at years 20 and 30, for a total of 20 miles at year 30. Channel margin enhancement would be performed only along channels that provide rearing and outmigration habitat for juvenile salmonids. These include channels that are protected by federal project levees—including the Sacramento River between Freeport and Walnut Grove among several others.

CM15 Localized Reduction of Predatory Fishes (Predator Control). CM15 would seek to reduce populations of predatory fishes at specific locations or modify holding habitat at selected locations of high predation risk (i.e., predation "hotspots"). This conservation measure seeks to benefit covered salmonids by reducing mortality rates of juvenile migratory life stages that are particularly vulnerable to predatory fishes. Predators are a natural part of the Delta ecosystem. Therefore, this conservation measure is not intended to entirely remove predators at any location, or substantially alter the abundance of predators at the scale of the Delta system. This conservation measure would also not remove piscivorous birds. Because of uncertainties regarding treatment methods and efficacy, implementation of CM15 would involve discrete pilot projects and research actions coupled with an adaptive management and monitoring program to evaluate effectiveness. Effects would be temporary, as new individuals would be expected to occupy vacated areas; therefore, removal activities would need to be continuous during periods of concern. CM15 also recognizes that the NDD intakes would create new predation hotspots.

As discussed in detail for Alternative 1A, the effects of Alternative 2A operations on through-Delta migration conditions for fall-/late fall-run Chinook salmon would be significant and unavoidable, due to predation and habitat loss associated with the five NDD intakes, and flow changes in the Feather and American Rivers. However, as with the conservation measures, the implementation of the mitigation measures listed below also has the potential to reduce the severity of the impact though not necessarily to a less-than-significant level. These mitigation measures would provide an adaptive management process, that may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6), for assessing impacts and developing appropriate minimization measures.

Mitigation Measure AQUA-78a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Fall-/Late Fall–Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Migration Conditions

Please refer to Mitigation Measure AQUA-78a under Alternative 1A (Impact AQUA-78) for fall/late fall-run Chinook salmon.

Mitigation Measure AQUA-78b: Conduct Additional Evaluation and Modeling of Impacts on Fall-/Late Fall–Run Chinook Salmon Migration Conditions Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-78b under Alternative 1A (Impact AQUA-78) for fall/late fall-run Chinook salmon.

Mitigation Measure AQUA-78c: Consult with USFWS and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Fall-/Late Fall–Run Chinook Salmon Migration Conditions Consistent with CM1

Please refer to Mitigation Measure AQUA-78c under Alternative 1A (Impact AQUA-78) for fall/late fall-run Chinook salmon.

Restoration Measures (CM2, CM4–CM7, and CM10)

Alternative 2A has the same restoration measures as Alternative 1A. Because no substantial differences in restoration-related fish effects are anticipated anywhere in the affected environment under Alternative 2A compared to those described in detail for Alternative 1A, the fish effects of restoration measures described for fall- and late fall–run Chinook salmon under Alternative 1A (Impact AQUA-79 through AQUA-81) also appropriately characterize effects under Alternative 2A.

The following impacts are those presented under Alternative 1A that are identical for Alternative 2A.

Impact AQUA-79: Effects of Construction of Restoration Measures on Chinook Salmon (Fall-/ Late Fall–Run ESU)

Impact AQUA-80: Effects of Contaminants Associated with Restoration Measures on Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-81: Effects of Restored Habitat Conditions on Chinook Salmon (Fall-/Late Fall–Run ESU)

NEPA Effects: All three of these impact mechanisms have been determined to result in no adverse effects on fall- or late fall-run Chinook salmon for NEPA purposes. Specifically for AQUA-80, the effects of contaminants on fall- and late fall-run Chinook salmon with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on fall- and late fall-run Chinook salmon are uncertain.

CEQA Conclusion: All three of these impact mechanisms would be considered less than significant on fall- or late fall-run Chinook salmon, for the reasons identified for Alternative 1A, and no mitigation is required.

Other Conservation Measures (CM12–CM19 and CM21)

Alternative 2A has the same other conservation measures as Alternative 1A. Because no substantial differences in other conservation-related fish effects are anticipated anywhere in the affected environment under Alternative 2A compared to those described in detail for Alternative 1A, the fish effects of other conservation measures described for fall- and late fall-run Chinook salmon under Alternative 1A (Impact AQUA-82 through AQUA-90) also appropriately characterize effects under Alternative 2A.

The following impacts are those presented under Alternative 1A that are identical for Alternative 2A.

Impact AQUA-82: Effects of Methylmercury Management on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM12)

Impact AQUA-83: Effects of Invasive Aquatic Vegetation Management on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM13)

Impact AQUA-84: Effects of Dissolved Oxygen Level Management on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM14)

Impact AQUA-85: Effects of Localized Reduction of Predatory Fish on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM15)

Impact AQUA-86: Effects of Nonphysical Fish Barriers on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM16)

Impact AQUA-87: Effects of Illegal Harvest Reduction on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM17)

Impact AQUA-88: Effects of Conservation Hatcheries on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM18)

Impact AQUA-89: Effects of Urban Stormwater Treatment on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM19)

Impact AQUA-90: Effects of Removal/Relocation of Nonproject Diversions on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM21)

NEPA Effects: The nine impact mechanisms have been determined to range from no effect, to no adverse effect, or beneficial effects on fall- or late fall-run Chinook salmon for NEPA purposes, for the reasons identified for Alternative 1A.

CEQA Conclusion: The nine impact mechanisms would be considered to range from no impact, to less than significant, or beneficial on fall- or late fall-run Chinook salmon, for the reasons identified for Alternative 1A, and no mitigation is required.

Steelhead

Construction and Maintenance of CM1

Impact AQUA-91: Effects of Construction of Water Conveyance Facilities on Steelhead

The potential effects of construction of the water conveyance facilities on steelhead would be similar to those described for Alternative 1A (Impact AQUA-91) except that Alternative 2A could potentially include two different intakes than under Alternative 1A. This would convert about 11,350 lineal feet of existing shoreline habitat into intake facility structures and would require about 26 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. The effects related to temporary increases in turbidity, accidental spills, underwater noise, in-water work activities, and disturbance of contaminated sediments would be similar to Alternative 1A and the same environmental commitments and mitigation measures (described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*) would be available to avoid and minimize potential effects.

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-91, environmental commitments and mitigation measures would be available to avoid and minimize potential effects, and the effect would not be adverse for steelhead.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-91, the impact of the construction of water conveyance facilities on steelhead would be less than significant except for construction noise associated with pile driving. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Alternative 1A, Impact AQUA-1.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Alternative 1A, Impact AQUA-1.

Impact AQUA-92: Effects of Maintenance of Water Conveyance Facilities on Steelhead

NEPA Effects: The potential impacts of the maintenance of water conveyance facilities under Alternative 2A would be the same as those described for Alternative 1A (see Impact AQUA-92). As concluded in Impact AQUA-92, the effect would not be adverse for steelhead.

CEQA Conclusion: As described in Impact AQUA-92 under Alternative 1A, the impact of the maintenance of water conveyance facilities on steelhead would be less than significant and no mitigation is required.

Water Operations of CM1

Impact AQUA-93: Effects of Water Operations on Entrainment of Steelhead

Water Exports from SWP/CVP South Delta Facilities

Alternative 2A would reduce overall entrainment of juvenile steelhead at the south Delta export facilities by 69%, as estimated by the salvage density method (Table 11-2A-48) across all years compared to NAA. Under Alternative 2A, the greatest reductions in entrainment would be in wetter years (90% decrease). Pre-screen loss at the south Delta facilities, typically attributed to predation, would be reduced commensurate with reductions in entrainment.

Table 11-2A-48. Juvenile Steelhead Annual Entrainment at the SWP and CVP Salvage Facilities—Differences between Model Scenarios for Alternative 2A

	Absolute Difference (Percent Difference)	
Water Year Type	EXISTING CONDITIONS vs. A2A	NAA vs. A2A
Wet	-5,679 (-90%)	-5,761 (-90%)
Above Normal	-10,511 (-79%)	-10,279 (-78%)
Below Normal	-5,567 (-50%)	-6,301 (-53%)
Dry	-1,711 (-25%)	-2,283 (-30%)
Critical	-1,039 (-19%)	-1,625 (-27%)
All Years	-5,999 (-68%)	-6,248 (-69%)

Note: Estimated annual number of fish lost, based on non-normalized data.

Steelhead predation loss at the south Delta facilities is assumed to be proportional to entrainment loss. Average pre-screen predation loss for steelhead entrained at the Clifton Court Forebay is about 80% (Clark et al. 2009) while predation loss for fish entrained at the CVP is assumed to be 15%. By reducing entrainment at the south Delta facilities, Alternative 2A would reduce predation losses commensurate with reductions in entrainment.

Water Exports from SWP/CVP North Delta Intake Facilities

The potential effects of the proposed North Delta diversions would be similar to these described for Chinook salmon juveniles (see Impact AQUA-39). The north Delta intakes would be screened to exclude fish larger than 15 mm, which would prevent steelhead smolts (which are larger than Chinook salmon juveniles and fry).

Water Export with a Dual Conveyance for the SWP North Bay Aqueduct

Entrainment and impingement effects on juvenile steelhead would be minimal for Alternative 2A because intakes would have state-of-the-art screens installed.

NEPA Effects: The effect under Alternative 2A would not be adverse.

CEQA Conclusion: As described above, entrainment and associated pre-screen predation losses of juvenile steelhead would decrease under Alternative 2A (A2A_LLT) compared to Existing Conditions at the south Delta export facilities (Table 11-2A-48). The north Delta screened intakes, as designed, would exclude juvenile salmonids, and decommissioning agricultural diversions would reduce potential entrainment. Impacts of water operations on entrainment of steelhead would be beneficial due to an overall reduction in entrainment and no mitigation would be required.

Impact AQUA-94: Effects of Water Operations on Spawning and Egg Incubation Habitat for Steelhead

In general, the effect of Alternative 2A on steelhead spawning habitat would be negligible relative to NAA.

Sacramento River

Flows in the Sacramento River between Keswick and upstream of Red Bluff Diversion Dam, where the majority of steelhead spawning occurs, were examined during the primary steelhead spawning and egg incubation period of January through April. (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Lower flows can reduce the instream area available for spawning and egg incubation, and rapid reductions in flow can expose redds, leading to mortality. Flows under A2A_LLT throughout the period would generally be similar to those under NAA except during February during below normal water years (7% higher flow).

Mean monthly water temperatures in the Sacramento River at Keswick and Red Bluff were examined during the January through April primary steelhead spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period at either location.

SacEFT predicts that there would be a 6% decrease in the percentage of years with good spawning availability, measured as weighted usable area, under A2A_LLT relative to NAA (Table 11-2A-49). SacEFT predicts that there would be negligible (<5%) differences between NAA and A2A_LLT in the percentage of years with good (lower) redd scour risk and no (0%) difference in the percentage of years with good (lower) egg incubation conditions. These results indicate that there would be a low effect of Alternative 2A on spawning habitat quantity but no difference in redd scour risk or temperature-related egg incubation conditions.

Table 11-2A-49. Difference and Percent Difference in Percentage of Years with "Good" Conditions for Steelhead Habitat Metrics in the Upper Sacramento River (from SacEFT)

Metric	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Spawning WUA	0 (0%)	-3 (-6%)
Redd Scour Risk	-3 (-4%)	0 (0%)
Egg Incubation	0 (0%)	0 (0%)
Redd Dewatering Risk	0 (0%)	3 (6%)
Juvenile Rearing WUA	-6 (-15%)	-10 (-22%)
Juvenile Stranding Risk	-16 (-47%)	-2 (-10%)

WUA = Weighted Usable Area.

Overall, these results indicate that the effects of Alternative 2A on steelhead spawning and egg incubation habitat in the Sacramento River would be negligible.

Clear Creek

Flows in Clear Creek were examined during the steelhead spawning and egg incubation period (January through April). Flows under A2A_LLT would generally be similar to flows under NAA throughout the period, except in critical years during February (6% lower), below normal years during March (6% lower), and critical years during January (7% higher) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Results of the flow analyses for the risk of redd dewatering for Clear Creek indicate that the greatest monthly flow reduction would be identical between NAA and A2A_LLT for all water year types (Table 11-2A-50).

Table 11-2A-50. Comparisons of Greatest Monthly Reduction (Percent Change) in Instream Flow under Alternative 2A Model Scenarios in Clear Creek during the January–April Steelhead Spawning and Egg Incubation Period[a]

Water Year Type	A2A_LLT vs. EXISTING CONDITIONS	A2A vs. NAA
Wet	-25 (-38%)	0 (0%)
Above Normal	0 (NA)	0 (NA)
Below Normal	0 (NA)	0 (NA)
Dry	0 (NA)	0 (NA)
Critical	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.

[a] Redd dewatering risk not applicable for months when flows during the egg incubation period were at or greater than flows in the month when spawning is assumed to occur. A negative value indicates that the greatest monthly reduction would be of greater magnitude (worse) under the alternative than under the baseline.

No water temperature modeling was conducted in Clear Creek.

Overall, these results indicate that the effects of Alternative 2A on steelhead spawning and egg incubation habitat in Clear Creek would be negligible.

Feather River

Flows were examined in the Feather River low-flow channel (upstream of Thermalito Afterbay) and high-flow channel (at Thermalito Afterbay) during the steelhead spawning and egg incubation period (January through April) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in the low-flow channel under A2A_LLT would not differ from NAA because minimum Feather River flows are included in the FERC settlement agreement and would be met for all model scenarios (California Department of Water Resources 2006). Flows under A2A_LLT at Thermalito Afterbay would generally be similar to or greater than flows under NAA, except in wet and critical years during January (7% and 12% lower, respectively) and in below normal years during March (8% lower).

Oroville Reservoir storage volume at the end of September and end of May influences flows downstream of the dam during the steelhead spawning and egg incubation period. Storage volume at the end of September under A2A_LLT would be similar to or up to 16% greater than storage under NAA depending on water year type (Table 11-2A-25). May Oroville storage under A2A_LLT would be similar to storage under NAA (Table 11-2A-28).

Mean monthly water temperatures in the Feather River low-flow channel (upstream of Thermalito Afterbay) and high-flow channel (at Thermalito Afterbay) were examined during the January through April steelhead spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period at either location.

The percent of months exceeding the 56°F temperature threshold in the Feather River above Thermalito Afterbay (low-flow channel) was evaluated during January through April (Table 11-2A-51). The percent of months exceeding the threshold under Alternative 2A would generally be similar to or lower (up to 14% lower on an absolute scale) than the percent under NAA depending on month and degrees above the threshold.

Table 11-2A-51. Differences between Baseline and Alternative 2A Scenarios in Percent of Months during the 82-Year CALSIM Modeling Period during Which Water Temperatures in the Feather River above Thermalito Afterbay Exceed the 56°F Threshold, January through April

	Degrees Above Threshold				
Month	>1.0	>2.0	>3.0	>4.0	>5.0
EXISTING CONDITIONS vs. A2A_LLT					
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
March	5 (400%)	1 (NA)	1 (NA)	1 (NA)	1 (NA)
April	32 (371%)	14 (275%)	12 (NA)	4 (NA)	0 (NA)
NAA vs. A2A_LLT					
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
March	-4 (-38%)	-1 (-50%)	0 (0%)	0 (0%)	0 (0%)
April	-12 (-23%)	-14 (-42%)	-5 (-29%)	-2 (-40%)	-1 (-100%)

NA = could not be calculated because the denominator was 0.

Total degree-months exceeding 56°F were summed by month and water year type above Thermalito Afterbay (low-flow channel) during January through April (Table 11-2A-52). Total degree-months would be similar between NAA and Alternative 2A in all months.

Table 11-2A-52. Differences between Baseline and Alternative 2A Scenarios in Total Degree-Months (°F-Months) by Month and Water Year Type for Water Temperature Exceedances above 56°F in the Feather River above Thermalito Afterbay, January through April

Month	Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
January	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
February	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
March	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	2 (NA)	0 (0%)
	Dry	3 (NA)	1 (50%)
	Critical	8 (800%)	0 (0%)
	All	13 (1,300%)	1 (8%)
April	Wet	4 (NA)	1 (33%)
	Above Normal	12 (600%)	1 (8%)
	Below Normal	16 (400%)	0 (0%)
	Dry	21 (420%)	-5 (-16%)
	Critical	21 (NA)	-2 (-9%)
	All	73 (664%)	-6 (-7%)

NA = could not be calculated because the denominator was 0.

American River

Flows in the American River at the confluence with the Sacramento River were examined for the January through April steelhead spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would generally be similar to flows under NAA during the period except in dry and critical years during March (6% and 7% lower, respectively) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*.

Mean monthly water temperatures in the American River at the Watt Avenue Bridge were evaluated during the January through April steelhead spawning and egg incubation period ((Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the*

Fish Analysis). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

The percent of months exceeding the 56°F temperature threshold in the American River at the Watt Avenue Bridge was evaluated during November through April (Table 11-2A-41). Steelhead spawn and eggs incubate in the American River between January and April. During this period, the percent of months exceeding the threshold under Alternative 2A would similar to or up to 20% lower (absolute scale) than the percent under NAA.

Total degree-months exceeding 56°F were summed by month and water year type at the Watt Avenue Bridge during November through April (Table 11-2A-42). During the January through April steelhead spawning and egg incubation period, total degree-months would be similar between NAA and Alternative 2A.

Overall, these results indicate that the effects of Alternative 2A on steelhead spawning and egg incubation habitat in the American River would be negligible or beneficial.

San Joaquin River

The mainstem San Joaquin River does not provide habitat for steelhead spawning or egg incubation.

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the January through April steelhead spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT throughout this period would generally be identical to flows under NAA.

Water temperatures throughout the Stanislaus River would be similar under NAA and Alternative 2A throughout the January through April steelhead spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

Mokelumne River

Flows in the Mokelumne River at the Delta were examined during the January through April steelhead spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT throughout this period would generally be identical to flows under NAA.

Water temperature modeling was not conducted in the Mokelumne River.

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because it would not substantially reduce suitable spawning habitat or substantially reduce the number of fish as a result of egg mortality. There would be no substantial effects of Alternative 2A on upstream flows or water temperatures that would affect steelhead spawning and egg incubation in any waterway evaluated. Further, SacEFT predicts no effects of Alternative 2A on steelhead spawning and egg incubation habitat.

CEQA Conclusion: In general, Alternative 2A would not reduce the quantity and quality of steelhead spawning habitat relative to the Existing Conditions.

Sacramento River

Flows in the Sacramento River between Keswick and upstream of Red Bluff Diversion Dam, where the majority of steelhead spawning occurs, were examined during the primary steelhead spawning and egg incubation period of January through April. (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Lower flows can reduce the instream area available for spawning and egg incubation, and rapid reductions in flow can expose redds, leading to mortality. At Keswick, flows under A2A_LLT would generally be similar to flows under Existing Conditions in January, March and April, and higher than flows under Existing Conditions in February with some exceptions. Upstream of Red Bluff Diversion Dam, flows would generally be similar between Existing Conditions and A2A_LLT throughout the period.

Mean monthly water temperatures in the Sacramento River at Keswick and Red Bluff were examined during the January through April primary steelhead spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 2A in any month or water year type throughout the period at either location.

SacEFT predicts no differences in spawning habitat, egg incubation, and redd dewatering risk between Existing Conditions and Alternative 2A, and negligible changes (<5%) in redd scour risk (Table 11-2A-15).

Overall in the Sacramento River, Alternative 2A would have negligible reductions in mean monthly flow (-6%) that would not affect steelhead spawning conditions in a biological meaningful way. SacEFT indicates that steelhead egg incubation and redd survival metrics would not be substantially affected by Alternative 2A. Impacts of Alternative 2A on water temperature would be less than significant.

Clear Creek

Flows in Clear Creek were examined during the steelhead spawning and egg incubation period (January through April). Flows under A2A_LLT would be similar to or greater than flows under Existing Conditions throughout the period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Results of the flow analyses for the risk of redd dewatering for Clear Creek indicate that the greatest monthly flow reduction would be identical between Existing Conditions and A2A_LLT for all water year types except wet, in which the greatest reduction would be 38% lower (worse) under A2A_LLT than under Existing Conditions (Table 11-2A-50).

No water temperature modeling was conducted in Clear Creek.

Overall, these results indicate that the effects of Alternative 2A on steelhead spawning and egg incubation habitat in Clear Creek would be negligible.

Feather River

Flows were examined in the Feather River low-flow channel (upstream of Thermalito Afterbay) and high-flow channel (at Thermalito Afterbay) during the steelhead spawning and egg incubation period (January through April) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in the low-flow channel under A2A_LLT would not differ from Existing Conditions because minimum Feather River flows are included in the FERC settlement agreement and would be met for all model scenarios (California Department of Water Resources 2006). Flows under A2A_LLT at Thermalito Afterbay would generally be similar to or greater than flows under Existing Conditions, except in above and below normal water years during January (36% and 44% lower, respectively), below normal, dry and critical water yeas during February (45%, 11%, and 8% lower, respectively), and below normal and dry water years during March (46% and 5% lower, respectively).

Oroville Reservoir storage volume at the end of September and end of May influences flows downstream of the dam during the steelhead spawning and egg incubation period. Oroville Reservoir storage volume at the end of September would be 7% to 36% lower under A2A_LLT relative to Existing Conditions depending on water year type (Table 11-2A-25). May Oroville storage volume under A2A_LLT would be lower than Existing Conditions by 6% to 21% depending on water year type, except in wet years, in which storage would be similar to Existing Conditions (Table 11-2A-28).

Mean monthly water temperatures in the Feather River low-flow channel (upstream of Thermalito Afterbay) and high-flow channel (at Thermalito Afterbay) were examined during the January through April steelhead spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). In the low-flow channel, mean monthly water temperatures under Alternative 2A would be 5% to 8% greater than those under Existing Conditions during January through March and similar to temperatures under Existing Conditions during April. In the high-flow channel, mean monthly water temperatures under Alternative 2A would be 7% greater than those under Existing Conditions during January and February and similar to temperatures under Existing Conditions during March and April except for below normal and critical years during March (6% greater for both years).

The percent of months exceeding the 56°F temperature threshold in the Feather River above Thermalito Afterbay (low-flow channel) was evaluated during January through April (Table 11-2A-51). The percent of months exceeding the threshold under Alternative 2A would generally be similar to the percent under Existing Conditions during January and February and similar to or up to 32% greater (absolute scale) than the percent under Existing Conditions depending on month and degrees above the threshold during March and April.

Total degree-months exceeding 56°F were summed by month and water year type above Thermalito Afterbay (low-flow channel) during January through April (Table 11-2A-52). Total degree-months would be similar between Existing Conditions and Alternative 2A during January and February and 664% to 1300% higher under Alternative 2A compared to Existing Conditions during March and April.

Overall, these results indicate that there would be negligible effects of Alternative 2A on mean monthly flows in the low-flow channel, but that flows in the high-flow channel would be substantially lower in some water year types and months. Alternative 2A would substantially increase exposure of spawning steelhead and their eggs to critical water temperatures, a result of reduced coldwater pool availability in Oroville Reservoir.

American River

Flows in the American River at the confluence with the Sacramento River were examined for the January through April steelhead spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would generally be lower than flows under Existing Conditions during January, greater than flows under Existing Conditions during February and March, and similar to flows under Existing Conditions during April with some exceptions. Mean monthly water temperatures in the American River at the Watt Avenue Bridge were evaluated during the January through April steelhead spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperature under Alternative 2A would be 5% to 7% higher than those under Existing Conditions during the period.

The percent of months exceeding the 56°F temperature threshold in the American River at the Watt Avenue Bridge was evaluated during November through April (Table 11-2A-41). Steelhead spawn and eggs incubate in the American River between January and April. During January and February, the percent of month exceeding the threshold under Existing Conditions and Alternative 2A would be identical. During March and April, the percent of months exceeding the threshold under Alternative 2A would be up to 31% greater (absolute scale) than the percent under Existing Conditions.

Total degree-months exceeding 56°F were summed by month and water year type at the Watt Avenue Bridge during November through April (Table 11-2A-42). During the January and February, there would be no difference in total degree-months above the threshold between Existing Conditions and Alternative 2A. During March and April, total degree-months under Alternative 2A would be 389% and 94% greater than those under Existing Conditions, respectively.

Overall, these results indicate that the effects of Alternative 2A on flows would not be negative. Flows would be mostly greater than flows under Existing Conditions and temperatures would not differ from Existing Conditions. However, Alternative 2A would substantially increase exposure of spawning steelhead and their eggs to critical water temperatures.

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the January through April steelhead spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT throughout this period would be up to 36% lower flows under Existing Conditions in all months with few exceptions.

Water temperatures in the Stanislaus River at the confluence with the San Joaquin River was evaluated during the January through April steelhead spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under Alternative 2A would be 6% higher than those under Existing Conditions in all months.

San Joaquin River

The mainstem San Joaquin River does not provide habitat for steelhead spawning or egg incubation.

Mokelumne River

Flows in the Mokelumne River at the Delta were examined during the January through April steelhead spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would generally be similar to or up to 18% higher than flows under Existing Conditions during January through March and up to 14% lower during April.

Water temperature modeling was not conducted in the Mokelumne River.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-94 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 2A could be significant because, when compared to the CEQA baseline, the alternative could substantially reduce suitable spawning habitat or substantially reduce the number of fish as a result of egg mortality, contrary to the NEPA conclusion set forth above.

Alternative 2A substantial reductions in mean monthly flow in the Stanislaus River and increased exposure to elevated water temperatures in the Feather, American, and Stanislaus Rivers. There would be beneficial effects due to moderate increases in mean monthly flow for specific months and water year types in Clear Creek and the American River, primarily in wetter water year types, and in the Feather River primarily during wetter water years but also in drier water year types in April. These would not offset the negative effects of the more persistent and/or substantial flow reductions. There would be no effects in the Sacramento River.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 2A does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 2A indicates that flows and reservoir storage in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 2A. This indicates that the differences between Existing Conditions and Alternative 2A found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 2A, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on spawning and egg incubation habitat for steelhead salmon. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-95: Effects of Water Operations on Rearing Habitat for Steelhead

In general, Alternative 2A would reduce the quantity and quality of steelhead rearing habitat relative to NAA.

Sacramento River

Juvenile steelhead rear within the Sacramento River for 1 to 2 years before migrating downstream to the ocean. Lower flows can reduce the instream area available for rearing and rapid reductions in flow can strand fry or juveniles leading to mortality. Year-round Sacramento River flows within the reach where the majority of steelhead spawning and juvenile rearing occurs (Keswick Dam to upstream of RBDD) were evaluated (Appendix 11C, *CALSIM II Model Results utilized in the Fish*

Analysis). Flows during September, October, and between December and July under A2A_LLT would generally be similar to or greater than those under NAA. Flows during August and November would generally be lower under A2A_LLT than under NAA.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the year-round steelhead juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period at either location.

SacEFT predicts that the percentage of years with good juvenile steelhead rearing WUA conditions under A2A_LLT would be 22% lower (10% on absolute scale) than that under NAA (Table 11-2A-49). Also, the percentage of years with good (lower) juvenile stranding risk conditions under A2A_LLT would be 10% lower (2% on absolute scale)than under NAA. These results indicate that Alternative 2A would cause a small decrease in rearing habitat availability in the Sacramento River.

Overall, these results indicate that Alternative 2A would reduce juvenile rearing conditions in the Sacramento River.

Clear Creek

Flows in Clear Creek below Whiskeytown during the year-round steelhead rearing period under A2A_LLT would generally be similar to or greater than flows under NAA, except for critical years in February and June and below normal years in March in which flows would be 6% to 8% lower (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).Water temperatures were not modeled in Clear Creek.

It was assumed that habitat for juvenile steelhead rearing would be constrained by the month having the lowest instream flows. Juvenile rearing habitat is assumed to increase as instream flows increase, and therefore the lowest monthly instream flow was used as an index of habitat constraints for juvenile rearing. Results of the analysis indicate that juvenile steelhead rearing habitat, based on minimum instream flows, is comparable for Alternative 2A relative to NAA in wet, above normal, and critical water year types (Table 11-2A-53). Minimum flows would be 86% higher in below normal years and 100% lower (reduction from 7 cfs to 0 cfs) in dry water years.

Table 11-2A-53. Difference (cfs) and Percent Difference in Minimum Monthly Mean Flow in Clear Creek during the Year-Round Juvenile Steelhead Rearing Period

Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wet	0 (0%)	0 (0%)
Above Normal	0 (0%)	0 (0%)
Below Normal	15 (21%)	39 (86%)
Dry	-50 (-100%)	-7 (-100%)
Critical	-50 (-100%)	0 (NA)

Note: Minimum flows occurred between October and March.
NA = could not be calculated because the denominator was 0.

Denton (1986) developed flow recommendations for steelhead in Clear Creek using IFIM (Figure 11-1A-4). The current Clear Creek management regime uses flows slightly lower than those recommended by Denton. Results from a new IFIM study on Clear Creek are currently being analyzed. Depending on results of this study the flow regime could be adjusted in the future. We expect that the modeled flows will be suitable for the existing steelhead populations in Clear Creek. No change in effect on steelhead in Clear Creek is anticipated.

Overall, these results indicate that Alternative 2A would not affect juvenile rearing conditions in Clear Creek.

Feather River

Year-round flows in the Feather River both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were reviewed to determine flow-related effects on steelhead juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). The low-flow channel is the primary reach of the Feather River utilized by steelhead spawning and rearing (Cavallo et al. 2003). Relatively constant flows in the low flow channel throughout the year under A2A_LLT would not differ from those under NAA. In the high flow channel, flows under A2A_LLT would be mostly lower (up to 50%) during July, August, November, December, and February and mostly similar to or greater (up to 217%) than flows under Existing Conditions in other months.

May Oroville storage under A2A_LLT would be similar to storage under NAA (Table 11-2A-28). September Oroville storage volume would be similar to or up to 5% lower than under NAA depending on water year type (Table 11-2A-25).

Mean monthly water temperatures in the Feather River in both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were examined during the year-round steelhead juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis).* There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period at either location.

An additional analysis evaluated the percent of months exceeding a 63°F temperature threshold in the Feather River above Thermalito Afterbay (low-flow channel) (May through August) and exceeding a 56°F threshold at Gridley (October through April) for each model scenario. In the low-flow channel, the percent of months exceeding the threshold under Alternative 2A would generally be similar to or lower (up to 23% lower on an absolute scale) than the percent under NAA (Table 11-2A-29). At Gridley, the percent of months exceeding the threshold under Alternative 2A would similar to or up to 11% lower (absolute scale) than the percent under NAA (Table 11-2A-38).

Total degree-months exceeding 56°F were summed by month and water year type in the Feather River above Thermalito Afterbay (low-flow channel) and at Gridley during November through April. In the low-flow channel, total degree-months under Alternative 2A would be similar to or lower than those under NAA depending on the month (Table 11-2A-30). At Gridley, total degree-months would be similar between NAA and Alternative 2A for December through February, while for October through April degree-months would be 6% to 33% lower under Alternative 2A (Table 11-2A-39).

Overall, these results indicate that there would be effects of Alternative 2A on flows during the juvenile steelhead rearing period in the Feather River.

American River

Flows in the American River at the confluence with the Sacramento River were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would generally be similar to flows under NAA during January through April and October through December, greater than flows under NAA during May and June, and lower than flows under NAA during July through September.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River and the Watt Avenue Bridge were examined during the year-round steelhead rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

The percent of months exceeding a 65°F temperature threshold in the American River at the Watt Avenue Bridge was evaluated during May through October (Table 11-2A-54). During May, June, and October, the percent of months exceeding the threshold under Alternative 2A would similar to or up to 23% lower (absolute scale) than the percent under NAA. During July through September, the percent of months exceeding the threshold would mostly be similar between NAA and Alternative 2A with three degree categories in which there would be decreases of up to 6% on an absolute scale in percent of months exceeding the threshold under Alternative 2A and one degree category in which there would be an increase of 6% on the absolute scale.

Total degree-months exceeding 65°F were summed by month and water year type at the Watt Avenue Bridge during May through October (Table 11-2A-55). During May, June, and October, total degree-months would be similar between NAA and Alternative 2A or up to 14% lower under Alternative 2A. During July through September, there would be 2% to 7% increases in total degree-months exceeding the threshold.

Table 11-2A-54. Differences between Baseline and Alternative 2A Scenarios in Percent of Months during the 82-Year CALSIM Modeling Period during Which Water Temperatures in the American River at the Watt Avenue Bridge Exceed the 65°F Threshold, May through October

	Degrees Above Threshold				
Month	>1.0	>2.0	>3.0	>4.0	>5.0
EXISTING CONDITIONS vs. A2A_LLT					
May	33 (169%)	26 (175%)	20 (178%)	14 (220%)	6 (125%)
June	33 (52%)	33 (63%)	17 (42%)	11 (36%)	10 (47%)
July	0 (0%)	1 (1%)	31 (49%)	36 (100%)	38 (221%)
August	0 (0%)	2 (3%)	19 (23%)	51 (105%)	65 (212%)
September	15 (17%)	41 (77%)	53 (165%)	54 (338%)	47 (633%)
October	73 (1,475%)	47 (1,900%)	36 (NA)	20 (NA)	11 (NA)
NAA vs. A2A_LLT					
May	-11 (-17%)	-9 (-18%)	-9 (-22%)	-12 (-38%)	-6 (-36%)
June	-1 (-1%)	-5 (-5%)	-23 (-29%)	-23 (-36%)	-17 (-36%)
July	0 (0%)	0 (0%)	-4 (-4%)	0 (0%)	0 (0%)
August	0 (0%)	0 (0%)	0 (0%)	2 (3%)	6 (7%)
September	0 (0%)	-4 (-4%)	0 (0%)	-4 (-5%)	-6 (-10%)
October	-2 (-3%)	-16 (-25%)	-10 (-22%)	-10 (-33%)	0 (0%)

NA = could not be calculated because the denominator was 0.

Table 11-2A-55. Differences between Baseline and Alternative 2A Scenarios in Total Degree-Months (°F-Months) by Month and Water Year Type for Water Temperature Exceedances above 65°F in the American River at the Watt Avenue Bridge, May through October

Month	Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
May	Wet	20 (333%)	-1 (-4%)
	Above Normal	21 (NA)	-6 (-22%)
	Below Normal	17 (567%)	-6 (-23%)
	Dry	22 (100%)	-12 (-21%)
	Critical	33 (174%)	1 (2%)
	All	113 (226%)	-24 (-13%)
June	Wet	45 (265%)	-23 (-27%)
	Above Normal	19 (79%)	-13 (-23%)
	Below Normal	27 (93%)	-11 (-16%)
	Dry	34 (50%)	-6 (-6%)
	Critical	46 (92%)	-4 (-4%)
	All	170 (90%)	-58 (-14%)
July	Wet	56 (72%)	7 (6%)
	Above Normal	13 (48%)	7 (21%)
	Below Normal	28 (82%)	7 (13%)
	Dry	63 (102%)	12 (11%)
	Critical	46 (57%)	0 (0%)
	All	207 (73%)	34 (7%)
August	Wet	104 (132%)	-4 (-2%)
	Above Normal	37 (90%)	4 (5%)
	Below Normal	52 (93%)	15 (16%)
	Dry	95 (140%)	14 (9%)
	Critical	69 (87%)	5 (3%)
	All	356 (110%)	33 (5%)
September	Wet	80 (333%)	6 (6%)
	Above Normal	42 (263%)	6 (12%)
	Below Normal	49 (175%)	2 (3%)
	Dry	81 (193%)	-5 (-4%)
	Critical	53 (108%)	0 (0%)
	All	305 (192%)	9 (2%)
October	Wet	49 (4,900%)	-5 (-9%)
	Above Normal	27 (NA)	1 (4%)
	Below Normal	37 (NA)	-2 (-5%)
	Dry	37 (NA)	0 (0%)
	Critical	30 (600%)	0 (0%)
	All	179 (2,983%)	-7 (-4%)

NA = could not be calculated because the denominator was 0.

Overall, these results indicate that effects of Alternative 2A on juvenile steelhead rearing habitat in the American River would be biologically meaningful during summer months.

Stanislaus River

Flows in the Stanislaus River under Alternative 2A would not differ from those under NAA throughout the year (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*.

Mean monthly water temperatures throughout the Stanislaus River would be similar under NAA and Alternative 2A throughout the year-round period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

San Joaquin River

Flows in the San Joaquin River under Alternative 2A would not differ from those under NAA throughout the year (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Flows in the Mokelumne River under Alternative 2A would not differ from those under NAA throughout the year (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*.

Water temperature modeling was not conducted in the Mokelumne River.

NEPA Effects: Collectively, it is concluded that the effect of Alternative 2A is adverse relative to NAA because it has the potential to substantially reduce rearing habitat. There would be small to moderate reductions in flows during substantial portions of the juvenile steelhead rearing period in the Sacramento, Feather, and American rivers. SacEFT predicts a small reduction in rearing habitat availability in the Sacramento River. There would be no effect on water temperatures in these rivers. Further, there would be no change in flows in any other river or on water temperature in the Stanislaus River.

CEQA Conclusion: In general, Alternative 2A would reduce the quantity and quality of steelhead rearing habitat relative to Existing Conditions.

Sacramento River

Year-round Sacramento River flows within the reach where the majority of steelhead spawning and juvenile rearing occurs (Keswick Dam to upstream of RBDD) were evaluated (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows during October and between December and July under A2A_LLT would generally be similar to or greater than those under Existing Conditions. Flows during August, September and November would generally be lower under A2A_LLT than under Existing Conditions.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the year-round steelhead juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). At both locations, mean monthly water temperatures under Alternative 2A would generally be similar to those under Existing Conditions, except during July through October, in which there would be 5% to 10% higher temperatures under Alternative 2A.

SacEFT predicts that there would be a 15% decrease in the percentage of years with good rearing availability, measured as weighted usable area, under A2A_LLT relative to Existing Conditions (Table 11-2A-49). SacEFT predicts that there would be a substantial reduction (-47%) in the number of years with good (lower) juvenile stranding risk under A2A_LLT relative Existing Conditions.

Overall, these results indicate that Alternative 2A would have biologically meaningful effects on juvenile rearing success in the Sacramento River. Alternative 2A would cause small reductions in mean monthly flows during three months of the year and SacEFT predicts that juvenile habitat area would be reduced and stranding risk would be substantially increased by 47% Water temperatures would be higher during 4 of 12 months.

Clear Creek

Flows in Clear Creek during the year-round rearing period under A2A_LLT would generally be similar to or greater than flows under Existing Conditions, except for critical years in February and August through December in which flows would be 6% to 29% lower (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Water temperatures were not modeled in Clear Creek.

Juvenile rearing habitat is assumed to increase in Clear Creek as instream flows increase, and therefore the use of the lowest monthly instream flow as an index of habitat constraints for juvenile rearing was selected for use in this analysis. Results of the analysis of minimum monthly instream flows affecting juvenile rearing habitat are shown in Table 11-2A-53. Results indicate that Alternative 2A would have no effect on juvenile rearing habitat, based on minimum instream flows, compared to Existing Conditions in wet and above normal water years. Minimum flows would be 21% greater in below normal years and 100% lower in dry and critical years (reduction from 50 cfs to 0 cfs.

Denton (1986) developed flow recommendations for steelhead in Clear Creek using IFIM (Figure 11-1A-4). The current Clear Creek management regime uses flows slightly lower than those recommended by Denton. Results from a new IFIM study on Clear Creek are currently being analyzed. Depending on results of this study the flow regime could be adjusted in the future. We expect that the modeled flows will be suitable for the existing steelhead populations in Clear Creek. No change in effect on steelhead in Clear Creek is anticipated.

Overall in Clear Creek, Alternative 2A would result in no biologically meaningful changes in mean monthly flow that would affect juvenile rearing habitats.

Feather River

The low-flow channel is the primary reach of the Feather River utilized by steelhead spawning and rearing (Cavallo et al. 2003). There would be no change in flows for Alternative 2A relative to Existing Conditions in the low-flow channel during the year-round steelhead juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). In the high flow channel (at Thermalito Afterbay), flows under A2A_LLT would be mostly lower (up to 50%) during February July, August, November, and December, and mostly similar to or greater (up to 217%) than flows under Existing Conditions in other months.

May Oroville storage volume under A2A_LLT would be lower than Existing Conditions by 6% to 21% depending on water year type, except in wet years, in which storage would be similar to Existing Conditions (Table 11-2A-28).

As reported in Impact AQUA-58 for spring-run Chinook salmon, September Oroville storage volume would be 7% to 36% lower under A2A_LLT relative to Existing Conditions depending on water year type (Table 11-2A-25).

Mean monthly water temperatures in the Feather River in both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were examined during the year-round steelhead juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). In the low-flow channel, mean monthly water temperatures under Alternative 2A would be similar to those under Existing Conditions between April and August, but would be 5% to 10% higher between October and March. In the high-flow channel, mean monthly water temperatures under Alternative 2A would be similar to those under Existing Conditions between April through June and September, but would be 5% to 9% higher in the remaining eight months.

An additional analysis evaluated the percent of months exceeding a 63°F temperature threshold in the Feather River above Thermalito Afterbay (low-flow channel) (May through August) and exceeding a 56°F threshold at Gridley (October through April) for each model scenario. In the low-flow channel, the percent of months exceeding the threshold under Alternative 2A would generally be similar to the percent under Existing Conditions during May, and similar or up to 51% (absolute scale) higher than the percent under Existing Conditions during June through August (Table 11-2A-29). At Gridley, the percent of months exceeding the threshold under Alternative 2A would similar to the percent under Existing Conditions during December through February, but similar to or up to 47% greater (absolute scale) than the percent under Existing Conditions in the remaining 4 months (Table 11-2A-38).

Total degree-months exceeding 56°F were summed by month and water year type in the Feather River above Thermalito Afterbay (low-flow channel) (May through August) at Gridley during October through April. In the low-flow channel, total degree-months under Alternative 2A would be similar to those under Existing Conditions during May and 51% to 159% higher during June through August (Table 11-2A-30). At Gridley, total degree-months under Alternative 2A would be similar to those under Existing Conditions during December through and February and 18% to 2500% greater than those under Existing Conditions in the remaining months of the period (Table 11-2A-39).

Overall, these results indicate that Alternative 2A would affect juvenile steelhead rearing conditions in the Feather River. Fish rearing in the high-low channel would experience lower flows during multiple months and fish rearing in both the low- and high-flow channels would experience increased exceedances of water temperature thresholds.

American River

Flows in the American River at the confluence with the Sacramento River were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would be up to 27% greater than to flows under Existing Conditions during February March, and June, similar to flows under Existing Conditions during April and October, and up to 56% lower than flows under Existing Conditions during the remaining seven months of the year.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River and the Watt Avenue Bridge were examined during the year-round steelhead rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results* *utilized in the Fish Analysis*). There would be temperature increases (>5%) of 5% to 13% in most water year types in most months although only in one water year in June and in two water years in July between Existing Conditions and Alternative 2A.

The percent of months exceeding a 65°F temperature threshold in the American River at the Watt Avenue Bridge was evaluated during May through October (Table 11-2A-54). In comparison to Existing Conditions the temperatures would be exceeded under Alternative 2A in all degree categories in all months (by 2% to 73% on the absolute scale) except for the > 1°F category during July and August.

Total degree-months exceeding 65°F were summed by month and water year type at the Watt Avenue Bridge during May through October (Table 11-2A-55). During all months, total degree-months would be higher under Alternative 2A compared to Existing Conditions by 48% to 4900%.

Overall, these results indicate that there would be substantial effects of Alternative 2A on juvenile steelhead rearing habitat in the American River during many months of the year.

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). There would be flow reductions (up to 36%) under Alternative 2A relative to Existing Conditions in all months.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were evaluated during the year-round juvenile steelhead rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under Alternative 2A would be 5% to 6% higher in all months except June, July, and October.

San Joaquin River

Flows in the San Joaquin River at Vernalis were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under Alternative 2A would be 5% to 33% lower than flows under Existing Conditions during March through October, similar to flows under Existing Conditions during November through February. Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Flows in the Mokelumne River at the Delta were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under Alternative 2A would be similar to flows under Existing Conditions during March, up to 14% greater than flows under Existing Conditions during December through February, and up to 46% lower than flows under Existing Conditions during April through November.

Water temperature modeling was not conducted in the Mokelumne River.

Summary of CEQA Conclusion

Collectively, the results indicate that the effect is significant because the alternative could substantially reduce juvenile rearing habitat. Alternative 2A would cause reduced juvenile steelhead rearing habitat conditions based primarily on flow reductions in the Sacramento, Feather, American, Stanislaus, San Joaquin, and Mokelumne rivers and degraded temperature conditions in the Sacramento, Feather, American, and Stanislaus Rivers. These flow reductions and temperature increases would affect the quantity and quality of juvenile rearing habitat and would contribute to reduced survival and increased stress.

Alternative 2A would cause reduced juvenile steelhead rearing habitat conditions in each of the rivers analyzed, based on flow reductions, particularly in drier water year types, in much of the year and increased exposure to water temperatures above critical thresholds in the Feather River. These flow reductions and temperature increases would affect the quantity and quality of juvenile rearing habitat and would contribute to reduced survival and increased stress, particularly in drier water years. This impact is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this impact to a less-than-significant level would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this impact is significant and unavoidable because there is no feasible mitigation available. Even so, proposed below is mitigation that has the potential to reduce the severity of impact though not necessarily to a less-than-significant level.

Mitigation Measure AQUA-95a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Steelhead to Determine Feasibility of Mitigation to Reduce Impacts to Rearing Habitat.

Although analysis conducted as part of the EIR/EIS determined that Alternative 2A would have significant and unavoidable adverse effects on rearing habitat, this conclusion was based on the best available scientific information at the time and may prove to have been overstated. Upon the commencement of operations of CM1 and continuing through the life of the permit, the BDCP proponents will monitor effects on rearing habitat in order to determine whether such effects would be as extensive as concluded at the time of preparation of this document and to determine any potentially feasible means of reducing the severity of such effects. This mitigation measure requires a series of actions to accomplish these purposes, consistent with the operational framework for Alternative 2A.

The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 2A operations only. Development of mitigation actions for the incremental impact on rearing habitat attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 2A.

Mitigation Measure AQUA-95b: Conduct Additional valuation and Modeling of Impacts on Steelhead Rearing Habitat Following Initial Operations of CM1.

Following commencement of initial operations of CM1 and continuing through the life of the permit, the BDCP proponents will conduct additional evaluations to define the extent to which modified operations could reduce impacts to rearing habitat under Alternative 2A. The analysis required under this measure may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6).

Mitigation Measure AQUA-95c: Consult with NMFS, USFWS and CDFW to Identify Potentially Feasible Means to Minimize Effects on Steelhead Habitat Consistent with CM1

In order to determine the feasibility of reducing the effects of CM1 operations on steelhead habitat, the BDCP proponents will consult with NMFS, USFWS and CDFW to identify any feasible operational means to minimize effects on rearing habitat. Any such action will be developed in conjunction with the ongoing monitoring and evaluation of habitat conditions required by Mitigation Measure AQUA-95a.

If feasible means are identified to reduce impacts on rearing habitat consistent with the overall operational framework of Alternative 2A without causing new significant adverse impacts on other covered species, such means shall be implemented. If sufficient operational flexibility to reduce effects on steelhead habitat is not feasible under Alternative 2A operations, achieving further impact reduction pursuant to this mitigation measure would not be feasible under this Alternative, and the impact on steelhead would remain significant and unavoidable.

Impact AQUA-96: Effects of Water Operations on Migration Conditions for Steelhead

In general, Alternative 2A would reduce steelhead migration conditions relative to NAA.

Upstream of the Delta

Sacramento River

Juveniles

Flows in the Sacramento River upstream of Red Bluff were evaluated during the October through May juvenile steelhead migration period. Flows under A2A_LLT would be 5% to 17% lower than flows under NAA during October depending on water year type and would be up to 13% higher during May (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT in the remaining six months of the migration period would be similar to flows under NAA.

Mean monthly water temperatures in the Sacramento River upstream of Red Bluff were evaluated during the October through May juvenile steelhead migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

Adults

Flows in the Sacramento River upstream of Red Bluff were evaluated during the September through March steelhead adult upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would be 5% to 17% lower than flows under NAA during October depending on water year type and similar to flows under NAA in the remaining six months of the period.

Mean monthly water temperatures in the Sacramento River upstream of Red Bluff were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period

Kelts

Flows in the Sacramento River upstream of Red Bluff were evaluated during the March and April steelhead kelt (post-spawning adult) downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows during these two months would not differ between NAA and A2A_LLT.

Mean monthly water temperatures in the Sacramento River upstream of Red Bluff were evaluated during the March through April steelhead kelt downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period

Overall, these results indicate that juvenile, adult, or kelt steelhead migration conditions in the Sacramento River would not be affected by Alternative 2A.

Clear Creek

Water temperatures were not modeled in Clear Creek.

Juveniles

Flows in Clear Creek during the October through May juvenile steelhead migration period under A2A_LLT would generally be similar to or greater than flows under NAA except in critical years during February (6% lower), and in below normal years in March (6% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Adults

Flows in Clear Creek during the September through March adult steelhead migration period under A2A_LLT would generally be similar to flows under NAA except in critical years during February (6% lower), and in below normal years in March (6% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Kelt

Flows in Clear Creek during the March through April steelhead kelt downstream migration period under A2A_LLT would generally be similar to flows under NAA except in below normal years in March (6% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Overall, these results indicate that juvenile, adult, or kelt steelhead migration conditions in Clear Creek would not be affected by Alternative 2A.

Feather River

Juveniles

Flows in the Feather River at the confluence with the Sacramento River were examined during the October through May juvenile steelhead migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would be similar to or greater than flows under NAA in all months and water years except during November in above normal years (8% lower).

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were evaluated during the October through May juvenile steelhead migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

Adults

Flows in the Feather River at the confluence with the Sacramento River were examined during the September through March adult steelhead upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would be up to 33% lower than flows under NAA during September, up to 32% higher than flows under NAA during October, and generally similar to flows under NAA in the remaining five months of the period.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period

Kelt

Flows in the Feather River at the confluence with the Sacramento River were examined during the March and April steelhead kelt downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would be similar to those under NAA in March and up to 20% greater than flows under NAA in April.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were evaluated during the March through April steelhead kelt downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

Overall, these results indicate that there would be negligible effects of Alternative 2A on steelhead juvenile, adult, and kelt migration conditions. There would be some flow-based beneficial effects in some months.

American River

Juveniles

Flows in the American River at the confluence with the Sacramento River were evaluated during the October through May juvenile steelhead migration period. Flows under A2A_LLT would generally be similar to flows under NAA except in wet and above normal water years during October (10% and 7% lower, respectively), critical water years during November (9% lower), and dry and critical water years during March (6% and 7% lower, respectively) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were evaluated during the October through May juvenile steelhead migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

Adults

Flows in the American River at the confluence with the Sacramento River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would be up to 19% lower depending on water year type than flows under NAA during September and generally similar to flows under NAA in the remaining six months of the period.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

Kelt

Flows in the American River at the confluence with the Sacramento River were evaluated for the March and April kelt migration period. Flows under A2A_LLT would generally be similar to flows under NAA except in dry and critical years during March (6% and 7% lower, respectively) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were evaluated during the March through April steelhead kelt downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

Overall in the American River, these results indicate that Alternative 2A would not affect juvenile, adult, or kelt steelhead migration in a biologically meaningful way.

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River for Alternative 2A are not different from flows under NAA for any month. Therefore, there would be no effect of Alternative 2A on juvenile, adult, or kelt migration in the Stanislaus River.

Further, mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River for Alternative 2A are not different from flows under NAA for any month. Therefore, there would be no effect of Alternative 2A on juvenile, adult, or kelt migration in the Stanislaus River.

San Joaquin River

Flows in the San Joaquin River at Vernalis for Alternative 2A are not different from flows under NAA for any month. Therefore, there would be no effect of Alternative 2A on juvenile, adult, or kelt migration in the San Joaquin River.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Flows in the Mokelumne River at the Delta for Alternative 2A are not different from flows under NAA for any month. Therefore, there would be no effect of Alternative 2A on juvenile, adult, or kelt migration in the Mokelumne River.

Water temperature modeling was not conducted in the Mokelumne River.

Through-Delta

The approach for steelhead impact assessment is similar to that for Chinook salmon (see Impact AQUA-42 above for description of the approach). Although steelhead have a similar life history to salmon, there are a few marked differences: juvenile steelhead spend from 1 to 3 years rearing in upstream habitats and migrate downstream as larger juveniles (usually >200 mm) compared to Chinook salmon, and adults do not necessarily die after spawning but can return to the ocean to grow and reproduce again. Adults can return one to three times before dying. The post-spawned adult life stage is termed a kelt and is unique to steelhead.

Overall, juvenile steelhead can be found in the Delta during most months of the year, but the outmigration spans from October through May with a peak outmigration period in February and March. Adult steelhead can also be found in the Delta almost year round with the adult upstream migration from September through March with a peak December through February. The kelt outmigration follows on the upstream migration and spawning and therefore is January through April. Olfactory cues for upstream migrating adults were assessed using fingerprinting analysis to estimate the percentage of source water from the Sacramento and San Joaquin Rivers

Sacramento River

Juveniles

Flows in the Sacramento River below the north Delta intakes during the juvenile steelhead migration period (October through May) under Alternative 2A would be similar to NAA. Juvenile steelhead and juvenile winter-run Chinook salmon migrate downstream during the same months and would be exposed to similar conditions. As discussed above in Impact AQUA-42, the five north Delta intakes structures of Alternative 1A would increase potential predation loss of migrating juvenile salmonids and would displace 22 acres of aquatic habitat. However, juvenile steelhead would be less vulnerable than winter-run Chinook salmon to predation associated with the intake facilities because of their greater size and strong swimming ability.

Adults

For Sacramento River steelhead, straying rates of adult hatchery-origin Chinook salmon that were released upstream of the Delta are low (Marston et al. 2012). Although straying rates for hatchery-origin steelhead apparently have not been examined in detail, for this analysis of effects, it was assumed with high certainty (based on Chinook salmon rates), that Plan Area flows in relation to straying have low importance under Existing Conditions for adult Sacramento River region steelhead.

As assessed by DSM2 fingerprinting analysis, the average percentage of Sacramento River–origin water at Collinsville was always slightly lower under Alternative 2A than for NAA during the September-March steelhead upstream migration period. Attraction flow, as estimated by the percentage of Sacramento River water at Collinsville, under Alternative 2A increased 13% in September and declined 1% to 9% during the October to March migration period for steelhead adults (Table 11-2A-56). The reductions in percentage are small in comparison with the magnitude of change in dilution reported to cause a significant change in migration by Fretwell (1989) and, therefore, are not expected to affect winter-run migration. While the proportion of Sacramento River flows would be reduced under Alternative 2A, the Sacramento River would still represent a substantial 62% to 78% of Delta flows and olfactory cues would still be strong for upstream migrating adults. However, uncertainty remains with regard to adult salmon behavioral response to anticipated changes in lower Sacramento River flow percentages. For further discussion of the topic see the analysis for Alternative 1A.

Table 11-2A-56. Summary of Finger Printing Analysis of the Percentage (%) of Water at Collinsville that Originated in the Sacramento River and San Joaquin River during the Steelhead Migration Period for Alternative 2A

	Percentage of Water			Difference	
Month	EXISTING CONDITIONS	NAA	A2A_LLT	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Sacramento River					
September	60	65	78	18	13
October	60	68	67	7	-1
November	60	66	62	2	-4
December	67	66	65	-2	-1
January	76	75	73	-3	-2
February	75	72	67	-8	-5
March	78	76	67	-11	-9
San Joaquin River					
September	0.3	0.1	1.3	1.0	1.2
October	0.2	0.3	3.6	3.4	3.3
November	0.4	1.0	5.4	5.0	4.4
December	0.9	1.0	3.0	2.1	2.0
January	1.6	1.7	3.2	1.6	1.5
February	1.4	1.5	3.8	2.4	2.3
March	2.6	2.8	6.1	3.5	3.3
	Shading indicates 10% or greater difference in flow proportion.				

San Joaquin River

Juveniles

The only changes on San Joaquin River flows at Vernalis would result from the modeled effects of climate change on inflows to the river downstream of Friant Dam and reduced tributary inflows. There no flow changes associated with the Alternatives. Alternative 2A would have no effect on steelhead migration success through the Delta.

Adults

Little information currently exists as to the importance of Plan Area flows on the straying of adult San Joaquin River region steelhead, in contrast to San Joaquin River fall-run Chinook salmon (Marston et al. 2012). Although information specific to steelhead is not available, for this analysis of effects, it was assumed with moderate certainty that the attribute of Plan Area flows (including olfactory cues associated with such flows) is of high importance to adult San Joaquin River region steelhead adults as well.

The percentage of water at Collinsville that originated from the San Joaquin River during the fall-run migration period (September to December) is small, typically 0.1% to less than 3% under NAA. Alternative 2A operations conditions would incrementally increase olfactory cues associated with the San Joaquin River, which would benefit adult steelhead migrating to the San Joaquin River.

Based on DPM results for Chinook salmon, the survival of juvenile steelhead through the Delta is not expected to decrease more than 1% (Impact AQUA-42 for Alternative 2A). Therefore, Alternative 2A would not negatively affect juvenile steelhead migration though the Delta. Based on expected Sacramento and San Joaquin River flows, adult steelhead olfactory cues and flows would be about the same for Alternatives 1A and 2A, resulting in similar impacts to adult steelhead upstream migration and kelt downstream migration. Therefore, Alternative 2A would not have a negative effect on adult, juvenile, or kelt steelhead migration through the Delta.

NEPA Effects: Overall, the results indicate that the effect of Alternative 2A is adverse due to the cumulative effects associated with five north Delta intake facilities, including mortality related to near-field effects (e.g. impingement and predation) and far-field effects (reduced survival due to reduced flows downstream of the intakes) associated with the five NDD intakes.

Upstream of the Delta, flow and water temperature conditions during juvenile, adult, and kelt steelhead migration periods under Alternative 2A would generally be similar to those under Existing Conditions in all rivers examined.

Adult attraction flows in the Delta under Alternative 2A would be lower than those under NAA, but adult attraction flows are expected to be adequate to provide olfactory cues for migrating adults.

Near-field effects of Alternative 2A NDD on steelhead from the Sacramento River and tributaries related to impingement and predation associated with five new intakes could result in substantial effects on juvenile migrating steelhead, although there is high uncertainty regarding the potential effects. Estimates within the effects analysis range from very low levels of effects (<2% mortality) to very significant effects (~ 19% mortality above current baseline levels). CM15 would be implemented with the intent of providing localized and temporary reductions in predation pressure at the NDD. Additionally, several pre-construction surveys to better understand how to minimize losses associated with the five new intake structures will be implemented as part of the final NDD screen design effort. Alternative 2A also includes an Adaptive Management Program and Real-Time Operational Decision-Making Process to evaluate and make limited adjustments intended to provide adequate migration conditions for steelhead. However, at this time, due to the absence of comparable facilities anywhere in the lower Sacramento River/Delta, the degree of mortality expected from near-field effects at the NDD remains highly uncertain.

Two recent studies (Newman 2003 and Perry 2010) indicate that far-field effects associated with the new intakes could cause a reduction in smolt survival in the Sacramento River downstream of the NDD intakes due to reduced flows in this area. The analyses of other elements of Alternative 2A predict improvements in smolt condition and survival associated with increased access to the Yolo Bypass, reduced interior Delta entry, and reduced south Delta entrainment. The overall magnitude of each of these factors and how they might interact and/or offset each other in affecting salmonid survival through the plan area is uncertain, and remains an area of active investigation for the BDCP.

The DPM is a flow-based model being developed for BDCP which attempts to combine the effects of all of these elements of BDCP operations and conservation measures to predict smolt migration survival throughout the entire Plan Area. The current draft of this model predicts that smolt migration survival under Alternative 2A would be similar to survival rates estimated for NAA. Further refinement and testing of the DPM, along with several ongoing and planned studies related to salmonid survival at and downstream of the NDD are expected to be completed in the foreseeable future. These efforts are expected to improve our understanding of the relationships and interactions among the various factors affecting salmonid survival, and reduce the uncertainty around the potential effects of BDCP implementation on migration conditions for Chinook salmon. Until these efforts are completed and their results are fully analyzed, the overall effect of Alternative 2A on steelhead through-Delta survival remains uncertain.

Therefore, primarily as a result of unacceptable levels of uncertainty regarding the cumulative impacts of near-field and far-field effects associated with the presence and operation of the five intakes on steelhead, this effect is adverse.

While the implementation of the conservation and mitigation measures described below would address these impacts, these measures are not anticipated to reduce the impact to a level considered not adverse.

CEQA Conclusion: In general, under Alternative 2A water operations, the quantity and quality of steelhead migration habitat would not be affected relative to the CEQA baseline.

Upstream of the Delta

Sacramento River

Juveniles

Flows in the Sacramento River upstream of Red Bluff were evaluated during the October through May juvenile steelhead migration period. Flows under A2A_LLT would be up to 13% lower than flows under Existing Conditions during November but would generally not differ between model scenarios for the remaining seven months of the migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River upstream of Red Bluff were evaluated during the October through May juvenile steelhead migration period (Appendix 11D, *Sacramento*

River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 2A in all months but October, in which temperatures under Alternative 2A would be 6% greater than those under Existing Conditions.

Adults

Flows in the Sacramento River upstream of Red Bluff were evaluated during the September through March steelhead adult upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would be up to 13% lower than flows under Existing Conditions during November but would generally not differ between model scenarios for the remaining six months of the migration period.

Mean monthly water temperatures in the Sacramento River upstream of Red Bluff were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 2A in all months except September and October, in which temperatures under Alternative 2A would be 5% to 12% greater than those under Existing Conditions.

Kelts

Flows in the Sacramento River upstream of Red Bluff were evaluated during the March and April steelhead kelt downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would generally be similar to those under Existing Conditions except in below normal water years during March (7% lower).Mean monthly water temperatures in the Sacramento River upstream of Red Bluff were evaluated during the March through April steelhead kelt downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 2A in any month or water year type throughout the period.

Overall in the Sacramento River, these results indicate that there would be no biologically meaningful impacts of Alternative 2A on juvenile, adult, and kelt migration.

Clear Creek

Water temperatures were not modeled in Clear Creek.

Juveniles

Flows in Clear Creek during the October through May juvenile steelhead migration period under A2A_LLT would generally be similar to or greater than flows under Existing Conditions except in critical years during October (7% lower) and November (6% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Adults

Flows in Clear Creek during the September through March adult steelhead migration period under A2A_LLT would generally be similar to flows under Existing Conditions except in critical years during September (29% lower), October (7% lower), and November (6% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Kelt

Flows in Clear Creek during the March through April steelhead kelt downstream migration period under A2A_LLT would generally be similar to or greater than flows under Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Overall, these results indicate that Alternative 2A would not affect juvenile, adult, or kelt migration conditions in Clear Creek.

Feather River

Juveniles

Flows in the Feather River at the confluence with the Sacramento River were examined during the October through May juvenile steelhead migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would be up to 32% greater than flows under Existing Conditions during October, up to 20% lower than flows under Existing Conditions during November, and similar to flows under Existing Conditions in the remaining six months of the period.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were evaluated during the October through May juvenile steelhead migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 2A in all months except November and December and two water years in October, in which temperatures under Alternative 2A would be 6% greater than temperatures under Existing Conditions.

Adults

Flows in the Feather River at the confluence with the Sacramento River were examined during the September through March adult steelhead upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would be up to 113% greater than flows under Existing Conditions during September and October, up to 20% lower than flows under Existing Conditions during November, and similar to flows under Existing Conditions in the remaining four months of the period.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 2A during January through March. During November and December, temperatures under Alternative 2A would be 5% greater than temperatures under Existing Conditions. Temperatures in three water years during September and two water years during October would be 5% greater than temperatures under Existing Conditions.

Kelt

Flows in the Feather River at the confluence with the Sacramento River were examined during the March and April steelhead kelt downstream migration period (Appendix 11C, *CALSIM II Model*

Results utilized in the Fish Analysis). Flows under A2A_LLT would be similar to or up to 19% greater than flows under Existing Conditions except in below normal water years during March (18% lower).

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were evaluated during the March through April steelhead kelt downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 2A in any month or water year type throughout the period.

Overall, these results indicate that migration conditions for steelhead in the Feather River would not be affected by Alternative 2A. Flows and temperatures would be mostly similar between Existing Conditions and Alternative 2A.

American River

Juveniles

Flows in the American River at the confluence with the Sacramento River were evaluated during the October through May juvenile steelhead migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would generally be up to 27% greater than flows under Existing Conditions during February and March. Flows under A2A_LLT would generally be up to 33% lower than flows under Existing Conditions during November through January and May. Flows would be similar to those under Existing Conditions during October and April.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were evaluated during the October through May juvenile steelhead migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under Alternative 2A would be 5% to 12% higher than those under Existing Conditions in all months during the period except April when only one water year would reach the 5% value.

Adults

Flows in the American River at the confluence with the Sacramento River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would generally be up to 27% greater than flows under Existing Conditions during February and March. Flows under A2A_LLT would generally be up to 33% lower than flows under Existing Conditions during September and November through January. Flows would be similar to those under Existing Conditions during October.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under Alternative 2A would be 5% to 12% higher than those under Existing Conditions in all months during the period.

Kelt

Flows in the American River at the confluence with the Sacramento River were evaluated for the March and April kelt migration period. Flows under A2A_LLT would generally be up to 14% greater than flows under Existing Conditions during March and generally similar to flows under Existing Conditions during April (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were evaluated during the March and April kelt migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under Alternative 2A would be 5% higher than those under Existing Conditions in March but temperatures would be similar between Existing Conditions and Alternative 2A during April.

Overall, these results indicate that Alternative 2A would reduce juvenile and adult migration conditions during a portion of their respective migration periods, but not kelt migration.

Stanislaus River

Juveniles

Flows in the Stanislaus River at the confluence with the San Joaquin River were evaluated for the October through May steelhead juvenile downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under Alternative 2A would be 6% to 16% lower than flows under Existing Conditions depending on month except during January, in which there would be no difference.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were evaluated during the October through May steelhead juvenile downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under Alternative 2A would be 6% higher than those under Existing Conditions in all months during the period except October, in which temperature would be similar between Existing Conditions and Alternative 2A.

Adults

Flows in the Stanislaus River at the confluence with the San Joaquin River were evaluated for the September through March steelhead adult upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under Alternative 2A would be 6% to 16% lower than flows under Existing Conditions depending on month, except during January, in which there would be no differences.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under Alternative 2A would be 6% higher than those under Existing Conditions in all months during the period except October, in which temperature would be similar between Existing Conditions and Alternative 2A.

Kelt

Flows in the Stanislaus River at the confluence with the San Joaquin River were evaluated for the March and April steelhead kelt downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under Alternative 2A would be 8% to 11% lower than flows under Existing Conditions during March and April, respectively.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were evaluated during the March and April steelhead kelt downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under Alternative 2A would be 6% higher than those under Existing Conditions during March and April.

San Joaquin River

Water temperature modeling was not conducted in the San Joaquin River.

Juveniles

Flows in the San Joaquin River at Vernalis were evaluated for the October through May steelhead juvenile downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under Alternative 2A would 5% greater than flows under Existing Conditions during January, 5% lower during October and in drier years during March, April, and May, and similar in the remaining 3 months of the period.

Adults

Flows in the San Joaquin River at Vernalis were evaluated for the September through March steelhead adult upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under Alternative 2A would 5% greater than flows under Existing Conditions during January, 8% lower during September and in drier years during March, and similar in the remaining 4 months of the period.

Kelt

Flows in the San Joaquin River at Vernalis were evaluated for the March and April steelhead kelt downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under Alternative 2A would be similar to flows under Existing Conditions during wet and above normal water years and up to 16% lower during below normal, dry, and critical years in both March and April.

Mokelumne River

Water temperature modeling was not conducted in the Mokelumne River.

Juveniles

Flows in the Mokelumne River at Delta were evaluated for the October through May steelhead juvenile downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under Alternative 2A would be similar to flows under Existing Conditions during March, 5% to 12% lower than flows under Existing Conditions during October, November, April, and May, and 12% to 14% higher than flows under Existing Conditions during December through February.

Adults

Flows in the Mokelumne River at Delta were evaluated for the September through March steelhead adult upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under Alternative 2A would be similar to flows under Existing Conditions during March, 5% to 27% lower than flows under Existing Conditions during September, October, and November, and 12% to 14% higher than flows under Existing Conditions during December through February.

Kelt

Flows in the Mokelumne River at Delta were evaluated for the March and April steelhead kelt downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under Alternative 2A would be similar to flows under Existing Conditions during March and 8% lower during April.

Through-Delta

Sacramento River

Juveniles

Juvenile steelhead migrating down the Sacramento River (October through May) would generally experience lower flows below the north Delta intakes compared to Existing Conditions. Through migrating juvenile Chinook salmon indicate that at these magnitudes of flow reductions predicted for Alternative 1A and 2A, juvenile survival would decrease less than 0.5%, well under the criteria of a 5% change in Delta migration survival. The five intake structures would attract predators and would displace about 22 acres of aquatic habitat.

Adults

Based on the proportion of Sacramento River flows, olfactory cues would be similar (<10% difference) to Existing Conditions for nearly all months of the year. The proportion of flows would decrease slightly in March by 11% during the post-peak period, but increase in September by 18% during the pre-peak.

San Joaquin River

Juveniles

The only changes on San Joaquin River flows at Vernalis would result from the modeled effects of climate change on inflows to the river downstream of Friant Dam and reduced tributary inflows. There no flow changes associated with the Alternatives. Alternative 2A would have no effect on steelhead migration success through the Delta.

Adults

Little information apparently currently exists as to the importance of Plan Area flows on the straying of adult San Joaquin River region steelhead, in contrast to San Joaquin River fall-run Chinook salmon

(Marston et al. 2012). Although information specific to steelhead is not available, for this analysis of effects, it was assumed with moderate certainty that the attribute of Plan Area flows (including olfactory cues associated with such flows) is of high importance to adult San Joaquin River region steelhead adults as well.

The percentage of water at Collinsville that originated from the San Joaquin River during the fall-run migration period (September to December) is small, typically 0.1% to less than 3% under Existing Conditions. Alternative 2A operations conditions would incrementally increase olfactory cues associated with the San Joaquin River, which would benefit adult steelhead migrating to the San Joaquin River.

Summary of CEQA Conclusion

Collectively, these results indicate that there would be significant impacts of Alternative 2A on steelhead migration conditions because the alternative could substantially interfere with the movement of fish. Alternative 2A would have significant impacts on migration in the American, Feather, Stanislaus, San Joaquin, and Mokelumne Rivers due to flow reductions and elevated water temperatures. These effects on flows and temperatures would reduce the ability for steelhead juveniles, adult, and kelts to migrate successfully. Through-Delta juvenile steelhead survival would be reduced under Alternative 2A. Potential predation losses would increase at the five intake structures, ranging hypothetically from <2% to 19% of juveniles that reach the Delta. Approximately 22 acres of habitat would be removed for new intake structures.

With respect to the NDD intakes, implementation of CM6 and CM15 and Mitigation Measures AQUA-60a through AQUA-60c would address these impacts, but are not anticipated to reduce them to a level considered less than significant. Although implementation of *CM6 Channel Margin Enhancement* would provide habitat similar to that which would be lost, it would not necessarily be located near the intakes and therefore would not fully compensate for the lost habitat. Additionally, implementation of this measure would not fully address predation losses. *CM15 Localized Reduction of Predatory Fishes (Predator Control)* has substantial uncertainties associated with its effectiveness such that it is considered to have no demonstrable effect. Conservation measures that address habitat and predation losses, therefore, would potentially minimize impacts to some extent but not to a less than significant level. Consequently, as a result of these changes in migration conditions, this impact is significant and unavoidable.

Applicable conservation measures are briefly described below and full descriptions are found in Chapter 3, Section 3.6.2.5 Channel Margin Enhancement (CM6) and Section 3.6.3.4 Localized Reduction of Predatory Fishes (Predator Control) (CM15).

CM6 Channel Margin Enhancement. CM6 would entail restoration of 20 linear miles of channel margin by improving channel geometry and restoring riparian, marsh, and mudflat habitats on the waterside side of levees along channels that provide rearing and outmigration habitat for juvenile salmonids. Linear miles of enhancement would be measured along one side or the other of a given channel segment (e.g., if both sides of a channel are enhanced for a length of 1 mile, this would account for a total of 2 miles of channel margin enhancement). At least 10 linear miles would be enhanced by year 10 of Plan implementation; enhancement would then be phased in 5-mile increments at years 20 and 30, for a total of 20 miles at year 30. Channel margin enhancement would be performed only along channels that provide rearing and outmigration habitat for juvenile salmonids. These include channels that are protected by federal project levees—including the Sacramento River between Freeport and Walnut Grove among several others.

CM15 Localized Reduction of Predatory Fishes (Predator Control). CM15 would seek to reduce populations of predatory fishes at specific locations or modify holding habitat at selected locations of high predation risk (i.e., predation "hotspots"). This conservation measure seeks to benefit covered salmonids by reducing mortality rates of juvenile migratory life stages that are particularly vulnerable to predatory fishes. Predators are a natural part of the Delta ecosystem. Therefore, this conservation measure is not intended to entirely remove predators at any location, or substantially alter the abundance of predators at the scale of the Delta system. This conservation measure would also not remove piscivorous birds. Because of uncertainties regarding treatment methods and efficacy, implementation of CM15 would involve discrete pilot projects and research actions coupled with an adaptive management and monitoring program to evaluate effectiveness. Effects would be temporary, as new individuals would be expected to occupy vacated areas; therefore, removal activities would need to be continuous during periods of concern. CM15 also recognizes that the NDD intakes would create new predation hotspots.

In addition to the conservation measures, the mitigation measures identified below would provide an adaptive management process, that may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6), for assessing impacts and developing appropriate minimization measures. However, this would not necessarily result in a less than significant determination.

Mitigation Measure AQUA-96a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Steelhead to Determine Feasibility of Mitigation to Reduce Impacts to Migration Conditions

Although analysis conducted as part of the EIR/EIS determined that Alternative 2A would have significant and unavoidable adverse effects on migration habitat, this conclusion was based on the best available scientific information at the time and may prove to have been over- or understated. Upon the commencement of operations of CM1 and continuing through the life of the permit, the BDCP proponents will monitor effects on migration habitat in order to determine whether such effects would be as extensive as concluded at the time of preparation of this document and to determine any potentially feasible means of reducing the severity of such effects. This mitigation measure requires a series of actions to accomplish these purposes, consistent with the operational framework for Alternative 2A.

The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 2A operations only. Development of mitigation actions for the incremental impact on migration habitat attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 2A.

Mitigation Measure AQUA-96b: Conduct Additional Evaluation and Modeling of Impacts on Steelhead Migration Conditions Following Initial Operations of CM1

Following commencement of initial operations of CM1 and continuing through the life of the permit, the BDCP proponents will conduct additional evaluations to define the extent to which modified operations could reduce impacts to migration habitat under Alternative 2A. The analysis required under this measure may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6).

Mitigation Measure AQUA-96c: Consult with USFWS, and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Steelhead Migration Conditions Consistent with CM1

In order to determine the feasibility of reducing the effects of CM1 operations on steelhead habitat, the BDCP proponents will consult with FWS and the Department of Fish and Wildlife to identify and implement any feasible operational means to minimize effects on migration habitat. Any such action will be developed in conjunction with the ongoing monitoring and evaluation of habitat conditions required by Mitigation Measure AQUA-96a.

If feasible means are identified to reduce impacts on migration habitat consistent with the overall operational framework of Alternative 2A without causing new significant adverse impacts on other covered species, such means shall be implemented. If sufficient operational flexibility to reduce effects on steelhead habitat is not feasible under Alternative 2A operations, achieving further impact reduction pursuant to this mitigation measure would not be feasible under this Alternative, and the impact on steelhead would remain significant and unavoidable.

Restoration Measures (CM2, CM4–CM7, and CM10)

Alternative 2A has the same restoration measures as Alternative 1A. Because no substantial differences in restoration-related fish effects are anticipated anywhere in the affected environment under Alternative 2A compared to those described in detail for Alternative 1A, the fish effects of restoration measures described for steelhead under Alternative 1A (Impact AQUA-97 through AQUA-99) also appropriately characterize effects under Alternative 2A.

The following impacts are those presented under Alternative 1A that are identical for Alternative 2A.

Impact AQUA-97: Effects of Construction of Restoration Measures on Steelhead

Impact AQUA-98: Effects of Contaminants Associated with Restoration Measures on Steelhead

Impact AQUA-99: Effects of Restored Habitat Conditions on Steelhead

NEPA Effects: All three of these impact mechanisms have been determined to result in no adverse effects on steelhead for NEPA purposes. Specifically for AQUA-98, the effects of contaminants on steelhead with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on steelhead are uncertain.

CEQA Conclusion: All three of these impact mechanisms would be considered less than significant on steelhead, for the reasons identified for Alternative 1A, and no mitigation is required.

Other Conservation Measures (CM12–CM19 and CM21)

Alternative 2A has the same other conservation measures as Alternative 1A. Because no substantial differences in other conservation-related fish effects are anticipated anywhere in the affected environment under Alternative 2A compared to those described in detail for Alternative 1A, the fish effects of other conservation measures described for steelhead under Alternative 1A (Impact AQUA-100 through AQUA-108) also appropriately characterize effects under Alternative 2A.

The following impacts are those presented under Alternative 1A that are identical for Alternative 2A.

Impact AQUA-100: Effects of Methylmercury Management on Steelhead (CM12)

Impact AQUA-101: Effects of Invasive Aquatic Vegetation Management on Steelhead (CM13)

Impact AQUA-102: Effects of Dissolved Oxygen Level Management on Steelhead (CM14)

Impact AQUA-103: Effects of Localized Reduction of Predatory Fish on Steelhead (CM15)

Impact AQUA-104: Effects of Nonphysical Fish Barriers on Steelhead (CM16)

Impact AQUA-105: Effects of Illegal Harvest Reduction on Steelhead (CM17)

Impact AQUA-106: Effects of Conservation Hatcheries on Steelhead (CM18)

Impact AQUA-107: Effects of Urban Stormwater Treatment on Steelhead (CM19)

Impact AQUA-108: Effects of Removal/Relocation of Nonproject Diversions on Steelhead (CM21)

NEPA Effects: The nine impact mechanisms have been determined to range from no effect, to no adverse effect, or beneficial effects on steelhead for NEPA purposes, for the reasons identified for Alternative 1A.

CEQA Conclusion: The nine impact mechanisms would be considered to range from no impact, to less than significant, or beneficial on steelhead, for the reasons identified for Alternative 1A, and no mitigation is required.

Sacramento Splittail

Construction and Maintenance of CM1

Impact AQUA-109: Effects of Construction of Water Conveyance Facilities on Sacramento Splittail

The potential effects of construction of the water conveyance facilities on Sacramento splittail would be similar to those described for Alternative 1A (Impact AQUA-109) except that Alternative 2A could potentially include two different intakes than under Alternative 1A. This would convert about 11,350 lineal feet of existing shoreline habitat into intake facility structures and would require about 26 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. As concluded for Alternative 1A, Impact AQUA-109, the effect would not be adverse for Sacramento splittail.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-109, the impact of the construction of water conveyance facilities on Sacramento splittail would be less than significant except for construction noise associated with pile driving. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Alternative 1A, Impact AQUA-1.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Alternative 1A, Impact AQUA-1.

Impact AQUA-110: Effects of Maintenance of Water Conveyance Facilities on Sacramento Splittail

The potential effects of the maintenance of water conveyance facilities under Alternative 2A would be the same as those described for Alternative 1A (see Impact AQUA-110). As concluded in Alternative 1A, Impact AQUA-110, the effect would not be adverse for Sacramento splittail.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-110, the impact of the maintenance of water conveyance facilities on Sacramento splittail would be less than significant and no mitigation is required.

Water Operations of CM1

Impact AQUA-111: Effects of Water Operations on Entrainment of Sacramento Splittail

Water Exports from SWP/CVP South Delta Facilities

Under Alternative 2A, total entrainment of juvenile splittail at the south Delta facilities (estimated from Yolo Bypass inundation) averaged across all years would be expected to be 211% greater than NAA, and 1,315% greater in above normal years (Table 11-2A-57). However, this increase is entirely due to the substantial increase in juvenile splittail abundance resulting from additional floodplain habitat in wetter water year types. The per capita rate of splittail entrainment averaged across all years would be reduced 47% for juveniles (Table 11-2A-58) and reduced 68% for adults (Table 11-2A-59). Per capita entrainment would be most reduced in wet water years (61% reduction for juveniles, 91% reduction for adults) and least reduced in below normal water years (26% reduction) for juveniles and critical water years (20%) for adults. The decrease in per capita entrainment of splittail is due to reductions in south Delta water exports during the main May–June entrainment period.

Table 11-2A-57. Juvenile Sacramento Splittail Entrainment Index[a] (Yolo Bypass Days of Inundation Method) at the SWP and CVP Salvage Facilities and Differences between Model Scenarios for Alternative 2A

	Absolute Difference (Percent Difference)	
Water Year	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wet	2,606,381 (272%)	2,419,722 (211%)
Above Normal	479,962 (1,049%)	488,567 (1,315%)
Below Normal	12,772 (374%)	13,204 (442%)
Dry	1,312 (46%)	1,657 (65%)
Critical	-267 (-18%)	184 (17%)
All Years	899,081 (288%)	841,372 (227%)

Shading indicates entrainment increased 10% or more.

[a] Estimated annual number of fish lost, based on normalized data, estimated from Yolo Bypass Inundation Method.

Table 11-2A-58. Juvenile Sacramento Splittail Entrainment Index[a] (per Capita Method) at the SWP and CVP Salvage Facilities and Differences between Model Scenarios for Alternative 2A

	Absolute Difference (Percent Difference)	
Water Year	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wet	-1,353,127 (-68%)	-1,028,808 (-61%)
Above Normal	-72,034 (-54%)	-54,202 (-47%)
Below Normal	-2,786 (-28%)	-2,468 (-26%)
Dry	-989 (-49%)	-499 (-33%)
Critical	-566 (-42%)	-308 (-29%)
All Years	-309,989 (-57%)	-208,441 (-47%)

Shading indicates entrainment increased 10% or more.

[a] Estimated annual number of fish lost, based on normalized data, estimated from delta inflow.

Table 11-2A-59. Adult Sacramento Splittail Entrainment Index[a] (Salvage Density Method) at the SWP and CVP Salvage Facilities and Differences between Model Scenarios for Alternative 2A

	Absolute Difference (Percent Difference)	
Water Year	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wet	-3,600 (-91%)	-3,736 (-91%)
Above Normal	-4,092 (-85%)	-4,108 (-85%)
Below Normal	-1,770 (-52%)	-1,505 (-48%)
Dry	-818 (-33%)	-653 (-29%)
Critical	-861 (-26%)	-639 (-20%)
All Years	-2,390 (-69%)	-2,312 (-68%)

Shading indicates entrainment increased 10% or more.

[a] Estimated annual number of fish lost, based on normalized data. Average (December–March).

Water Exports from SWP/CVP North Delta Intake Facilities

The impact from entrainment of splittail to the proposed SWP/CVP north Delta intakes is the same as Impact AQUA-111 under Alternative 1A. Splittail larvae would be vulnerable to entrainment to these intakes, although little is known about their densities around this vicinity. Entrainment and impingement monitoring would be implemented to determine the extent to which splittail larvae are present.

Water Export with a Dual Conveyance for the SWP North Bay Aqueduct

The effect of implementing dual conveyance for the NBA with an alternative Sacramento River intake would be the same as described under Alternative 1A (Impact AQUA-111). Reduced pumping from Barker Slough could reduce entrainment losses of larval splittail produced in the Yolo Bypass. There would be potential for increased predation and impingement risk associated with the alternative intake, which would be screened to exclude splittail greater than 10 mm.

Predation Associated with Entrainment

As described for Alternative 1A (Impact AQUA-111), Sacramento splittail predation loss at the south Delta facilities is assumed to be proportional to entrainment loss. Per capita splittail entrainment at the south Delta would be reduced under Alternative 2A by 47% compared to NAA; predation losses would be expected to decrease at a similar proportion.

The impact from potential predation associated with the north Delta intake structures (5 intakes) would be the same as described for Alternative 1A (Impact AQUA-111). Potential predation at the north Delta would be partially offset by reduced predation loss at the SWP/CVP south Delta intakes and the increased production of juvenile splittail resulting from CM2 actions (Yolo Bypass Fisheries Enhancement). Further, the fishery agencies concluded that predation was not a factor currently limiting splittail abundance.

NEPA Effects: The effect of Alternative 2A on entrainment and predation loss would not be adverse, because while predation loss of splittail would be increased, it would be offset by the substantial reductions in per capita entrainment risk at the south Delta facilities and the increased production of juvenile splittail under CM2 (Yolo Bypass Fisheries Enhancement).

CEQA Conclusion: Operational activities associated with decreased water exports from SWP/CVP south Delta facilities would result in an overall decrease in the proportion of the splittail population entrained. However, operational activities associated with reduced south Delta water exports would result in an overall decrease in the proportion of splittail population entrained for all water year types. Estimated per capita juvenile entrainment to the south Delta facilities would be reduced 57% while adult per capita entrainment would be reduced 69% relative to Existing Conditions. At the proposed north Delta facilities, Sacramento splittail would be subject to larval entrainment and impingement, and predation losses at the same levels described for Alternative 1A (Impact AQUA-111).

In conclusion, the impact from entrainment and predation loss would be less than significant, because increase in predation losses at the north Delta under Alternative 2A would be offset by the substantial reduction in south Delta entrainment losses and the increased production of juvenile splittail from CM2 actions. No mitigation would be required.

Impact AQUA-112: Effects of Water Operations on Spawning and Egg Incubation Habitat for Sacramento Splittail

In general, Alternative 2A would have beneficial effects on splittail spawning habitat relative to NAA by increasing the quantity and quality of spawning habitat in the Yolo Bypass. There would be negligible effects on channel margin and side-channel habitats in the Sacramento River at Wilkins Slough and the Feather River, and negligible effects on water temperatures in the Feather River, relative to NAA. There would be beneficial effects on spawning conditions in channel margin and side-channel habitats from increases in mean monthly flow during the spawning period in both the Sacramento River and the Feather River. There would also be a beneficial effect from reductions in the occurrence of critical high water temperatures in the Feather River in wetter water year types.

Sacramento splittail spawn in floodplains and channel margins and in side-channel habitat upstream of the Delta, primarily in the Sacramento River and Feather River. Floodplain spawning overwhelmingly dominates production in wet years. During low-flow years when floodplains are not inundated, spawning in side channels and channel margins would be much more critical.

Floodplain Habitat

Effects of Alternative 2A on floodplain spawning habitat were evaluated for Yolo Bypass. Increased flows into Yolo Bypass may reduce flooding and flooded spawning habitat to some extent in the Sutter Bypass (the upstream counterpart to Yolo Bypass) but this effect was not quantified. Effects in Yolo Bypass were evaluated using a habitat suitability approach based on water depth (2 m threshold) and inundation duration (minimum of 30 days). Effects of flow velocity were ignored because flow velocity was generally very low throughout the modeled area for most conditions, with generally 80 to 90% of the total available area having flow velocities of 0.5 foot per second or less (a reasonable critical velocity for early life stages of splittail; Young and Cech 1996).

The proposed changes to the Fremont Weir would increase the frequency and duration of Yolo Bypass inundation events compared to NAA, especially for dry and critical year types; the changes are attributable to the influence of the Fremont Weir notch at lower flows. Only the inundation events lasting more than 30 days are considered biologically beneficial to splittail, so are the focus of the analyses provided here. A2A_LLT compared to NAA for the drier type years (below normal, dry, and critical), results in no change or an increase in frequency for events greater than 30 days compared to NAA over the 82-year simulation period (Figure 11-2A-4, Table 11-2A-60). For below normal years, Alternative 2A would result in occurrence of 2 inundation events ≥70 days, compared to 0 such events for NAA. For dry and critical years, project-related increases are for 30–49 day duration events as there are no events of longer duration. These results indicate that overall project-related effects on occurrence of various duration inundation events would be beneficial for splittail spawning by creating better spawning habitat conditions.

Table 11-2A-60. Differences in Frequencies of Inundation Events (for 82-Year Simulations) of Different Durations on the Yolo Bypass under Different Scenarios and Water Year Types, February through June, from 15 2-D and Daily CALSIM II Modeling Runs

Number of Days of Continuous Inundation	Change in Number of Inundation Events for Each Scenario	
	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
30–49 Days		
Wet	-5	-3
Above Normal	0	0
Below Normal	4	4
Dry	1	1
Critical	1	1
50–69 Days		
Wet	-5	-5
Above Normal	1	1
Below Normal	0	0
Dry	0	0
Critical	0	0
≥70 Days		
Wet	8	7
Above Normal	1	1
Below Normal	2	2
Dry	0	0
Critical	0	0

There would be increases in area of suitable splittail habitat in Yolo Bypass under A2A_LLT ranging from 5 to 949 acres relative to NAA. Areas under A2A_LLT would be 56%, 60%, and 196% greater than areas under NAA in wet, above normal, and below normal water years, respectively (Table 11-2A-61). There would also be increases in area under A2A_LLT in dry and critical years relative to NAA, but they would be minimal (14 and 5 acres, respectively). These results indicate that increases in inundated acreage in each water year type would result in increased habitat and have a beneficial effect on splittail spawning.

Table 11-2A-61. Increase in Splittail Weighted Habitat Area (Acres and Percent) in Yolo Bypass from Existing Biological Conditions to Alternative 2A by Water Year Type from 15 2-D and Daily CALSIM II Modeling Runs

Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wet	1,088 (70%)	949 (56%)
Above Normal	698 (61%)	690 (60%)
Below Normal	245 (187%)	249 (196%)
Dry	14 (NA)	14 (NA)
Critical	5 (NA)	5 (NA)

NA = percent differences could not be computed because no splittail weighted habitat occurred in the bypass for NAA and EXISTING CONDITIONS in those years (dividing by 0).

A potential adverse effect of Alternative 2A that is not included in the modeling is reduced inundation of the Sutter Bypass as a result of increased flow diversion at the Fremont Weir. The Fremont Weir notch with gates opened would increase the amount Sacramento River flow diverted from the river into the bypass when the river's flow is greater than about 14,600 cfs (Munévar pers. comm.). As much as about 6,000 cfs more flow would be diverted from the river with the opened notch than without the notch, resulting in a 6,000 cfs decrease in Sacramento River flow at the weir. A decrease of 6,000 cfs in the river, according to rating curves developed for the river at the Fremont Weir, could result in as much as 3 feet of reduction in river stage (Munévar pers. comm.), although understanding of how notch flows would affect river stage is incomplete (Kirkland pers. comm.). In any case, a lower river stage at the Fremont Weir would be expected to result in a lower level of inundation in the lower Sutter Bypass. Because of the uncertainties regarding how drawdown of the river will propagate, the relationship between notch flow and the magnitude of lower Sutter Bypass inundation is poorly known. Despite this uncertainty, it is evident that *CM2 Yolo Bypass Fisheries Enhancement* has the potential to reduce some of the habitat benefits of Yolo Bypass inundation on splittail production due to effects on Sutter Bypass inundation. Splittail use the Sutter Bypass for spawning and rearing as they do the Yolo Bypass.

Channel Margin and Side-Channel Habitat

Splittail spawning and larval and juvenile rearing also occur in channel margin and side-channel habitat upstream of the Delta. These habitats are likely to be especially important during dry years, when flows are too low to inundate the floodplains (Sommer et al. 2007). Side-channel habitats are affected by changes in flow because greater flows cause more flooding, thereby increasing availability of such habitat, and because rapid reductions in flow dewater the habitats, potentially stranding splittail eggs and rearing larvae. Effects of the BDCP on flows in years with low-flows are expected to be most important to the splittail population because in years of high-flows, when most production comes from floodplain habitats, the upstream side-channel habitats contribute relatively little production.

Effects on channel margin and side-channel habitat were evaluated by comparing flow conditions for the Sacramento River at Wilkins Slough and the Feather River at the confluence with the Sacramento River for the time-frame February through June. These are the most important months for splittail spawning and larval rearing (Sommer pers. comm.), and juveniles likely emigrate from the side-channel habitats during May and June if conditions become unfavorable.

Differences between model scenarios for monthly average flows during February through June by water-year type were determined for the Sacramento River at Wilkins Slough and for the Feather River at the confluence (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

For the Sacramento River at Wilkins Slough, flows during February through April under A2A_LLT would be similar to flows under NAA. During May and June, flows under A2A_LLT would be up to 26% greater than flows under NAA, resulting in a beneficial effect on rearing conditions. Water temperature in the Sacramento River under Alternative 2A would not differ from results for Alternative 1A, which indicate that these results indicate that there would be some increases in flow (up to 26%) would have beneficial effects on splittail rearing conditions in the Sacramento River.

For the Feather River at the confluence, flows during February and March under A2A_LLT would be similar to flows under NAA. During April through June, flows under A2A_LLT would be up to 73% greater than flows under NAA, resulting in a beneficial effect on spawning conditions.

Simulated daily and monthly water temperatures in Sacramento River at Hamilton City and Feather River at the confluence with the Sacramento River, respectively were used to investigate the potential effects of Alternative 2A on the suitability of water temperatures for splittail spawning and egg incubation. A range of 45°F to 75°F was selected for evaluating the suitable range for splittail spawning and egg incubation.

There would be no biologically meaningful difference (>5% absolute scale) between NAA and Alternative 2A in the frequency of water temperatures in the Sacramento and Feather Rivers being within the suitable 45°F to 75°F regardless of water year type.

Overall, Alternative 2A would have negligible or beneficial effects on upstream spawning and rearing conditions in the upper Sacramento and Feather rivers.

Table 11-2A-62. Difference (Percent Difference) in Percent of Days or Months[a] during February to June in Which Temperature Would Be below 45°F or above 75°F in the Sacramento River at Hamilton City and Feather River at the Confluence with the Sacramento River[b]

	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Sacramento River at Hamilton City		
Temperatures below 45°F		
Wet	-4 (-86%)	0 (0%)
Above Normal	-4 (-86%)	0 (0%)
Below Normal	-4 (-79%)	0 (0%)
Dry	-2 (-68%)	0 (0%)
Critical	-1 (-49%)	1 (NA)
All	-3 (-76%)	0 (0%)
Temperatures above 75°F		
Wet	0 (NA)	0 (NA)
Above Normal	0 (NA)	0 (NA)
Below Normal	0 (NA)	0 (NA)
Dry	0 (NA)	0 (NA)
Critical	0 (NA)	0 (NA)
All	0 (NA)	0 (NA)
Feather River at Sacramento River Confluence		
Temperatures below 45°F		
Wet	0 (NA)	0 (NA)
Above Normal	0 (NA)	0 (NA)
Below Normal	0 (NA)	0 (NA)
Dry	0 (NA)	0 (NA)
Critical	0 (NA)	0 (NA)
All	0 (NA)	0 (NA)
Temperatures above 75°F		
Wet	3 (NA)	-2 (-43%)
Above Normal	0 (NA)	-9 (-100%)
Below Normal	6 (NA)	-6 (-50%)
Dry	13 (300%)	0 (0%)
Critical	13 (800%)	0 (0%)
All	7 (560%)	-3 (-27%)

NA = could not be calculated because the denominator was 0.

[a] Days were used in the Sacramento River and months were used in the Feather River.

[b] Based on the modeling period of 1922 to 2003.

Stranding Potential

As indicated above, rapid reductions in flow can dewater channel margin and side-channel habitats, potentially stranding splittail eggs and rearing larvae. Due to a lack of quantitative tools and historical data to evaluate possible stranding effects, the following provides a narrative summary of potential effects. The Yolo Bypass is exceptionally well-drained because of grading for agriculture, which likely helps limit stranding mortality of splittail. Moreover, water stage decreases on the bypass are relatively gradual (Sommer et al. 2001). Stranding of Sacramento splittail in perennial ponds on the Yolo Bypass does not appear to be a problem under Existing Conditions (Feyrer et al. 2004). Yolo Bypass improvements would be designed, in part, to further reduce the risk of stranding by allowing water to inundate certain areas of the bypass to maximize biological benefits, while keeping water away from other areas to reduce stranding in isolated ponds. Actions under Alternative 2A to increase the frequency of Yolo Bypass inundation would increase the frequency of potential stranding events. For splittail, an increase in inundation frequency would also increase the production of Sacramento splittail in the bypass. While total stranding losses may be greater under Alternative 2A than under NAA, the total number of splittail would be expected to be greater under Alternative 2A.

In the Yolo Bypass, Sommer et al. (2005) found these potential losses are offset by the improvement in rearing conditions. Henning et al. (2006) also noted the potential for stranding risk as wetlands desiccate and oxygen concentrations decline, but the seasonal timing of use by juveniles may decrease these risks. Sommer et al. (2005) addressed the question of stranding and concluded the potential improvements in habitat capacity outweighed the potential stranding problems that may exist in some years. Overall, these effects are not adverse.

NEPA Effects: Collectively, these results indicate that the effect is not adverse because it would not substantially reduce suitable spawning habitat or substantially reduce the number of fish as a result of egg mortality. The effects of Alternative 2A on splittail spawning habitat are primarily beneficial. There would be benefits due to increased inundation in the Yolo Bypass that would increase the quantity and quality of spawning habitat there, and benefits to channel margin and side-channel habitat in the Sacramento River and Feather River from increases in mean monthly flow and decreases in high water temperatures during the spawning period.

CEQA Conclusion: In general, Alternative 2A would have beneficial effects on splittail spawning habitat relative to the Existing Conditions by increasing the quantity of spawning habitat in the Yolo Bypass through increased acreage subjected to periodic inundation. There would be negligible effects on channel margin and side-channel habitats in the Sacramento River at Wilkins Slough and the Feather River, with some beneficial effect due to increases in mean monthly flow for some months and water year types during the spawning period. There would be negative effects on water temperatures in the Feather River relative to the Existing Conditions, but the benefits due to increased inundation in the Yolo Bypass would outweigh the detrimental effects of increased water temperatures in the Feather River because the Yolo Bypass is a more important spawning habitat to splittail than channel margin habitat in the Feather River, as evidenced by the large amount of spawning activity when inundated.

Floodplain Habitat

Comparisons of splittail weighted habitat area for Alternative 2A and Existing Conditions show relatively little difference between the two scenarios in longer-duration inundation events, with no change or relatively small increases or decreases for Alternative 2A compared to Existing Conditions (Table 11-2A-60 and Figure 11-2A-4). However, Alternative 2A would result in increased acreage of suitable spawning habitat compared to Existing Conditions (Table 11-2A-61), with increases of between 5 and 1,088 acres of suitable spawning habitat depending on water year type. Increased areas for wet, above normal, and below normal water years are predicted to be 70%, 61%, and 187%, respectively, for Alternative 2A. Comparisons for dry and critical water years indicate project-related increases of 14 and 5 acres of suitable spawning habitat, respectively, compared to 0 acres for Existing Conditions. These results indicate that Alternative 2A would have beneficial effects on splittail habitat through increasing spawning habitats.

Channel Margin and Side-Channel Habitat

Modeled flows were evaluated in the Sacramento River at Wilkins Slough for the February through June splittail spawning and early life stage rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Results indicate that Alternative 2A would have negligible effects (<5%) on channel margin and side-channel habitats during February through April with the exception of one small decrease in flow (-6%) during March in below normal years. Flows under A2A_LLT would generally be up to 42% greater than flows under Existing Conditions during May and June. These results indicate that effects of Alternative 2A on flows would generally have beneficial effects on splittail spawning and rearing conditions in the upper Sacramento River.

Flows in the Feather River at the confluence with the Sacramento River were evaluated during February through June. Flows during this period would generally be similar between Existing Conditions and A2A_LLT with some exceptions. Based on the relatively small magnitude and infrequent nature of the flow differences, the effects of Alternative 2A on flow would not have biologically meaningful effects on splittail rearing conditions in the Feather River.

There would generally be no biologically meaningful difference (>5% absolute scale) between Existing Conditions and Alternative 2A in the frequency of water temperatures in the Sacramento and Feather Rivers being within the suitable 45°F to 75°F, except in dry and critical water years (13% greater) for the 75°F threshold in the Feather River.

There would be no difference between Existing Conditions and A2A_LLT in the number of years in which temperatures would be below 45°F (Table 11-2A-62) because there are never any months with temperatures below 45°F under any scenario. Exceedances above 75°F under A2A_LLT would occur more often than under Existing Conditions in all water years except above normal. These results indicate that Alternative 2A would have negative temperature effects on splittail spawning in the Feather River and would provide benefits in wetter water year types.

Stranding Potential

Because there would be little difference in flow conditions between Alternative 2A and Existing Conditions, the project would not have biologically meaningful effects on stranding potential.

Summary of CEQA Conclusion

Overall, these results indicate that the impact is less than significant because it would not substantially reduce suitable spawning habitat or substantially reduce the number of fish as a result of egg mortality. No mitigation is necessary.

Impact AQUA-113: Effects of Water Operations on Rearing Habitat for Sacramento Splittail

NEPA Effects: In general, Alternative 2A would have beneficial effects on splittail rearing habitat relative to NAA based on an increase in the quantity and quality of rearing habitat in the Yolo Bypass, beneficial effects on rearing conditions in channel margin and side-channel habitats in the Sacramento River and the Feather River, and reductions in the occurrence of critical high water temperatures in the Feather River in wetter water year types.

Sacramento splittail rear in floodplain and main-channel environments; the analyses of splittail weighted habitat area in Yolo Bypass and effects of flow conditions on channel margin and side-channel habitats provided in the previous impact, Impact AQUA-112, apply to rearing as well as spawning habitat for splittail. As concluded above, the effect is not adverse because it would not substantially reduce suitable rearing habitat or substantially reduce the number of fish as a result of juvenile mortality. Effects of Alternative 2A on flow would have beneficial effects on the availability of channel margin and main-channel habitat through increases in mean monthly flow for some months and water year types during the rearing period. Increased flows into Yolo Bypass may reduce flooding and flooded rearing habitat to some extent in the Sutter Bypass but would create habitat in the Yolo Bypass that would have a beneficial effect on rearing conditions.

CEQA Conclusion: In general, Alternative 2A would have beneficial effects on splittail rearing habitat relative to the Existing Conditions by increasing the quantity of rearing habitat in the Yolo Bypass, and increases in mean monthly flow for some months and water year types in the Sacramento River and the Feather River.

Project effects on splittail rearing habitat are the same as described for spawning habitat in the previous impact discussion, Impact AQUA-112. As concluded above, the impact is not significant because it would not substantially reduce suitable rearing habitat or substantially reduce the number of fish as a result of juvenile mortality and no mitigation is necessary. Effects of Alternative 2A on flow would not have negative effects on the availability of channel margin and main-channel habitat, and would have a beneficial effect through increases in mean monthly flow for some months and water year types during the rearing period. Increased flows into Yolo Bypass may reduce flooding and flooded rearing habitat to some extent in the Sutter Bypass but would create habitat in the Yolo Bypass that would have a beneficial effect on rearing conditions. Benefits to rearing habitat availability in the Yolo Bypass would outweigh negative effects of increased exposures to water temperatures above the upper threshold of 75°F in the Feather River in drier water year types.

Impact AQUA-114: Effects of Water Operations on Migration Conditions for Sacramento Splittail

Upstream of the Delta

In general, effects of Alternative 2A would not affect splittail migration conditions in the Sacramento River or the Feather River relative to NAA based on negligible or beneficial effects on mean monthly flow during the migration period and negligible or beneficial effects on water temperatures in the Feather River.

The effects of Alternative 2A on splittail migration conditions would be the same as described for channel margin and side-channel habitats in the Sacramento River and Feather River for Impact AQUA-112 above. There would be benefits to channel margin and side-channel habitat in both locations from increases in mean monthly flow and decreases in high water temperatures compared to baseline conditions.

Through-Delta

Alternative 2A is expected to reduce OMR reverse flows during the period of juvenile splittail migration through the Delta. OMR flows are greatly improved in June and July compared to baseline conditions across all water years. While flows are decreased slightly in all water year types except wet in May, OMR flows averaged across all water years are still positive and flowing towards the San Francisco estuary.

NEPA Effects: The effect of Alternative 2A is not adverse because it would not substantially reduce or degrade migration habitat or substantially reduce the number of fish as a result of mortality. Similarly, because OMR flows are overall improved, the effect of Alternative 2A on through-Delta migration conditions for Sacramento splittail would be beneficial.

CEQA Conclusion:

Upstream of the Delta

In general, effects of Alternative 2A would not affect splittail migration conditions in the Sacramento River relative to the Existing Conditions, but would reduce the suitability of channel conditions for migration in the Feather River due to increased exposure to critical water temperatures. However, splittail spawning in the Feather River is not as important as in Yolo Bypass, and therefore, net effects from Alternative 2A on migration conditions in the Feather River would be negligible.

Effects of Alternative 2A on splittail migration conditions are the same as described for channel margin and side-channel habitats in Impact AQUA-112. As concluded above, the impact is not significant because it would not substantially reduce suitable migration habitat or substantially reduce the number of fish as a result of mortality and no mitigation is necessary. Effects of Alternative 2A on flow would not have negative effects on the availability of channel margin and main-channel habitat, and would have a beneficial effect through increases in mean monthly flow for some months and water year types during the migration period. Benefits to habitat availability in the Yolo Bypass would outweigh negative effects of increased exposures to water temperatures above the upper threshold of 75°F in the Feather River in drier water year types.

Through-Delta

As described above, average OMR flows under Alternative 2A are expected to improve during the juvenile splittail migration through the Delta, especially during the summer months. In dry and below-normal water years in May, the reverse OMR flows would be increased under Alternative 2A compared to Existing Conditions, however monthly average OMR flows would be still be slightly improved in May compared to Existing Conditions. In addition, the periods of increased reverse flows in May would remain within the NMFS and USFWS BiOp requirements, thus the changes are expected to have a less-than-significant impact. Therefore, the impact on splittail migration survival would be beneficial because of the overall improvement in OMR flows.

Summary of CEQA Conclusion

Overall, Alternative 2A would not affect splittail migration conditions in the Sacramento River relative to the Existing Conditions, the impact is not significant because it would not substantially reduce suitable migration habitat or substantially reduce the number of fish as a result of mortality and no mitigation is necessary. Similarly, Alternative 2A is expected to reduce OMR reverse flows during the period of juvenile splittail migration through the Delta, resulting in greatly improved conditions in June and July compared to baseline conditions across all water years. Therefore the impact on splittail migration survival is less than significant. No mitigation is required.

Restoration Measures (CM2, CM4–CM7, and CM10)

Alternative 2A has the same restoration measures as Alternative 1A. Because no substantial differences in restoration-related fish effects are anticipated anywhere in the affected environment under Alternative 2A compared to those described in detail for Alternative 1A, the fish effects of restoration measures described for Sacramento splittail under Alternative 1A (Impact AQUA-115 through AQUA-117) also appropriately characterize effects under Alternative 2A.

The following impacts are those presented under Alternative 1A that are identical for Alternative 2A.

Impact AQUA-115: Effects of Construction of Restoration Measures on Sacramento Splittail

Impact AQUA-116: Effects of Contaminants Associated with Restoration Measures on Sacramento Splittail

Impact AQUA-117: Effects of Restored Habitat Conditions on Sacramento Splittail

NEPA Effects: All three of these impact mechanisms have been determined to result in no adverse effects on Sacramento splittail for NEPA purposes. Specifically for AQUA-116, the effects of contaminants on Sacramento splittail with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on Sacramento splittail are uncertain.

CEQA Conclusion: All three of these impact mechanisms would be considered less than significant on Sacramento splittail, for the reasons identified for Alternative 1A, and no mitigation is required.

Other Conservation Measures (CM12–CM19 and CM21)

Alternative 2A has the same other conservation measures as Alternative 1A. Because no substantial differences in other conservation-related fish effects are anticipated anywhere in the affected environment under Alternative 2A compared to those described in detail for Alternative 1A, the fish effects of other conservation measures described for Sacramento splittail under Alternative 1A (Impact AQUA-118 through AQUA-126) also appropriately characterize effects under Alternative 2A.

The following impacts are those presented under Alternative 1A that are identical for Alternative 2A.

Impact AQUA-118: Effects of Methylmercury Management on Sacramento Splittail (CM12)

Impact AQUA-119: Effects of Invasive Aquatic Vegetation Management on Sacramento Splittail (CM13)

Impact AQUA-120: Effects of Dissolved Oxygen Level Management on Sacramento Splittail (CM14)

Impact AQUA-121: Effects of Localized Reduction of Predatory Fish on Sacramento Splittail (CM15)

Impact AQUA-122: Effects of Nonphysical Fish Barriers on Sacramento Splittail (CM16)

Impact AQUA-123: Effects of Illegal Harvest Reduction on Sacramento Splittail (CM17)

Impact AQUA-124: Effects of Conservation Hatcheries on Sacramento Splittail (CM18)

Impact AQUA-125: Effects of Urban Stormwater Treatment on Sacramento Splittail (CM19)

Impact AQUA-126: Effects of Removal/Relocation of Nonproject Diversions on Sacramento Splittail (CM21)

NEPA Effects: The nine impact mechanisms have been determined to range from no effect, to no adverse effect, or beneficial effects on Sacramento splittail for NEPA purposes, for the reasons identified for Alternative 1A.

CEQA Conclusion: The nine impact mechanisms would be considered to range from no impact, to less than significant, or beneficial on Sacramento splittail, for the reasons identified for Alternative 1A, and no mitigation is required.

Green Sturgeon

Construction and Maintenance of CM1

Impact AQUA-127: Effects of Construction of Water Conveyance Facilities on Green Sturgeon

The potential effects of construction of the water conveyance facilities on green sturgeon would be similar to those described for Alternative 1A (Impact AQUA-127) except that Alternative 2A could potentially include two different intakes than under Alternative 1A. This would convert about 11,350 lineal feet of existing shoreline habitat into intake facility structures and would require about 26 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. The effects related to temporary increases in turbidity, accidental spills, underwater noise, in-water work activities, and disturbance of contaminated sediments would be similar to Alternative 1A and the same environmental commitments and mitigation measures (described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*) would be available to avoid and minimize potential effects.

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-127, environmental commitments and mitigation measures would be available to avoid and minimize potential effects, and the effect would not be adverse for green sturgeon.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-127, the impact of the construction of water conveyance facilities on green sturgeon would be less than significant except for construction noise associated with pile driving. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Alternative 1A, Impact AQUA-1.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Alternative 1A, Impact AQUA-1.

Impact AQUA-128: Effects of Maintenance of Water Conveyance Facilities on Green Sturgeon

NEPA Effects: The potential effects of the maintenance of water conveyance facilities under Alternative 2A would be the same as those described for Alternative 1A (see Impact AQUA-128). As concluded in Alternative 1A, Impact AQUA-128, the effect would not be adverse for green sturgeon.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-128, the impact of the maintenance of water conveyance facilities on green sturgeon would be less than significant and no mitigation is required.

Water Operations of CM1

Impact AQUA-129: Effects of Water Operations on Entrainment of Green Sturgeon

Water Exports from SWP/CVP South Delta Facilities

Alternative 2A is expected to substantially reduce overall entrainment of juvenile green sturgeon at the south Delta export facilities. Average annual loss of juvenile green sturgeon, as estimated by the salvage density method, would be approximately 58 fish for the combined SWP and CVP south Delta facilities (Table 11-2A-63; A2A_LLT). Losses would be slightly greater in wetter water year types (32 fish) than in drier years (26 fish). Losses would decrease 60–64% for Alternative 2A as compared to NAA. Entrainment reductions would be greater in wetter years (69–71% decrease) compared to Existing Conditions.

Water Exports from SWP/CVP North Delta Intake Facilities

The overall potential entrainment effects of operating the new north Delta intakes under Alternative 2A would be the same as described for Impact AQUA-129 under Alternative 1A. The intakes would have screens to avoid or reduce entrainment; there would be no adverse effect.

Water Export with a Dual Conveyance for the SWP North Bay Aqueduct

The overall potential entrainment effects of operating the dual conveyance of the North Bay Aqueduct under Alternative 2A would be the same as described for Impact AQUA-129 under Alternative 1A. The intakes would have screens to avoid or reduce entrainment; there would be no adverse effect.

Predation Associated with Entrainment

Juvenile green sturgeon predation loss at the south Delta facilities is assumed to be proportional to entrainment loss. Sturgeon develop bony scutes at a young age which reduces their predation vulnerability. The total reduction of juvenile green sturgeon entrainment, and hence predation loss, would change minimally between Alternative 2A and NAA (88 fish). Based on their early development of scutes and rapid growth rates, the number of juvenile green sturgeon lost to predation at the south Delta facilities would change negligibly between Alternative 2A and NAA. The impact and conclusion for predation risk associated with NPB structures and the north Delta intakes would be the same as described for Alternative 1A (Impact AQUA-3 for green sturgeon).

NEPA Effects: The effect on entrainment and predation losses under Alternative 2A would not be adverse, because green sturgeon grow rapidly and develop bony scutes early in their development which reduces their predation risk.

CEQA Conclusion: As described above, annual entrainment losses of juvenile green sturgeon across all years would decrease 65% under Alternative 2A (A2A_LLT) (58 fish) relative to Existing Conditions (166 fish) (Table 11-2A-63). impacts of water operations on green sturgeon would be beneficial due to an overall reduction in entrainment and no mitigation would be required.

Table 11-2A-63. Juvenile Green Sturgeon Annual Entrainment Index[a] at the SWP and CVP Salvage Facilities for Alternative 2A

	Entrainment Index			Absolute Difference (Percent Difference)	
Water Year[b]	EXISTING CONDITIONS	NAA	A2A_LLT	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wet and Above Normal	116	104	32	-84 (-72%)	-72 (-69%)
Below Normal, Dry, and Critical	50	42	26	-24 (-48%)	-16 (-38%)
All Years	166	146	58	-108 (-65%)	-88 (-60%)

[a] Estimated annual number of fish lost.
[b] Sacramento Valley water year-types.

The impact of predation associated with entrainment would be the same as described immediately above because the rapid growth and development of bony scutes reduces the predation risk for juvenile green sturgeon. Since few juvenile green sturgeon are entrained at the south Delta, reductions in entrainment (65% reduction compared to Existing Conditions, representing 108 fish) under Alternative 2A would have little effect on entrainment-related predation loss. Overall, the impact would be less than significant, because there would be little change in predation loss under Alternative 2A.

Impact AQUA-130: Effects of Water Operations on Spawning and Egg Incubation Habitat for Green Sturgeon

In general, Alternative 2A would not affect spawning and egg incubation habitat for green sturgeon relative to NAA.

Sacramento River

Mean monthly flows were examined in the Sacramento River between Keswick and upstream of Red Bluff during the March to July spawning and egg incubation period for green sturgeon. Lower flows can reduce the instream area available for spawning and egg incubation. Flows under A2A_LLT would always be similar to or greater than flows under NAA during March through July (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). During July flows would be lower than under NAA up to 6%. Also flows can be lower or higher in individual months of individual years

These results indicate that there would be very few reductions in flows in the Sacramento River under Alternative 2A.

Mean monthly water temperatures in the Sacramento River at Bend Bridge were examined during the March through July green sturgeon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

The number of days on which temperature exceeded 63°F by >0.5°F to >5°F in 0.5°F increments was determined for each month (May through September) and year of the 82-year modeling period (Table 11-2A-10). The combination of number of days and degrees above the 63°F threshold were further assigned a "level of concern" as defined in Table 11-2A-11. Differences between baselines and Alternative 2A in the highest level of concern across all months and all 82 modeled years are presented in Table 11-2A-64. There would be no difference in levels of concern between NAA and Alternative 2A.

Table 11-2A-64. Differences between Baseline and Alternative 2A Scenarios in the Number of Years in Which Water Temperature Exceedances above 63°F Are within Each Level of Concern, Sacramento River at Bend Bridge, May through September

Level of Concern	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Red	11 (275%)	2 (13%)
Orange	1 (100%)	1 (50%)
Yellow	2 (100%)	-1 (-25%)
None	-14 (-19%)	-2 (-3%)

Total degree-days exceeding 63°F at Bend Bridge were summed by month and water year type during May through September (Table 11-2A-65). Total degree-days under Alternative 2A would be 22% and 11% lower than under NAA during May and June, respectively, and 8% to 17% higher during July through September.

Table 11-2A-65. Differences between Baseline and Alternative 2A Scenarios in Total Degree-Days (°F-Days) by Month and Water Year Type for Water Temperature Exceedances above 63°F in the Sacramento River at Bend Bridge, May through September

Month	Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
May	Wet	38 (292%)	-17 (-25%)
	Above Normal	0 (NA)	-5 (-100%)
	Below Normal	4 (NA)	2 (100%)
	Dry	0 (NA)	0 (NA)
	Critical	4 (NA)	3 (300%)
	All	46 (354%)	-17 (-22%)
June	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	1 (NA)	1 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	6 (NA)	-12 (-67%)
	All	7 (NA)	-11 (-61%)
July	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	1 (NA)	1 (NA)
	Dry	6 (NA)	6 (NA)
	Critical	734 (9,175%)	104 (16.3%)
	All	741 (9,263%)	111 (17%)
August	Wet	3 (NA)	0 (0%)
	Above Normal	1 (NA)	1 (NA)
	Below Normal	2 (NA)	2 (NA)
	Dry	125 (NA)	59 (89%)
	Critical	1,652 (822%)	91 (5%)
	All	1,783 (887%)	153 (8%)
September	Wet	0 (NA)	0 (NA)
	Above Normal	16 (NA)	14 (700%)
	Below Normal	80 (NA)	67 (515%)
	Dry	556 (1,794%)	73 (14%)
	Critical	1,295 (485%)	33 (2%)
	All	1,947 (653%)	187 (9%)

NA = could not be calculated because the denominator was 0.

Feather River

In the Feather River between Thermalito Afterbay and the confluence with the Sacramento River during February through June, flows under A2A_LLT would be similar to or greater than flows under NAA during March through June except for March of below normal water years (8%) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These results indicate that there would be very few reductions in flows in the Feather River under Alternative 2A.

Mean monthly water temperatures in the Feather River at Gridley were examined during the February through June green sturgeon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

The percent of months exceeding the 64°F temperature threshold in the Feather River at Gridley was evaluated during May through September (Table 11-2A-66). For this impact, only the months of May and June were examined because spawning and egg incubation does not generally extend beyond June in the Feather River. Subsequent months are examined under Impact AQUA-131. In both May and June, the percent of months exceeding the threshold under Alternative 2A would be similar to or lower (up to 32% lower on an absolute scale) than the percent under NAA.

Table 11-2A-66. Differences between Baseline and Alternative 2A Scenarios in Percent of Months during the 82-Year CALSIM Modeling Period during Which Water Temperatures in the Feather River at Gridley Exceed the 64°F Threshold, May through September

	Degrees Above Threshold				
Month	>1.0	>2.0	>3.0	>4.0	>5.0
EXISTING CONDITIONS vs. A2A_LLT					
May	27 (85%)	17 (93%)	12 (125%)	11 (300%)	7 (300%)
June	0 (0%)	-4 (-4%)	0 (0%)	0 (0%)	7 (15%)
July	0 (0%)	0 (0%)	0 (0%)	10 (11%)	26 (38%)
August	0 (0%)	0 (0%)	7 (8%)	17 (22%)	35 (56%)
September	10 (14%)	10 (18%)	23 (83%)	32 (433%)	25 (1,000%)
NAA vs. A2A_LLT					
May	-12 (-17%)	-21 (-37%)	-10 (-31%)	-4 (-20%)	-2 (-20%)
June	-6 (-6%)	-12 (-13%)	-16 (-17%)	-28 (-31%)	-32 (-37%)
July	0 (0%)	0 (0%)	0 (0%)	0 (0%)	-2 (-3%)
August	0 (0%)	0 (0%)	-1 (-1%)	-2 (-2%)	0 (0%)
September	11 (16%)	5 (8%)	2 (5%)	-4 (-9%)	-1 (-4%)

Total degree-days exceeding 64°F were summed by month and water year type at Gridley during May through September (Table 11-2A-67). Only May and June were examined for spawning and egg incubation habitat here. Subsequent months are examined under Impact AQUA-131. Total degree-months exceeding the threshold under Alternative 2A would be 11% to 23% lower than those under NAA during May and June.

Table 11-2A-67. Differences between Baseline and Alternative 2A Scenarios in Total Degree-Months (°F-Months) by Month and Water Year Type for Water Temperature Exceedances above 64°F in the Feather River at Gridley, May through September

Month	Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
May	Wet	18 (300%)	-6 (-20%)
	Above Normal	9 (82%)	-5 (-20%)
	Below Normal	17 (213%)	-7 (-22%)
	Dry	27 (193%)	-2 (-5%)
	Critical	20 (118%)	0 (0%)
	All	92 (164%)	-19 (-11%)
June	Wet	21 (28%)	-46 (-32%)
	Above Normal	-9 (-18%)	-38 (-48%)
	Below Normal	0 (0%)	-32 (-33%)
	Dry	42 (45%)	-11 (-7%)
	Critical	35 (63%)	-4 (-4%)
	All	89 (26%)	-131 (-23%)
July	Wet	46 (27%)	30 (16%)
	Above Normal	21 (40%)	4 (6%)
	Below Normal	44 (65%)	12 (12%)
	Dry	91 (106%)	47 (36%)
	Critical	75 (95%)	21 (16%)
	All	277 (61%)	114 (18%)
August	Wet	52 (29%)	35 (18%)
	Above Normal	39 (87%)	17 (25%)
	Below Normal	51 (73%)	19 (19%)
	Dry	100 (147%)	22 (15%)
	Critical	49 (58%)	-1 (-1%)
	All	291 (65%)	92 (14%)
September	Wet	-8 (-21%)	19 (158%)
	Above Normal	8 (50%)	17 (243%)
	Below Normal	36 (129%)	-4 (-6%)
	Dry	51 (182%)	-1 (-1%)
	Critical	53 (265%)	-1 (-1%)
	All	139 (106%)	29 (12%)

San Joaquin River

Flows in the San Joaquin River at Vernalis under Alternative 2A during March through June would not be different from flows under NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*.

No water temperatures modeling was conducted in the San Joaquin River.

NEPA Effects: Collectively, these results indicate that the effect is not adverse because it does not have the potential to substantially reduce the amount of suitable spawning and egg incubation habitat or substantially reduce the number of individuals as a result of egg mortality. Flows in the Sacramento, Feather and San Joaquin River and water temperatures in the Sacramento and Feather Rivers under Alternative 2A would not be lower than those under NAA and therefore, would not to degrade spawning and egg incubation habitat conditions. Alternative 2A would reduce the frequency of exceedances above NMFS temperature thresholds in the Sacramento and Feather Rivers.

CEQA Conclusion: In general, Alternative 2A would not affect spawning and egg incubation habitat for green sturgeon relative to the Existing Conditions.

Sacramento River

In the Sacramento River between Keswick and upstream of Red Bluff during the March to July spawning and egg incubation period for green sturgeon, mean monthly flows under A2A_LLT would nearly always be similar to or greater than those under Existing Conditions, except in March during wet years (6% to 10% reduction depending on location), in May during wet years (14% to 15% reduction depending on location), and in July during critical years (12% reduction) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Also flows can be lower or higher in individual months of individual years. These results indicate that there would be very few reductions in flows in the Sacramento River under Alternative 2A relative to the Existing Conditions.

Mean monthly water temperatures in the Sacramento River at Bend Bridge were examined during the March through July green sturgeon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 2A in any month or water year type throughout the period.

The number of days on which temperature exceeded 63°F by >0.5°F to >5°F in 0.5°F increments was determined for each month (May through September) and year of the 82-year modeling period (Table 11-2A-64). The combination of number of days and degrees above the 63°F threshold were further assigned a "level of concern" as defined in Table 11-2A-11. Differences between baselines and Alternative 2A in the highest level of concern across all months and all 82 modeled years are presented in Table 11-2A-64. The number of "red" years would be 275% higher under Alternative 2A relative to Existing Conditions.

Total degree-days exceeding 63°F at Bend Bridge were summed by month and water year type during May through September (Table 11-2A-65). Water temperatures under Alternative 2A would exceed the threshold 46 degree-days (354%) and 7 degree-days (no relative change calculation possible due to division by 0) more than those under Existing Conditions during May and June, respectively.

Feather River

In the Feather River between Thermalito Afterbay and the confluence with the Sacramento River during February through June, flows under A2A_LLT would nearly always be similar to or greater than those under Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). The only exceptions would be in below normal, dry and critical years in February (8% to 45% lower, in below normal and dry years during March (5% to 46% lower depending on location and water year type), in wet years during May (24% to 31% lower depending on location), and at the confluence during June of wet (8% reduction) and critical years (11% reduction). These results indicate that there would be few reductions in flows in the Feather River under Alternative 2A relative to the Existing Conditions.

Mean monthly water temperatures in the Feather River at Gridley were examined during the February through June green sturgeon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would generally be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 2A in any month or water year type throughout the period, except during February and during below normal and critical years in March, in which mean monthly temperatures under Alternative 2A would be 6% higher than those under Existing Conditions.

The percent of months exceeding the 64°F temperature threshold in the Feather River at Gridley was evaluated during May through September (Table 11-2A-66). For this impact, only the months of May and June were examined because spawning and egg incubation does not generally extend beyond June in the Feather River. Subsequent months are examined under Impact AQUA-131. During the period, the percent of months exceeding the threshold under Alternative 2A would be similar to or higher (up to 27% higher on an absolute scale) than the percent under Existing Conditions.

Total degree-days exceeding 64°F were summed by month and water year type at Gridley during May through September (Table 11-2A-67). Only May and June were examined for spawning and egg incubation habitat here. Subsequent months are examined under Impact AQUA-131. Total degree-months exceeding the threshold under Alternative 2A would be 164% to 26% higher than those under Existing Conditions during May and June.

San Joaquin River

Flows in the San Joaquin River at Vernalis under Alternative 2A during March through June would not be different from flows under Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-130 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 2A could be significant because, under the CEQA baseline, the alternative could substantially reduce suitable spawning and egg incubation habitat, contrary to the NEPA conclusion set forth above. Flows in the Sacramento, Feather, and San Joaquin River would generally be similar between Alternative 2A and the CEQA baseline, but the exceedance above NMFS temperature thresholds would be greater in the Sacramento and Feather Rivers under Alternative 2A.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 2A does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 2A indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 2A. This indicates that the differences between Existing Conditions and Alternative 2A found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 2A, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on green sturgeon spawning and egg incubation habitat. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-131: Effects of Water Operations on Rearing Habitat for Green Sturgeon

In general, Alternative 2A would not affect the quantity and quality of green sturgeon larval and juvenile rearing habitat relative to NAA.

Sacramento River

Mean monthly water temperatures in the Sacramento River at Bend Bridge were examined during the May through October green sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

Feather River

Mean monthly water temperatures in the Feather River at Gridley were examined during the April through August green sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

The percent of months exceeding the 64°F temperature threshold in the Feather River at Gridley was evaluated during May through September (Table 11-2A-66). The percent of months exceeding the threshold under Alternative 2A would be similar to or lower (up to 32% lower on an absolute scale) than the percent under NAA in all months except September, in which the percent of months under Alternative 2A would be 2% to 11% (absolute scale) higher than the percent under NAA.

Total degree-days exceeding 64°F were summed by month and water year type at Gridley during May through September (Table 11-2A-67). Total degree-months exceeding the threshold under Alternative 2A would be 11% to 23% lower than those under NAA during May and June and 12% to 18% greater than those under NAA during July through September.

San Joaquin River

Flows in the San Joaquin River at Vernalis under Alternative 2A during the March through June spawning and egg incubation periods would similar to those under NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Water temperature modeling was not conducted in the San Joaquin River.

NEPA Effects: Collectively, the results indicate that the effect would not be adverse because does not have the potential to substantially reduce suitable rearing habitat. Flows and water temperatures would not differ substantially between Existing Conditions and Alternative 2A in any river evaluated during the green sturgeon spawning and egg incubation period.

CEQA Conclusion: In general, Alternative 2A would not affect the quantity and quality of green sturgeon larval and juvenile rearing habitat relative to the Existing Conditions.

Sacramento River

Mean monthly water temperatures in the Sacramento River at Bend Bridge were examined during the May through October green sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperature under Alternative 2A would be similar to those under Existing Conditions during May and June, but 5% to 12% higher than those under Existing Conditions during July through October.

Feather River

Mean monthly water temperatures in the Feather River at Gridley were examined during the April through August green sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 2A in any month except August and in dry and critical years in July, in which temperatures under Alternative 2A would be 5% to 9% greater than those under Existing Conditions.

The percent of months exceeding the 64°F temperature threshold in the Feather River at Gridley was evaluated during May through September (Table 11-2A-66). The percent of months exceeding the threshold under Alternative 2A would be similar to or greater (up to 32% higher on an absolute scale) than the percent under Existing Conditions in all months during the period.

Total degree-days exceeding 64°F were summed by month and water year type at Gridley during May through September (Table 11-2A-67). Total degree-months exceeding the threshold under Alternative 2A would be 26% to 164% greater than those under Existing Conditions depending on month.

San Joaquin River

Water temperature modeling was not conducted in the San Joaquin River.

Collectively, the results of the Impact AQUA-131 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 2A could be significant because, under the CEQA baseline, the alternative could substantially reduce suitable rearing habitat, contrary to the NEPA conclusion set forth above. Alternative 2A would cause higher temperatures for rearing larval and juvenile green sturgeon in the Sacramento and Feather River that could increase stress, mortality, and susceptibility to disease.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 2A does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 2A indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 2A. This indicates that the differences between Existing Conditions and Alternative 2A found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 2A, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on green sturgeon rearing habitat. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-132: Effects of Water Operations on Migration Conditions for Green Sturgeon

In general, Alternative 2A would reduce green sturgeon migration conditions relative to NAA.

Analyses for green sturgeon migration conditions focused on flows in the Sacramento River between Keswick and Wilkins Slough and in the Feather River between Thermalito and the confluence with the Sacramento River during the April through October larval migration period, the August through March juvenile migration period, and the November through June adult migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Because these periods encompass the entire year, flows during all months were compared. Reduced flows could slow or inhibit downstream migration of larvae and juveniles and reduce the ability to sense upstream migration cues and pass impediments by adults.

Sacramento River flows under A2A_LLT would generally be similar to or greater than flows under NAA in all months except July, August, and November, during which flows would be up to 28% lower depending on location, month, and water year type.

Larval transport flows were also examined by utilizing the positive correlation between white sturgeon year class strength and Delta outflow during April and May (USFWS 1995) under the assumption that the mechanism responsible for the relationship is that Delta outflow provides improved green sturgeon larval transport that results in improved year class strength. Results for white sturgeon presented in Impact AQUA-150 below suggest that, using the positive correlation between Delta outflow and year class strength, green sturgeon year class strength would be lower under Alternative 2A.

Feather River flows under A2A_LLT would generally be lower by up to 52% than those under NAA during July through August. Flows during other months under A2A_LLT would generally be similar to or greater than flows under NAA with some exceptions.

NEPA Effects: Collectively, these results indicate that the effect is adverse because it has the potential to substantially interfere with the movement of green sturgeon. Reductions in flows in the Feather River during July through September would affect larval and juvenile migratory abilities by slowing or inhibiting downstream migration, but would not affect adult migration. Reductions in flows in the Sacramento River during July, August, and November would affect the migration of all three life stages.

This effect is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this effect to a level that is not adverse would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this would be an unavoidable adverse effect because there is no feasible mitigation available. Even so, proposed mitigation (Mitigation Measure AQUA-132a through AQUA-132c) has the potential to reduce the severity of impact, although not necessarily to a not adverse level.

CEQA Conclusion: In general, Alternative 2A would reduce green sturgeon migration conditions relative to the Existing Conditions.

Analyses for green sturgeon migration conditions focused on flows in the Sacramento River between Keswick and Wilkins Slough and in the Feather River between Thermalito and the confluence with the Sacramento River during the April through October larval migration period, the August through March juvenile migration period, and the November through July adult migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Because these periods encompass the entire year, flows during all months were compared. Reduced flows could slow or inhibit downstream migration of larvae and juveniles and reduce the ability to sense upstream migration cues and pass impediments by adults.

Sacramento River flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions in all months except August, September, and November. Flows during other months would generally be similar to or greater than flows under Existing Conditions.

Flows in the Feather River under A2A_LLT would generally be up to 53% lower than flows under Existing Conditions in July, August, November, and December. Flows during other months under A2A_LLT would generally be similar to or greater than flows under Existing Conditions.

For Delta outflow, the percent of months exceeding flow thresholds under A2A_LLT would consistently be lower than those under Existing Conditions for each flow threshold, water year type, and month (8% to 75% lower on a relative scale) (Table 11-2A-73).

Summary of CEQA Conclusion

Collectively, these results indicate that the impact would be significant because it has the potential to substantially interfere with the movement of fish. The reduction in flows in the Sacramento River during August, September, and December and in the Feather River during July, August, November, and December would affect larval, juvenile, and adult migration period, which could slow or inhibit their migration in both rivers. This impact is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this impact to a less-than-significant level would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this impact is significant and unavoidable because there is no feasible mitigation available. Even so, proposed below is mitigation that has the potential to reduce the severity of impact though not necessarily to a less-than-significant level.

Mitigation Measure AQUA-132a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Green Sturgeon to Determine Feasibility of Mitigation to Reduce Impacts to Migration Conditions

Although analysis conducted as part of the EIR/EIS determined that Alternative 2A would have significant and unavoidable adverse effects on spawning habitat, this conclusion was based on the best available scientific information at the time and may prove to have been overstated. Upon the commencement of operations of CM1 and continuing through the life of the permit, the BDCP proponents will monitor effects on migration habitat in order to determine whether such effects would be as extensive as concluded at the time of preparation of this document and to determine any potentially feasible means of reducing the severity of such effects. This mitigation measure requires a series of actions to accomplish these purposes, consistent with the operational framework for Alternative 2A.

The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 2A operations only. Development of mitigation actions for the incremental impact on migration habitat attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 2A.

Mitigation Measure AQUA-132b: Conduct Additional Evaluation and Modeling of Impacts on Green Sturgeon Migration Conditions Following Initial Operations of CM1

Following commencement of initial operations of CM1 and continuing through the life of the permit, the BDCP proponents will conduct additional evaluations to define the extent to which modified operations could reduce impacts to migration habitat under Alternative 2A. The analysis required under this measure may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6).

Mitigation Measure AQUA-132c: Consult with NMFS, USFWS, and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Green Sturgeon Migration Conditions Consistent with CM1

In order to determine the feasibility of reducing the effects of CM1 operations on green sturgeon habitat, the BDCP proponents will consult with NMFS, USFWS and CDFW to identify and implement any feasible operational means to minimize effects on migration habitat. Any such action will be developed in conjunction with the ongoing monitoring and evaluation of habitat conditions required by Mitigation Measure AQUA-132a.

If feasible means are identified to reduce impacts on migration habitat consistent with the overall operational framework of Alternative 2A without causing new significant adverse impacts on other covered species, such means shall be implemented. If sufficient operational flexibility to reduce effects on green sturgeon habitat is not feasible under Alternative 2A operations, achieving further impact reduction pursuant to this mitigation measure would not be feasible under this Alternative, and the impact on green sturgeon would remain significant and unavoidable.

Restoration Measures (CM2, CM4–CM7, and CM10)

Alternative 2A has the same restoration measures as Alternative 1A. Because no substantial differences in restoration-related fish effects are anticipated anywhere in the affected environment under Alternative 2A compared to those described in detail for Alternative 1A, the fish effects of restoration measures described for green sturgeon under Alternative 1A (Impact AQUA-133 through AQUA-135) also appropriately characterize effects under Alternative 2A.

The following impacts are those presented under Alternative 1A that are identical for Alternative 2A.

Impact AQUA-133: Effects of Construction of Restoration Measures on Green Sturgeon

Impact AQUA-134: Effects of Contaminants Associated with Restoration Measures on Green Sturgeon

Impact AQUA-135: Effects of Restored Habitat Conditions on Green Sturgeon

NEPA Effects: All three of these impact mechanisms have been determined to result in no adverse effects on green sturgeon for NEPA purposes. Specifically for AQUA-134, the effects of contaminants on green sturgeon with respect to copper, ammonia and pesticides would not be adverse. The effects of methylmercury and selenium on green sturgeon are uncertain.

CEQA Conclusion: All three of these impact mechanisms would be considered less than significant on green sturgeon, for the reasons identified for Alternative 1A, and no mitigation is required.

Other Conservation Measures (CM12–CM19 and CM21)

Alternative 2A has the same other conservation measures as Alternative 1A. Because no substantial differences in other conservation-related fish effects are anticipated anywhere in the affected environment under Alternative 2A compared to those described in detail for Alternative 1A, the fish effects of other conservation measures described for green sturgeon under Alternative 1A (Impact AQUA-136 through AQUA-144) also appropriately characterize effects under Alternative 2A.

The following impacts are those presented under Alternative 1A that are identical for Alternative 2A.

Impact AQUA-136: Effects of Methylmercury Management on Green Sturgeon (CM12)

Impact AQUA-137: Effects of Invasive Aquatic Vegetation Management on Green Sturgeon (CM13)

Impact AQUA-138: Effects of Dissolved Oxygen Level Management on Green Sturgeon (CM14)

Impact AQUA-139: Effects of Localized Reduction of Predatory Fish on Green Sturgeon (CM15)

Impact AQUA-140: Effects of Nonphysical Fish Barriers on Green Sturgeon (CM16)

Impact AQUA-141: Effects of Illegal Harvest Reduction on Green Sturgeon (CM17)

Impact AQUA-142: Effects of Conservation Hatcheries on Green Sturgeon (CM18)

Impact AQUA-143: Effects of Urban Stormwater Treatment on Green Sturgeon (CM19)

Impact AQUA-144: Effects of Removal/Relocation of Nonproject Diversions on Green Sturgeon (CM21)

NEPA Effects: The nine impact mechanisms have been determined to range from no effect, to no adverse effect, or beneficial effects on green sturgeon for NEPA purposes, for the reasons identified for Alternative 1A.

CEQA Conclusion: The nine impact mechanisms would be considered to range from no impact, to less than significant, or beneficial on green sturgeon, for the reasons identified for Alternative 1A, and no mitigation is required.

White Sturgeon

Construction and Maintenance of CM1

Impact AQUA-145: Effects of Construction of Water Conveyance Facilities on White Sturgeon

The potential effects of construction of the water conveyance facilities on white sturgeon would be similar to those described for Alternative 1A (Impact AQUA-145) except that Alternative 2A could potentially include two different intakes than under Alternative 1A. This would convert about 11,350 lineal feet of existing shoreline habitat into intake facility structures and would require about 26 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. The effects related to temporary increases in turbidity, accidental spills, underwater noise, in-water work activities, and disturbance of contaminated sediments would be similar to Alternative 1A and the same environmental commitments and mitigation measures (described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*) would be available to avoid and minimize potential effects.

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-145, environmental commitments and mitigation measures would be available to avoid and minimize potential effects, and the effect would not be adverse for white sturgeon.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-145, the impact of the construction of water conveyance facilities on white sturgeon would be less than significant except for construction noise associated with pile driving. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Alternative 1A, Impact AQUA-1.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Alternative 1A, Impact AQUA-1.

Impact AQUA-146: Effects of Maintenance of Water Conveyance Facilities on White Sturgeon

NEPA Effects: The potential effects of the maintenance of water conveyance facilities under Alternative 2A would be the same as those described for Alternative 1A (see Impact AQUA-146). As concluded in Alternative 1A, Impact AQUA-146, the effect would not be adverse for white sturgeon.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-146 for white sturgeon, the impact of the maintenance of water conveyance facilities on white sturgeon would be less than significant and no mitigation is required.

Water Operations of CM1

Impact AQUA-147: Effects of Water Operations on Entrainment of White Sturgeon

Water Exports from SWP/CVP South Delta Facilities

Alternative 2A is expected to substantially reduce overall entrainment of juvenile white sturgeon at the south Delta export facilities, estimated as salvage density, by about 66–69% across all years as compared to NAA (Table 11-2A-68). As discussed for Alternative 1A (Impact AQUA-3), entrainment is highest in wet and above normal water years. Under Alternative 2A, entrainment in wet and above normal water years would be reduced 68–71% for juveniles, compared to baseline conditions. Therefore, Alternative 2A would not have adverse effects on juvenile white sturgeon.

Water Exports from SWP/CVP North Delta Intake Facilities

The potential entrainment effects of operating the new north Delta intakes under Alternative 2A would be the same as described for Impact AQUA-129 under Alternative 1A. The intakes would have screens to avoid or reduce entrainment; there would be no adverse effect.

Water Export with a Dual Conveyance for the SWP North Bay Aqueduct

The potential entrainment effects of operating dual conveyance of the North Bay Aqueduct under Alternative 2A would be the same as described for Impact AQUA-129 under Alternative 1A. The intakes would have screens to avoid or reduce entrainment; there would be no adverse effect.

Predation Associated with Entrainment

Juvenile white sturgeon predation loss at the south Delta facilities is assumed to be proportional to entrainment loss. Sturgeon develop bony scutes at a young age which reduces their predation vulnerability. The total reduction of juvenile white sturgeon entrainment, and hence predation loss, would change minimally between Alternative 2A and NAA (182 fish). Based on their early development of scutes and rapid growth rates, the number of juvenile white sturgeon lost to predation at the south Delta facilities would change negligibly between Alternative 2A and NAA. The impact and conclusion for predation risk associated with NPB structures and the north Delta intakes would be the same as described for Alternative 1A.

NEPA Effects: As concluded for Alternative 1A, the effect on entrainment and predation under Alternative 2A would not be adverse, because sturgeon grow rapidly and develop bony scutes early in their development which reduces they predation risk.

CEQA Conclusion: As described above, operational activities associated with water exports from SWP/CVP south Delta facilities would result in an overall decrease in entrainment of white sturgeon under Alternative 2A compared to Existing Conditions (Table 11-2A-68; Existing Conditions vs. 2A_LLT). Impacts of Alternative 2A water operations on entrainment of white sturgeon would be beneficial due to an overall reduction in entrainment and no mitigation would be required.

Table 11-2A-68. Juvenile White Sturgeon Entrainment Index[a] at the SWP and CVP Salvage Facilities for Sacramento Valley Water Year-Types and Differences (Absolute and Percentage) between Model Scenarios

	Absolute Difference (Percent Difference)	
Water Year[b]	NAA vs. A2A_LLT	EXISTING CONDITIONS vs. A2A_LLT
Wet and Above Normal	-164 (-68%)	-211 (-73%)
Below Normal, Dry, and Critical	-18 (-54%)	-25 (-61%)
All Years	-211 (-66%)	-182 (-72%)

[a] Estimated annual number of fish lost.
[b] Sacramento Valley water year-types.

The impact of predation associated with entrainment would be the same as described immediately above because the rapid growth and development of bony scutes reduces the predation risk for juvenile white sturgeon. Since few juvenile white sturgeon are entrained at the south Delta, reductions in entrainment (69% reduction compared to Existing Conditions, representing 236 fish) under Alternative 2A would have little effect in affecting entrainment related predation loss. Overall, the impact would be less than significant, because there would be little change in predation loss under Alternative 2A.

Impact AQUA-148: Effects of Water Operations on Spawning and Egg Incubation Habitat for White Sturgeon

In general, Alternative 2A would not affect spawning and egg incubation habitat for white sturgeon relative to NAA.

Sacramento River

Flows in the Sacramento River at Wilkins Slough and Verona were examined during the February to May spawning and egg incubation period for white sturgeon. Flows at Keswick under A2A_LLT would always be similar to or greater than flows under NAA during February to May (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT would be greater than those under NAA in 1 to 2 water years (up to 8% lower) during February through April, but would be similar to NAA during May (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These results indicate that there would be reductions in flows in the Sacramento River during this period under Alternative 2A.

Mean monthly water temperatures in the Sacramento River at Hamilton City were examined during the February through May white sturgeon spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

The number of days on which temperature exceeded a 61°F optimal and 68°F lethal threshold by >0.5°F to >5°F in 0.5°F increments were determined for each month (March through June) and year of the 82-year modeling period (Table 11-2A-10). The combination of number of days and degrees above each threshold were further assigned a "level of concern" as defined in Table 11-2A-11. Differences between baselines and Alternative 2A in the highest level of concern across all months and all 82 modeled years are presented in Table 11-2A-69. For the 61°F threshold, there would be 13 fewer (30% fewer) "red" years under Alternative 2A than under NAA. For the 68°F threshold, there would be negligible differences in the number of years under each level of concern between NAA and Alternative 2A.

Table 11-2A-69. Differences between Baselines and Alternative 2A in the Number of Years in Which Water Temperature Exceedances above the 61°F and 68°F Thresholds Are within Each Level of Concern, Sacramento River at Hamilton City, March through June

Level of Concern	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
61°F threshold		
Red	36 (450%)	-13 (-30%)
Orange	-1 (-7%)	2 (14%)
Yellow	-15 (-48%)	6 (38%)
None	-20 (-71%)	5 (63%)
68°F threshold		
Red	0 (NA)	0 (NA)
Orange	0 (NA)	0 (NA)
Yellow	1 (NA)	-2 (-200%)
None	-1 (-1%)	2 (2%)

NA = could not be calculated because the denominator was 0.

Total degree-days exceeding 61°F and 68°F were summed by month and water year type at Hamilton City during March through June (Table 11-2A-70, Table 11-2A-71). Total degree-days exceeding the 61°F threshold under Alternative 2A would be 19% higher than those under NAA during March, although this is an increase of only 3 degree-days, which would not cause biologically meaningful effect to white sturgeon. During April through June, total degree days exceeding the threshold would be 15% to 18% lower than those under NAA. Total degree-days exceeding the 68°F threshold would not differ between NAA and Alternative 2A during March and April, but would be 45% to 55% lower under Alternative 2A than under NAA during May and June.

Table 11-2A-70. Differences between Baseline and Alternative 2A Scenarios in Total Degree-Days (°F-Days) by Month and Water Year Type for Water Temperature Exceedances above 61°F in the Sacramento River at Hamilton City, March through June

Month	Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
March	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	7 (NA)	3 (75%)
	Dry	11 (NA)	0 (0%)
	Critical	1 (NA)	0 (0%)
	All	19 (NA)	3 (19%)
April	Wet	65 (542%)	-1 (-1%)
	Above Normal	60 (600%)	-8 (-10%)
	Below Normal	62 (1,033%)	0 (0%)
	Dry	114 (224%)	-30 (-15%)
	Critical	15 (1,500%)	1 (7%)
	All	316 (395%)	-38 (-9%)
May	Wet	927 (278%)	-188 (-13%)
	Above Normal	207 (95%)	-144 (-25%)
	Below Normal	382 (208%)	-67 (-11%)
	Dry	237 (117%)	-196 (-31%)
	Critical	381 (189%)	31 (6%)
	All	2,134 (187%)	-564 (-15%)
June	Wet	514 (89%)	-444 (-29%)
	Above Normal	91 (30%)	-275 (-41%)
	Below Normal	387 (183%)	-115 (-16%)
	Dry	634 (189%)	-68 (-7%)
	Critical	589 (157%)	43 (5%)
	All	2,215 (123%)	-859 (-18%)

NA = could not be calculated because the denominator was 0.

Table 11-2A-71. Differences between Baseline and Alternative 2A Scenarios in Total Degree-Days (°F-Days) by Month and Water Year Type for Water Temperature Exceedances above 68°F in the Sacramento River at Hamilton City, March through June

Month	Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
March	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
April	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
May	Wet	26 (371%)	-10 (-23%)
	Above Normal	0 (NA)	-20 (-100%)
	Below Normal	1 (NA)	1 (NA)
	Dry	0 (NA)	-2 (-100%)
	Critical	2 (NA)	1 (100%)
	All	29 (414%)	-30 (-45%)
June	Wet	4 (NA)	-4 (-50%)
	Above Normal	1 (100%)	-3 (-60%)
	Below Normal	2 (NA)	0 (0%)
	Dry	0 (NA)	0 (NA)
	Critical	11 (NA)	-16 (-59%)
	All	18 (1,800%)	-23 (-55%)

NA = could not be calculated because the denominator was 0.

Feather River

In the Feather River between Thermalito Afterbay and the confluence with the Sacramento River during February to May, flows under A2A_LLT would be similar to or greater than flows under NAA, except for March of below normal water years (8%) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These results indicate that there would be very few reductions in flows in the Feather River under Alternative 2A.

Mean monthly water temperatures in the Feather River below Thermalito Afterbay and at the confluence with the Sacramento River were examined during the February through May white sturgeon spawning and egg incubation period. Mean monthly water temperatures would not differ between NAA and Alternative 2A at either location throughout the period.

San Joaquin River

Flows in the San Joaquin River at Vernalis under Alternative 2A during February through May would not be different from flows under NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*.

Water temperature modeling was not conducted for the San Joaquin River.

NEPA Effects: Collectively, these results indicate that the effect is not adverse because it does not have the potential to substantially reduce the amount of suitable habitat. Flows under Alternative 2A are generally greater than or similar to flows under NAA. In addition, there would be no effect on water temperatures in the Sacramento and Feather Rivers or on exceedances above NMFS water temperature thresholds for spawning adults and egg incubation in the Sacramento River.

CEQA Conclusion: In general, under Alternative 2A water operations, the quantity and quality of spawning and egg incubation habitat for white sturgeon would not be affected relative to the CEQA baseline.

Sacramento River

Flows in the Sacramento River at Wilkins Slough and Verona were examined during the February to May spawning and egg incubation period for white sturgeon. Flows at Keswick under A2A_LLT would generally be similar to or greater than flows under Existing Conditions with few exceptions (up to 14% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows at Verona under A2A_LLT would generally be similar to those under Existing Conditions except in February in which flows would be up to 8% lower. These results indicate that there would not be reductions in flows in the Sacramento River during this period under Alternative 2A.

Mean monthly water temperatures in the Sacramento River at Hamilton City were examined during the February through May white sturgeon spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and Alternative 2A in any month or water year type throughout the period.

The number of days on which temperature exceeded a 61°F optimal and 68°F lethal threshold by >0.5°F to >5°F in 0.5°F increments were determined for each month (March through June) and year of the 82-year modeling period (Table 11-2A-10). The combination of number of days and degrees above each threshold were further assigned a "level of concern" as defined in Table 11-2A-11. Differences between baselines and Alternative 2A in the highest level of concern across all months and all 82 modeled years are presented in Table 11-2A-69. For the 61°F threshold, there would be 36 more (450% increase) "red" years under Alternative 2A than under Existing Conditions. For the 68°F threshold, there would be negligible differences in the number of years under each level of concern between Existing Conditions and Alternative 2A.

Total degree-days exceeding 61°F and 68°F were summed by month and water year type at Hamilton City during March through June (Table 11-2A-70, Table 11-2A-71). Total degree-days exceeding the 61°F threshold under Alternative 2A would be 19 degree-days (percent change unable to be calculated due to division by 0) to 2215 degree-days (123%) higher depending on month. Total degree-days exceeding the 68°F threshold would not differ between Existing Conditions and Alternative 2A during March and April. During May and June, total degree-days would be 29 (414%)

and 18 (1800%) degree-days higher under Alternative 2A, although these small absolute differences would not cause a biologically meaningful effect on white sturgeon.

Feather River

In the Feather River between Thermalito Afterbay and the confluence with the Sacramento River during February to May, flows under A2A_LLT would generally be similar to or greater than those under Existing Conditions, except during February at Thermalito Afterbay, in which flows would be up to 45% lower (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These results indicate that there would be very few reductions in flows in the Feather River under Alternative 2A.

Mean monthly water temperatures in the Feather River below Thermalito Afterbay and at the confluence with the Sacramento River were examined during the February through May white sturgeon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures would not differ between Existing Conditions and Alternative 2A at either location throughout the period, except below Thermalito Afterbay during February, in which temperatures under Alternative 2A would be 6% higher than temperatures under Existing Conditions.

San Joaquin River

Flows in the San Joaquin River at Vernalis under Alternative 2A during the February through May period would be similar to or lower than flows under Existing Conditions in some water years during February and up to 16% lower during March through May.

Water temperature modeling was not conducted for the San Joaquin River.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-148 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 2A could be significant because, under the CEQA baseline, the alternative could substantially reduce the amount of suitable habitat, contrary to the NEPA conclusion set forth above. Flows in the San Joaquin River would be lower during a substantial portion of the spawning and egg incubation period. Lower flows could reduce white sturgeon spawning habitat availability or reduce water quality in spawning and egg incubation areas. Also, water temperatures under Alternative 2A in the Feather River would exceed NMFS thresholds at a substantially higher frequency than that under Existing Conditions. Elevated water temperatures can lead to reduced white sturgeon spawning success and higher egg mortality.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 2A does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 2A indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 2A. This indicates that the differences between Existing Conditions and Alternative 2A found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 2A, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on spawning habitat for white sturgeon. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-149: Effects of Water Operations on Rearing Habitat for White Sturgeon

In general, Alternative 2A would not affect the quantity and quality of white sturgeon larval and juvenile rearing habitat relative to NAA.

Water temperature was used to determine the potential effects of Alternative 2A on white sturgeon larval and juvenile rearing habitat because larvae and juveniles are benthic oriented and, therefore, their habitat is more likely to be limited by changes in water temperature than flow rates.

Mean monthly water temperatures in the Sacramento River at Hamilton City were examined during the year-round white sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period.

Mean monthly water temperatures in the Feather River at Honcut Creek were examined during the year-round white sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 2A in any month or water year type throughout the period

Water temperatures were not modeled in the San Joaquin River.

NEPA Effects: These results indicate that the effect is not adverse because it does not have the potential to substantially reduce the amount of suitable rearing habitat. There would be no differences in water temperatures between the NEPA baseline and Alternative 2A in either the Sacramento or Feather Rivers throughout the white sturgeon rearing period.

CEQA Conclusion: In general, Alternative 2A would not affect the quantity and quality of white sturgeon larval and juvenile rearing habitat relative to the Existing Conditions.

Water temperature was used to determine the potential effects of Alternative 2A on white sturgeon larval and juvenile rearing habitat because larvae and juveniles are benthic oriented and, therefore, their habitat is more likely to be limited by changes in water temperature than flow rates.

Mean monthly water temperatures in the Sacramento River at Hamilton City were examined during the year-round white sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures would be similar between Existing Conditions and Alternative 2A during November through June, but up to 11% higher under Alternative 2A relative to Existing Conditions during August through October and in dry and critical years during July.

Mean monthly water temperatures in the Feather River at Honcut Creek were examined during the year-round white sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures would be similar between Existing Conditions during April through June and in most years during July and September, but 5% to 9% higher under Alternative 2A relative to Existing Conditions during August and October through February.

Water temperatures were not modeled in the San Joaquin River.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-149 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 2A could be significant because, when compared to the CEQA baseline, the alternative could substantially reduce suitable rearing, contrary to the NEPA conclusion set forth above. There would be small, but persistent, increases in water temperatures during substantial portions of the larval and juvenile white sturgeon rearing period in both the Sacramento and Feather Rivers.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 2A does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 2A indicates that flows and reservoir storage in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 2A. This indicates that the differences between Existing Conditions and Alternative 2A found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 2A, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on rearing habitat for white sturgeon. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-150: Effects of Water Operations on Migration Conditions for White Sturgeon

In general, the effects of Alternative 2A on white sturgeon migration conditions relative to NAA are uncertain.

Analyses for white sturgeon focused on the Sacramento River (North Delta to RM 143—i.e., Wilkins Slough and Verona CALSIM nodes). Larval transport flows were represented by the average number of months per year that exceeded thresholds of 17,700 cfs (Wilkins Slough) and 31,000 cfs (Verona) (Table 11-2A-72). Exceedances of the 17,700 cfs threshold for Wilkins Slough under A2A_LLT were similar to those under NAA. The number of months per year above 31,000 cfs at Verona would range from a reduction of 1.5 months (67% lower in wet years) to an increase of 0.8 months (350% higher in dry years) relative to NAA depending on water year type. Overall, there is no consistent difference between Alternative 2A and the baselines.

Table 11-2A-72. Difference and Percent Difference in Number of Months between February and May in Which Flow Rates Exceed 17,700 and 5,300 cfs in the Sacramento River at Wilkins Slough and 31,000 cfs at Verona

	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wilkins Slough, 17,700 cfs[a]		
Wet	-0.04 (-2%)	0 (0%)
Above Normal	0.3 (18%)	0.1 (5%)
Below Normal	-0.1 (-25%)	0 (0%)
Dry	0 (0%)	0 (0%)
Critical	0 (0%)	0 (0%)
Wilkins Slough, 5,300 cfs[b]		
Wet	-0.2 (-2%)	0.04 (1%)
Above Normal	-0.3 (-4%)	0.1 (1%)
Below Normal	0.3 (5%)	0.6 (12%)
Dry	0.5 (10%)	0.2 (4%)
Critical	0.3 (10%)	0.3 (7%)
Verona, 31,000 cfs[a]		
Wet	-1.8 (-72%)	-1.5 (-67%)
Above Normal	-0.5 (-30%)	-0.3 (-22%)
Below Normal	0.4 (71%)	0.4 (100%)
Dry	0.7 (260%)	0.8 (350%)
Critical	0 (0%)	0 (0%)

[a] Months analyzed: February through May.
[b] Months analyzed: November through May.

Larval transport flows were also examined by utilizing the positive correlation between year class strength and Delta outflow during April and May (USFWS 1995) under the assumption that the mechanism responsible for the relationship is that Delta outflow provides improved larval transport that results in improved year class strength. The percent of months exceeding flow thresholds under A2A_LLT generally be lower than those under NAA (up to 67%) with few exceptions (Table 11-2A-73). These results suggest that, using the positive correlation between Delta outflow and year class strength, year class strength would be lower under Alternative 2A.

Table 11-2A-73. Difference and Percent Difference in Percentage of Months in Which Average Delta Outflow is Predicted to Exceed 15,000, 20,000, and 25,000 Cubic Feet per Second in April and May of Wet and Above-Normal Water Years

Flow	Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
April			
15,000 cfs	Wet	-8 (-8%)	-8 (-8%)
	Above Normal	-17 (-18%)	-17 (-18%)
20,000 cfs	Wet	-8 (-9%)	-8 (-9%)
	Above Normal	-25 (-33%)	-17 (-25%)
25,000 cfs	Wet	-19 (-24%)	-15 (-20%)
	Above Normal	-25 (-43%)	-17 (-33%)
May			
15,000 cfs	Wet	-12 (-13%)	-4 (-5%)
	Above Normal	-25 (-30%)	0 (0%)
20,000 cfs	Wet	-38 (-45%)	-15 (-25%)
	Above Normal	-8 (-20%)	0 (0%)
25,000 cfs	Wet	-31 (-44%)	-19 (-33%)
	Above Normal	-25 (-75%)	-17 (-67%)
April/May Average			
15,000 cfs	Wet	-12 (-12%)	-4 (-4%)
	Above Normal	-25 (-25%)	-17 (-18%)
20,000 cfs	Wet	-23 (-26%)	-19 (-23%)
	Above Normal	-17 (-25%)	0 (0%)
25,000 cfs	Wet	-19 (-24%)	-8 (-11%)
	Above Normal	-25 (-50%)	-25 (-50%)

For juveniles, year-round migration flows at Verona were more than 5% lower under A2A_LLT relative to NAA throughout much of the year under each water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

For adults, the average number of months per year during the November through May adult migration period in which flows in the Sacramento River at Wilkins Slough exceed 5,300 cfs was determined (Table 11-2A-72). The average number of months exceeding 5,300 cfs under A2A_LLT would generally be similar to the number of months under NAA, except in below normal (12% higher), dry (9% higher), and critical (10% higher) water year types. These increase in exceedances are considered small (<15%) and would not affect white sturgeon adult migration.

These results suggest that, using the positive correlation between Delta outflow and year class strength, year class strength would be lower under Alternative 2A. However, there is high uncertainty that year class strength is due to Delta outflow or if both year class strength and Delta outflows are caused by another unknown factor. There is no difference in the ability of Alternative 2A to meet flow targets in the Sacramento River relative to NAA (Table 11-2A-72).

NEPA Effects: Upstream flows (above north Delta intakes) are similar between Alternative 2A and NAA (Table 11-2A-72). However, due to the removal of water at the North Delta intakes, there are substantial differences in through-Delta flows between Alternative 2A and NAA (Table 11-2A-73). Analysis of white sturgeon year-class strength (USFWS 1995) found a positive correlation between year class strength and Delta outflow during April and May. However, this conclusion was reached in the absence of north Delta intakes and the exact mechanism that causes this correlation is not known at this time. One hypothesis suggests that the correlation is caused by high flows in the upper river resulting in improved migration, spawning, and rearing conditions in the upper river. Another hypothesis suggests that the positive correlation is a result of higher flows through the Delta triggering more adult sturgeon to move up into the river to spawn. It is also possible that some combination of these factors are working together to produce the positive correlation between high flows and sturgeon year-class strength.

The scientific uncertainty regarding which mechanisms are responsible for the positive correlation between year class strength and river/Delta flow will be addressed through targeted research and monitoring to be conducted in the years leading up to the initiation of north Delta facilities operations. If these targeted investigations determine that the primary mechanisms behind the positive correlation between high flows and sturgeon year-class strength are related to upstream conditions, then Alternative 2A would be deemed Not Adverse due to the similarities in upstream flow conditions between Alternative 2A and NAA. However, if the targeted investigations lead to a conclusion that the primary mechanisms behind the positive correlation are related to in-Delta and through-Delta flow conditions, then Alternative 2A would be deemed Adverse due to the magnitude of reductions in through-Delta flow conditions in Alternative 2A as compared to NAA.

CEQA Conclusion: In general, under Alternative 2A water operation, migration conditions for white sturgeon would not change relative to the CEQA baseline.

The number of months per year with exceedances above the 17,700 cfs threshold for Wilkins Slough under A2A_LLT would be similar to those under Existing Conditions in wet, dry, and critical years (Table 11-2A-72). The number of months per year above 17,000 cfs at Wilkins Slough under A2A_LLT would be 18% greater than under Existing Conditions in above normal years and 25% lower than under Existing Conditions in below normal water years. The number of months per year above 31,000 cfs at Verona would range from a reduction of 1.8 months (72% reduction in wet years) to an increase of 0.7 months (260% higher in dry years) relative to Existing Conditions depending on water year type.

For Delta outflow, the percent of months exceeding flow thresholds under A2A_LLT would consistently be lower than those under Existing Conditions for each flow threshold, water year type, and month (8% to 75% lower on a relative scale) (Table 11-2A-73).

For juveniles, year-round migration flows would be more than 5% lower under A2A_LLT relative to Existing Conditions throughout much of the year under each water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

For adult migration, the average number of months exceeding 5,300 cfs under A2_LLT would generally be similar to the number of months under Existing Conditions, except in below normal (5% higher) and in dry and critical water years (10% higher in both) (Table 11-2A-72).

Summary of CEQA Conclusion

The results of the AQUA-150 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 2A could be significant because, under the CEQA baseline, the alternative could substantially reduce the amount of suitable habitat, contrary to the NEPA conclusion set forth above.

As discussed above, the Delta outflow-white sturgeon year class strength correlation has high uncertainty such that it is not possible to determine whether reduced outflow would result in a significant impact. However, the inability of Alternative 2A to meet flow targets in the Sacramento River relative to the Existing Conditions would have biologically meaningful effects on white sturgeon (Table 11-2A-72).

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 2A does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 2A indicates that flows and reservoir storage in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 2A. This indicates that the differences between Existing Conditions and Alternative 2A found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 2A, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion of not adverse, and therefore would not in itself result in a significant impact on migration conditions for white sturgeon. Additionally, as described above in the NEPA Effects statement, further investigation is needed to better understand the association of Delta outflow to sturgeon recruitment, and if needed, adaptive management would be used to make adjustments to meet the biological goals and objectives. This impact is found to be less than significant and no mitigation is required.

Restoration Measures (CM2, CM4–CM7, and CM10)

Alternative 2A has the same restoration measures as Alternative 1A. Because no substantial differences in restoration-related fish effects are anticipated anywhere in the affected environment under Alternative 2A compared to those described in detail for Alternative 1A, the fish effects of restoration measures described for white sturgeon under Alternative 1A (Impact AQUA-151 through AQUA-153) also appropriately characterize effects under Alternative 2A.

The following impacts are those presented under Alternative 1A that are identical for Alternative 2A.

Impact AQUA-151: Effects of Construction of Restoration Measures on White Sturgeon

Impact AQUA-152: Effects of Contaminants Associated with Restoration Measures on White Sturgeon

Impact AQUA-153: Effects of Restored Habitat Conditions on White Sturgeon

NEPA Effects: All three of these impact mechanisms have been determined to result in no adverse effects on white sturgeon for NEPA purposes. Specifically for AQUA-152, the effects of contaminants on white sturgeon with respect to copper, ammonia and pesticides would not be adverse. The effects of methylmercury and selenium on white sturgeon are uncertain.

CEQA Conclusion: All three of these impact mechanisms would be considered less than significant on white sturgeon, for the reasons identified for Alternative 1A, and no mitigation is required.

Other Conservation Measures (CM12–CM19 and CM21)

Alternative 2A has the same other conservation measures as Alternative 1A. Because no substantial differences in other conservation-related fish effects are anticipated anywhere in the affected environment under Alternative 2A compared to those described in detail for Alternative 1A, the fish effects of other conservation measures described for white sturgeon under Alternative 1A (Impact AQUA-154 through AQUA-162) also appropriately characterize effects under Alternative 2A.

The following impacts are those presented under Alternative 1A that are identical for Alternative 2A.

Impact AQUA-154: Effects of Methylmercury Management on White Sturgeon (CM12)

Impact AQUA-155: Effects of Invasive Aquatic Vegetation Management on White Sturgeon (CM13)

Impact AQUA-156: Effects of Dissolved Oxygen Level Management on White Sturgeon (CM14)

Impact AQUA-157: Effects of Localized Reduction of Predatory Fish on White Sturgeon (CM15)

Impact AQUA-158: Effects of Nonphysical Fish Barriers on White Sturgeon (CM16)

Impact AQUA-159: Effects of Illegal Harvest Reduction on White Sturgeon (CM17)

Impact AQUA-160: Effects of Conservation Hatcheries on White Sturgeon (CM18)

Impact AQUA-161: Effects of Urban Stormwater Treatment on White Sturgeon (CM19)

Impact AQUA-162: Effects of Removal/Relocation of Nonproject Diversions on White Sturgeon (CM21)

NEPA Effects: The nine impact mechanisms have been determined to range from no effect, to no adverse effect, or beneficial effects on white sturgeon for NEPA purposes, for the reasons identified for Alternative 1A.

CEQA Conclusion: The nine impact mechanisms would be considered to range from no impact, to less than significant, or beneficial on white sturgeon, for the reasons identified for Alternative 1A, and no mitigation is required.

Pacific Lamprey

Construction and Maintenance of CM1

Impact AQUA-163: Effects of Construction of Water Conveyance Facilities on Pacific Lamprey

The potential effects of construction of the water conveyance facilities on Pacific lamprey would be similar to those described for Alternative 1A (Impact AQUA-163) except that Alternative 2A could potentially include two different intakes than under Alternative 1A. This would convert about 11,350 lineal feet of existing shoreline habitat into intake facility structures and would require about 26 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. The effects related to temporary increases in turbidity, accidental spills, underwater noise, in-water work activities, and disturbance of contaminated sediments would be similar to Alternative 1A and the same environmental commitments and mitigation measures (described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*) would be available to avoid and minimize potential effects.

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-163, environmental commitments and mitigation measures would be available to avoid and minimize potential effects, and the effect would not be adverse for Pacific lamprey.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-163, the impact of the construction of water conveyance facilities on Pacific lamprey would be less than significant except for construction noise associated with pile driving. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Alternative 1A, Impact AQUA-1.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Alternative 1A, Impact AQUA-1.

Impact AQUA-164: Effects of Maintenance of Water Conveyance Facilities on Pacific Lamprey

NEPA Effects: The potential effects of the maintenance of water conveyance facilities under Alternative 2A would be the same as those described for Alternative 1A (see Impact AQUA-164). As concluded in Alternative 1A, Impact AQUA-164, the effect would not be adverse for Pacific lamprey.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-164, the impact of the maintenance of water conveyance facilities on Pacific lamprey would be less than significant and no mitigation is required.

Water Operations of CM1

Impact AQUA-165: Effects of Water Operations on Entrainment of Pacific Lamprey

Water Exports

Alternative 2A is expected to substantially reduce average annual entrainment of Pacific lamprey, estimated by salvage density, by about 59–60% (Table 11-2A-74) averaged across all years compared to NAA.

The potential entrainment impacts of Alternative 2A on Pacific lamprey would be the same as described above for Alternative 1A (Impact AQUA-165). These actions would avoid or reduce potential entrainment and the effect is not adverse.

The analysis of Pacific lamprey and river lamprey entrainment at the SWP/CVP south Delta facilities is combined because the salvage facilities do not distinguish between the two lamprey species. Similar to Alternative 1A (Impact AQUA-165), Alternative 2A is not expected to have an adverse effect on lamprey.

Predation Associated with Entrainment

Lamprey predation loss at the south Delta facilities is assumed to be proportional to entrainment loss. Average pre-screen predation loss for fish entrained at the south Delta is 75% at Clifton Court Forebay and 15% at the CVP. Lamprey entrainment to the south Delta would be reduced by 59–60% compared to NAA and predation losses would be expected to be reduced at a similar proportion. The impact and conclusion for predation risk associated with NPB structures would be the same as described for Alternative 1A.

NEPA Effects: Predation at the north Delta would be increased due to the construction of the proposed water export facilities on the Sacramento River. The effect on lamprey from predation loss at the north Delta is unknown because of the lack of knowledge about their distribution and population abundances in the Delta. As described for Alternative 1A, the overall effect on entrainment and predation of lamprey is considered not adverse.

CEQA Conclusion: As described above, annual entrainment losses of lamprey would be decreased under Alternative 2A by approximately 60% compared to Existing Conditions (Table 11-2A-74). At the north Delta facilities and the alternate NBA intake, the screened intakes as designed would exclude this species. Decommissioning agricultural diversions would slightly reduce potential entrainment. Impacts of Alternative 2A water operations on entrainment on Pacific lamprey are anticipated to be less than significant and may be beneficial, due to reductions in entrainment at the Delta export facilities. No mitigation would be required.

Table 11-2A-74. Lamprey Annual Entrainment Index at the SWP and CVP Salvage Facilities for Alternative 2A[a]

	Absolute Difference (Percent Difference)	
Water Year	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
All Years	-2,044 (-60%)	-1,939 (-59%)

[a] Number of fish lost, based on non-normalized data, for all months.

The impact of predation associated with entrainment would be the same as described immediately above because the additional predation losses associated with the proposed north Delta intakes would be offset by the reduction in predation loss at the south Delta. The relative impact of predation loss on the lamprey population is unknown since there is little available knowledge on their distribution and abundance in the Delta. The impact is considered to be less than significant. No mitigation is required.

Impact AQUA-166: Effects of Water Operations on Spawning and Egg Incubation Habitat for Pacific Lamprey

In general, effects of Alternative 2A would not affect the quantity and quality of Pacific lamprey spawning habitat relative to NAA.

Flow-related impacts on Pacific lamprey spawning habitat were evaluated by estimating effects of flow alterations on egg exposure, called redd dewatering risk, and effects on water temperature. A redd is a gravel-covered nest of eggs; Pacific lamprey eggs take between 18 and 49 days to incubate and must remain covered by sufficient water for that time. Rapid reductions in flow can dewater redds leading to mortality. Locations for each river used in the dewatering risk analysis were based on available literature, personal conversations with agency experts, and spatial limitations of the CALSIM II model, and include the Sacramento River at Keswick, Sacramento River at Red Bluff, Trinity River downstream of Lewiston, Feather River at Thermalito Afterbay, and American River at Nimbus Dam and at the confluence with the Sacramento River. Pacific lamprey spawn in these rivers between January and August so flow reductions during those months have the potential to dewater redds, which could result in incomplete development of the eggs to ammocoetes (the larval stage). Water temperature results from the SRWQM and the Reclamation Temperature Model were used to assess the exceedances of water temperatures under all model scenarios in the upper Sacramento, Trinity, Feather, American, and Stanislaus rivers.

Dewatering risk to redd cohorts was characterized by the number of cohorts experiencing a month-over-month reduction in flows (using CALSIM II outputs) of greater than 50%. Small-scale spawning location suitability characteristics (e.g., depth, velocity, substrate) of Pacific lamprey are not adequately described to employ a more formal analysis such as a weighted usable area analysis. Therefore, the change in month-over-month flows is used as a surrogate for a more formal analysis, and a month-over-month flow reduction of 50% was chosen as a best professional estimate of flow conditions in which redd dewatering is expected to occur, but does not estimate empirically derived redd dewatering events. As such, there is uncertainty that these values represent actual redd dewatering events, and results should be treated as rough estimates of flow fluctuations under each model scenario. Results were expressed as the number of cohorts exposed to dewatering risk and as a percentage of the total number of cohorts anticipated in the river based on the applicable time-frame, January to August.

Flows in all rivers evaluated indicate an increase in redd cohorts exposed to month-over-month flow reductions between January and August for Alternative 2A compared to NAA would only occur in the Feather River, which would consist of a small increase in dewatering risk (9 cohorts or 8%) (Table 11-2A-75). These results indicate no effect of Alternative 2A on the number of Pacific lamprey redd cohorts predicted to experience a month-over-month change in flow of greater than 50% in the Sacramento, Trinity, and American Rivers. Alternative 2A would result in a small increase (8%) in the number of cohorts predicted to experience a month-over-month change of flow greater than 50% in the Feather River which would not constitute have biologically meaningful effects.

Table 11-2A-75. Differences between Model Scenarios in Dewatering Risk of Pacific Lamprey Redd Cohorts[a]

Location	Comparison[b]	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Sacramento River at Keswick	Difference	9	-13
	Percent Difference	16%	-17%
Sacramento River at Red Bluff	Difference	8	-10
	Percent Difference	15%	-14%
Trinity River down-stream of Lewiston	Difference	0	0
	Percent Difference	0%	0%
Feather River at Thermalito Afterbay	Difference	-33	9
	Percent Difference	-22%	8%
American River at Nimbus Dam	Difference	36	-1
	Percent Difference	42%	-1%
American River at Sacramento River confluence	Difference	40	0
	Percent Difference	42%	0%

[a] Difference and percent difference between model scenarios in the number of Pacific lamprey redd cohorts experiencing a month-over-month reduction in flows of greater than 50%.

[b] Positive values indicate a higher value in Alternative 2A than in the baseline.

Significant reduction in survival of eggs and embryos of Pacific lamprey were observed at 22°C (71.6°F; Meeuwig et al. 2005). Therefore, in the Sacramento River, this analysis predicted the number of consecutive 49 day periods for the entire 82-year CALSIM period during which at least one day exceeds 22°C (71.6°F) using daily data from SRWQM. For other rivers, the analysis predicted the number of consecutive 2 month periods during which at least one month exceeds 22°C (71.6°F) using monthly averaged data from the Reclamation temperature model. Each individual day or month starts a new "egg cohort" such that there are 19,928 cohorts for the Sacramento River, corresponding to 82 years of eggs being laid every day each year from January 1 through August 31, and 648 cohorts for the other rivers using monthly data over the same period. The incubation periods used in this analysis are conservative and represent the extreme long end of the egg incubation period (Brumo 2006). Also, the utility of the monthly average time step is limited because the extreme temperatures are masked; however, no better analytical tools are currently available for this analysis. Exact spawning locations of Pacific lamprey are not well defined. Therefore, this analysis uses the widest range in which the species is thought to spawn in each river.

In most locations, egg cohort exposure would not differ between NAA and Alternative 2A (Table 11-2A-76). However, the number of cohorts exposed to 22°C (71.6°F) under Alternative 2A would be 11% higher in the Sacramento River at Hamilton City and 61% higher in the Feather River at Thermalito Afterbay. The increase in the Sacramento River is negligible considering that it represents a difference of <0.1% of the total number of egg cohorts evaluated (19,928 cohorts).

Table 11-2A-76. Differences (Percent Differences) between Model Scenarios in Pacific Lamprey Egg Cohort Temperature Exposure[a]

Location	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Sacramento River at Keswick	51 (NA)	0 (0%)
Sacramento River at Hamilton City	1,188 (NA)	120 (11%)
Trinity River at Lewiston	6 (NA)	1 (20%)
Trinity River at North Fork	15 (NA)	-3 (-17%)
Feather River at Fish Barrier Dam	0 (NA)	-1 (-100%)
Feather River below Thermalito Afterbay	124 (517%)	56 (61%)
American River at Nimbus	71 (645%)	-3 (-4%)
American River at Sacramento River Confluence	161 (288%)	1 (0%)
Stanislaus River at Knights Ferry	2 (NA)	0 (0%)
Stanislaus River at Riverbank	87 (4,350%)	0 (0%)

NA = could not be calculated because the denominator was 0.

[a] Difference and percent difference between model scenarios in the number of Pacific lamprey egg cohorts experiencing water temperatures above 71.6°F during January to August on at least one day during a 49-Day incubation period in the Sacramento River or for at least one month during a 2-month incubation period for each model scenario in other rivers. Positive values indicate a higher value in the proposed project than in EXISTING CONDITIONS or NAA.

NEPA Effects: Collectively, these results indicate that the effect is not adverse because Alternative 2A does not have the potential to substantially reduce suitable spawning habitat and substantially reduce the number of fish as a result of egg mortality. Flows reductions that increase redd dewatering risk would be of similar or lower frequency under Alternative 2A relative to the NEPA baseline in all locations except the in Feather River at Thermalito Afterbay, in which there is a small (9%) increase. There would be increased exposure risk of eggs to elevated temperatures in the Feather River, but this isolated result is not expected to cause a biologically meaningful effect to the Pacific lamprey population.

CEQA Conclusion: In general, Alternative 2A would not affect the quantity and quality of Pacific lamprey spawning habitat relative to the Existing Conditions.

Rapid reductions in flow can dewater redds leading to mortality. In the Sacramento American Rivers, Alternative 2A would increase in the number of redd cohorts predicted to experience a month-over-month change in flow of greater than 50% relative to Existing Conditions (Table 11-2A-75). The small values (9 and 8 cohorts) in the Sacramento River would not translate into biologically meaningful effects considering the total number of redd cohorts evaluated (656 cohorts). Changes would be most substantial for the American River (increased risk of dewatering exposure to 36 cohorts or 43% at Nimbus Dam, and 40 cohorts or 42% at the confluence). For the Feather River, there are 25 fewer redd cohorts (-33 cohorts or -17%) predicted to experience a month-over-month change in flow of greater than 50% for Alternative 2A relative to Existing Conditions. No effects are predicted for the Trinity River (0%).These results indicate that Alternative 2A would not have biologically meaningful effects on Pacific lamprey redd dewatering risk in the Sacramento, Feather, and Trinity Rivers; but would affect dewatering risk in the Sacramento River and the American River (maximum increases of 36 cohorts or 43% at Nimbus Dam and 40 cohorts or 42% at the confluence).

The number of egg cohorts exposed to 22°C (71.6°F) under Alternative 2A would be greater than that under Existing Conditions in all rivers (Table 11-1A-76).

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-166 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 2A could be significant because, under the CEQA baseline, the alternative could substantially reduce suitable spawning habitat and substantially reduce the number of fish as a result of egg mortality, contrary to the NEPA conclusion set forth above. Redd dewatering risk under Alternative 2A would be higher relative to Existing Conditions in the American River, which would increase the risk of desiccation of eggs in this river. There would be increases in egg cohorts exposed to water temperatures above 71.6°F under Alternative 2A relative to Existing Conditions in at least one location in all rivers evaluated. Increased exposure to elevated temperatures would reduce egg survival in these rivers.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 2A does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 2A indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 2A. This indicates that the differences between Existing Conditions and Alternative 2A found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 2A, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on spawning habitat for Pacific lamprey. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-167: Effects of Water Operations on Rearing Habitat for Pacific Lamprey

In general, Alternative 2A would have negligible effects on Pacific lamprey rearing habitat conditions relative to NAA.

Flow-related impacts to Pacific lamprey rearing habitat were evaluated by estimating effects of flow alterations on ammocoete exposure, called ammocoete stranding risk. Lower flows can reduce the instream area available for rearing and rapid reductions in flow can strand ammocoetes leading to mortality. Comparisons of effects were made for ammocoete cohorts in the Sacramento River at Keswick and Red Bluff, the Trinity River, Feather River, and the American River at Nimbus Dam and at the confluence with the Sacramento River. An ammocoete is the filter-feeding larval stage of the lamprey that remains relatively immobile in the sediment in the same location for 5 to 7 years, after which it migrates downstream. During the upstream rearing period there is potential for ammocoete stranding from rapid reductions in flow.

The analysis of ammocoete stranding was conducted by analyzing a range of month-over-month flow reductions from CALSIM II outputs, using the range of 50%–90% in 5% increments. A cohort of ammocoetes was assumed to be born every month during their spawning period (January through August) and spend 7 years rearing upstream. Therefore, a cohort was considered stranded if at least one month-over-month flow reduction was greater than the flow reduction at any time during the period.

Effects of Alternative 2A on Pacific lamprey ammocoete stranding were analyzed by calculating month-over-month flow reductions for the Sacramento River at Keswick for January through August (Table 11-2A-77). Results indicate either no effect (0%), negligible effects (<5%), or decreases (-12%) in the occurrence of flow reductions attributable solely to the project.

Table 11-2A-77. Percent Difference between Model Scenarios in the Number of Pacific Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Sacramento River at Keswick

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
-50%	0	0
-55%	0	0
-60%	0	
-65%	0	3
-70%	4	-2
-75%	1	-3
-80%	4	-12
-85%	2	0
-90%	NA	NA

NA = all values were 0.
[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 2A.

Results of comparisons for the Sacramento River at Red Bluff provide similar conclusions, with slightly more variability in results (Table 11-2A-78). Results for Alternative 2A compared to NAA indicate no change (0%), negligible increases (<5%), and small to moderate decreases (-7 to -12%) attributable to the project that would not have biologically meaningful effects on stranding risk.

Table 11-2A-78. Percent Difference between Model Scenarios in the Number of Pacific Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Sacramento River at Red Bluff

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
-50%	0	0
-55%	4	0
-60%	7	5
-65%	-2	-3
-70%	9	-2
-75%	-3	-12
-80%	5	-7
-85%	100	0
-90%	NA	NA

NA = could not be calculated because the denominator was 0.
[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 2A.

Comparisons for the Trinity River indicate no effect (0%) or (negligible changes ±3%) attributable to the project (Table 11-2A-79).

Table 11-2A-79. Percent Difference between Model Scenarios in the Number of Pacific Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Trinity River at Lewiston

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
-50%	0	0
-55%	0	0
-60%	0	0
-65%	0	0
-70%	0	0
-75%	21	-3
-80%	27	0
-85%	18	0
-90%	41	3

[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 2A.

In the Feather River, all comparisons resulted in no difference (0%) or reductions in the occurrence of flow reductions between 50-90% (Table 11-2A-80).

Table 11-2A-80. Percent Difference between Model Scenarios in the Number of Pacific Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Feather River at Thermalito Afterbay

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
-50%	0	0
-55%	0	0
-60%	0	0
-65%	0	0
-70%	0	0
-75%	0	0
-80%	-1	1
-85%	-24	-42
-90%	-64	-28

[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 2A.

Comparisons for the American River at Nimbus Dam (Table 11-2A-81) and at the confluence with the Sacramento River (Table 11-2A-82) indicate negligible increases (2%) or substantial decreases (-1 to -60%) attributable to the project (Table 11-2A-81), with an increase of 14% for only one flow reduction category, 80% flow reduction, for the confluence.

Table 11-2A-81. Percent Difference between Model Scenarios in the Number of Pacific Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, American River at Nimbus Dam

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
-50%	0	0
-55%	0	0
-60%	1	0
-65%	1	-1
-70%	34	-4
-75%	96	2
-80%	236	-11
-85%	336	-14
-90%	25	-58

NA = could not be calculated because the denominator was 0.
[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 2A.

Table 11-2A-82. Percent Difference between Model Scenarios in the Number of Pacific Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, American River at the Confluence with the Sacramento River

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
-50%	0	0
-55%	0	0
-60%	1	0
-65%	1	0
-70%	7	-1
-75%	35	-1
-80%	236	14
-85%	221	-8
-90%	168	-36

[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 2A.

These results indicate that Alternative 2A would primarily have no effect (0%), negligible effects (<5%), or decreases in stranding risk that would be beneficial to on rearing success. Isolated occurrences of small increases in dewatering for some flow reduction categories would not have biologically meaningful effects. There would also be small, beneficial effects in the Sacramento River (decreased occurrence of month-over-month flow reductions to -12%) and more substantial beneficial effects in the American River (decreased occurrence of flow reductions to -60%) due to project-related effects of Alternative 2A.

To evaluate water temperature-related effects of Alternative 2A on Pacific lamprey ammocoetes, we examined the predicted number of ammocoete "cohorts" that experience water temperatures greater than 71.6°F for at least one day in the Sacramento River (because daily water temperature data are available) or for at least one month in the Feather, American, Stanislaus, and Trinity rivers over a 7 year period, the maximum likely duration of the ammocoete life stage (Moyle 2002). Each individual day or month starts a new "cohort" such that there are 18,244 cohorts for the Sacramento River, corresponding to 82 years of ammocoetes being "born" every day each year from January 1 through August 31, and 593 cohorts for the other rivers using monthly data over the same period.

In general, there would be no differences in the number of ammocoete cohorts exposed to temperatures greater than 71.6°F in each river (Table 11-2A-83).There would be 23 more cohorts (20% increase) exposed under Alternative 2A in the Trinity River at Lewiston, but there would be 22 fewer cohorts (7% decrease) exposed at North Fork. In addition, there would be 72 more cohorts (14% increase) exposed under Alternative 2A in the Feather River below Thermalito Afterbay, but there would be 56 fewer cohorts (100% decrease) fewer exposed at Fish Barrier Dam. Overall, the small to moderate increases and decreases will balance out within rivers such that there would be no overall effect on Pacific lamprey ammocoetes.

Table 11-2A-83. Differences (Percent Differences) between Model Scenarios in Pacific Lamprey Ammocoete Cohorts Exposed to Temperatures in the Feather River Greater than 71.6°F in at Least One Day or Month

Location	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Sacramento River at Keswick[b]	1,705 (NA)	0 (0%)
Sacramento River at Hamilton City[b]	12,464 (NA)	1,209 (11%)
Trinity River at Lewiston	136 (NA)	23 (20%)
Trinity River at North Fork	283 (NA)	-22 (-7%)
Feather River at Fish Barrier Dam	0 (NA)	-56 (-100%)
Feather River below Thermalito Afterbay	211 (55%)	72 (14%)
American River at Nimbus	359 (185%)	-8 (-1%)
American River at Sacramento River Confluence	159 (37%)	0 (0%)
Stanislaus River at Knights Ferry	56 (NA)	0 (0%)
Stanislaus River at Riverbank	530 (946%)	0 (0%)

NA = could not be calculated because the denominator was 0.
[a] Positive values indicate a higher value in Alternative 2A than in EXISTING CONDITIONS or NAA.
[b] Based on daily data; all other locations use monthly data; 1922–2003.

NEPA Effects: These results indicate that the effect would not be adverse because it would not substantially reduce rearing habitat or substantially reduce the number of fish as a result of ammocoete mortality. There would be negligible effects on ammocoete cohort survival under Alternative 2A relative to the NEPA baseline for all locations. There would be increase and decreases in exposure risk of ammocoetes to elevated temperatures within each river evaluated that would balance out such that there would be no net effect on Pacific lamprey ammocoetes.

CEQA Conclusion: In general, under Alternative 2A water operations, the quantity and quality of Pacific lamprey rearing habitat would not be affected relative to the CEQA baseline

Lower flows can reduce the instream area available for rearing and rapid reductions in flow can strand ammocoetes leading to mortality. Comparisons of Alternative 2A to Existing Conditions for the Sacramento River at Keswick indicate negligible changes (<5%) in occurrence of flow reductions for all flow reduction categories (Table 11-2A-77). Comparisons for the Sacramento River at Red Bluff indicate no effect (0%) or negligible effects (±5%) for all flow reduction categories except for 60%, 70% and 85% flow reductions (increases of 7%, 9% and 100% [from 56 to 112], respectively) (Table 11-2A-78). Increases of 18-41% are predicted for flow reduction categories from 75% to 90% for the Trinity River (Table 11-2A-79) based on increases from approximately 400 to 500 ammocoete cohorts exposed to stranding risk.

The number of Pacific lamprey ammocoete cohorts exposed to 71.6°F temperatures under Alternative 2A would be substantially higher than those under Existing Conditions in at least one location in all rivers evaluated (Table 11-1A-83).

Summary of CEQA Conclusion

The results of the Impact AQUA-167 CEQA analysis indicate that that the difference between the CEQA baseline and Alternative 2A could be significant because, under the CEQA baseline, the alternative could substantially reduce rearing habitat and substantially reduce the number of fish as a result of ammocoete mortality, contrary to the NEPA conclusion set forth above. Increased water temperatures would increase stress and reduce survival of lamprey ammocoetes. In the Sacramento River, Trinity River, and the American River at Nimbus Dam and at the confluence with the Sacramento River, there would be substantial increases in the number of cohorts exposed to stranding risk due to flow reductions in each of the higher flow reduction categories. Increased stranding risk in these rivers would increase the risk of desiccation and reduce survival of ammocoete cohorts. There would be no effect on ammocoete stranding risk under Alternative 2A relative to Existing Conditions in the Feather River, and small increases in stranding risk for the Sacramento River at Red Bluff that would not have biologically meaningful effects. Exposure of ammocoetes to elevated temperatures under Alternative 2A would be substantially higher than those under Existing Conditions in at least one location in all rivers evaluated.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 2A does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 2A indicates that flows and reservoir storage in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 2A. This indicates that the differences between Existing Conditions and Alternative 2A found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 2A, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on rearing habitat for Pacific lamprey. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-168: Effects of Water Operations on Migration Conditions for Pacific Lamprey

In general, effects of Alternative 2A would be negligible relative to NAA based on a prevalence of negligible effects or beneficial increases in mean monthly flow for most of the locations analyzed, which would have a beneficial effect on migration conditions.

After 5–7 years, Pacific lamprey ammocoetes migrate downstream and become macropthalmia (juveniles) once they reach the Delta. Migration generally is associated with large flow pulses in winter months (December through March) (USFWS unpubl. data) meaning alterations in flow have the potential to affect downstream migration conditions. The effects of Alternative 2A on seasonal migration flows for Pacific lamprey macropthalmia were assessed using CALSIM II flow output. Flow rates along the migration pathways of Pacific lamprey during the likely migration period (December through May) were examined for the Sacramento River at Rio Vista and Red Bluff, the Feather River at the confluence with the Sacramento River, and the American River at the confluence with the Sacramento River.

CALSIM flow data form the basis for the summary of changes in adult lamprey migration flows.

Sacramento River

Macropthalmia The difference in mean monthly flow rate for the Sacramento River at Rio Vista for December to May for Alternative 2A compared to NAA indicates reductions in flow for most months/water year types in the migration period with persistent flow reductions ranging from -5% to -31% depending on the specific month and water year (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*. There would be project-related decreases in flow during January to April in dry and critical years (to -18%) when reductions in flow would have the greatest effect on migration conditions. The project-related decreases in flow in the Sacramento River at Rio Vista could adversely affect outmigrating macropthalmia during these months.

For the Sacramento River at Red Bluff, the difference in mean monthly flow rate for Alternative 2A compared to NAA indicate negligible effects (<5%) on flow attributable to the project for December through April and increases in flow attributable to the project during May ranging from 6% to 13% (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*. The project-related increases in flow in the Sacramento River at Red Bluff would have a beneficial effect on migration conditions.

These results indicate that project-related effects of Alternative 2A on flow consist of negligible effects (<5%), or small increases in flow that would have a beneficial effect on migration in the Sacramento River at Red Bluff, but that effects for Sacramento River at Rio Vista would consist primarily of reductions in flow, including during drier water years, for much of the macropthalmia migration period that would adversely affect outmigrating macropthalmia.

Adults

For the Sacramento River at Red Bluff for the time-frame January to June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*), effects of Alternative 2A on mean monthly flow indicate effects would be negligible (<5%) with small increases in flow (to 14%) during May and June for some water years. Increases in flow would have a beneficial effect on migration conditions.

Feather River

Macropthalmia Comparisons for the Feather River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) indicate negligible (<5%) project-related effects or small increases in flow (to 9%) for December through March, and more substantial increases during April and May in some water year types (to 29%). Increases in mean monthly flow would be beneficial for migration conditions. Based on negligible effects and/or increases in flow that would be beneficial for migration, the project would not have adverse effects on macropthalmia in the Feather River at the confluence.

Adults

For the Feather River at the confluence with the Sacramento River, January to June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*), mean monthly flows under Alternative 2A are variable, with primarily negligible changes (<5%) for most months and water year types, with the exception of fairly substantial increases for most water year types for April (10–20%), May (9–29%), and June (17–73%) that would have beneficial effects on migration conditions.

American River

Macropthalmia Comparisons for the American River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) indicate negligible effects (<5%) or small to moderate increases in flows in all months, with more substantial increases during May (to 28%), with the exception of small decreases during March in dry (-6%) and critical (-7%) years that would not have biologically meaningful effects on migration conditions. The increases in flow would be beneficial for migration conditions.

Overall flow-related effects of Alternative 2A on outmigrating macropthalmia are negligible (<5%) in the Sacramento River at Red Bluff, Feather River at the confluence with the Sacramento River, and American River at the confluence with the Sacramento River. Effects of Alternative 2A on flow in the Sacramento River at Rio Vista would consist of flow reductions, particularly in drier water year types, which would affect outmigrating macropthalmia.

Adults

Comparisons of mean monthly flow for the American River at the confluence with the Sacramento River for January to June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) indicate predominantly negligible effects (<5%) attributable to the project with the exception of increased flows in May (11–28%) and June (23–31%) which would enhance migration especially during drier water year types, and small decreases in flow (to -7%) during March in dry and critical years that would not have biologically meaningful effects on migration conditions.

Project-related effects of Alternative 2A on mean monthly flows during the Pacific lamprey adult migration period would consist of negligible effects (<5%) or increases in flow (up to 73% depending on the location, month, and water year type) that would not negatively affect adult migration in the rivers analyzed in a biological meaningful way. Project-related increases in flows would enhance migration, particularly in drier water year types such as for the American River.

NEPA Effects: Collectively, these results indicate that the effect is not adverse because it would not substantially reduce the amount of suitable habitat and substantially interfere with the movement of fish. Flows in the Sacramento River at Rio Vista under Alternative 2A would be reduced relative to NAA, with persistent flow reductions to -31% throughout the migration period that would affect conditions for outmigrating macropthalmia at that location. The degree to which this reduction would affect lamprey is unknown, but given the predominance of negligible effects in other locations, it is not likely that reduced flows at this location would affect the Pacific lamprey population. Effects of Alternative 2A in the other locations analyzed would consist primarily of negligible effects (<5%), infrequent, small decreases in flow (to -7%) that would not have biologically meaningful effects, and small to substantial (to 73%) increases in flow that would have beneficial effects on migration conditions.

CEQA Conclusion: In general, the effect of Alternative 2A on Pacific lamprey migration conditions would be negligible relative to the Existing Conditions.

Sacramento River

Macropthalmia Comparisons of mean monthly flow rates in the Sacramento River at Rio Vista (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for December to May for Alternative 2A relative to Existing Conditions indicate reductions in flow ranging from -5% to -48% in most water years for each of these months. These results indicate that effects of Alternative 2A on flow would have negative effects on outmigrating macropthalmia in the Sacramento River. Comparisons for the Sacramento River at Red Bluff (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) indicate negligible (<5%) effects or small increases or decreases in flow (to 11%) that would not have biologically meaningful effects on migration conditions. Exceptions include a decrease in flow of -15% during May in wet years when flow reductions would not be as critical for migration conditions, and an increase of 16% during May in dry years that would have beneficial effects on migration. Therefore, Alternative 2A would not have biologically meaningful negative effects on outmigrating macropthalmia at this location.

Adults

Comparisons of mean monthly flow for the Sacramento River at Red Bluff (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) during the Pacific lamprey adult migration period from January through June indicate that for most months and water year types, flows under Alternative 2A would be similar to (<5% difference) flows under Existing Conditions, with infrequent occurrences of small-scale (to 13%) increases or decreases in flow that would not have biologically meaningful effects on migration conditions. Exceptions include a slightly greater reduction in flow during May in wet years (-15%) when effects of flow reductions would be less critical for migration, and slightly greater increases in flow during May in dry years (16%) and during June in above normal years (21%) that would have beneficial effects on migration. Therefore, effects of Alternative 2A consist of negligible effects or increases in flow that would have beneficial effects, and small reductions in flow that would not have biologically meaningful effects.

Feather River

Macropthalmia Comparisons for the Feather River at the confluence (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for December to May indicate variable effects by month and water year type, with increases in flow during December in above normal and below normal years (to 11%) and decreases in wet and critical years (to -31%), generally increases in flow during January through March in wetter years (to 20%) and decreases during some drier water year types (to -18%), and negligible effects or increases in flow (to 24%) during April and May except for a decrease (-24%) during May in wet years. Increases in flow would have beneficial effects on migration conditions, and decreases in wetter water years would not have significant effects on migration. Based on this limited occurrence of flow decreases at times that would be most critical for migration, and the prevalence of negligible effects or flow increases for most of the migration period, effects of Alternative 2A on flows would not have biologically meaningful effects on macropthalmia migration in the Feather River.

Adults

Comparisons of mean monthly flow for the Feather River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for January to June indicate variable effects of Alternative 2A depending on the month and water year type, with primarily negligible effects (<5%) and small increases or decreases in flow (to about 13%) that would not have biologically meaningful effects on migration conditions, with the exception of more substantial increases in flow during February in wet years (20%), March in above normal years (14%), April in dry years (19%), May in below normal years (24%), and June in above normal (51%) and below normal (58%) years. These flow increases would have a beneficial effect on migration conditions. There would be more substantial decreases in flow during March in below normal years (-18%) and during May in wet years (-24%) when effects of flow reduction on migration would be less critical. These flow reductions are isolated occurrences of relatively small magnitude and would therefore not have biologically meaningful effects on migration conditions. Therefore, effects of Alternative 2A on flow would not affect migration conditions in the Feather River.

American River

Macropthalmia Comparisons for the American River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for December to May indicate negligible effects (<5%) or decreases in flow during December and April, increases in flow during January through March for some wetter water year types (to 27%) and decreases for some drier water year types (to -18%), and decreases to -26% during May in all water year types except dry (increase of 16%). Decreases in drier water years for December through March and May encompass much of the migration period and would affect macropthalmia migration conditions for that time-frame (particularly critical years).

Overall conclusions are that impacts of Alternative 2A on mean monthly flows during the Pacific lamprey macropthalmia migration period, December to May, would not affect migration conditions in the Sacramento River at Red Bluff and the Feather River, but would affect conditions in the Sacramento River at Rio Vista and in the American River during drier water years.

Adults

Comparisons of mean monthly flow for the American River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for January to June indicate variable effects of Alternative 2A depending on the month and water year type, with meaningful changes in flow (±>5%) consisting of increases up to 27% (February, above normal years) that would have beneficial effects on migration conditions, and decreases to -18% in drier years. There would be primarily negligible effects (<5%) or small decreases (to -9%) during April. There would be decreases (to -26%) in all but critical years (increase of 16%) during May, and decreases during June in wet (-27%) and critical (-36%) years with increases (to 24%) in the remaining water years. Conclusions are that effects of Alternative 2A consist of variable effects on flow and predicted flow reductions would not have biologically meaningful effects on river lamprey macropthalmia migration based on the magnitude of the decreases and infrequent or isolated occurrences.

Summary of CEQA Conclusion

Collectively, these results indicate that the impact is not significant because it would not substantially reduce the amount of suitable habitat or substantially interfere with the movement of fish, and no mitigation is necessary. Effects of Alternative 2A compared to Existing Conditions during the January to June adult Pacific lamprey migration period consist predominantly of negligible effects (<5%), increases in flow, or small, isolated occurrences of decreases in flow for some water year types that would not have biologically meaningful effects on migration conditions. Flows at Rio Vista would decrease for much of the period. However, the degree to which this reduction would affect lamprey is unknown, but given the predominance of negligible effects in other locations, it is not likely that reduced flows at this location would affect the Pacific lamprey population.

Restoration Measures (CM2, CM4–CM7, and CM10)

Alternative 2A has the same restoration measures as Alternative 1A. Because no substantial differences in restoration-related fish effects are anticipated anywhere in the affected environment under Alternative 2A compared to those described in detail for Alternative 1A, the fish effects of restoration measures described for Pacific lamprey under Alternative 1A (Impact AQUA-169 through AQUA-171) also appropriately characterize effects under Alternative 2A.

The following impacts are those presented under Alternative 1A that are identical for Alternative 2A.

Impact AQUA-169: Effects of Construction of Restoration Measures on Pacific Lamprey

Impact AQUA-170: Effects of Contaminants Associated with Restoration Measures on Pacific Lamprey

Impact AQUA-171: Effects of Restored Habitat Conditions on Pacific Lamprey

NEPA Effects: All three of these impact mechanisms have been determined to result in no adverse effects on Pacific lamprey for NEPA purposes.

CEQA Conclusion**:** All three of these impact mechanisms would be considered less than significant on Pacific lamprey, for the reasons identified for Alternative 1A, and no mitigation is required.

Other Conservation Measures (CM12–CM19 and CM21)

Alternative 2A has the same other conservation measures as Alternative 1A. Because no substantial differences in other conservation-related fish effects are anticipated anywhere in the affected environment under Alternative 2A compared to those described in detail for Alternative 1A, the fish effects of other conservation measures described for Pacific lamprey under Alternative 1A (Impact AQUA-172 through AQUA-180) also appropriately characterize effects under Alternative 2A.

The following impacts are those presented under Alternative 1A that are identical for Alternative 2A.

Impact AQUA-172: Effects of Methylmercury Management on Pacific Lamprey (CM12)

Impact AQUA-173: Effects of Invasive Aquatic Vegetation Management on Pacific Lamprey (CM13)

Impact AQUA-174: Effects of Dissolved Oxygen Level Management on Pacific Lamprey (CM14)

Impact AQUA-175: Effects of Localized Reduction of Predatory Fish on Pacific Lamprey (CM15)

Impact AQUA-176: Effects of Nonphysical Fish Barriers on Pacific Lamprey (CM16)

Impact AQUA-177: Effects of Illegal Harvest Reduction on Pacific Lamprey (CM17)

Impact AQUA-178: Effects of Conservation Hatcheries on Pacific Lamprey (CM18)

Impact AQUA-179: Effects of Urban Stormwater Treatment on Pacific Lamprey (CM19)

Impact AQUA-180: Effects of Removal/Relocation of Nonproject Diversions on Pacific Lamprey (CM21)

NEPA Effects: The nine impact mechanisms have been determined to range from no effect, to no adverse effect, or beneficial effects on Pacific lamprey for NEPA purposes, for the reasons identified for Alternative 1A.

CEQA Conclusion**:** The nine impact mechanisms would be considered to range from no impact, to less than significant, or beneficial on Pacific lamprey, for the reasons identified for Alternative 1A, and no mitigation is required.

River Lamprey

Construction and Maintenance of CM1

Impact AQUA-181: Effects of Construction of Water Conveyance Facilities on River Lamprey

The potential effects of construction of the water conveyance facilities on river lamprey would be similar to those described for Alternative 1A (Impact AQUA-181) except that Alternative 2A could potentially include two different intakes than under Alternative 1A. This would convert about 11,350 lineal feet of existing shoreline habitat into intake facility structures and would require about 26 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. The effects related to temporary increases in turbidity, accidental spills, underwater noise, in-water work activities, and disturbance of contaminated sediments would be similar to Alternative 1A and the same environmental commitments and mitigation measures (described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*) would be available to avoid and minimize potential effects.

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-181, environmental commitments and mitigation measures would be available to avoid and minimize potential effects, and the effect would not be adverse for river lamprey.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-181, the impact of the construction of water conveyance facilities on river lamprey would be less than significant except for construction noise associated with pile driving. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Alternative 1A, Impact AQUA-1.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Alternative 1A, Impact AQUA-1.

Impact AQUA-182: Effects of Maintenance of Water Conveyance Facilities on River Lamprey

NEPA Effects: The potential effects of the maintenance of water conveyance facilities under Alternative 2A would be the same as those described for Alternative 1A (see Impact AQUA-182). As concluded in Alternative 1A, Impact AQUA-182, the effect would not be adverse for river lamprey.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-182 for lamprey, the impact of the maintenance of water conveyance facilities on river lamprey would be less than significant and no mitigation is required.

Water Operations of CM1

Impact AQUA-183: Effects of Water Operations on Entrainment of River Lamprey

The potential entrainment impacts of Alternative 2A on river lamprey would be the same as described above for Alternative 1A (Impact AQUA-183).

NEPA Effects: The analysis of river lamprey entrainment at the SWP/CVP south Delta facilities is combined with the analysis of Pacific lamprey because the salvage facilities do not distinguish between the two lamprey species. Like Alternative 1A (Impact AQUA-3), Alternative 2A is expected to substantially reduce average annual entrainment of lamprey, estimated by salvage density, by about 59–60% (Table 11-2A-84) averaged across all years compared to NAA. Overall, Alternative 2A would not have adverse effects on lamprey.

CEQA Conclusion: As described above, annual entrainment losses of juvenile green sturgeon would be decreased under Alternative 2A by approximately 60% compared to Existing Conditions (Table 11-2A-84). At the north Delta facilities and the alternate NBA intake, the screened intakes as designed would exclude this species. Decommissioning agricultural diversions would slightly reduce potential entrainment. Impacts of water operations on entrainment of river lamprey are considered less than significant and may be beneficial; no mitigation is required.

Table 11-2A-84. Lamprey Annual Entrainment Index at the SWP and CVP Salvage Facilities for Alternative 2A[a]

	Absolute Difference (Percent Difference)	
Water Year	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
All Years	-2,044 (-60%)	-1,939 (-59%)

[a] Number of fish lost, based on non-normalized data, for all months.

Impact AQUA-184: Effects of Water Operations on Spawning and Egg Incubation Habitat for River Lamprey

In general, Alternative 2A would not affect the quantity and quality of river lamprey spawning habitat relative to NAA.

Flow-related impacts to river lamprey spawning habitat were evaluated by estimating effects of flow alterations on redd dewatering risk as described for Pacific lamprey with appropriate time-frames for river lamprey incorporated into the analysis. Lower flows can reduce the instream area available for spawning and rapid reductions in flow can dewater redds leading to mortality. The same locations were analyzed as for Pacific lamprey: the Sacramento River at Keswick and Red Bluff, Trinity River downstream of Lewiston, Feather River at Thermalito Afterbay, and American River at Nimbus Dam and at the confluence with the Sacramento River. River lamprey spawn in these rivers between February and June so flow reductions during those months have the potential to dewater redds, which could result in incomplete development of the eggs to ammocoetes (the larval stage).

Dewatering risk to redd cohorts was characterized by the number of cohorts experiencing a month-over-month reduction in flows (using CALSIM II outputs) of greater than 50%. Small-scale spawning location suitability characteristics (e.g., depth, velocity, substrate) of river lamprey are not adequately described to employ a more formal analysis such as a weighted usable area analysis. Therefore, as described for Pacific lamprey, there is uncertainty that these values represent actual redd dewatering events, and results should be treated as rough estimates of flow fluctuations under each model scenario. Results were expressed as the number of cohorts exposed to dewatering risk and as a percentage of the total number of cohorts anticipated in the river based on the applicable time-frame, February to June.

Flows in all rivers evaluated indicated increases in redd cohorts exposed would only occur in the Feather River (9% increase) (Table 11-2A-85). All other locations would experience no change (0%) or negligible change (±5%) attributable to the project. The increased risk for the Feather River is small (9%) and would not cause a biologically meaningful effect on spawning success.

Table 11-2A-85. Differences between Model Scenarios in Dewatering Risk of River Lamprey Redd Cohorts[a]

Location	Comparison[b]	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Sacramento River at Keswick	Difference	4	1
	Percent Difference	13%	3%
Sacramento River at Red Bluff	Difference	2	0
	Percent Difference	5%	0%
Trinity River downstream of Lewiston	Difference	-4	-2
	Percent Difference	-6%	-3%
Feather River Below Thermalito Afterbay	Difference	-5	5
	Percent Difference	-7%	9%
American River at Nimbus	Difference	10	1
	Percent Difference	18%	2%
American River at Sacramento River confluence	Difference	16	-1
	Percent Difference	27%	-1%

[a] Difference and percent difference between model scenarios in the number of Pacific lamprey redd cohorts experiencing a month-over-month reduction in flows of greater than 50%.

[b] Positive values indicate a higher value in Alternative 2A than in EXISTING CONDITIONS or NAA).

River lamprey generally spawn between February and June (Beamish 1980, Moyle 2002). Using Pacific lamprey as a surrogate, eggs are assumed to hatch in 18-49 days depending on water temperature (Brumo 2006) and are, therefore, assumed to be present during roughly the same period and locations as spawners. Moyle et al. (1995) indicate that river lamprey "adults need… temperatures [that] do not exceed 25°C," although there is no mention of thermal requirements for eggs in this or any existing literature. Meeuwig et al. (2005) reported that, for Pacific lamprey eggs, significant reductions in survival were observed at 22°C (71.6°F). Therefore, for this analysis, both temperatures, 22°C (71.6°F) and 25°C (77°F), were used as upper thresholds of river lamprey eggs. The analysis predicted the number of consecutive 49 day periods for the entire 82-year CALSIM period during which at least one day exceeds 22°C (71.6°F) or 25°C (77°F) using daily data from USRWQM. For other rivers, the analysis predicted the number of consecutive two-month periods during which at least one month exceeds 22°C (71.6°F) or 25°C (77°F) using monthly averaged data from the Bureau's temperature model. Each individual day or month starts a new "egg cohort" such that there are 12,320 cohorts for the Sacramento River, corresponding to 82 years of eggs being laid every day each year from February 1 through June 30, and 405 cohorts for the other rivers using monthly data over the same period. The incubation periods used in this analysis are conservative and represent the extreme long end of the egg incubation period (Brumo 2006). Also, the utility of the monthly average time step is limited because the extreme temperatures are masked; however, no better analytical tools are currently available for this analysis. Spawning locations of river lamprey are not well defined. Therefore, this analysis uses the widest range in which the species is thought to spawn in each river.

For both thresholds, there would be few differences in egg cohort exposure between NAA and Alternative 2A among all sites (Table 11-2A-86). Differences of 20 cohorts in the Sacramento River at Hamilton City are negligible to the population considering the total number of cohorts is 12,320. In the Feather River below Thermalito Afterbay, there would be 10 more cohorts (26% increase) exposed to the 71.6°F threshold under Alternative 2A relative to NAA, although differences at the 77°F threshold would be negligible. In addition, there would be no differences between NAA and Alternative 2A in egg exposure at the Fish Barrier Dam in the Feather River. Overall, except at one location in the Feather River for the more conservative threshold temperature (71.6°F), these results indicate that there would be no differences in egg exposure to elevated temperatures under Alternative 2A.

Table 11-2A-86. Differences (Percent Differences) between Model Scenarios in River Lamprey Egg Cohort Temperature Exposure

Location	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
71.6°F Threshold		
Sacramento River at Keswick	0 (NA)	0 (NA)
Sacramento River at Hamilton City	315 (NA)	-8 (-2%)
Trinity River at Lewiston	0 (NA)	-1 (-100%)
Trinity River at North Fork	4 (NA)	-1 (-20%)
Feather River at Fish Barrier Dam	0 (NA)	0 (NA)
Feather River below Thermalito Afterbay	39 (433%)	10 (26%)
American River at Nimbus	21 (420%)	-4 (-13%)
American River at Sacramento River Confluence	43 (154%)	-11 (-13%)
Stanislaus River at Knights Ferry	0 (NA)	0 (NA)
Stanislaus River at Riverbank	-1 (-100%)	-35 (-100%)
77°F Threshold		
Sacramento River at Keswick	0 (NA)	0 (NA)
Sacramento River at Hamilton City	56 (NA)	20 (56%)
Trinity River at Lewiston	0 (NA)	0 (NA)
Trinity River at North Fork	0 (NA)	0 (NA)
Feather River at Fish Barrier Dam	0 (NA)	0 (NA)
Feather River below Thermalito Afterbay	4 (NA)	2 (100%)
American River at Nimbus	5 (NA)	1 (25%)
American River at Sacramento River Confluence	7 (NA)	1 (17%)
Stanislaus River at Knights Ferry	0 (NA)	0 (NA)
Stanislaus River at Riverbank	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.

[a] Difference and percent difference between model scenarios in the number of Pacific lamprey egg cohorts experiencing water temperatures above 71.6°F and 77°F during February to June on at least one day during a 49-Day incubation period in the Sacramento River or for at least one month during a 2-month incubation period for each model scenario in other rivers. Positive values indicate a higher value in the proposed project than in EXISTING CONDITIONS or NAA.

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because it does not have the potential to substantially reduce rearing habitat or substantially reduce the number of fish as a result of ammocoete mortality. Alternative 2A would cause minor effects to river lamprey redd dewatering and exposure to elevated water temperatures that would not be substantial.

CEQA Conclusion: In general, Alternative 2A would not affect the quantity and quality of river lamprey spawning habitat relative to the Existing Conditions due to increases in exposure to critical water temperatures in the Feather River and moderate increases in dewatering risk from flow reductions in the Sacramento River and the American River.

Lower flows can reduce the instream area available for spawning and rapid reductions in flow can dewater redds leading to mortality. Effects of Alternative 2A on flow reductions during the river lamprey spawning period from February to June in the Sacramento River and American River consist of increases in river lamprey redd cohort dewatering risk relative to Existing Conditions (Table 11-2A-85). Changes would be most substantial for the American River (increased risk of dewatering exposure to 10 cohorts or 18% at Nimbus Dam, and 16 cohorts or 27% at the confluence). For the Trinity River there are 4 fewer redd cohorts (-6%), and for the Feather River there are five fewer redd cohorts (-7%), predicted to experience a month-over-month change in flow of greater than 50% for Alternative 2A relative to Existing Conditions.

In most locations, the number of ammocoete cohorts exposed to each threshold under Alternative 2A would be similar to or lower than those under NAA (Table 11-2A-86). Biologically meaningful exceptions includes the Trinity River at Lewiston, Feather River below Thermalito Afterbay and the Sacramento River at Hamilton City for the 71.6°F threshold, and the Feather River below Thermalito Afterbay for the 77°F threshold. In all cases, there would be another location within the river that would have similar or lower exceedances under Alternative 2A.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-184 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 2A could be significant because, under the CEQA baseline, the alternative could substantially reduce suitable spawning habitat and substantially reduce the number of fish as a result of egg mortality, contrary to the NEPA conclusion set forth above. Alternative 2A would reduce river lamprey survival due to increases in water temperature in the Feather River below Thermalito Afterbay relative to the Existing Conditions. Increased water temperatures would increase stress and reduce survival of lamprey ammocoetes. Alternative 2A would cause minor impacts on river lamprey redd dewatering that would be less than significant.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 2A does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 2A indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 2A. This indicates that the differences between Existing Conditions and Alternative 2A found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 2A, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on spawning habitat for river lamprey. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-185: Effects of Water Operations on Rearing Habitat for River Lamprey

In general, Alternative 2A would not affect the quantity and quality of river lamprey rearing habitat relative to NAA due to increased exposure to critical water temperatures in the Feather River below Thermalito Afterbay. There would be a beneficial effect from substantial decreases in exposure to flow reductions in the American River, but negligible effects on stranding risk in the other locations analyzed.

Flow-related effects on river lamprey rearing habitat were evaluated by estimating effects of flow alterations on ammocoete exposure, or stranding risk, as described for Pacific lamprey. Lower flows can reduce the instream area available for rearing and rapid reductions in flow can strand ammocoetes leading to mortality. Effects of Alternative 2A on flow were evaluated in the Sacramento River at Keswick and Red Bluff, the Trinity River, Feather River, and the American River at Nimbus Dam and at the confluence with the Sacramento River. As for Pacific lamprey, the analysis of river lamprey ammocoete stranding was conducted by analyzing a range of month-over-month flow reductions from CALSIM II outputs, using the range of 50%–90% in 5% increments. A cohort of ammocoetes was assumed to be born every month during their spawning period (February through June) and spend 5 years rearing upstream. Therefore, a cohort was considered stranded if at least one month-over-month flow reduction was greater than the flow reduction at any time during the period. Comparisons of flow reductions for Alternative 2A relative to NAA for the Sacramento River at Keswick (Table 11-2A-87) predicted either no effect (0%), negligible effects (±5%), or small decreases (-13%) in the occurrence of flow reductions attributable solely to the project, which would have beneficial effects on rearing success.

Table 11-2A-87. Percent Difference between Model Scenarios in the Number of River Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Sacramento River at Keswick

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
-50%	0	0
-55%	2	0
-60%	5	2
-65%	4	3
-70%	-2	-2
-75%	-8	-2
-80%	-4	-13
-85%	44	0
-90%	NA	NA

NA = could not be calculated because the denominator was 0.

[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 2A.

Results of comparisons for the Sacramento River at Red Bluff (Table 11-2A-88) provided similar conclusions, with slightly more variability in results. Alternative 2A compared to NAA indicated no change (0%), negligible increases (<5%), and small decreases (-3 to -12%) attributable to the project for different flow reduction categories. There is a single flow reduction category, 60%, that would experience a small increase in occurrence attributable to the project, 6%. Based on the general decrease in frequency of most of the flow reduction categories, the small increase (6%) predicted for 60% flow reduction event would not have biologically meaningful effects on rearing success.

Table 11-2A-88. Percent Difference between Model Scenarios in the Number of River Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Sacramento River at Red Bluff

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
-50%	0	0
-55%	6	3
-60%	13	6
-65%	-2	-3
-70%	10	1
-75%	7	-12
-80%	6	-4
-85%	100 [0 to 50]	0
-90%	NA	NA

NA = could not be calculated because the denominator was 0.

[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 2A.

Comparisons for the Trinity River indicate increases in occurrence of 75 through 90% flow reductions under Alternative 2A relative to NAA (Table 11-2A-89) indicates no effect (0%) or (negligible changes ±5%) attributable to the project.

Table 11-2A-89. Percent Difference between Model Scenarios in the Number of River Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Trinity River at Lewiston

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
-50%	0	0
-55%	0	0
-60%	0	0
-65%	0	0
-70%	0	0
-75%	26	-5
-80%	39	0
-85%	28	-2
-90%	59	4

[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 2A.

In the Feather River, there would be no difference (0%) or reductions in the occurrence of flow reductions between 50-90% (Table 11-2A-90).

Table 11-2A-90. Percent Difference between Model Scenarios in the Number of River Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Feather River at Thermalito Afterbay

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
-50%	0	0
-55%	0	0
-60%	0	0
-65%	0	0
-70%	0	0
-75%	-1	-1
-80%	-12	-6
-85%	-29	-46
-90%	-62	-32

[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 2A.

Flow reduction comparisons for the American River at Nimbus Dam (Table 11-2A-91) and at the confluence with the Sacramento River (Table 11-2A-92) indicated no effect (0%), negligible increases (<5%), or substantial decreases (to -55%) attributable to the project, with an increase of 15% for only one flow reduction category, 80% flow reduction, for the confluence. Based on the general decrease in frequency of most of the flow reduction categories, the small increase (15%) predicted for a single flow reduction category (80%) would not have biologically meaningful effects.

Table 11-2A-91. Percent Difference between Model Scenarios in the Number of River Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, American River at Nimbus Dam

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
-50%	0	0
-55%	0	0
-60%	3	-1
-65%	4	-3
-70%	48	-6
-75%	131	2
-80%	312	-13
-85%	388 [25 to 122]	-13
-90%	36	-55

NA = could not be calculated because the denominator was 0.
[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 2A.

Table 11-2A-92. Relative Difference between Model Scenarios in the Number of River Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, American River at the Confluence with the Sacramento River

Percent Flow Reduction	Percent Difference[a]	
	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
-50%	0	0
-55%	0	0
-60%	3	-1
-65%	4	-1
-70%	20	-3
-75%	52	-1
-80%	289 [71–276]	15
-85%	290 [50–195]	-9
-90%	200 [25–75]	-35

[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 2A.

River lamprey generally spawn between February and June (Beamish 1980, Moyle 2002). Using Pacific lamprey as a surrogate, eggs are assumed to hatch in 18-49 days depending on water temperature (Brumo 2006) and are, therefore, assumed to be present during roughly the same period and locations as spawners. Moyle et al. (1995) indicate that river lamprey "adults need… temperatures [that] do not exceed 25°C," although there is no mention of thermal requirements for eggs in this or any existing literature. Meeuwig et al. (2005) reported that, for Pacific lamprey eggs, significant reductions in survival were observed at 22°C (71.6°F). Therefore, for this analysis, both temperatures, 22°C (71.6°F) and 25°C (77°F), were used as upper thresholds of river lamprey eggs. The analysis predicted the number of consecutive 49 day periods for the entire 82-year CALSIM period during which at least one day exceeds 22°C (71.6°F) or 25°C (77°F) using daily data from USRWQM. For other rivers, the analysis predicted the number of consecutive two-month periods during which at least one month exceeds 22°C (71.6°F) or 25°C (77°F) using monthly averaged data from the Bureau's temperature model. Each individual day or month starts a new "egg cohort" such that there are 12.320 cohorts for the Sacramento River, corresponding to 82 years of eggs being laid every day each year from February 1 through June 30, and 405 cohorts for the other rivers using monthly data over the same period. The incubation periods used in this analysis are conservative and represent the extreme long end of the egg incubation period (Brumo 2006). Also, the utility of the monthly average time step is limited because the extreme temperatures are masked; however, no better analytical tools are currently available for this analysis. Spawning locations of river lamprey are not well defined. Therefore, this analysis uses the widest range in which the species is thought to spawn in each river.

In the Sacramento River at Hamilton City, there would be 685 more cohorts (could not calculate relative difference due to division by 0) exposed to the 71.6°F threshold under Alternative 2A relative to Existing Conditions, although this represents a small proportion (6%) of the total number of cohorts evaluated (12,320 cohorts) (Table 11-2A-93). Therefore, would not be biologically meaningful. There would be 15 more (30% increase) and 60 more (19% increase) cohorts exposed to elevated temperatures in the Trinity River at Lewiston and in the Feather River below Thermalito Afterbay, respectively. These would also be small proportions of total cohorts and, therefore, would not be biologically meaningful. There are no other increases in any rivers at the 71.6°F temperature threshold and no biologically meaningful increases at the 77°F temperature threshold.

Table 11-2A-93. Differences (Percent Differences) between Model Scenarios in River Lamprey Ammocoete Cohorts Exposed to Temperatures in the Feather River Greater than 71.6°F and 77°F in at Least One Month

Location	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
71.6°F Threshold		
Sacramento River at Keswick[b]	1,218 (NA)	0 (0%)
Sacramento River at Hamilton City[b]	10,180 (NA)	685 (7%)
Trinity River at Lewiston	65 (NA)	15 (30%)
Trinity River at North Fork	135 (NA)	-25 (-16%)
Feather River at Fish Barrier Dam	0 (NA)	-25 (-100%)
Feather River below Thermalito Afterbay	190 (100%)	60 (19%)
American River at Nimbus	240 (267%)	-5 (-1%)
American River at Sacramento River Confluence	135 (55%)	0 (0%)
Stanislaus River at Knights Ferry	25 (NA)	0 (0%)
Stanislaus River at Riverbank	335 (1,340%)	0 (0%)
77°F Threshold		
Sacramento River at Keswick[b]	0 (NA)	0 (NA)
Sacramento River at Hamilton City[b]	0 (NA)	0 (NA)
Trinity River at Lewiston	0 (NA)	0 (NA)
Trinity River at North Fork	0 (NA)	0 (NA)
Feather River at Fish Barrier Dam	0 (NA)	0 (NA)
Feather River below Thermalito Afterbay	90 (NA)	50 (125%)
American River at Nimbus	175 (NA)	-45 (-20%)
American River at Sacramento River Confluence	235 (470%)	5 (2%)
Stanislaus River at Knights Ferry	0 (NA)	0 (NA)
Stanislaus River at Riverbank	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.

[a] Positive values indicate a higher value in the preliminary proposal than in EXISTING CONDITIONS or NAA.

[b] Based on daily data; all other locations use monthly data; 1922–2003.

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because it does not have the potential to substantially reduce rearing habitat or substantially reduce the number of fish as a result of ammocoete mortality. Alternative 2A would not affect river lamprey ammocoete stranding relative to the NEPA baseline. Further, increases in exposure to water temperatures under Alternative 2A would not be biologically meaningful.

CEQA Conclusion: In general, Alternative 2A would not affect the quantity and quality of river lamprey rearing habitat relative to the Existing Conditions

Lower flows can reduce the instream area available for rearing and rapid reductions in flow can strand ammocoetes leading to mortality. Comparisons of Alternative 2A to Existing Conditions for the Sacramento River at Keswick indicate decreases (to -8%) or negligible increases (<5%) in the occurrence of flow reductions for all flow reduction categories (Table 11-2A-87) with the exception of a small increase (6%) in month-over-month flow reductions of 60% and a 44% increase in reductions of 85%. Comparisons for the Sacramento River at Red Bluff indicate slightly more variable results with no effect (0%) or negligible effects (<5%) for all flow reduction categories except for small increases (6% to 13%) in the 55%, 70% through 80% flow reductions, and a more substantial increase (100%, or from 0 to 50 cohorts) in the 85% flow reduction category (Table 11-2A-88).

Comparisons for the Trinity River indicated no effect (0%) for flow reduction categories from 50% to 70%, and increases ranging from 26% to 59% for the higher flow reduction categories (Table 11-2A-89).

Comparisons for the Feather River indicated no effect or reductions in frequency of occurrence for all flow reduction categories (Table 11-2A-90).

Comparisons for the American River at Nimbus Dam (Table 11-2A-91) and at the confluence with the Sacramento River (Table 11-2A-92) indicated increased chance of occurrence of flow reductions between 70 and 90% for Alternative 2A compared to Existing Conditions; meaningful (>5%) predicted increases are from 48 to 388% (increase in cohorts exposed from 25 to 122) for Nimbus Dam and from 20 to 290% (increase in cohorts exposed from 50 to 195) for the confluence.

The number of ammocoete cohorts exposed to 71.6°F under Alternative 2A would be substantially higher than those under Existing Conditions in most locations examined (Table 11-A1-93). The number of ammocoete cohorts exposed to 77°F under Alternative 2A would be similar at all locations except the Feather River below Thermalito Afterbay and at both locations in the American River, at which exposure would increase by 90 to 235 cohorts.

Summary of CEQA Conclusion

The results of the Impact AQUA-185 CEQA analysis indicate that that the difference between the CEQA baseline and Alternative 2A could be significant because, under the CEQA baseline, the alternative could substantially reduce rearing habitat and substantially reduce the number of fish as a result of ammocoete mortality, contrary to the NEPA conclusion set forth above. There would be substantial increases in stranding risk in the Trinity and American Rivers under Alternative 2A relative to the Existing Conditions. Increased stranding risk in these rivers would increase the risk of desiccation and reduce survival of ammocoete cohorts. Additionally, the risk of exposure to elevated water temperatures would substantially increase under Alternative 2A relative to the Existing Conditions. Increased water temperatures would increase stress and reduce survival of lamprey ammocoetes.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 2A does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in

the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 2A indicates that flows and reservoir storage in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 2A. This indicates that the differences between Existing Conditions and Alternative 2A found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 2A, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on rearing habitat for river lamprey. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-186: Effects of Water Operations on Migration Conditions for River Lamprey

In general, Alternative 2A would have negligible effects on river lamprey migration conditions relative to NAA due to negligible effects on mean monthly flows. There would be beneficial effects due to moderate increases in mean monthly flow for some months and water year types but these generally would be offset by flow reductions in other months.

Macropthalmia

After 3 to 5 years river lamprey ammocoetes migrate downstream and become macropthalmia once they reach the Delta. River lamprey migration generally occurs September through November (USFWS unpubl. data). The effects of water operations on seasonal migration flows for river lamprey macropthalmia were assessed using CALSIM II flow output. Flow rates along the likely migration pathways of river lamprey during the likely migration period (September through November) were examined to predict how Alternative 2A may affect migration flows for outmigrating macropthalmia.

Analyses were conducted for the Sacramento River at Red Bluff, Feather River at the confluence with the Sacramento River, and the American River at the confluence with the Sacramento River.

Sacramento River

Comparisons for the Sacramento River at Red Bluff for September through November indicate variable effects of Alternative 2A depending on the month and the water year type. Alternative 2A indicates variable effects, with project-related increases (9% to 17% in dry and critical years) that would have beneficial effects on migration conditions and decreases (-5% and -15% in above normal and below normal years) in September, primarily negligible effects (<5%) in October, and decreases in flows for all but critical years (with <5% difference) in November (-11 to -17%). Decreases in wetter years in September would less detrimental because flows are higher; the increases in drier water years would be beneficial for outmigration. Decreases (to 17%) for all but critical years in November would affect migration conditions during that month, which is the last month in the relatively short migration period.

Feather River

Comparisons for the Feather River at the confluence with the Sacramento River for September through November indicate decreases in flow during wetter years in September (-10, -19, and -33% for wet, above normal, below normal, respectively) and increases in flow during drier years (6 and 19% for dry and critical years, respectively. The increases in flow during dry and critical years for

September would have a positive effect on migration when flow conditions are most critical. There would also be project-related increases in flow during October in all water years, ranging from 9 to 32% depending on water year type. Project-related effects during November would be negligible (<5%) in all water year types with the exception of a small decrease in mean monthly flow (-8%) during above normal years that would not have biologically meaningful effects. These results indicate Alternative 2A would not affect migration in the Feather River.

American River

Comparisons for the American River at the confluence with the Sacramento River for September through November indicate decreased flows during September in wetter water years (to -19%) and negligible effects (<5%) in drier water years when flow effects would be more detrimental for migration, increases in mean monthly flows during October in drier water year types (10 and 15% for below normal and dry years), and negligible project-related changes during November except for small changes in dry (+6%) and critical (-9%) water years. These results indicate Alternative 2A would not affect migration conditions in the American River.

Overall conclusions are that, with some variation in results by location, month, and water year type, Alternative 2A would generally not have biologically meaningful effects on macropthalmia migration based on negligible effects (<5%), decreases in flow during wetter water year types that would not have biologically meaningful effects, and increases in flow during drier water years that would have a beneficial effect on migration.

Adults

Effects of Alternative 2A on flow during the adult migration period, September through November, would be the same as described for the macropthalmia migration period, September through November, above.

NEPA Effects: Collectively, these results indicate that is not adverse because it would not substantially reduce the amount of suitable habitat or substantially interfere with the movement of fish. Flows under Alternative 2A would not be reduced from NAA in any waterway analyzed that would affect river lamprey macropthalmia or adults in a biologically meaningful way. There would be small to moderate increases in mean monthly flow for some months and water year types that would have beneficial effects on migration conditions.

CEQA Conclusion: In general, under Alternative 2A water operations, the quantity and quality of suitable migration habitat for river lamprey would not be affected relative to the CEQA baseline.

Macropthalmia

Sacramento River

Comparisons for the Sacramento River at Red Bluff for September through November indicate variable effects of Alternative 2A during September, with increases in mean monthly flow for wetter water year types (38 to 55%) that would have beneficial effects on migration conditions, and decreases for drier water year types (-13 and -17% for below normal and dry years, respectively). Alternative 2A would have negligible effects (±<5%) for October with the exception of increased flows (10%) during dry years. Alternative 2A would result in small decreases in mean monthly flows compared to Existing Conditions for all water year types in November (-6 to -13%). Persistent small to moderate reductions in flow in drier water years for two of the three months in the migration period would affect migration conditions in the Sacramento River.

Feather River

Comparisons for the Feather River at the confluence with the Sacramento River for September through November indicate variable results by month and water year type, with increases for wetter years and decreases in drier years in September, variable results with primarily increases in drier years (13 and 15% for dry and critical years, respectively) in October that would have a small beneficial effect on migration, and primarily decreases for most water year types in November (-6 to -20%). Decreased mean monthly flows in September and November during drier water years would affect migration conditions; increases in these water year types in September would have a beneficial effect.

American River

Comparisons for the American River at the confluence with the Sacramento River for September through November indicate reductions in flow for most months and most water year types, ranging from -6 to -56%, with the exception of a 20% increase in mean monthly flow during October for below normal water years. There would also be negligible decreases (<5%) for October flows during dry years. The predominance of decreased flows for Alternative 2A compared to Existing Conditions would affect migration conditions, with substantial decreases for dry and critical years in September (-42 and -56%, respectively) and November (-33 and -28%, respectively).

Overall, these results indicate that Alternative 2A would cause decreases in mean monthly flow during all or portions of the river lamprey macropthalmia migration period in the Sacramento River (to -17% in dry years), Feather River (to -20%), and American River (to -56%).

Adults

Effects of Alternative 2A on flow during the adult migration period, September through November, would be the same as described for the macropthalmia migration period, September through November, above.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-186 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 2A could be significant because, under the CEQA baseline, the alternative could substantially reduce the amount of suitable habitat and substantially interfere with the movement of fish, contrary to the NEPA conclusion set forth above. Reductions in flows during the macropthalmia and adult migration periods would reduce migration ability of both life stages. For macropthalmia, reduced migration ability would increase straying risk and delay initiation of the oceanic life stage. For adults, reduced flows would reduce the ability to sense olfactory cues if adults use such cues to return to natal spawning grounds.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 2A does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 2A indicates that flows and reservoir storage in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 2A. This indicates that the differences between Existing Conditions and Alternative 2A found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 2A, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on migration conditions for river lamprey. This impact is found to be less than significant and no mitigation is required.

Restoration Measures (CM2, CM4–CM7, and CM10)

Alternative 2A has the same restoration measures as Alternative 1A. Because no substantial differences in restoration-related fish effects are anticipated anywhere in the affected environment under Alternative 2A compared to those described in detail for Alternative 1A, the fish effects of restoration measures described for river lamprey under Alternative 1A (Impact AQUA-187 through AQUA-189) also appropriately characterize effects under Alternative 2A.

The following impacts are those presented under Alternative 1A that are identical for Alternative 2A.

Impact AQUA-187: Effects of Construction of Restoration Measures on River Lamprey

Impact AQUA-188: Effects of Contaminants Associated with Restoration Measures on River Lamprey

Impact AQUA-189: Effects of Restored Habitat Conditions on River Lamprey

NEPA Effects: All three of these impact mechanisms have been determined to result in no adverse effects on river lamprey for NEPA purposes.

CEQA Conclusion: All three of these impact mechanisms would be considered less than significant on river lamprey, for the reasons identified for Alternative 1A, and no mitigation is required.

Other Conservation Measures (CM12–CM19 and CM21)

Alternative 2A has the same other conservation measures as Alternative 1A. Because no substantial differences in other conservation-related fish effects are anticipated anywhere in the affected environment under Alternative 2A compared to those described in detail for Alternative 1A, the fish effects of other conservation measures described for river lamprey under Alternative 1A (Impact AQUA-190 through AQUA-198) also appropriately characterize effects under Alternative 2A.

The following impacts are those presented under Alternative 1A that are identical for Alternative 2A.

Impact AQUA-190: Effects of Methylmercury Management on River Lamprey (CM12)

Impact AQUA-191: Effects of Invasive Aquatic Vegetation Management on River Lamprey (CM13)

Impact AQUA-192: Effects of Dissolved Oxygen Level Management on River Lamprey (CM14)

Impact AQUA-193: Effects of Localized Reduction of Predatory Fish on River Lamprey (CM15)

Impact AQUA-194: Effects of Nonphysical Fish Barriers on River Lamprey (CM16)

Impact AQUA-195: Effects of Illegal Harvest Reduction on River Lamprey (CM17)

Impact AQUA-196: Effects of Conservation Hatcheries on River Lamprey (CM18)

Impact AQUA-197: Effects of Urban Stormwater Treatment on River Lamprey (CM19)

Impact AQUA-198: Effects of Removal/Relocation of Nonproject Diversions on River Lamprey (CM21)

NEPA Effects: The nine impact mechanisms have been determined to range from no effect, to no adverse effect, or beneficial effects on river lamprey for NEPA purposes, for the reasons identified for Alternative 1A.

CEQA Conclusion: The nine impact mechanisms would be considered to range from no impact, to less than significant, or beneficial on river lamprey, for the reasons identified for Alternative 1A, and no mitigation is required.

Non-Covered Aquatic Species of Primary Management Concern

Construction and Maintenance of CM1

The effects of construction and maintenance of CM1 under Alternative 2A would be similar for all non-covered species; therefore, the analysis below is combined for all non-covered species instead of analyzed by individual species.

Impact AQUA-199: Effects of Construction of Water Conveyance Facilities on Non-Covered Aquatic Species of Primary Management Concern

Refer to Impact AQUA-1 under delta smelt for a discussion of the effects of construction of water conveyance facilities on non-covered species of primary management concern. That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. The potential effects of the construction of water conveyance facilities under Alternative 2A would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-1) except that Alternative 2A could potentially include two different intakes than under Alternative 1A. This would convert about 11,350 lineal feet of existing shoreline habitat into intake facility structures and would require about 26 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. The effects related to temporary increases in turbidity, accidental spills, underwater noise, in-water work activities, and disturbance of contaminated sediments would be similar to Alternative 1A and the same environmental commitments and mitigation measures (described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*) would be available to avoid and minimize potential effects. Additionally, California bay shrimp would not be affected because they do not occur in the vicinity and Sacramento-San Joaquin roach and hardhead are unlikely to be affected because their primary distributions are upstream.

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-199, environmental commitments and mitigation measures would be available to avoid and minimize potential effects, and the effect would not be adverse for non-covered species of management concern.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-199, the impact of the construction of the water conveyance facilities on non-covered aquatic species of primary management concern would be less than significant except for construction noise associated with pile driving. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in the discussion of Alternative 1A.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in the discussion of Alternative 1A.

Impact AQUA-200: Effects of Maintenance of Water Conveyance Facilities on Non-Covered Aquatic Species of Primary Management Concern

Refer to Impact AQUA-2 under delta smelt for a discussion of the effects of maintenance of water conveyance facilities on non-covered species of primary management concern. That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. The potential effects of the construction of water conveyance facilities under Alternative 2A would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-2). California bay shrimp would not be affected because they do not occur in the vicinity and Sacramento-San Joaquin roach and hardhead are unlikely to be affected because their primary distributions are upstream. Consequently, the effects would not be adverse.

Water Operations of CM1

The effects of water operations of CM1 under Alternative 2A include a detailed analysis of the following species:

- Striped Bass
- American Shad
- Threadfin Shad
- Largemouth Bass

- Sacramento tule perch
- Sacramento-San Joaquin roach – California species of special concern
- Hardhead – California species of special concern
- California bay shrimp

Impact AQUA-201: Effects of Water Operations on Entrainment of Non-Covered Aquatic Species of Primary Management Concern

Also, see Alternative 1A, Impact AQUA-201 for additional background information relevant to non-covered species of primary management concern.

Striped Bass

Striped bass spawn mostly upstream of the Delta in the Sacramento River, between Colusa and the Feather River confluence; however spawning can take place as far downstream as Isleton (Moyle 2002). Limited spawning occurs in the south Delta and lower San Joaquin River. Striped bass eggs could be transported downstream from spawning grounds towards the proposed north Delta intakes. Although these intakes would be screened to exclude fish smaller than 15 mm, striped bass eggs or larvae that drift downstream would have the potential to be entrained. Similarly, the screens of the alternate NBA intake would be screened to exclude larger fish, but eggs and larvae would be exposed to entrainment.

At the south Delta facilities, entrainment peaks during the summer months, based on historical salvage. Entrainment losses under Alternative 2A would be expected to decrease compared to baseline conditions since exports are substantially reduced in the summer. This result is based on the assumption that striped bass entrainment is proportional to south Delta exports.

Striped bass may be vulnerable to entrainment at the new alternate NBA intake on the Sacramento River. Similar to the north Delta diversion intakes, the NBA alternate intake on the Sacramento River would be equipped with state-of-the-art fish screens that would exclude larger juveniles and adult striped bass, but would not exclude eggs and larvae.

Agricultural diversions are potential sources of entrainment for small fish such as larval and juvenile striped bass (Nobriga et al. 2004). These diversions are typically small and located on-shore, which may reduce the vulnerability of striped bass to entrainment to these diversions due to their pelagic nature. Reduction or consolidation of diversions from the ROA's (approximately 4–12% of diversions) would not increase entrainment and may provide a minor benefit. In addition, restoration activities as part of the conservation measures should increase the amount of habitat for young striped bass (e.g. inshore rearing habitat), and increase their food supply. The expectation is that these habitat changes would result in at least a minor improvement in production of juvenile striped bass.

NEPA Effects: In summation, potential entrainment would increase for Sacramento River eggs and larvae that drift downstream past the north Delta intakes and the NBA alternative intake on the Sacramento River compared to baseline (no intake facilities), while entrainment of bass at the south Delta facilities would potentially decrease. Although egg and larval survival is correlated with striped bass young of year (YOY) production, the variability in egg and larval survival is dampened by a population bottleneck between YOY abundance and striped bass recruitment at three years of age (Kimmerer et al. 2000). Hence variations in striped bass survival rates during the first few months of life are moderated by this bottleneck (Kimmerer et al. 2000). Therefore it would be expected that reductions in entrainment of juveniles and adults at the south Delta intakes would have a greater population impact than increases in entrainment at the proposed SWP/CVP north Delta intakes and the NBA intake. Furthermore, reductions in agricultural diversions may also reduce entrainment of striped bass. Overall, the effect on striped bass entrainment is not adverse.

CEQA Conclusion: The impact of water operations on entrainment of striped bass would be the same as described immediately above. The changes in entrainment under Alternative 2A would not substantially reduce the striped bass population when other conservation measures are taken into consideration. The impact would be less than significant and no mitigation would be required.

American Shad

The majority of American shad spawning occurs upstream of the Delta but some spawning is believed to occur in the Delta along the Sacramento River (Stevens 1966). American shad eggs stay suspended in the water column and may gradually drift downstream towards the proposed north delta intakes. The north Delta is also used as nursery habitat for American shad. The intakes of the north Delta diversion and the NBA intake would be screened, but small life stages (eggs and larvae) would have the potential to be entrained. Some larval American shad would be in the north Delta, but only a small fraction of the total larval population would encounter the proposed North Delta intakes when they are still vulnerable to entrainment.

At the SWP/CVP south Delta facilities, historical salvage of American shad was highest in the summer months but continued to be elevated through the fall months. American shad entrainment losses under Alternative 2A would decrease compared to baseline conditions due to reduced south delta exports for all months. Reduced south delta entrainment would also be expected to reduce predation loss associated with these facilities, especially within Clifton Court Forebay. Reduction or consolidation of agricultural diversions in ROA's would not increase entrainment.

NEPA Effects: Overall, the effect on American shad is not adverse, and would likely be slightly beneficial.

CEQA Conclusion: The impact of water operations on entrainment of American shad would be the same as described immediately above. The changes in entrainment under Alternative 2A would not substantially reduce the American shad population. The impact would be less than significant and no mitigation would be required.

Threadfin Shad

Threadfin shad are widely distributed throughout the Delta, however they are most abundant in the southeastern region of the Delta where areas of dense SAV in shallow water serve as important spawning and rearing habitat (Feyrer et al. 2009). The proposed SWP/CVP north delta intakes and alternate NBA intake would be located well upstream of this region, which would limit potential entrainment of shad eggs and larvae, and the intakes would be screened to avoid entrainment of juveniles and adults.

At the SWP/CVP south Delta facilities, historical salvage of threadfin shad peaks sharply in the summer months, with smaller peaks occurring in late fall and early winter. Threadfin shad entrainment losses would decrease due to reduced south Delta exports under Alternative 2A Additionally, reduced south delta entrainment is expected to reduce the amount of elevated predation loss associated with these facilities, especially within Clifton Court Forebay.

Agricultural diversions may be sources of entrainment for threadfin shad. Reduction or consolidation of these agricultural diversions under the Plan would decrease or have no impact on threadfin shad entrainment.

NEPA Effects: Overall, entrainment would be reduced, which would benefit threadfin shad. The effect on threadfin shad is not adverse.

CEQA Conclusion: The impact of water operations on entrainment of threadfin shad would be the same as described immediately above. The changes in entrainment under Alternative 2A would not substantially reduce and may benefit the threadfin shad population. The impact would be less than significant and no mitigation would be required.

Largemouth Bass

Historically, entrainment of largemouth bass to the south delta export facilities peaks during the summer months. At the SWP/CVP south Delta facilities, entrainment losses under Alternative 2A are expected to decrease compared to baseline conditions, assuming largemouth bass entrainment is proportional to south Delta exports. Water exports from the south delta would decrease in all months under Alternative 2A compared to baseline conditions.

Largemouth bass are predominantly distributed in the central and south sections of the Delta in areas of dense SAV, and thus would have minimal overlap with propose north Delta intake facilities and alternate NBA intake on the Sacramento River. The proposed intakes would be screened to exclude fish larger than 15 mm. Largemouth bass lay demersal eggs in a nest guarded by the male, and newly hatched largemouth bass hold around their nests until they begin feeding. Parental male bass protect newly hatched young bass for several weeks. These behaviors further minimize the potential for larval largemouth bass to encounter and be entrained into the proposed north Delta intakes and NBA intake.

Agricultural diversions may be sources of entrainment for largemouth bass. Agricultural diversions are typically located nearshore, which is the habitat mainly used by juvenile and adult largemouth bass. Reduction or consolidation of these agricultural diversions under the Plan is not expected to increase entrainment of largemouth bass and would likely reduce overall entrainment attributable to these diversions.

NEPA Effects: Overall, entrainment of largemouth bass would decrease compared to baseline conditions. The effect from Alternative 2A is not adverse and would likely provide minor benefits.

CEQA Conclusion: The impact of water operation on largemouth bass would be as described immediately above. The changes in entrainment under Alternative 2A could benefit the largemouth bass population. The impact would be less than significant and no mitigation would be required.

Sacramento Tule Perch

At the SWP/CVP south Delta facilities, entrainment losses under Alternative 2A would be expected to decrease compared to baseline conditions, because Sacramento tule perch entrainment is assumed to be proportional to south delta exports. Because water would be exported from the proposed north delta facilities under Alternative 2A, less water will be exported from the south delta, leading to presumed reductions in largemouth bass south delta entrainment. Additionally, reduced south delta entrainment is expected to reduce the amount of the elevated predation loss associated with these facilities, especially within Clifton Court Forebay.

The proposed SWP/CVP north delta intakes would be screened with state-of-the-art fish screens so only larval fish should be vulnerable to entrainment. Because Sacramento tule perch are viviparous, newly emerged Sacramento tule perch will already too large to be entrained at the north delta facilities.

Agricultural diversions may be sources of entrainment for Sacramento tule perch. Agricultural diversions are typically located nearshore, which is the habitat mainly used by juvenile and adult Sacramento tule perch. Reduction or consolidation of these agricultural diversions under the Plan would decrease entrainment of Sacramento tule perch into these agricultural intakes.

NEPA Effects: In summation, entrainment of Sacramento tule perch is expected to decrease compared to Existing Conditions. Overall, the effect on entrainment from Alternative 2A is not adverse.

CEQA Conclusion: The impact of water operations on entrainment of Sacramento tule perch would be the same as described immediately above. The changes in entrainment under Alternative 2A would not substantially reduce the Sacramento tule perch population. The impact would be less than significant and no mitigation would be required.

Sacramento-San Joaquin Roach

NEPA Effects: The effect of water operations on entrainment of Sacramento-San Joaquin roach under Alternative 2A would be similar to that described for Alternative 1A (see Alternative 1A, Impact AQUA-201). For a detailed discussion, please see Alternative 1A, Impact AQUA-201. The effects would not be adverse.

CEQA Conclusion: The impact of water operations on entrainment of Sacramento-San Joaquin roach would be the same as described immediately above and would be less than significant.

Hardhead

NEPA Effects: The effect of water operations on entrainment of hardhead under Alternative 2A would be similar to that described for Alternative 1A (see Alternative 1A, Impact AQUA-3). That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. For a discussion, please see Alternative 1A, Impact AQUA-3. The effects would not be adverse.

CEQA Conclusion: The impact of water operations on entrainment of hardhead would be the same as described immediately above and would be less than significant.

California Bay Shrimp

California bay shrimp do not occur in the vicinity of the intakes so there would be no entrainment effect on them.

CEQA Conclusion: California bay shrimp do not occur in the vicinity of the intakes so there would no entrainment impact on them.

Impact AQUA-202: Effects of Water Operations on Spawning and Egg Incubation Habitat for Non-Covered Aquatic Species of Primary Management Concern

Also, see Alternative 1A, Impact AQUA-202 for additional background information relevant to non-covered species of primary management concern.

Striped Bass

In general, Alternative 2A would slightly improve the quality and quantity of upstream habitat conditions for striped bass relative to NAA.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the April through June striped bass spawning, embryo incubation, and initial rearing period. Lower flows could reduce the quantity and quality of instream habitat available for spawning, egg incubation, and rearing.

In the Sacramento River upstream of Red Bluff, flows under A2A_LLT would generally be similar to or greater than flows under NAA during April through June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A2A_LLT would generally be similar to or greater than flows under NAA during April through June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A2A_LLT would generally be similar to or greater than flows under NAA during April through June except in critical years during June (8% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A2A_LLT would generally be substantially greater than flows under NAA during April through June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A2A_LLT would generally be greater than flows under NAA regardless of water year type.

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months outside of the 59°F to 68°F suitable water temperature range for striped bass spawning, embryo incubation, and initial rearing during April through June was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced spawning success and increased egg and larval stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature related effects in these rivers during the April through June period.

In the Feather River below Thermalito Afterbay, the percentage of months under A2A_LLT outside the range would be similar to or lower than the percentage under NAA in all water year types (Table 11-2A-94).

Table 11-2A-94. Difference and Percent Difference in the Percentage of Months during April–June in Which Water Temperatures in the Feather River below Thermalito Afterbay Are outside the 59°F to 68°F Water Temperature Range for Striped Bass Spawning, Embryo Incubation, and Initial Rearing[a]

Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wet	-3 (-6%)	-8 (-19%)
Above Normal	-27 (-60%)	-24 (-133%)
Below Normal	-12 (-28%)	-14 (-46%)
Dry	-4 (-8%)	0 (0%)
Critical	8 (21%)	-6 (-12%)
All	-6 (-14%)	-9 (-24%)

[a] A negative value indicates a benefit (reduction in percentage of months outside suitable range) of the alternative.

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because Alternative 2A would not cause a substantial reduction in striped bass spawning, incubation, or initial rearing habitat. Flows in all rivers examined during the April through June spawning, incubation, and initial rearing period under Alternative 2A would generally be similar to or greater than flows under NAA. The percentage of months outside the 59°F to 68°F water temperature range would generally be lower under Alternative 2A than under NAA.

CEQA Conclusion: In general, Alternative 2A would slightly improve the quality and quantity of upstream habitat conditions for striped bass relative to the Existing Conditions.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the April through June striped bass spawning, embryo incubation, and initial rearing period. Lower flows could reduce the quantity and quality of instream habitat available for spawning, egg incubation, and rearing.

In the Sacramento River upstream of Red Bluff, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions during April through June, except in wet years during May (15% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions during April through June, except in critical years during May (6% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A2A_LLT would always be similar to or greater than flows under Existing Conditions during April through June regardless of water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions during April through June, except in wet years during May (31% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions during April and June, except in above normal years during April (7% lower) and wet and critical years during June (25% and 31% lower, respectively), but generally lower, by up to 24%, during May (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months outside of the 59°F to 68°F suitable water temperature range for striped bass spawning, embryo incubation, and initial rearing during April through June was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced spawning success and increased egg and larval stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature related effects in these rivers during the April through June period.

In the Feather River below Thermalito Afterbay, the percentage of months under A2A_LLT outside of the 59°F to 68°F suitable water temperature range for striped bass spawning, embryo incubation, and initial rearing during April through June would be lower than the percentage under Existing Conditions in all water years except critical years (21% higher) (Table 11-2A-94).

Collectively, these results indicate that the impact would not be significant because Alternative 2A would not cause a substantial reduction in spawning, incubation, and initial rearing habitat of striped bass. Therefore, no mitigation is necessary. Flows in all rivers except the San Joaquin and Stanislaus rivers during the April through June spawning, incubation, or initial rearing period under Alternative 2A would generally be similar to or greater than flows under the Existing Conditions. Flows in the San Joaquin and Stanislaus rivers would be lower under Alternative 2A, although this effect would not be biologically meaningful to striped bass. The percentage of months outside the 59°F to 68°F water temperature range would generally be lower under Alternative 2A than under Existing Conditions.

American Shad

In general, Alternative 2A would slightly improve the quality and quantity of upstream habitat conditions for American shad relative to NAA.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the April through June American shad adult migration and spawning period. Lower flows could reduce migration ability and instream habitat quantity and quality for spawning.

In the Sacramento River upstream of Red Bluff, flows under A2A_LLT would generally be similar to or greater than flows under NAA during April through June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A2A_LLT would generally be similar to or greater than flows under NAA during April through June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A2A_LLT would generally be similar to or greater than flows under NAA during April through June except in critical years during June (8% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A2A_LLT would generally be substantially greater than flows under NAA during April through June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A2A_LLT would generally be greater than flows under NAA regardless of water year type.

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months outside of the 60°F to 70°F water temperature range for American shad adult migration and spawning during April through June was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced spawning success and increased adult migrant stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature related effects in these rivers during the April through June period.

In the Feather River below Thermalito Afterbay, the percentage of months under A2A_LLT outside the 60°F to 70°F water temperature range would generally be lower than the percentage under NAA depending on water year type (Table 11-2A-95).

Table 11-2A-95. Difference and Percent Difference in the Percentage of Months during April–June in Which Water Temperatures in the Feather River below Thermalito Afterbay Are outside the 60°F to 70°F Water Temperature Range for American Shad Adult Migration and Spawning[a]

Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wet	-6 (-14%)	-1 (-3%)
Above Normal	-6 (-17%)	-15 (-50%)
Below Normal	0 (0%)	-7 (-23%)
Dry	-2 (-5%)	-7 (-20%)
Critical	3 (8%)	-3 (-7%)
All	-3 (-7%)	-6 (-16%)

[a] A negative value indicates a benefit (reduction in percentage of months outside suitable range) of the alternative.

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because Alternative 2A would not cause a substantial reduction in American shad spawning or adult migration. Flows in all rivers examined during the April through June adult migration and spawning period under Alternative 2A would generally be similar to or greater than flows under NAA. The percentage of months outside the 60°F to 70°F water temperature range would generally be lower under Alternative 2A than under NAA.

CEQA Conclusion: In general, Alternative 2A would slightly improve the quality and quantity of upstream habitat conditions for American shad relative to the Existing Conditions.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the April through June American shad adult migration and spawning period. Lower flows could reduce migration ability and instream habitat quantity and quality for spawning.

In the Sacramento River upstream of Red Bluff, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions during April through June, except in wet years during May (15% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions during April through June, except in critical years during May (6% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A2A_LLT would always be similar to or greater than flows under Existing Conditions during April through June regardless of water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions during April through June, except in wet years during May (31% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions during April and June, except in above normal years during April (7% lower) and wet and critical years during June (25% and 31% lower, respectively), but generally lower, by up to 24%, during May (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months outside of the 60°F to 70°F water temperature range for American shad adult migration and spawning during April through June was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced spawning success and increased adult migrant stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature related effects in these rivers during the April through June period.

In the Feather River below Thermalito Afterbay, the percentage of months under A2A_LLT outside of the 60°F to 70°F water temperature range would be similar to or lower than the percentage under Existing Conditions in all water years except critical years (8% higher) (Table 11-2A-95).

Collectively, these results indicate that the impact would not be significant because Alternative 2A would not cause a substantial reduction in American shad adult migration and spawning habitat, and no mitigation is necessary. Flows in all rivers examined except the San Joaquin and Stanislaus rivers during the April through June adult migration and spawning period under Alternative 2A would generally be similar to or greater than flows under the Existing Conditions. Flows in the San Joaquin and Stanislaus rivers would be lower under Alternative 2A, although this effect would be biologically meaningful to American shad. The percentage of months outside the 60°F to 70°F water temperature range would generally be similar to or lower under Alternative 2A than under the Existing Conditions.

Threadfin Shad

In general, Alternative 2A would not affect the quality and quantity of upstream habitat conditions for threadfin shad relative to NAA.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during April through August threadfin shad spawning period. Lower flows could reduce the quantity and quality of instream habitat available for spawning.

In the Sacramento River upstream of Red Bluff, flows under A2A_LLT during April through July would generally be similar to or greater than flows under NAA throughout the period with some exceptions (up to 15% lower). During August, flows under A2A_LLT would generally be lower than flows under NAA, by up to 15%, depending on water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A2A_LLT would generally be similar to or greater than flows under NAA, except in critical years during August (11% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A2A_LLT would nearly always be similar to or greater than flows under NAA throughout the period, except in critical years during June (8% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A2A_LLT would generally be lower than those under NAA during July and August (up to 44% lower) and greater during April through June (up to 166% greater) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*),

In the American River at Nimbus Dam, flows under A2A_LLT would generally be similar between NAA during April.

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months below 68°F water temperature threshold for the April through August adult threadfin shad spawning period was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures below this threshold could delay or prevent successful spawning in these areas. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers throughout the year.

In the Feather River below Thermalito Afterbay, the percentage of months under A2A_LLT below 68°F would be greater than those under NAA in wet above normal, and below normal water years (10% to 21% higher depending on water year type), 11% lower than those under NAA in dry years, and not different from those under NAA in critical water years (Table 11-2A-96).

Table 11-2A-96. Difference and Percent Difference in the Percentage of Months during April–August in Which Water Temperatures in the Feather River below Thermalito Afterbay Fall below the 68°F Water Temperature Threshold for Threadfin Shad Spawning[a]

Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wet	-8 (-12%)	5 (10%)
Above Normal	-16 (-21%)	13 (21%)
Below Normal	-19 (-27%)	6 (11%)
Dry	-34 (-46%)	-4 (-11%)
Critical	-28 (-44%)	0 (0%)
All	-20 (-29%)	3 (7%)

[a] A negative value indicates a benefit (reduction in percentage of months outside suitable range) of the alternative.

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because Alternative 2A would not cause a substantial reduction in spawning habitat. Flows in all rivers examined during the April through August spawning period under Alternative 2A would generally be similar to or greater than flows under NAA, except during summer months in the Sacramento, Feather, and American rivers. Lower flows during these months in these rivers are not of sufficient magnitude or frequency to have a biologically meaningful effect on threadfin shad. The percentage of months below the spawning temperature threshold would be moderately higher under Alternative 2A relative to NAA, but this increase is not expected to have a biologically meaningful effect on the threadfin shad population because there are no temperature-related effects in any other rivers.

CEQA Conclusion: In general, Alternative 2A would not affect the quality and quantity of upstream habitat conditions for threadfin shad relative to the Existing Conditions.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during April through August spawning period. Lower flows could reduce the quantity and quality of instream habitat available for spawning.

In the Sacramento River upstream of Red Bluff, flows under A2A_LLT during April through July would generally be similar to or greater than flows under Existing Conditions, except in wet years during May and critical years during July (15% and 13% lower, respectively). Flows under A2A_LLT during August would generally be lower than flows under Existing Conditions, by up to 24% (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions throughout the period, except in critical years during May and August (6% and 33% lower, respectively) and wet years during July (14% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A2A_LLT would nearly always be similar to or greater than flows under Existing Conditions throughout the period, except in critical years during August (17% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*)

In the Feather River at Thermalito Afterbay, flows under A2A_LLT would generally be greater (up to 153% greater) than flows under Existing Conditions during April through June and lower (up to 50% lower) during July and August (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A2A_LLT would generally be similar to flows under Existing Conditions during April, lower during May, July, and August (up to 49% lower), and greater during June (up to 24% greater) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months below 68°F water temperature threshold for the April through August adult threadfin shad spawning period was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures below this threshold could delay or prevent successful spawning in these areas. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the April through November period.

In the Feather River below Thermalito Afterbay, the percentage of months below the 68°F water temperature threshold for threadfin shad spawning under A2A_LLT would be 12% to 46% lower than the percentage under Existing Conditions, depending on water year type (Table 11-2A-96).

Collectively, these results indicate that the impact would not be significant because Alternative 2A would not cause a substantial reduction in habitat, and no mitigation is necessary. Flows in all rivers examined during the April through August spawning period under Alternative 2A would generally be similar to or greater than flows under the Existing Conditions, except during summer months in the Sacramento, Feather, and American rivers. Lower flows during these months in these rivers would not be of sufficient magnitude or frequency to cause a biologically meaningful effect on threadfin shad. The percentage of months outside all temperature thresholds are generally lower under Alternative 2A than under the Existing Conditions, indicating that there would be a net temperature-related benefit of Alternative 2A to threadfin shad.

Largemouth Bass

In general, Alternative 2A would not affect the quality and quantity of upstream habitat conditions for largemouth bass relative to NAA.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the March through June largemouth bass spawning period. Lower flows could reduce the quantity and quality of instream spawning habitat.

In the Sacramento River upstream of Red Bluff, flows under A2A_LLT would generally be similar to or greater than flows under NAA during March through June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A2A_LLT would generally be similar to or greater than flows under NAA during March through June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A2A_LLT would generally be similar to or greater than flows under NAA during March through June, except in below normal years in March (6% lower) and critical years during June (8% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A2A_LLT would be substantially greater (up to 166% greater) than flows under NAA during March through June, except in below normal years during March (8% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A2A_LLT would generally be similar to or greater than flows under NAA during March, April, and June, with some exceptions (up to 24% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows during May under A2A_LLT would generally be greater by up to 24%.

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months outside of the 59°F to 75°F suitable water temperature range for largemouth bass spawning during March through June was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced spawning success. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the March through June period.

In the Feather River below Thermalito Afterbay, the percentage of months under A2A_LLT outside the 59°F to 75°F water temperature range would be similar to or lower than the percentage under NAA in all water years except dry years (5% higher) (Table 11-2A-97).

Table 11-2A-97. Difference and Percent Difference in the Percentage of Months during March–June in Which Water Temperatures in the Feather River below Thermalito Afterbay Are outside the 59°F to 75°F Water Temperature Range for Largemouth Bass Spawning[a]

Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wet	-9 (-16%)	0 (0%)
Above Normal	-16 (-32%)	-2 (-7%)
Below Normal	-11 (-24%)	0 (0%)
Dry	-17 (-35%)	1 (5%)
Critical	-19 (-43%)	-8 (-33%)
All	-13 (-27%)	-1 (-3%)

[a] A negative value indicates a benefit (reduction in percentage of months outside suitable range) of the alternative.

CEQA Conclusion: In general, Alternative 2A would reduce the quality and quantity of upstream habitat conditions for largemouth bass relative to the Existing Conditions.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the March through June largemouth bass spawning period. Lower flows could reduce the quantity and quality of instream spawning habitat.

In the Sacramento River upstream of Red Bluff, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions during March through June, except in below normal years during March (10% lower) and wet years during May (15% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions during March through June, except in below normal years during March and critical years during May (6% lower in both) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A2A_LLT would always be similar to or greater than flows under Existing Conditions during March through June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A2A_LLT would generally be substantially greater (up to 153% greater) than flows under Existing Conditions during March through June, except in below normal and dry years during March (46% and 5%, respectively) and in wet years during May (31% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions during March, April, and June, except in critical years during March and June (8% and 31% lower, respectively), above normal years during April (7% lower) and wet years during June (25% lower). Flows under A2A_LLT in May would generally be lower, up to 24%, than those under Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months outside of the 59°F to 75°F suitable water temperature range for largemouth bass spawning during March through June was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced spawning success. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the March through June period.

In the Feather River below Thermalito Afterbay, the percentage of months under A2A_LLT outside of the 59°F to 75°F water temperature range for largemouth bass spawning would be lower than the percentage under Existing Conditions in all water years (Table 11-2A-97).

Collectively, these results indicate that the impact would be less than significant because Alternative 2A would not cause a substantial reduction in largemouth bass habitat. No mitigation is necessary.

Sacramento Tule Perch

The effects of water operations on spawning habitat for Sacramento tule perch under Alternative 2A would be similar to that described for Alternative 1A (see Alternative 1A, Impact AQUA-202). For a detailed discussion, please see Alternative 1A, Impact AQUA-202.

Sacramento-San Joaquin Roach

In general, Alternative 2A would not affect the quality and quantity of upstream habitat conditions for Sacramento-San Joaquin Roach relative to NAA.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the March through June Sacramento-San Joaquin roach spawning period. Lower flows could reduce the quantity and quality of instream habitat available for spawning.

In the Sacramento River upstream of Red Bluff, flows under A2A_LLT would generally be similar to or greater than flows under NAA during March through June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A2A_LLT would generally be similar to or greater than flows under NAA during March through June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A2A_LLT would generally be similar to or greater than flows under NAA during March through June, except in below normal years in March (6% lower) and critical years during June (8% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A2A_LLT would be substantially greater (up to 166% greater) than flows under NAA during March through June, except in below normal years during March (8% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A2A_LLT would generally be similar to or greater than flows under NAA during March, April, and June, with some exceptions (up to 24% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows during May under A2A_LLT would generally greater by up to 24% relative to NAA.

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months below the 60.8°F water temperature threshold for Sacramento-San Joaquin roach spawning initiation during March through June was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures below this threshold could delay or prevent spawning initiation. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the March through June period.

In the Feather River below Thermalito Afterbay, the percentage of months in which temperatures would be below the 60.8°F water temperature threshold for roach spawning initiation under A2A_LLT would be similar to or lower than the percentage under NAA in all water year types except below normal years (7% higher) (Table 11-2A-98).

Table 11-2A-98. Difference and Percent Difference in the Percentage of Months during March–June in Which Water Temperatures in the Feather River below Thermalito Afterbay Fall below the 60.8°F Water Temperature Threshold Range for the Initiation of Sacramento-San Joaquin Roach Spawning[a]

Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wet	-13 (-19%)	0 (0%)
Above Normal	-7 (-13%)	0 (0%)
Below Normal	-2 (-4%)	4 (7%)
Dry	-11 (-21%)	0 (0%)
Critical	-19 (-33%)	-4 (-11%)
All	-10 (-18%)	0 (0%)

[a] A negative value indicates a benefit (reduction in percentage of months outside suitable range) of the alternative.

CEQA Conclusion: In general, Alternative 2A would not affect the quality and quantity of upstream habitat conditions for Sacramento-San Joaquin Roach relative to the Existing Conditions.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the March through June Sacramento-San Joaquin roach spawning period. Lower flows could reduce the quantity and quality of instream habitat available for spawning.

In the Sacramento River upstream of Red Bluff, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions during March through June, except in below normal years during March (10% lower) and wet years during May (15% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions during March through June, except in below normal years during March and critical years during May (6% lower in both) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A2A_LLT would always be similar to or greater than flows under Existing Conditions during March through June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A2A_LLT would generally be substantially greater (up to 153% greater) than flows under Existing Conditions during March through June, except in below normal and dry years during March (46% and 5%, respectively) and in wet years during May (31% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions during March, April, and June, except in critical years during March and June (8% and 31% lower, respectively), above normal years during April (7% lower) and wet years during June (25% lower). Flows under A2A_LLT in May would generally be lower, up to 24%, than those under Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months below the 60.8°F water temperature threshold for Sacramento-San Joaquin roach spawning initiation during March through June was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures below this threshold could delay or prevent spawning initiation. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the March through June period.

In the Feather River below Thermalito Afterbay, the percentage of months in which temperatures would be below the 60.8°F water temperature threshold for roach spawning initiation under A2A_LLT would be lower than the percentage under Existing Conditions in all water years (Table 11-2A-98).

Hardhead

In general, Alternative 2A would not affect the quality and quantity of upstream habitat conditions for hardhead relative to NAA.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the April through May hardhead spawning period. Lower flows could reduce the quantity and quality of instream habitat available for spawning.

In the Sacramento River upstream of Red Bluff, flows under A2A_LLT would generally be similar to or greater than flows under NAA throughout the period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A2A_LLT would generally be similar to or greater than flows under throughout the period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A2A_LLT would always to be similar to flows under NAA throughout the period regardless of water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A2A_LLT would generally be substantially greater (up to 166% greater) than flows under NAA throughout the period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A2A_LLT would be similar to flows under NAA in April. During May, flows under A2A_LLT would generally be greater than flows under NAA (up to 24% greater) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months outside of the 59°F to 64°F suitable water temperature range for hardhead spawning during April through May was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced spawning success and increased egg and larval stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers throughout the year.

In the Feather River below Thermalito Afterbay, the percentage of months under A2A_LLT outside the range would generally be lower than the percentage under NAA in all water year types except below normal, in which there would be no difference (Table 11-2A-99).

Table 11-2A-99. Difference and Percent Difference in the Percentage of Months during April–May in Which Water Temperatures in the Feather River below Thermalito Afterbay Are outside the 59°F to 64°F Water Temperature Range for Hardhead Spawning[a]

Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wet	-4 (-6%)	-6 (-10%)
Above Normal	-18 (-29%)	-9 (-20%)
Below Normal	21 (50%)	0 (0%)
Dry	-8 (-15%)	-3 (-6%)
Critical	-4 (-8%)	-4 (-8%)
All	-2 (-4%)	-4 (-8%)

[a] A negative value indicates a benefit (reduction in percentage of months outside suitable range) of the alternative.

CEQA Conclusion: In general, Alternative 2A would not affect the quality and quantity of upstream habitat conditions for hardhead relative to the Existing Conditions.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the April through May hardhead spawning period. Lower flows could reduce the quantity and quality of instream habitat available for spawning.

In the Sacramento River upstream of Red Bluff, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions throughout the period, except in wet years during May (15% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions throughout the period, except in critical years during May (6% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A2A_LLT would always be similar to or greater than flows under Existing Conditions throughout the period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions throughout the period, except in wet years during May (30% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A2A_LLT would be similar to or greater than flows under Existing Conditions during April except in above normal years (7% lower) and generally lower than flows under Existing Conditions, by up to 24%, during May (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months outside of the 59°F to 64°F suitable water temperature range for hardhead spawning during April through May was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced spawning success and increased egg and larval stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A.

In the Feather River below Thermalito Afterbay, the percentage of months under A2A_LLT outside of the 59°F to 64°F water temperature range for hardhead spawning would be lower than the percentage under Existing Conditions in all water years except below normal years (50% higher) (Table 11-2A-99).

California Bay Shrimp

The effect of water operations on spawning habitat of California bay shrimp under Alternative 2A would be similar to that described for Alternative 1A (see Alternative 1A, Impact AQUA-4). That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species.

NEPA Effects: For a discussion, please see Alternative 1A, Impact AQUA-4. That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. The effects would not be adverse.

CEQA Conclusion: The impact of water operations on spawning habitat of California bay shrimp would be the same as described immediately above. The impacts would be less than significant.

Impact AQUA-203: Effects of Water Operations on Rearing Habitat for Non-Covered Aquatic Species of Primary Management Concern

Also, see Alternative 1A, Impact AQUA-203 for additional background information relevant to non-covered species of primary management concern.

Striped Bass

NEPA Effects: The discussion under Alternative 2A, Impact AQUA-202 for striped bass also addresses the egg incubation and initial rearing period. That analysis indicates that there is no adverse effect on striped bass rearing during that period. Other effects of water operations on rearing habitat for striped bass under Alternative 2A would be similar to that described for Alternative 1A (see Alternative 1A, Impact AQUA-202). For a detailed discussion, please see Alternative 2A, Impact AQUA-202. The effects would not be adverse.

CEQA Conclusion: As described above the impacts on striped bass rearing habitat would be less than significant.

American Shad

NEPA Effects: The effects of water operations on rearing habitat for American shad under Alternative 2A would be similar to that described for Alternative 1A (see Alternative 1A, Impact

AQUA-203). For a detailed discussion, please see Alternative 1A, Impact AQUA-203. The effects would not be adverse.

CEQA Conclusion: As described above the impacts on American shad rearing habitat would be less than significant.

Threadfin Shad

NEPA Effects: The effects of water operations on rearing habitat for threadfin shad under Alternative 2A would be similar to that described for Alternative 1A (see Alternative 1A, Impact AQUA-203). For a detailed discussion, please see Alternative 1A, Impact AQUA-203. The effects would not be adverse.

CEQA Conclusion: As described above the impacts on threadfin shad rearing habitat would be less than significant.

Largemouth Bass

Juveniles

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the April through November juvenile largemouth bass rearing period. Lower flows could reduce the quantity and quality of instream habitat available for juvenile rearing.

In the Sacramento River upstream of Red Bluff, flows under A2A_LLT would generally be similar to or greater than flows under NAA during all months but August and November with some exceptions (up to 15% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT during August and November would be lower, by up to 25%, than NAA depending on month, water year type, and time period.

In the Trinity River below Lewiston Reservoir, flows under A2A_LLT would generally be similar to or greater than flows under NAA during the April through November period with some exceptions (up to 58% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A2A_LLT would generally be similar to or greater than NAA throughout the year, except in critical years during June (8% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A2A_LLT would generally be lower (up to 52%) than flows under NAA during July through September, greater during April through June and October (up to 105% greater), and similar during November (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A2A_LLT would generally be similar to NAA during April, October and November (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months above the 88°F water temperature threshold for juvenile largemouth bass rearing during April through November was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Elevated water temperatures could lead to reduced quantity and quality of instream habitat available for juvenile rearing and increased stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the April through November period.

In the Feather River below Thermalito Afterbay, water temperatures would not exceed 88°F under NAA or A2A_LLT (Table 11-2A-100). As a result, there would be no difference in the percentage of months in which the 88°F water temperature threshold is exceeded between Alternative 2A and NAA.

Table 11-2A-100. Difference and Percent Difference in the Percentage of Months during April–November in Which Water Temperatures in the Feather River below Thermalito Afterbay Exceed the 88°F Water Temperature Threshold for Juvenile Largemouth Bass Rearing[a]

Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wet	0 (NA)	0 (NA)
Above Normal	0 (NA)	0 (NA)
Below Normal	0 (NA)	0 (NA)
Dry	0 (NA)	0 (NA)
Critical	0 (NA)	0 (NA)
All	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.

[a] A negative value indicates a benefit (reduction in percentage of months outside suitable range) of the alternative.

Adults

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during year-round adult largemouth bass rearing period. Lower flows could reduce the quantity and quality of instream habitat available for adult rearing.

In the Sacramento River upstream of Red Bluff, flows under A2A_LLT would generally be similar to or greater than flows under NAA during all months but August and November with some exceptions (up to 15% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT during August and November would be lower than flows under NAA (up to 25% and 17% lower depending on month, water year type, and time period).

In the Trinity River below Lewiston Reservoir, flows under A2A_LLT would generally be similar to or greater than flows under NAA with some exceptions (up to 12% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A2A_LLT would generally be similar to or greater than NAA throughout the year, except in critical years during February and June (6% and 8% lower, respectively) and below normal years during March (6% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A2A_LLT would generally be greater than those under NAA during February through June and October (up to 105% greater), similar during January, November, and December, and lower during July through September (up to 52% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A2A_LLT would generally be greater than flows under NAA during May and June (up to 24% greater), lower during July through September (up to 27% lower), and similar during the remaining months (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months above the 86°F water temperature threshold for year-round adult largemouth bass rearing period was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Elevated water temperatures could lead to reduced quantity and quality of adult rearing habitat and increased stress and mortality of rearing adults. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the year-round period.

In the Feather River below Thermalito Afterbay, water temperatures would not exceed 86°F under NAA or A2A_LLT (Table 11-2A-101). As a result, there would be no difference in the percentage of years in which the 86°F water temperature threshold is exceeded between Alternative 2A and NAA.

Table 11-2A-101. Difference and Percent Difference in the Percentage of Months Year-Round in Which Water Temperatures in the Feather River below Thermalito Afterbay Exceed the 86°F Water Temperature Threshold for Adult Largemouth Bass Survival[a]

Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wet	0 (NA)	0 (NA)
Above Normal	0 (NA)	0 (NA)
Below Normal	0 (NA)	0 (NA)
Dry	0 (NA)	0 (NA)
Critical	0 (NA)	0 (NA)
All	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.

[a] A negative value indicates a benefit (reduction in months outside suitable range) of the alternative.

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because Alternative 2A would not cause a substantial reduction in juvenile and adult rearing habitat. Flows in all rivers examined during the year under Alternative 2A are generally similar to or greater than flows under NAA in most months. Flows in July through September are generally lower in the Feather River high flow channel and in the American River below Nimbus Dam, although these reductions would not be biologically meaningful to the largemouth bass population. The percentage of months outside all temperature thresholds examined in the Feather River under Alternative 2A are generally similar to or lower than under NAA. There would be no temperature-related effects in any other rivers examined.

CEQA Conclusion: In general, Alternative 2A would reduce the quality and quantity of upstream habitat conditions for largemouth bass relative to the Existing Conditions.

Juveniles

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the April through November juvenile largemouth bass rearing period. Lower flows could reduce the quantity and quality of instream habitat available for juvenile rearing.

In the Sacramento River upstream of Red Bluff, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions in all months but August and November with some exceptions (up to 17% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows during August and November under A2A_LLT would be up to 24% lower than flows under Existing Conditions.

In the Trinity River below Lewiston Reservoir, flows under A2A_LLT during April through September would generally be similar to or greater than flows under Existing Conditions throughout the year with some exceptions (up to 58% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT during October and November would be up to 25% lower than flows under Existing Conditions.

In Clear Creek at Whiskeytown Dam, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions throughout the April through November period, except in critical years during August through November (6% to 29% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A2A_LLT would generally be greater (up to 217% greater) than flows under Existing Conditions during April through June and September through October and lower (up to 50% lower) during July, August, and November (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions during April and October with some exceptions (up to 31% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT during May, July through September, and November would be lower by up to 50% and flows during October would be similar between Existing Conditions and A2A_LLT.

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months above the 88°F water temperature threshold for juvenile largemouth bass rearing during April through November was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Elevated water temperatures could lead to reduced quantity and quality of instream habitat available for juvenile rearing and increased stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the April through November period.

In the Feather River below Thermalito Afterbay, water temperatures would not exceed the 88°F water temperature threshold for April through November juvenile largemouth bass occurrence under Existing Conditions or A2A_LLT (Table 11-2A-100). As a result, there would be no difference in the percentage of months in which the 88°F water temperature threshold is exceeded between Alternative 2A and the Existing Conditions.

Adults

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the year-round adult largemouth bass rearing period. Lower flows could reduce the quantity and quality of instream habitat available for adult rearing.

In the Sacramento River upstream of Red Bluff, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions during all months but August and November with some exceptions (up to 17% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT during August and November would be lower than flows under Existing Conditions (up to 24% lower and 13% lower, respectively).

In the Trinity River below Lewiston Reservoir, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions throughout the year with some exceptions (up to 58% lower), except during October and November when it would generally be lower (up to 25% lower during both months) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions throughout the year, except in critical years during August through November (6% to 29% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A2A_LLT would generally be greater than those under Existing Conditions during March through June and September through October (up to 217% greater), lower during February, July through August, and November through December (up to 50% lower), and similar during January (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A2A_LLT would generally greater than flows under Existing Conditions during February, March, and June (up to 27% greater), lower during January, May, July through September, and November through December (up to 49% lower), and similar during April and October (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months above the 86°F water temperature threshold for year-round adult largemouth bass rearing period was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Elevated water temperatures could lead to reduced quantity and quality of adult rearing habitat and increased stress and mortality of rearing adults. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the April through November period.

In the Feather River below Thermalito Afterbay, water temperatures would not exceed the 86°F water temperature range for year-round adult largemouth bass occurrence under Existing Conditions or A2A_LLT (Table 11-2A-101). As a result, there would be no difference in the percentage of months in which the 86°F water temperature threshold is exceeded between Alternative 2A and the Existing Conditions.

Collectively, these results indicate that the impact would be significant because Alternative 2A would cause a substantial reduction in largemouth bass habitat. Flows would be substantially lower during the majority of the year-round adult rearing period in the American River and in nearly half of the period (5 months) in the Feather River. Reduced flows in other rivers including the San Joaquin and Stanislaus rivers would not have biologically meaningful effects on largemouth bass. The percentages of months outside all temperature thresholds are generally lower under Alternative 2A than under the Existing Conditions. This impact is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this impact to a less-than-significant level would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this impact is significant and unavoidable because there is no feasible mitigation available.

The NEPA and CEQA conclusions differ for this impact statement because they were determined using two unique baselines. The NEPA conclusion was based on the comparison of A2A_LLT with NAA and the CEQA conclusion was based on the comparison of A2A_LLT with Existing Conditions. These baselines differ in two ways. First, the NAA includes the Fall X2 standard in wet above normal water years whereas the CEQA Existing Conditions do not. Second, the NAA is assumed to occur during the late long-term implementation period whereas the CEQA conclusion assumes existing climate conditions. Therefore, differences in model outputs between Existing Conditions and Alternative 2A are due primarily to both the alternative and future climate change.

Sacramento Tule Perch

In general, Alternative 2A would not affect the quality and quantity of upstream habitat conditions for Sacramento tule perch relative to NAA.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during year-round Sacramento tule perch presence. Lower flows could reduce the quantity and quality of instream habitat available for rearing.

In the Sacramento River upstream of Red Bluff, flows under A2A_LLT would generally be similar to or greater than flows under NAA during all months but August and November with some exceptions (up to 15% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT during August and November would be lower than flows under NAA (up to 25% and 17% lower depending on month, water year type, and time period).

In the Trinity River below Lewiston Reservoir, flows under A2A_LLT would generally be similar to or greater than flows under NAA with some exceptions (up to 12% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A2A_LLT would generally similar to or greater than NAA throughout the year, except in critical years during February and June (6% and 8% lower, respectively) and below normal years during March (6% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A2A_LLT would generally greater than those under NAA during February through June and October (up to 105% greater), similar during January, November, and December, and lower during July through September (up to 52% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A2A_LLT would generally be greater than flows under NAA during May and June (up to 24% greater), lower during July through September (up to 27% lower), and similar during the remaining months (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months exceeding water temperature thresholds of 72°F and 75°F for the year-round occurrence of all life stages of Sacramento tule perch was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures exceeding these thresholds could lead to reduced rearing habitat quantity and quality and increased stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers throughout the year.

In the Feather River below Thermalito Afterbay, the percentage of years under A2A_LLT exceeding the 72°F threshold would be higher than the percentage under NAA by 13% to 73% depending on water year type (Table 11-2A-102). Although relative differences in above normal, below normal, and critical years are large due to small values, the absolute differenced in percent exceedance are only 2% to 4%, respectively, and do not represent biologically meaningful effects to Sacramento tule perch.

The percentage of months under A2A_LLT exceeding the 75°F threshold would be similar to or lower than the percentage under NAA in all water year except wet and dry years (100% and 50% higher, respectively) (Table 11-2A-102). Although the relative differences in wet and dry years are large due to small values, the absolute differenced in percent exceedance are only 0.3% and 1%, respectively, and do not represent biologically meaningful effects to Sacramento tule perch.

Table 11-2A-102. Difference and Percent Difference in the Percentage of Months Year-Round in Which Water Temperatures in the Feather River below Thermalito Afterbay Exceed 72°F and 75°F Water Temperature Thresholds for Sacramento Tule Perch Occurrence[a]

Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
72°F Threshold		
Wet	5 (214%)	5 (73%)
Above Normal	2 (NA)	2 (67%)
Below Normal	7 (NA)	4 (58%)
Dry	12 (NA)	6 (56%)
Critical	13 (300%)	2 (13%)
All	8 (562%)	4 (49%)
75°F Threshold		
Wet	0.3 (NA)	0.3 (100%)
Above Normal	0 (NA)	0 (NA)
Below Normal	0 (NA)	0 (NA)
Dry	2 (NA)	1 (50%)
Critical	6 (900%)	0 (0%)
All	1 (1,400%)	0.3 (20%)

NA = could not be calculated because the denominator was 0.

[a] A negative value indicates a benefit (reduction in percentage of months outside suitable range) of the alternative.

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because Alternative 2A would not cause a substantial reduction in Sacramento tule perch rearing habitat. Flows under Alternative 2A in all rivers examined throughout the year are generally similar to or greater than flows under NAA, except during summer months in the Feather and American rivers. These reductions in flows, however, would not result in an overall biologically meaningful effect on

Sacramento tule perch. The percentages of months outside temperature thresholds under Alternative 2A are generally similar to the percentages under NAA.

CEQA Conclusion: In general, Alternative 2A would not affect the quality and quantity of upstream habitat conditions for Sacramento tule perch relative to the Existing Conditions.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during year-round Sacramento tule perch presence. Lower flows could reduce the quantity and quality of instream habitat available for rearing.

In the Sacramento River upstream of Red Bluff, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions during all months but August and November with some exceptions (up to 17% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT during August and November would be lower than flows under Existing Conditions (up to 24% lower and 13% lower, respectively).

In the Trinity River below Lewiston Reservoir, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions throughout the year with some exceptions (up to 58% lower), except during October and November when it would generally be lower (up to 25% for during both months) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions throughout the year, except in critical years during August through November (6% to 29% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A2A_LLT would generally be greater than those under Existing Conditions during March through June and September through October (up to 217% greater), lower during February, July through August, and November through December (up to 50% lower), and similar during January (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A2A_LLT would generally greater than flows under Existing Conditions during February, March, and June (up to 27% greater), lower during January, May, July through September, and November through December (up to 49% lower), and similar during April and October (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months exceeding water temperatures of 72°F and 75°F for the year-round occurrence of all life stages of Sacramento tule perch was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures exceeding these thresholds could lead to reduced rearing habitat quality and increased stress and mortality. Water temperatures were not modeled in Clear Creek or the San Joaquin River.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the year.

In the Feather River below Thermalito Afterbay, the percentage of months under A2A_LLT exceeding 72°F relative to the percentage under Existing Conditions would be similar to or higher, by up to 300% (Table 11-2A-102).

The percentage of months under A2A_LLT exceeding 75°F would be similar to the percentage under Existing Conditions in all water years except critical years (900% higher) (Table 11-2A-102).

Collectively, these results indicate that the impact would be significant because Alternative 2A would cause a substantial reduction in Sacramento tule perch habitat. Flows would be substantially lower during the majority of the year-round period in the American River and in half of the period in the Feather River. Flows in other rivers would not have biologically meaningful effects. The percentages of months above both temperature thresholds are generally lower under Alternative 2A than under the Existing Conditions. This impact is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this impact to a less-than-significant level would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this impact is significant and unavoidable because there is no feasible mitigation available.

The NEPA and CEQA conclusions differ for this impact statement because they were determined using two unique baselines. The NEPA conclusion was based on the comparison of A2A_LLT with NAA and the CEQA conclusion was based on the comparison of A2A_LLT with Existing Conditions. These baselines differ in two ways. First, the NAA includes the Fall X2 standard in wet above normal water years whereas the CEQA Existing Conditions do not. Second, the NAA baseline is assumed to occur during the late long-term implementation period whereas the CEQA conclusion assumes existing climate conditions. Therefore, differences in model outputs between Existing Conditions and Alternative 2A are due primarily to both the alternative and future climate change.

Sacramento-San Joaquin Roach

In general, Alternative 2A would not affect the quality and quantity of upstream habitat conditions for Sacramento-San Joaquin roach relative to NAA.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the year-round juvenile and adult Sacramento-San Joaquin roach rearing period. Lower flows could reduce the quantity and quality of instream habitat available for rearing.

In the Sacramento River upstream of Red Bluff, flows under A2A_LLT would generally be similar to or greater than flows under NAA during all months but August and November with some exceptions (up to 15% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT during August and November would be lower than flows under NAA (up to 25% and 17% lower depending on month, water year type, and time period).

In the Trinity River below Lewiston Reservoir, flows under A2A_LLT would generally be similar to or greater than flows under NAA with some exceptions (up to 12% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A2A_LLT would generally be similar to or greater than NAA throughout the year, except in critical years during February and June (6% and 8% lower, respectively) and below normal years during March (6% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A2A_LLT would generally be greater than those under NAA during February through June and October (up to 105% greater), similar during January, November, and December, and lower during July through September (up to 52% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A2A_LLT would be greater than flows under NAA during May and June (up to 24% greater), lower during July through September (up to 27% lower), and similar during the remaining months (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months above the 86°F water temperature threshold for year-round juvenile and adult Sacramento-San Joaquin roach rearing period was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Elevated water temperatures could lead to reduced rearing habitat quality and increased stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers throughout the year.

In the Feather River below Thermalito Afterbay, water temperatures would not exceed 86°F under NAA or A2A_LLT (Table 11-2A-103). As a result, there would be no difference in the percentage of months in which the 86°F water temperature threshold is exceeded between Alternative 2A and NAA.

Table 11-2A-103. Difference and Percent Difference in the Percentage of Months Year-Round in Which Water Temperatures in the Feather River below Thermalito Afterbay Exceed the 86°F Water Temperature Range for Sacramento-San Joaquin Roach Survival[a]

Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wet	0 (NA)	0 (NA)
Above Normal	0 (NA)	0 (NA)
Below Normal	0 (NA)	0 (NA)
Dry	0 (NA)	0 (NA)
Critical	0 (NA)	0 (NA)
All	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.
[a] A negative value indicates a benefit (reduction in months outside suitable range) of the alternative.

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because Alternative 2A would not cause a substantial reduction in spawning and juvenile and adult Sacramento-San Joaquin roach rearing habitat. Flows under Alternative 2A in all rivers examined throughout the year are generally similar to or greater than flows under NAA, except during summer months in the Feather and American rivers, although these reductions would not be biologically meaningful to the roach population. The percentage of months outside temperature thresholds are generally similar to or lower under Alternative 2A than under NAA.

CEQA Conclusion: In general, Alternative 2A would not affect the quality and quantity of upstream habitat conditions for Sacramento-San Joaquin Roach relative to the Existing Conditions.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the year-round juvenile and adult Sacramento-San Joaquin roach rearing period. Lower flows could reduce the quantity and quality of instream habitat available for rearing.

In the Sacramento River upstream of Red Bluff, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions during all months but August and November with some exceptions (up to 17% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT during August and November would be lower than flows under Existing Conditions (up to 24% lower and 13% lower, respectively).

In the Trinity River below Lewiston Reservoir, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions throughout the year with some exceptions (up to 58% lower), except during October and November when it would generally be lower (up to 25% lower during both months) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions throughout the year, except in critical years during August through November (6% to 29% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A2A_LLT would generally be greater than those under Existing Conditions during March through June and September through October (up to 217% greater), lower during February, July through August, and November through December (up to 50% lower), and similar during January (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A2A_LLT would generally greater than flows under Existing Conditions during February, March, and June (up to 27% greater), lower during January, May, July through September, and November through December (up to 49% lower), and similar during April and October (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months above the 86°F water temperature threshold for year-round juvenile and adult Sacramento-San Joaquin roach rearing period was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Elevated water temperatures could lead to reduced quantity and quality of adult rearing habitat and increased stress and mortality of rearing adults. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the April through November period.

In the Feather River below Thermalito Afterbay, water temperatures would not exceed 86°F water temperature threshold for Sacramento-San Joaquin roach occurrence under Existing Conditions or A2A_LLT (Table 11-2A-103). As a result, there would be no difference in the percentage of months in which the 86°F water temperature threshold is exceeded between Alternative 2A and the Existing Conditions.

Collectively, these results indicate that the impact would be significant because Alternative 2A would cause a substantial reduction in Sacramento-San Joaquin roach habitat. Flows would be substantially lower during the majority of the year-round juvenile and adult rearing period in the American River and in half of the period in the Feather River. Flows in other rivers would not have biologically meaningful effects. The percentages of months outside both temperature thresholds are generally lower under Alternative 2A than under the Existing Conditions. This impact is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this impact to a less-than-significant level would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this impact is significant and unavoidable because there is no feasible mitigation available.

The NEPA and CEQA conclusions differ for this impact statement because they were determined using two unique baselines. The NEPA conclusion was based on the comparison of A2A_LLT with NAA and the CEQA conclusion was based on the comparison of A2A_LLT with Existing Conditions.

These baselines differ in two ways. First, the NAA includes the Fall X2 standard in wet above normal water years whereas the CEQA Existing Conditions do not. Second, the NAA is assumed to occur during the late long-term implementation period whereas the CEQA conclusion assumes existing climate conditions. Therefore, differences in model outputs between the Existing Conditions and Alternative 2A are due primarily to both the alternative and future climate change.

Hardhead

In general, Alternative 2A would not affect the quality and quantity of upstream habitat conditions for hardhead relative to NAA.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the year-round juvenile and adult hardhead rearing period. Lower flows could reduce the quantity and quality of instream habitat available for juvenile and adult rearing.

In the Sacramento River upstream of Red Bluff, flows under A2A_LLT would generally be similar to or greater than flows under NAA during all months but August and November with some exceptions (up to 15% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT during August and November would be lower than flows under NAA (up to 25% and 17% lower depending on month, water year type, and time period).

In the Trinity River below Lewiston Reservoir, flows under A2A_LLT would generally be similar to or greater than flows under NAA with some exceptions (up to 12% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A2A_LLT would generally be similar to or greater than NAA throughout the year, except in critical years during February and June (6% and 8% lower, respectively) and below normal years during March (6% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A2A_LLT would generally be greater than those under NAA during February through June and October (up to 105% greater), similar during January, November, and December, and lower during July through September (up to 52% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A2A_LLT would generally be greater than flows under NAA during May and June (up to 24% greater), lower during July through September (up to 27% lower), and similar during the remaining months (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months outside of the 65°F to 82.4°F suitable water temperature range for juvenile and adult hardhead rearing was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced rearing habitat quality and increased stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers throughout the year.

In the Feather River below Thermalito Afterbay, the percentage of months under A2A_LLT outside the range would be similar to or lower than the percentage under NAA in all water year except below normal (9% higher) (Table 11-2A-104).

Table 11-2A-104. Difference and Percent Difference in the Percentage of Months Year-Round in Which Water Temperatures in the Feather River below Thermalito Afterbay Are outside the 65°F to 82.4°F Water Temperature Range for Juvenile and Adult Hardhead Occurrence[a]

Water Year Type	EXISTING CONDITIONS vs. A2A_LLT	NAA vs. A2A_LLT
Wet	-1 (-1%)	2 (3%)
Above Normal	-8 (-11%)	-4 (-6%)
Below Normal	-5 (-7%)	6 (9%)
Dry	-8 (-11%)	0 (-1%)
Critical	-6 (-8%)	1 (2%)
All	-5 (-7%)	1 (2%)

[a] A negative value indicates a benefit (reduction in percentage of months outside suitable range) of the alternative.

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because Alternative 2A would not cause a substantial reduction in spawning and juvenile and adult hardhead rearing. Flows under Alternative 2A in all rivers examined throughout the year are generally similar to or greater than flows under NAA, except during summer months in the Feather and American rivers. These reductions in flows, however, would not cause an overall biologically meaningful effect on hardhead. The percentages of months outside all temperature thresholds are generally lower under Alternative 2A than under NAA.

CEQA Conclusion: In general, Alternative 2A would not affect the quality and quantity of upstream habitat conditions for hardhead relative to the Existing Conditions.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the year-round juvenile and adult hardhead rearing period. Lower flows could reduce the quantity and quality of instream habitat available for juvenile and adult rearing.

In the Sacramento River upstream of Red Bluff, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions during all months but August and November with some exceptions (up to 17% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A2A_LLT during August and November would be lower than flows under Existing Conditions (up to 24% lower and 13% lower, respectively).

In the Trinity River below Lewiston Reservoir, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions throughout the year with some exceptions (up to 58% lower), except during October and November when it would generally be lower (up to 25% lower during both months) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A2A_LLT would generally be similar to or greater than flows under Existing Conditions throughout the year, except in critical years during August through November (6% to 29% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A2A_LLT would generally be greater than those under Existing Conditions during March through June and September through October (up to 217% greater), lower during February, July through August, and November through December (up to 50% lower), and similar during January (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A2A_LLT would generally greater than flows under Existing Conditions during February, March, and June (up to 27% greater), lower during January, May, July through September, and November through December (up to 49% lower), and similar during April and October (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months in which year-round in-stream temperatures would be outside of the 65°F to 82.4°F suitable water temperature range for juvenile and adult hardhead rearing was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced rearing habitat quality and increased stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under Alternative 2A would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the April through November period.

In the Feather River below Thermalito Afterbay, the percentage of months under A2A_LLT outside of the 65°F to 82.4°F water temperature range for juvenile and adult hardhead occurrence would be similar to or lower than the percentage under Existing Conditions in all water years (Table 11-2A-104).

Collectively, these results indicate that the impact would be significant because Alternative 2A would cause a substantial reduction in hardhead habitat. Flows would be substantially lower during the majority of the year-round juvenile and adult rearing period in the American River and in half of the period in the Feather River. Flows in other rivers would not have biologically meaningful effects on hardhead. The percentages of months outside both temperature thresholds are generally lower under Alternative 2A than under the Existing Conditions. This impact is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this impact to a less-than-significant level would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this impact is significant and unavoidable because there is no feasible mitigation available.

The NEPA and CEQA conclusions differ for this impact statement because they were determined using two unique baselines. The NEPA conclusion was based on the comparison of A2A_LLT with NAA and the CEQA conclusion was based on the comparison of A2A_LLT with Existing Conditions. These baselines differ in two ways. First, the NAA includes the Fall X2 standard in wet above normal water years whereas the CEQA Existing Conditions do not. Second, the NAA is assumed to occur during the late long-term implementation period whereas the CEQA conclusion assumes existing climate conditions. Therefore, differences in model outputs between the Existing Conditions and Alternative 2A are due primarily to both the alternative and future climate change.

California Bay Shrimp

NEPA Effects: The effect of water operations on rearing habitat of California bay shrimp under Alternative 2A would be similar to that described for Alternative 1A (see Alternative 1A, Impact AQUA-3). That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. These effects would not be adverse.

CEQA Conclusion: As described above the impacts on California bay shrimp rearing habitat would be less than significant.

Impact AQUA-204: Effects of Water Operations on Migration Conditions for Non-Covered Aquatic Species of Primary Management Concern

Also, see Alternative 1A, Impact AQUA-204 for additional background information relevant to non-covered species of primary management concern.

Striped Bass

Adult striped bass migrate up the Delta via the Sacramento River to reach suitable spawning habitat upstream. It is assumed that this migration period occurs around the same timing as spawning, from April through June.

NEPA Effects: Flows in the Sacramento River below the north Delta diversion facilities would be lower than NAA during the April through June period. Monthly flows on average would be 14–23% lower than NAA. Sacramento River flows are highly variable interannually, and striped bass are still able to migrate upstream the Sacramento River during lower flow years. The effect of reduced Sacramento flows under Alternative 2A would not be adverse.

CEQA Conclusion: Impacts would be as described immediately above and would be less than significant because the changes in flow (22–30% lower compared to Existing Conditions) would not interfere substantially with movement of spawning striped bass through the Delta. No mitigation would be required.

American Shad

Adult American shad migrate up the Delta to reach suitable spawning habitat upstream around March-May. American shad migrate up the Sacramento River while some shad spawn in the San Joaquin River basin. Flows in the Sacramento River below the north Delta diversion facilities would be lower than NAA during March–May. Monthly flows on average would be 18–25% less than NAA. Flows from the San Joaquin River at Vernalis would be unchanged. Sacramento River flows are highly variable interannually, and American shad are still able to migrate upstream the Sacramento River during lower flow years.

NEPA Effects: Overall, the impact to American shad migration habitat conditions would not be adverse under Alternative 2A.

CEQA Conclusion: Impacts would be as described immediately above and would be less than significant because the changes in flow (22–30% lower compared to Existing Conditions) would not interfere substantially with movement of American shad from the Delta to upstream spawning habitat. No mitigation would be required.

Threadfin Shad

NEPA Effects: Threadfin shad are semi-anadromous, moving between freshwater and brackish water habitats. Threadfin shad found in the Delta to not actively migrate upstream to spawn. Therefore, there is no effect on migration habitat conditions.

CEQA Conclusion: Impacts would be as described immediately above and would be less than significant because flow changes in the Delta under Alternative 2A would not alter movement patterns for threadfin shad. No mitigation would be required.

Largemouth Bass

NEPA Effects: Largemouth bass are non-migratory fish within the Delta. Therefore they do not use the Delta as migration habitat corridor. There would be no effect.

CEQA Conclusion: As described immediately above, flow changes under Alternative 2A would not affect largemouth movements within the Delta. No mitigation would be required.

Sacramento Tule Perch

NEPA Effects: Similar with largemouth bass, Sacramento tule perch are a non-migratory species and do not use the Delta as a migration corridor as they are a resident Delta species. There would be no effect.

CEQA Conclusion: As described immediately above, flow changes would not affect Sacramento tule perch movements within the Delta. No migration would be required.

Sacramento-San Joaquin Roach

NEPA Effects: For Sacramento-San Joaquin roach the overall flows and temperature in upstream rivers during migration to their spawning grounds would be similar to those described under Alternative 2A, Impact AQUA-202 for spawning. As described there, the flows would slightly improve the upstream conditions relative to NAA. These conditions would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of water operations on migration conditions for Sacramento-San Joaquin roach would not be significant and no mitigation is required.

Hardhead

NEPA Effects: For hardhead the overall flows and temperature in upstream rivers during migration to their spawning grounds would be similar to those described under Alternative 2A, Impact AQUA-202 for spawning. As described under Impact AQUA-202, the flows would slightly improve the upstream conditions relative to NAA. These conditions would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of water operations on migration conditions for hardhead would not be significant and no mitigation is required.

California Bay Shrimp

NEPA Effects: The effect of water operations on migration conditions of California bay shrimp under Alternative 2A would be similar to that described for Alternative 1A (see Alternative 1A, Impact AQUA-4). That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. As described under Alternative 1A, Impact AQUA-4 the effect would not be adverse.

CEQA Conclusion: As described above the impacts on California bay shrimp rearing habitat would be less than significant.

Restoration Measures (CM2, CM4–CM7, and CM10)

The effects of restoration measures under Alternative 2A would be similar for all non-covered species; therefore, the analysis below is combined for all non-covered species instead of analyzed by individual species.

Impact AQUA-205: Effects of Construction of Restoration Measures on Non-Covered Aquatic Species of Primary Management Concern

NEPA Effects: Refer to Impact AQUA-7 under delta smelt for a discussion of the effects of construction of restoration measures on non-covered species of primary management concern. That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. The potential effects of the construction of restoration measures under Alternative 2A would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-7). The effects would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of the construction of restoration measures would be less than significant.

Impact AQUA-206: Effects of Contaminants Associated with Restoration Measures on Non-Covered Aquatic Species of Primary Management Concern

NEPA Effects: Refer to Impact AQUA-8 under delta smelt a discussion of the effects of contaminants associated with restoration measures on non-covered species of primary management concern. That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. The potential effects of the construction of contaminants associated with restoration measures under Alternative 2A would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-8). The effects would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of the contaminants associated with restoration measures would be less than significant.

Impact AQUA-207: Effects of Restored Habitat Conditions on Non-Covered Aquatic Species of Primary Management Concern

Refer to Impact AQUA-9 under delta smelt a general discussion of the effects of restored habitat conditions on non-covered species of primary management concern. Although there are minor differences the effects are similar. That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. The potential effects of restored habitat conditions under Alternative 2A would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-8). In addition, see Alternative 1A, Impact AQUA-207 for a discussion of the different effects on non-covered species of primary management concern.

NEPA Effects: Overall, the effects range from slightly beneficial to beneficial.

CEQA Conclusion: As described immediately above, the impacts of restored habitat conditions would range from slightly beneficial to beneficial.

Impact AQUA-208: Effects of Methylmercury Management on Non-Covered Aquatic Species of Primary Management Concern (CM12)

NEPA Effects: Refer to Impact AQUA-10 under delta smelt for a discussion of the effects of methylmercury management on non-covered species of primary management concern. That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. The potential effects of methylmercury management under Alternative 2A would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-10). As described in detail under Alternative 1A, Impact AQUA-10. The effects would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of methylmercury management would be less than significant.

Impact AQUA-209: Effects of Invasive Aquatic Vegetation Management on Non-Covered Aquatic Species of Primary Management Concern (CM13)

Refer to Impact AQUA-11 under delta smelt a discussion of the effects of invasive aquatic vegetation management on non-covered species of primary management concern. That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. The potential effects of invasive aquatic vegetation management under Alternative 2A would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-11) except for predatory species (striped bass and largemouth bass) and Sacramento tule perch. Invasive aquatic vegetation provides hiding habitat for predatory fish which improves their hunting success. Sacramento tule perch also use the cover of aquatic plants in the Sacramento and San Joaquin rivers and in Suisun marsh. Consequently, reducing the amount of invasive aquatic habitat will negatively affect these predatory species and Sacramento tule perch. However, this control will not substantially reduce the ability of the predatory species to hunt and there will still be many other habitats in which the predatory species can successfully hunt and in which Sacramento tule perch will thrive.

NEPA Effects: The overall effect will not be adverse. Control of invasive aquatic vegetation would not occur within California bay shrimp habitat and there would be no effect on them.

CEQA Conclusion: Refer to Impact AQUA-11 under delta smelt a discussion of the effects of invasive aquatic vegetation management on non-covered species of primary management concern. There are minor differences and the effects are similar except for predatory species (striped bass and largemouth bass) and Sacramento tule perch. Invasive aquatic vegetation provides hiding habitat for predatory fish which improves their hunting success. Control of invasive aquatic vegetation would not occur within California bay shrimp habitat and there would be no effect on them. Sacramento tule perch use the cover of aquatic plants in the Sacramento and San Joaquin rivers and in Suisun marsh. Consequently, reducing the amount of invasive aquatic habitat will negatively affect the predatory species and Sacramento tule perch. However, this control will not substantially reduce the ability of the predatory species to hunt and there will still be many other habitats in which the predatory species can successfully hunt and in which Sacramento tule perch will thrive. Therefore the effect on them will not be significant and no mitigation is required.

Other Conservation Measures (CM12–CM19 and CM21)

The effects of other conservation measures under Alternative 2A would be similar for all non-covered species; therefore, the analysis below is combined for all non-covered species instead of analyzed by individual species.

Impact AQUA-210: Effects of Dissolved Oxygen Level Management on Non-Covered Aquatic Species of Primary Management Concern (CM14)

NEPA Effects: Refer to Impact AQUA-12 under delta smelt for a discussion of the effects of dissolved oxygen management on non-covered species of primary management concern. That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. The potential effects of dissolved oxygen management under Alternative 2A would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-12). For a detailed discussion, please see Alternative 1A, Impact AQUA-12. California bay shrimp do not occur in this habitat and there would be no effect on them. These effects would be beneficial.

CEQA Conclusion: As described immediately above, the impacts of oxygen level management would be beneficial.

Impact AQUA-211: Effects of Localized Reduction of Predatory Fish on Non-Covered Aquatic Species of Primary Management Concern (CM15)

NEPA Effects: Refer to Alternative 1A, Impact AQUA-13 under delta smelt a discussion of the effects of predatory fish (striped bass and largemouth bass) and predator management on non-predatory fish. That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. The purpose of predatory fish management is to reduce the numbers of predatory fish and to reduce their hunting success. This management will have negative effects on predatory fish. However, the numbers of predatory fish are high and the extent of the habitats in which they hunt is extensive. Therefore the effects of this management will not be adverse. California bay shrimp do not occur in these habitats and there would be no effect on them.

CEQA Conclusion: Refer to Alternative 1A, Impact AQUA-13 under delta smelt a discussion of the effects of predatory fish and predator management on non-predatory fish. The purpose of predatory fish management is to reduce the numbers of predatory fish and to reduce their hunting success. This management will have negative effects on predatory fish. However, the numbers of predatory fish are high and the extent of the habitats in which they hunt is extensive. Therefore the effects of this management will not be significant. No mitigation is required. California bay shrimp do not occur in these habitats and there would be no effect on them.

Impact AQUA-212: Effects of Nonphysical Fish Barriers on Non-Covered Aquatic Species of Primary Management Concern (CM16)

Refer to Impact AQUA-14 under delta smelt for a discussion of the effects of nonphysical fish barriers on non-covered species of primary management concern. That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. The potential effects of nonphysical fish barriers under Alternative 2A would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-14). For a detailed discussion, please see Alternative 1A, Impact AQUA-14. The effects would be similar except for Sacramento-San Joaquin roach, hardhead and Sacramento perch which are unlikely to be present in their vicinity.

NEPA Effects: California bay shrimp do not occur in these habitats and there would be no effect on them. The effects would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of nonphysical fish barriers would be less than significant.

Impact AQUA-213: Effects of Illegal Harvest Reduction on Non-Covered Aquatic Species of Primary Management Concern (CM17)

Refer to Impact AQUA-15 under delta smelt for a discussion of the effects of illegal harvest reduction on non-covered species of primary management concern. That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. The potential effects of illegal harvest reduction under Alternative 2A would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-15). For a detailed discussion, please see Alternative 1A, Impact AQUA-15.

NEPA Effects: California bay shrimp do not occur in these habitats and there would be no effect on them. The effects would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of illegal harvest reduction would be less than significant.

Impact AQUA-214: Effects of Conservation Hatcheries on Non-Covered Aquatic Species of Primary Management Concern (CM18)

NEPA Effects: Refer to Impact AQUA-16 under delta smelt for a discussion of the effects of conservation hatcheries on non-covered species of primary management concern. The potential effects of conservation hatcheries under Alternative 2A would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-16). For a detailed discussion, please see Alternative 1A, Impact AQUA-16. There would be no effect,

CEQA Conclusion: As described immediately above, conservation hatcheries would have not impact.

Impact AQUA-215: Effects of Urban Stormwater Treatment on Non-Covered Aquatic Species of Primary Management Concern (CM19)

NEPA Effects: Refer to Impact AQUA-17 under delta smelt for a discussion of the effects of stormwater treatment on non-covered species of primary management concern. That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. The potential effects of stormwater treatment under Alternative 2A would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-17). The effects would be beneficial.

CEQA Conclusion: As described immediately above, the impacts of stormwater management would be beneficial.

Impact AQUA-216: Effects of Removal/Relocation of Nonproject Diversions on Non-Covered Aquatic Species of Primary Management Concern (CM21)

Refer to Impact AQUA-18 under delta smelt for a discussion of the effects of removal/relocation of nonproject diversions on non-covered species of primary management concern. The potential effects of removal/relocation of nonproject diversions under Alternative 2A would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-18). That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species.

NEPA Effects: The effects would be similar except for Sacramento-San Joaquin roach, hardhead and Sacramento perch which are unlikely to be present near these diversions. California bay shrimp do not occur in these habitats and there would be no effect on them. The effects would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of removal/relocation of nonproject diversions would be less than significant.

Upstream Reservoirs

Impact AQUA-217: Effects of Water Operations on Reservoir Coldwater Fish Habitat

NEPA Effects: Similar to the description for Alternative 1A, this effect would not be adverse because coldwater fish habitat in the CVP and SWP upstream reservoirs under Alternative 2A would not be substantially reduced when compared to NAA.

CEQA Conclusion: Similar to the description for Alternative 1A, Alternative 2A would reduce the quantity of coldwater fish habitat in the CVP and SWP as shown in Table 11-1A-102. There would be a greater than 5% increase (5 years) for the reservoirs, which could result in a significant impact. These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 2A does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. As a result, the CEQA conclusion regarding Alternative 2A, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on coldwater habitat in upstream reservoirs. This impact is found to be less than significant and no mitigation is required.

11.3.4.6 Alternative 2B—Dual Conveyance with East Alignment and Five Intakes (15,000 cfs; Operational Scenario B)

Alternative 2B would include the same physical/structural water conveyance components, including a surface canal and eastern alignment, culvert and tunnel siphons, and bridges as Alternative 1B. Like Alternatives 1A and 1B, Alternative 2B would include five intake facilities on the Sacramento River. Intakes one through three would be in the same locations as Alternatives 1A and 1B, but the locations of the fourth and fifth intakes may be located 5 to 6 miles downstream of the intakes described in Alternative 1A. Also, the number of barge landings has not been determined. Overall, construction impacts associated with Alternative 2B would be the same as those described for Alternative 1B.

Currently, as an alternative to Intakes 1–5, intake locations 1, 2, 3, 6, and 7 are being considered. Selection of intake locations 6 and 7 would entail construction in the same region (north Delta) and would result in the same construction effects on fish species as discussed for Alternative 1A. This alternative would convey water from five fish-screened intakes between Clarksburg and Walnut Grove (Intakes 6 and 7, if selected, would be downstream of Sutter and Steamboat Sloughs) to a new Byron Tract Forebay adjacent to CCF. Construction effects for all fish species would be similar to those analyzed for Alternative 1A. Implementation of mitigation measures (described below) and environmental commitments (see Appendix 3B, *Environmental Commitments*) would reduce impacts as described under Alternative 1A.

Alternative 2B water conveyance operational criteria (Operational Scenario B) would be modified from those described for Alternative 1A, but the same as Alternative 2A. Like Alternatives 1A and 2A, the Alternative 2B facilities could convey up to 15,000 cfs from the north Delta. Operational Scenario B includes incorporation of Fall X2 guidelines, more restrictive south Delta OMR flows, and an operable barrier at the head of Old River (see Chapter 3, *Description of Alternatives*, Section 3.6.4.2, *North Delta and South Delta Water Conveyance Operational Criteria*). Operational Scenario B also includes north Delta diversion bypass flow criteria, south Delta export/inflow ratio, flow criteria over Fremont Weir into Yolo Bypass, Delta inflow and outflow criteria, DCC gate operations, Rio Vista minimum instream flow criteria, operations for Delta water quality and residence criteria, and water quality criteria for agricultural and municipal/industrial diversions.

CM2–CM22 would be implemented under this alternative, and these conservation measures would be identical to those under Alternative 1A. See Chapter 3, *Description of Alternatives*, for additional details on Alternative 2B.

Delta Smelt

Construction and Maintenance of CM1

Construction of Alternative 2B infrastructure would occur in the same area as described for Alternative 2A, as well as Alternative 1A, except for Intakes 6 and 7. Small numbers of delta smelt eggs, larvae, and adults could be present in the in-water construction areas in June and July (see Table 11-4). These construction and maintenance sites also occur entirely within designated delta smelt critical habitat.

Impact AQUA-1: Effects of Construction of Water Conveyance Facilities on Delta Smelt

NEPA Effects: The potential effects of construction of water conveyance facilities on delta smelt or designated critical habitat would be similar to those described under Alternative 1A, Impact AQUA-1. As concluded in Alternative 1A, Impact AQUA-1, the effect would not be adverse for delta smelt.

CEQA Conclusion: As described in Impact AQUA-1 under Alternative 1A for delta smelt, the impact of the construction of water conveyance facilities on delta smelt or critical habitat would not be significant except for construction noise associated with pile driving. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Alternative 1A, Impact AQUA-1.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Alternative 1A, Impact AQUA-1.

Impact AQUA-2: Effects of Maintenance of Water Conveyance Facilities on Delta Smelt

NEPA Effects: The potential effects of the maintenance of water conveyance facilities under Alternative 2B would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-2). As concluded under Alternative 1A, Impact AQUA-2, the impact would not be adverse for delta smelt.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-2 for delta smelt, the impact of the maintenance of water conveyance facilities on delta smelt would be less than significant and no mitigation is required.

Water Operations of CM1

While Operational Scenario B under Alternative 2B (and Alternative 2A) has slight differences from Operational Scenario A (see Alternative 2B introduction above), Alternative 2B has the same diversion and conveyance operations as Alternative 2A. As a result, there would be little or no differences between these alternatives in upstream of the Delta river flows or reservoir operations, Delta inflow, and hydrodynamics in the Delta. Because no substantial differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 2A (Impact AQUA-3 through AQUA-6), the fish effects described for these other alternatives also appropriately characterize effects under Alternative 2B.

The following impacts are those presented under Alternative 2A that are identical for Alternative 2B.

Impact AQUA-3: Effects of Water Operations on Entrainment of Delta Smelt

Impact AQUA-4: Effects of Water Operations on Spawning and Egg Incubation Habitat for Delta Smelt

Impact AQUA-5: Effects of Water Operations on Rearing Habitat for Delta Smelt

Impact AQUA-6: Effects of Water Operations on Migration Conditions for Delta Smelt

NEPA Effects: With the exception of Impact AQUA-5, the other impact mechanisms listed above, would not be adverse to delta smelt under Alternative 2B. This is the same conclusion as described in detail under Alternative 2A, and is based on the expected overall limited or slightly beneficial impacts. However, the overall effect of Impact AQUA-5 on delta smelt rearing habitat would remain adverse because there likely would still be a loss of suitable habitat even with BDCP restoration efforts (see Alternative 2A, AQUA-5 for details on expected effects).

CEQA Conclusion: The effects of three of the above listed impact mechanisms would be less than significant, or slightly beneficial to delta smelt, and no mitigation would be required. In addition, the effects of Impact AQUA-5 would also be considered less than significant, because it would not substantially reduce rearing habitat. Therefore, no mitigation would be required for any of the impact mechanisms listed above. Detailed discussions regarding these conclusions are presented in Alternative 1A.

Restoration and Conservation Measures

Alternative 2B has the same restoration and conservation measures as Alternative 1A. Because no substantial differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 1A, the effects of these restoration and conservation measures described for Alternative 1A (Impact AQUA-7 through AQUA-18) also appropriately characterize effects under Alternative 2B.

The following impacts are those presented under Alternative 1A that are identical for Alternative 2B.

Impact AQUA-7: Effects of Construction of Restoration Measures on Delta Smelt

Impact AQUA-8: Effects of Contaminants Associated with Restoration Measures on Delta Smelt

Impact AQUA-9: Effects of Restored Habitat Conditions on Delta Smelt

Impact AQUA-10: Effects of Methylmercury Management on Delta Smelt (CM12)

Impact AQUA-11: Effects of Invasive Aquatic Vegetation Management on Delta Smelt (CM13)

Impact AQUA-12: Effects of Dissolved Oxygen Level Management on Delta Smelt (CM14)

Impact AQUA-13: Effects of Localized Reduction of Predatory Fish on Delta Smelt (CM15)

Impact AQUA-14: Effects of Nonphysical Fish Barriers on Delta Smelt (CM16)

Impact AQUA-15: Effects of Illegal Harvest Reduction on Delta Smelt (CM17)

Impact AQUA-16: Effects of Conservation Hatcheries on Delta Smelt (CM18)

Impact AQUA-17: Effects of Urban Stormwater Treatment on Delta Smelt (CM19)

Impact AQUA-18: Effects of Removal/Relocation of Nonproject Diversions on Delta Smelt (CM21)

NEPA Effects: As described in Alternative 1A, none of these impact mechanisms (Impact AQUA-7 through AQUA-18) would be adverse to delta smelt, and most would be at least slightly beneficial. Specifically for AQUA-8, the effects of contaminants on delta smelt with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on delta smelt are uncertain.

CEQA Conclusion: All of the impact mechanisms listed above would be at least slightly beneficial, or less-than-significant effects, and no mitigation is required.

Longfin Smelt

The potential effects of construction and maintenance of water conveyance facilities, operations of water conveyance facilities, restoration measures and other conservation measures on longfin smelt would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 1A (Impact AQUA-19 and AQUA-20), the fish effects described for longfin smelt under Alternative 1A also appropriately characterize effects for longfin smelt under Alternative 2B.

The following impacts on longfin smelt are those presented under Alternatives 1A and 2A that are identical or very similar for Alternative 2B.

Construction and Maintenance of CM1

Impact AQUA-19: Effects of Construction of Water Conveyance Facilities on Longfin Smelt

Impact AQUA-20: Effects of Maintenance of Water Conveyance Facilities on Longfin Smelt

NEPA Effects: While maintenance activities would not be adverse to longfin smelt, construction activities could result in adverse effects from impact pile driving activities. The implementation of the avoidance and minimization measures included in Mitigation Measures AQUA-1a and AQUA-1b, would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality).

CEQA Conclusion: Similar to the discussion provided above for Alternatives 1A and 2A, most of these impact mechanisms listed above would be beneficial or less than significant, and no mitigation would be required. However, several mechanisms could result in significant effects. While Impact AQUA-19 could result in significant underwater noise effects from impact pile driving, implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of conveyance facility operations on longfin smelt would be similar to those described under Alternative 2A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 2A (Impact AQUA-21 and AQUA-22), the fish effects described for longfin smelt under Alternative 2A also appropriately characterize effects for longfin smelt under Alternative 2B.

Impact AQUA-21: Effects of Water Operations on Entrainment of Longfin Smelt

Impact AQUA-22: Effects of Water Operations on Spawning, Egg Incubation, and Rearing Habitat for Longfin Smelt

Impact AQUA-23: Effects of Water Operations on Rearing Habitat for Longfin Smelt

Impact AQUA-24: Effects of Water Operations on Migration Conditions for Longfin Smelt

NEPA Effects: As presented under Alternative 2A, the effects of Alternative 2A operations would be expected to result in 5–6% lower longfin smelt abundance compared to NAA, for all years combined. Longfin smelt may benefit from habitat restoration actions (*CM2 Yolo Bypass Fisheries Enhancement and CM4 Tidal Natural Communities Restoration*, which are intended to provide additional food production and export to longfin smelt rearing areas in Suisun Marsh, West Delta, and Cache Slough ROAs.

CEQA Conclusion: As presented under Alternative 2A, the effects of Alternative 2B operations would be less than significant for spawning and rearing conditions. The effects on longfin smelt from reduced entrainment and predation would be beneficial. No mitigation would be required.

Restoration and Conservation Measures

The potential effects of restoration measures and other conservation measures on longfin smelt would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 1A (Impact AQUA-25 through AQUA-36), the fish effects described for longfin smelt under Alternative 1A also appropriately characterize effects for longfin smelt under Alternative 2B.

Impact AQUA-25: Effects of Construction of Restoration Measures on Longfin Smelt

Impact AQUA-26: Effects of Contaminants Associated with Restoration Measures on Longfin Smelt

Impact AQUA-27: Effects of Restored Habitat Conditions on Longfin Smelt

Impact AQUA-28: Effects of Methylmercury Management on Longfin Smelt (CM12)

Impact AQUA-29: Effects of Invasive Aquatic Vegetation Management on Longfin Smelt (CM13)

Impact AQUA-30: Effects of Dissolved Oxygen Level Management on Longfin Smelt (CM14)

Impact AQUA-31: Effects of Localized Reduction of Predatory Fish on Longfin Smelt (CM15)

Impact AQUA-32: Effects of Nonphysical Fish Barriers on Longfin Smelt (CM16)

Impact AQUA-33: Effects of Illegal Harvest Reduction on Longfin Smelt (CM17)

Impact AQUA-34: Effects of Conservation Hatcheries on Longfin Smelt (CM18)

Impact AQUA-35: Effects of Urban Stormwater Treatment on Longfin Smelt (CM19)

Impact AQUA-36: Effects of Removal/Relocation of Nonproject Diversions on Longfin Smelt (CM21)

NEPA Effects: Similar to the discussion provided above for Alternative 1A, the impact mechanisms listed above would not be adverse to longfin smelt, and would typically be beneficial. Specifically for AQUA-26, the effects of contaminants on longfin smelt with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on longfin smelt are uncertain.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, the impact mechanisms listed above would be beneficial or less than significant, and no mitigation would be required.

Winter-Run Chinook Salmon

The potential effects of construction and maintenance of water conveyance facilities, operations of water conveyance facilities, restoration measures and other conservation measures on winter-run Chinook salmon would be similar to those described under Alternatives 1A and 2A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance activities on winter-run Chinook salmon would be similar to those described under Alternatives 1A and 2A, because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for these alternatives (Impact AQUA-37 and AQUA-38), the fish effects described for winter-run Chinook salmon under Alternative 1A also appropriately characterize effects under Alternative 2B.

Impact AQUA-37: Effects of Construction of Water Conveyance Facilities on Chinook Salmon (Winter-Run ESU)

Impact AQUA-38: Effects of Maintenance of Water Conveyance Facilities on Chinook Salmon (Winter-Run ESU)

NEPA Effects: These impact mechanisms would not be adverse to winter-run Chinook salmon. While construction activities (Impact AQUA-37) could result in adverse effects from impact pile driving activities, the implementation of Mitigation Measures AQUA-1a and AQUA-1b, would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality).

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A and 2A, Impact AQUA-37 could result in significant underwater noise effects from impact pile driving, although implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of operations of water conveyance facilities on winter-run Chinook salmon would be similar to those described for Alternative 2A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 2A (Impacts AQUA-39 through AQUA-42), the effects described for winter-run Chinook salmon also appropriately characterize the effects under Alternative 2B.

Impact AQUA-39: Effects of Water Operations on Entrainment of Chinook Salmon (Winter-Run ESU)

Impact AQUA-40: Effects of Water Operations on Spawning and Egg Incubation Habitat for Chinook Salmon (Winter-Run ESU)

Impact AQUA-41: Effects of Water Operations on Rearing Habitat for Chinook Salmon (Winter-Run ESU)

Impact AQUA-42: Effects of Water Operations on Migration Conditions for Chinook Salmon (Winter-Run ESU)

NEPA Effects: As discussed for Alternative 2A, the impact mechanisms listed above could be adverse to winter-run Chinook salmon under Alternative 2B. The effects could be adverse because of the potential to substantially reduce suitable spawning and rearing habitat, the number of fish as a result of egg mortality, and reduced migration conditions. These effects are the result of specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this effect to a level that is not adverse would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, these would be an unavoidable adverse effects because there is no feasible mitigation available. However, implementing Mitigation Measure AQUA-40a through AQUA-40c and AQUA-41a through AQUA-41c has the potential to reduce the severity of impact though not necessarily to a not adverse level.

CEQA Conclusion: As discussed in detail under Alternative 2A, the effects under Alternative 2B would be significant because it has the potential to substantially reduce suitable spawning habitat and, therefore, in adult spawner and redd carrying capacity, as well as substantially reducing the number of fish as a result of egg mortality and reducing rearing habitat. These impacts are a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this impact to a less-than-significant level would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this impact is significant and unavoidable because there is no feasible mitigation available. Even so, proposed below is mitigation that has the potential to reduce the severity of impact though not necessarily to a less-than-significant level.

Mitigation Measure AQUA-40a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Winter-Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Spawning Habitat

Please refer to Mitigation Measure AQUA-40a under Impact AQUA-40 of Alternative 2A.

Mitigation Measure AQUA-40b: Conduct Additional Evaluation and Modeling of Impacts on Winter-Run Chinook Salmon Spawning Habitat Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-40b under Impact AQUA-40 of Alternative 2A.

Mitigation Measure AQUA-40c: Consult with NMFS, USFWS, and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Winter-Run Chinook Salmon Spawning Habitat Consistent with CM1

Please refer to Mitigation Measure AQUA-40c under Impact AQUA-40 of Alternative 2A.

Mitigation Measure AQUA-41a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Winter-Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Rearing Habitat

Please refer to Mitigation Measure AQUA-41a under Impact AQUA-41 of Alternative 2A.

Mitigation Measure AQUA-41b: Conduct Additional Evaluation and Modeling of Impacts on Winter-Run Chinook Salmon Rearing Habitat Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-41b under Impact AQUA-41 of Alternative 2A.

Mitigation Measure AQUA-41c: Consult with NMFS, USFWS, and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Winter-Run Chinook Salmon Rearing Habitat Consistent with CM1

Please refer to Mitigation Measure AQUA-41c under Impact AQUA-41 of Alternative 2A.

Restoration and Conservation Measures

The potential effects of restoration measures and other conservation measures on winter-run Chinook salmon would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 1A (Impact AQUA-43 through AQUA-54), the effects described for winter-run Chinook salmon under Alternative 1A also appropriately characterize effects under Alternative 2B.

Impact AQUA-43: Effects of Construction of Restoration Measures on Chinook Salmon (Winter-Run ESU)

Impact AQUA-44: Effects of Contaminants Associated with Restoration Measures on Chinook Salmon (Winter-Run ESU)

Impact AQUA-45: Effects of Restored Habitat Conditions on Chinook Salmon (Winter-Run ESU)

Impact AQUA-46: Effects of Methylmercury Management on Chinook Salmon (Winter-Run ESU) (CM12)

Impact AQUA-47: Effects of Invasive Aquatic Vegetation Management on Chinook Salmon (Winter-Run ESU) (CM13)

Impact AQUA-48: Effects of Dissolved Oxygen Level Management on Chinook Salmon (Winter-Run ESU) (CM14)

Impact AQUA-49: Effects of Localized Reduction of Predatory Fish on Chinook Salmon (Winter-Run ESU) (CM15)

Impact AQUA-50: Effects of Nonphysical Fish Barriers on Chinook Salmon (Winter-Run ESU) (CM16)

Impact AQUA-51: Effects of Illegal Harvest Reduction on Chinook Salmon (Winter-Run ESU) (CM17)

Impact AQUA-52: Effects of Conservation Hatcheries on Chinook Salmon (Winter-Run ESU) (CM18)

Impact AQUA-53: Effects of Urban Stormwater Treatment on Chinook Salmon (Winter-Run ESU) (CM19)

Impact AQUA-54: Effects of Removal/Relocation of Nonproject Diversions on Chinook Salmon (Winter-Run ESU) (CM21)

NEPA Effects: As discussed in detail for Alternative 1A, the impact mechanisms listed above would not be adverse, and would typically be beneficial to winter-run Chinook salmon. Specifically for AQUA-44, the effects of contaminants on winter-run Chinook salmon with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on winter-run Chinook salmon are uncertain.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would be less than significant, or beneficial, so no additional mitigation would be required.

Spring-Run Chinook Salmon

The potential effects of construction and maintenance, operations of water conveyance facilities, restoration measures and other conservation measures on spring-run Chinook salmon would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance activities on spring-run Chinook salmon would be similar to those described under Alternatives 1A and 2A, because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 1A (Impact AQUA-55 through AQUA-56), the fish effects described for spring-run Chinook salmon under Alternative 1A also appropriately characterize effects for spring-run Chinook salmon under Alternative 2B

Impact AQUA-55: Effects of Construction of Water Conveyance Facilities on Chinook Salmon (Spring-Run ESU)

Impact AQUA-56: Effects of Maintenance of Water Conveyance Facilities on Chinook Salmon (Spring-Run ESU)

NEPA Effects: These impact mechanisms would not be adverse to spring-run Chinook salmon. While construction activities (Impact AQUA-55) could result in adverse effects from impact pile driving activities, the implementation of Mitigation Measures AQUA-1a and AQUA-1b, would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality).

CEQA Conclusion: Similar to the discussion provided above for Alternatives 1A and 2A, Impact AQUA-55 could result in significant underwater noise effects from impact pile driving, although implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of water conveyance facility operations on spring-run Chinook salmon would be similar to those described under Alternative 2A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B compared to Alternative 2A (Impact AQUA-57 through AQUA-60), the fish effects described for spring-run Chinook salmon under Alternatives 2A also appropriately characterize effects under Alternative 2B.

Impact AQUA-57: Effects of Water Operations on Entrainment of Chinook Salmon (Spring-Run ESU)

Impact AQUA-58: Effects of Water Operations on Spawning and Egg Incubation Habitat for Chinook Salmon (Spring-Run ESU)

Impact AQUA-59: Effects of Water Operations on Rearing Habitat for Chinook Salmon (Spring-Run ESU)

Impact AQUA-60: Effects of Water Operations on Migration Conditions for Chinook Salmon (Spring-Run ESU)

NEPA Effects: As discussed in detail for Alternative 2A, except for Impact AQUA-60, the impact mechanisms listed above would not be adverse to spring-run Chinook salmon under Alternative 2B. However, adverse effects would occur from Impact AQUA-60 because habitat and migration conditions for juvenile spring-run Chinook salmon would be substantially reduced, and because it has the potential to substantially increase predation and remove important instream habitat as the result of the presence of five north Delta intake structures. The implementation of conservation and mitigation measures would reduce the severity of effects, although not necessarily to a not adverse level.

CEQA Conclusion: Similar to the discussion provided above for Alternative 2A, three of the impact mechanisms listed above would be less than significant under Alternative 2B, so no additional mitigation would be required. However, Impact AQUA-60 would result in significant reductions in migration habitat conditions. In addition to the benefits provided by the implementation of CM6 and CM15, the mitigation measures identified below would provide an adaptive management process, for assessing impacts and developing appropriate minimization measures. This process may be implemented as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6). However, the overall effect of Impact AQUA-60 would still be considered significant and unavoidable.

Mitigation Measure AQUA-60a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Spring-Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Migration Conditions

Please refer to Mitigation Measure AQUA-60a under Alternative 1A (Impact AQUA-60) for spring-run Chinook salmon.

Mitigation Measure AQUA-60b: Conduct Additional Evaluation and Modeling of Impacts on Spring-Run Chinook Salmon Migration Conditions Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-60b under Alternative 1A (Impact AQUA-60) for spring-run Chinook salmon.

Mitigation Measure AQUA-60c: Consult with USFWS, and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Spring-Run Chinook Salmon Migration Conditions Consistent with CM1

Please refer to Mitigation Measure AQUA-60c under Alternative 1A (Impact AQUA-60) for spring-run Chinook salmon.

Restoration and Conservation Measures

The potential effects of restoration measures and other conservation measures on spring-run Chinook salmon would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 1A (Impact AQUA-61 through AQUA-72). Therefore, the effects on spring-run Chinook salmon under Alternative 1A also appropriately characterize effects for spring-run Chinook salmon under Alternative 2B.

Impact AQUA-61: Effects of Construction of Restoration Measures on Chinook Salmon (Spring-Run ESU)

Impact AQUA-62: Effects of Contaminants Associated with Restoration Measures on Chinook Salmon (Spring-Run ESU)

Impact AQUA-63: Effects of Restored Habitat Conditions on Chinook Salmon (Spring-Run ESU)

Impact AQUA-64: Effects of Methylmercury Management on Chinook Salmon (Spring-Run ESU) (CM12)

Impact AQUA-65: Effects of Invasive Aquatic Vegetation Management on Chinook Salmon (Spring-Run ESU) (CM13)

Impact AQUA-66: Effects of Dissolved Oxygen Level Management on Chinook Salmon (Spring-Run ESU) (CM14)

Impact AQUA-67: Effects of Localized Reduction of Predatory Fish on Chinook Salmon (Spring-Run ESU) (CM15)

Impact AQUA-68: Effects of Nonphysical Fish Barriers on Chinook Salmon (Spring-Run ESU) (CM16)

Impact AQUA-69: Effects of Illegal Harvest Reduction on Chinook Salmon (Spring-Run ESU) (CM17)

Impact AQUA-70: Effects of Conservation Hatcheries on Chinook Salmon (Spring-Run ESU) (CM18)

Impact AQUA-71: Effects of Urban Stormwater Treatment on Chinook Salmon (Spring-Run ESU) (CM19)

Impact AQUA-72: Effects of Removal/Relocation of Nonproject Diversions on Chinook Salmon (Spring-Run ESU) (CM21)

NEPA Effects: As discussed for Alternative 1A and 2A, with the implementation of environmental commitments and conservation measures (Impact AQUA-61 through AQUA-72), the effects would typically be beneficial to spring-run Chinook salmon. Specifically for AQUA-62, the effects of contaminants on spring-run Chinook salmon with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on spring-run Chinook salmon are uncertain.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A and 2A, the impact mechanisms listed above would be beneficial or less than significant, and no mitigation would be required.

Fall-/Late Fall–Run Chinook Salmon

The potential effects of construction and maintenance of water conveyance facilities, operations of water conveyance facilities, restoration measures and other conservation measures on fall- and late fall-run Chinook salmon would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance of water conveyance facilities on fall- and late fall-run Chinook salmon would be similar to those described under Alternative 1A because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 1A (Impact AQUA-73 through AQUA-74), the fish effects described for fall- and late fall-run Chinook salmon under Alternative 1A also appropriately characterize effects for fall- and late fall-run Chinook salmon under Alternative 2B.

Impact AQUA-73: Effects of Construction of Water Conveyance Facilities on Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-74: Effects of Maintenance of Water Conveyance Facilities on Chinook Salmon (Fall-/Late Fall–Run ESU)

NEPA Effects: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would not be adverse to fall- and late fall-run Chinook salmon. While construction activities (Impact AQUA-73) could result in adverse effects from impact pile driving activities, the implementation of Mitigation Measures AQUA-1a and AQUA-1b, would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality).

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, Impact AQUA-73 could result in significant underwater noise effects from impact pile driving, although implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of operations of water conveyance facilities on fall- and late fall-run Chinook salmon would be similar to those described for Alternative 2A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 2A (Impacts AQUA-75 through AQUA-78), the fish effects described for fall- and late fall-run Chinook salmon also appropriately characterize the effects for Alternative 2B.

Impact AQUA-75: Effects of Water Operations on Entrainment of Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-76: Effects of Water Operations on Spawning and Egg Incubation Habitat for Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-77: Effects of Water Operations on Rearing Habitat for Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-78: Effects of Water Operations on Migration Conditions for Chinook Salmon (Fall-/Late Fall–Run ESU)

NEPA Effects: Overall, the effects of water operations vary by location. Similar to effects described in detail under Alternative 2A, Alternative 2B would have an adverse effect on fall-/late fall-run Chinook salmon juvenile survival due to habitat and predation losses at the NDD intakes. Through-delta conditions on the Sacramento River would substantially affect migration conditions relative to NAA while through-Delta conditions on the San Joaquin River would be positive. However, upstream of the Delta, Alternative 2B conditions relative to NAA would not substantially affect migration conditions. The implementation of the conservation and mitigation measures listed below, would reduce the overall effects, but they would still likely remain adverse.

CEQA Conclusion: As described for Alternative 2A, the differences between the CEQA baseline and Alternative 2B vary, depending on location. Through-Delta conditions on the Sacramento River would substantially impact migration conditions relative to Existing Conditions while through-Delta conditions on the San Joaquin River would be positive relative to Existing Conditions. Upstream of the Delta conditions relative to Existing Conditions would be reduced although the impacts are related to climate change. Alternative 2B also has the potential to substantially increase predation and remove important instream habitat as the result of the presence of five NDD structures.

Implementation of *CM6 Channel Margin Enhancement* and *CM15 Localized Reduction of Predatory Fishes (Predator Control)* would address habitat and predation losses, therefore, would potentially minimize impacts to some extent but not to a less than significant level.

CM6 Channel Margin Enhancement. CM6 would entail restoration of 20 linear miles of channel margin by improving channel geometry and restoring riparian, marsh, and mudflat habitats on the waterside side of levees along channels that provide rearing and outmigration habitat for juvenile salmonids.

CM15 Localized Reduction of Predatory Fishes (Predator Control). CM15 would seek to reduce populations of predatory fishes at specific locations or modify holding habitat at selected locations of high predation risk (i.e., predation "hotspots"), including the NDD intakes. This conservation measure seeks to reduce mortality rates of juvenile migratory salmonids that are particularly vulnerable to predatory fishes. Because of uncertainties regarding treatment methods and efficacy, implementation of CM15 would involve discrete pilot projects and research actions coupled with an adaptive management and monitoring program to evaluate effectiveness.

As with the conservation measures, the implementation of the mitigation measures listed below also has the potential to reduce the severity of the impact though not necessarily to a less-than-significant level. These mitigation measures would provide an adaptive management process, that may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6), for assessing impacts and developing appropriate minimization measures.

Mitigation Measure AQUA-78a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Fall-/Late Fall–Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Migration Conditions

Please refer to Mitigation Measure AQUA-78a under Alternative 1A (Impact AQUA-78) for fall/late fall-run Chinook salmon.

Mitigation Measure AQUA-78b: Conduct Additional Evaluation and Modeling of Impacts on Fall-/Late Fall–Run Chinook Salmon Migration Conditions Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-78b under Alternative 1A (Impact AQUA-78) for fall/late fall-run Chinook salmon.

Mitigation Measure AQUA-78c: Consult with USFWS and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Fall-/Late Fall–Run Chinook Salmon Migration Conditions Consistent with CM1

Please refer to Mitigation Measure AQUA-78c under Alternative 1A (Impact AQUA-78) for fall/late fall-run Chinook salmon.

Restoration and Conservation Measures

The potential effects of restoration measures and other conservation measures on fall- and late fall-run Chinook salmon would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 1A (Impact AQUA-79 through AQUA-90), the fish effects under Alternative 1A also appropriately characterize effects for fall- and late fall-run Chinook salmon under Alternative 2B.

Impact AQUA-79: Effects of Construction of Restoration Measures on Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-80: Effects of Contaminants Associated with Restoration Measures on Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-81: Effects of Restored Habitat Conditions on Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-82: Effects of Methylmercury Management on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM12)

Impact AQUA-83: Effects of Invasive Aquatic Vegetation Management on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM13)

Impact AQUA-84: Effects of Dissolved Oxygen Level Management on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM14)

Impact AQUA-85: Effects of Localized Reduction of Predatory Fish on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM15)

Impact AQUA-86: Effects of Nonphysical Fish Barriers on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM16)

Impact AQUA-87: Effects of Illegal Harvest Reduction on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM17)

Impact AQUA-88: Effects of Conservation Hatcheries on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM18)

Impact AQUA-89: Effects of Urban Stormwater Treatment on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM19)

Impact AQUA-90: Effects of Removal/Relocation of Nonproject Diversions on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM21)

NEPA Effects: As discussed in detail for Alternative 1A, these restoration and conservation commitment impact mechanisms (Impact AQUA-79 through AQUA-90),would not be adverse, and would typically be beneficial to fall- and late fall-run Chinook salmon. Specifically for AQUA-80, the effects of contaminants on fall- and late fall-run Chinook salmon with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on fall- and late fall-run Chinook salmon are uncertain.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

Steelhead

The potential effects of construction and maintenance of water conveyance facilities, operations of water conveyance facilities, restoration measures and other conservation measures on steelhead would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance activities on steelhead would be similar to those described under Alternative 1A because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 1A (Impact AQUA-91 through AQUA-108), the fish effects described for steelhead under Alternative 1A also appropriately characterize effects for steelhead under Alternative 2B.

Impact AQUA-91: Effects of Construction of Water Conveyance Facilities on Steelhead

Impact AQUA-92: Effects of Maintenance of Water Conveyance Facilities on Steelhead

NEPA Effects: These impact mechanisms would typically not be adverse to steelhead. While construction activities (Impact AQUA-91) could result in adverse effects from impact pile driving activities, the implementation of Mitigation Measures AQUA-1a and AQUA-1b, would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality).

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, Impact AQUA-91 could result in significant underwater noise effects from impact pile driving, although implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of` water conveyance facility operations on steelhead would be similar to those described above under Alternative 2A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 2A (Impact AQUA-93 through AQUA-96), the fish effects described for steelhead under Alternative 2A also appropriately characterize effects under Alternative 2B.

Impact AQUA-93: Effects of Water Operations on Entrainment of Steelhead

Impact AQUA-94: Effects of Water Operations on Spawning and Egg Incubation Habitat for Steelhead

Impact AQUA-95: Effects of Water Operations on Rearing Habitat for Steelhead

Impact AQUA-96: Effects of Water Operations on Migration Conditions for Steelhead

NEPA Effects: As discussed in detail for Alternative 2A, the above listed impact mechanisms (Impact AQUA-93 through AQUA-96) flow reductions and temperature increases would affect the quantity and quality of juvenile rearing habitat and would contribute to reduced survival and increased stress, particularly in drier water years. This impact is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this impact would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. However, implementing Mitigation Measures AQUA-95a through AQUA-95c has the potential to reduce the severity of impact though not necessarily to a not adverse level.

CEQA Conclusion: Similar to the detailed discussion provided above for Alternative 2A, flow reductions and temperature increases would have a significant and unavoidable impact on the quantity and quality of juvenile rearing habitat and would contribute to reduced survival and increased stress, particularly in drier water years. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this impact to a less-than-significant level would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this impact is significant and unavoidable because there is no feasible mitigation available. Even so, proposed below is mitigation that has the potential to reduce the severity of impact though not necessarily to a less-than-significant level.

Mitigation Measure AQUA-95a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Steelhead to Determine Feasibility of Mitigation to Reduce Impacts to Rearing Habitat.

Please refer to Mitigation Measure AQUA-95a under Alternative 2A for winter-run Chinook salmon.

Mitigation Measure AQUA-95b: Conduct Additional Evaluation and Modeling of Impacts on Steelhead Rearing Habitat Following Initial Operations of CM1.

Please refer to Mitigation Measure AQUA-95b under Alternative 2A for winter-run Chinook salmon.

Mitigation Measure AQUA-95c: Consult with NMFS, USFWS and CDFW to Identify Potentially Feasible Means to Minimize Effects on Steelhead Habitat Consistent with CM1

Please refer to Mitigation Measure AQUA-95c under Alternative 2A for winter-run Chinook salmon.

Restoration and Conservation Measures

The potential effects of restoration measures and other conservation measures on steelhead would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B, compared to those described in detail for Alternative 1A (Impact AQUA-97 through AQUA-108), the fish effects described for steelhead also appropriately characterize the effects under Alternative 2B.

Impact AQUA-97: Effects of Construction of Restoration Measures on Steelhead

Impact AQUA-98: Effects of Contaminants Associated with Restoration Measures on Steelhead

Impact AQUA-99: Effects of Restored Habitat Conditions on Steelhead

Impact AQUA-100: Effects of Methylmercury Management on Steelhead (CM12)

Impact AQUA-101: Effects of Invasive Aquatic Vegetation Management on Steelhead (CM13)

Impact AQUA-102: Effects of Dissolved Oxygen Level Management on Steelhead (CM14)

Impact AQUA-103: Effects of Localized Reduction of Predatory Fish on Steelhead (CM15)

Impact AQUA-104: Effects of Nonphysical Fish Barriers on Steelhead (CM16)

Impact AQUA-105: Effects of Illegal Harvest Reduction on Steelhead (CM17)

Impact AQUA-106: Effects of Conservation Hatcheries on Steelhead (CM18)

Impact AQUA-107: Effects of Urban Stormwater Treatment on Steelhead (CM19)

Impact AQUA-108: Effects of Removal/Relocation of Nonproject Diversions on Steelhead (CM21)

NEPA Effects: As discussed in detail for Alternative 1A, these impact mechanisms would not be adverse, and would typically be beneficial to steelhead. Specifically for AQUA-98, the effects of contaminants on steelhead with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on steelhead are uncertain.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

Sacramento Splittail

The potential effects of construction and maintenance of water conveyance facilities, operations of water conveyance facilities, restoration measures and other conservation measures on Sacramento splittail would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance activities on Sacramento splittail would be similar to those described under Alternative 1A because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 1A (Impact AQUA-109 and AQUA-110), the fish effects described for Sacramento splittail under Alternative 1A also appropriately characterize effects for Sacramento splittail under Alternative 2B.

Impact AQUA-109: Effects of Construction of Water Conveyance Facilities on Sacramento Splittail

Impact AQUA-110: Effects of Maintenance of Water Conveyance Facilities on Sacramento Splittail

NEPA Effects: These impact mechanisms would generally not be adverse to Sacramento splittail. While construction activities (Impact AQUA-109) could result in adverse effects from impact pile driving activities, the implementation of Mitigation Measures AQUA-1a and AQUA-1b would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality).

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, Impact AQUA-109 could result in significant underwater noise effects from impact pile driving, although implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant. The effects of Impact AQUA-110 would be less than significant, so no additional mitigation would be required.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of water conveyance facility operations on Sacramento splittail would be similar to those described for Alternative 2A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B, compared to those described in detail for Alternative 2A (Impacts AQUA-111 through AQUA-114), the fish effects described would also appropriately characterize the effects under Alternative 2B.

Impact AQUA-111: Effects of Water Operations on Entrainment of Sacramento Splittail

Impact AQUA-112: Effects of Water Operations on Spawning and Egg Incubation Habitat for Sacramento Splittail

Impact AQUA-113: Effects of Water Operations on Rearing Habitat for Sacramento Splittail

Impact AQUA-114: Effects of Water Operations on Migration Conditions for Sacramento Splittail

NEPA Effects: As discussed in detail for Alternative 2A, the operations impact mechanisms would not be adverse to Sacramento splittail.

CEQA Conclusion: Similar to the discussion provided above for Alternative 2A, these impact mechanisms would be less than significant, and no mitigation would be required.

Restoration and Conservation Measures

The potential effects of restoration measures and other conservation measures on Sacramento splittail would be similar to those described for Alternative 2A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 2A (Impacts AQUA-115 through AQUA-126), the fish effects described also appropriately characterize the effects under Alternative 2B.

Impact AQUA-115: Effects of Construction of Restoration Measures on Sacramento Splittail

Impact AQUA-116: Effects of Contaminants Associated with Restoration Measures on Sacramento Splittail

Impact AQUA-117: Effects of Restored Habitat Conditions on Sacramento Splittail

Impact AQUA-118: Effects of Methylmercury Management on Sacramento Splittail (CM12)

Impact AQUA-119: Effects of Invasive Aquatic Vegetation Management on Sacramento Splittail (CM13)

Impact AQUA-120: Effects of Dissolved Oxygen Level Management on Sacramento Splittail (CM14)

Impact AQUA-121: Effects of Localized Reduction of Predatory Fish on Sacramento Splittail (CM15)

Impact AQUA-122: Effects of Nonphysical Fish Barriers on Sacramento Splittail (CM16)

Impact AQUA-123: Effects of Illegal Harvest Reduction on Sacramento Splittail (CM17)

Impact AQUA-124: Effects of Conservation Hatcheries on Sacramento Splittail (CM18)

Impact AQUA-125: Effects of Urban Stormwater Treatment on Sacramento Splittail (CM19)

Impact AQUA-126: Effects of Removal/Relocation of Nonproject Diversions on Sacramento Splittail (CM21)

NEPA Effects: As discussed in detail for Alternative 1A, the restoration and conservation measure impact mechanisms would not be adverse, and would typically be beneficial to Sacramento splittail. Specifically for AQUA-116, the effects of contaminants on Sacramento splittail with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on Sacramento splittail are uncertain.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, most of these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

Green Sturgeon

The potential effects of construction and maintenance of water conveyance facilities, operations of water conveyance facilities, restoration measures and other conservation measures on green sturgeon would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance activities on Sacramento splittail would be similar to those described under Alternative 1A because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 1A (Impact AQUA-127 and AQUA-128), the fish effects described for green sturgeon under Alternative 1A also appropriately characterize effects for green sturgeon under Alternative 2B.

Impact AQUA-127: Effects of Construction of Water Conveyance Facilities on Green Sturgeon

Impact AQUA-128: Effects of Maintenance of Water Conveyance Facilities on Green Sturgeon

NEPA Effects: While the maintenance impact mechanism (Impact AQUA-128) would not be adverse to green sturgeon, construction activities (Impact AQUA-127) could result in adverse effects from impact pile driving activities. However, the implementation of Mitigation Measures AQUA-1a and AQUA-1b, would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality).

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, Impact AQUA-127 could result in significant underwater noise effects from impact pile driving, although implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant. The other impact mechanism would be less than significant, so no additional mitigation would be required.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of operations of water conveyance facilities on green sturgeon would be similar to those described for Alternative 2A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 2A (Impacts AQUA-129 through AQUA-132), the fish effects described for green sturgeon also appropriately characterize the effects under Alternative 2B.

Impact AQUA-129: Effects of Water Operations on Entrainment of Green Sturgeon

Impact AQUA-130: Effects of Water Operations on Spawning and Egg Incubation Habitat for Green Sturgeon

Impact AQUA-131: Effects of Water Operations on Rearing Habitat for Green Sturgeon

Impact AQUA-132: Effects of Water Operations on Migration Conditions for Green Sturgeon

NEPA Effects: As discussed for Alternative 2A, the expected effects of Impact AQUA-130 and Impact AQUA-132 on green sturgeon spawning and migration habitat under Alternative 2B would be limited, although adverse effects would still be expected from Impact AQUA-132, because it has the potential to substantially interfere with the movement of green sturgeon. This effect is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this effect to a level that is not adverse would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. Therefore, this would be an unavoidable adverse effect because there is no feasible mitigation available, although the implementation of Mitigation Measures AQUA-132a through AQUA-132c, is expected to reduce the overall effects.

As discussed for Alternative 2A, the expected effects of Alternative 2B on green sturgeon entrainment and rearing habitat (Impact AQUA-129 and Impact AQUA-131) would not be adverse.

CEQA Conclusion: As discussed in detail for Alternative 2A, Impact AQUA-130 through AQUA-132 could result in significant, but unavoidable, effects on water temperature, and green sturgeon rearing and migration habitat conditions under Alternative 2B. These impacts are a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this impact to a less-than-significant level would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, these impacts are significant and unavoidable because there is no feasible mitigation available. Even so, proposed below is mitigation (Mitigation Measure 132a through 132c) that has the potential to reduce the severity of impact though not necessarily to a less-than-significant level.

Mitigation Measure AQUA-132a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Green Sturgeon to Determine Feasibility of Mitigation to Reduce Impacts to Migration Conditions

Please refer to Mitigation Measure AQUA-132a under Alternative 2A.

Mitigation Measure AQUA-132b: Conduct Additional Evaluation and Modeling of Impacts on Green Sturgeon Migration Conditions Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-132b under Alternative 2A.

Mitigation Measure AQUA-132c: Consult with NMFS, USFWS, and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Green Sturgeon Migration Conditions Consistent with CM1

Please refer to Mitigation Measure AQUA-132c under Alternative 2A.

Restoration and Conservation Measures

The potential effects of restoration measures and other conservation measures on green sturgeon would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 1A (Impact AQUA-133 through AQUA-144), the fish effects under Alternative 1A would appropriately characterize effects under Alternative 2B.

Impact AQUA-133: Effects of Construction of Restoration Measures on Green Sturgeon

Impact AQUA-134: Effects of Contaminants Associated with Restoration Measures on Green Sturgeon

Impact AQUA-135: Effects of Restored Habitat Conditions on Green Sturgeon

Impact AQUA-136: Effects of Methylmercury Management on Green Sturgeon (CM12)

Impact AQUA-137: Effects of Invasive Aquatic Vegetation Management on Green Sturgeon (CM13)

Impact AQUA-138: Effects of Dissolved Oxygen Level Management on Green Sturgeon (CM14)

Impact AQUA-139: Effects of Localized Reduction of Predatory Fish on Green Sturgeon (CM15)

Impact AQUA-140: Effects of Nonphysical Fish Barriers on Green Sturgeon (CM16)

Impact AQUA-141: Effects of Illegal Harvest Reduction on Green Sturgeon (CM17)

Impact AQUA-142: Effects of Conservation Hatcheries on Green Sturgeon (CM18)

Impact AQUA-143: Effects of Urban Stormwater Treatment on Green Sturgeon (CM19)

Impact AQUA-144: Effects of Removal/Relocation of Nonproject Diversions on Green Sturgeon (CM21)

NEPA Effects: Similar to the discussion provided above for Alternative 1A, the restoration and conservation measure impact mechanisms listed above would not be adverse, and would typically be beneficial to green sturgeon. Specifically for AQUA-134, the effects of contaminants on green sturgeon with respect to copper, ammonia and pesticides would not be adverse. The effects of methylmercury and selenium on green sturgeon are uncertain.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, the impact mechanisms related to restoration and conservation measures would be beneficial or less than significant, and no mitigation would be required.

White Sturgeon

The potential effects of construction and maintenance of water conveyance facilities, operations of water conveyance facilities, restoration measures and other conservation measures on white sturgeon would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance activities on white sturgeon would be similar to those described under Alternative 1A because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 1A (Impact AQUA-145 and AQUA-146), the fish effects described for white sturgeon under Alternative 1A also appropriately characterize effects under Alternative 2B.

Impact AQUA-145: Effects of Construction of Water Conveyance Facilities on White Sturgeon

Impact AQUA-146: Effects of Maintenance of Water Conveyance Facilities on White Sturgeon

NEPA Effects: These impact mechanisms would generally not be adverse to white sturgeon. However, construction activities (Impact AQUA-145) could result in adverse effects from impact pile driving activities, although the implementation of Mitigation Measures AQUA-1a and AQUA-1b would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality).

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, Impact AQUA-145 could result in significant underwater noise effects from impact pile driving, implementation of

Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of water conveyance operations on white sturgeon would be similar to those described for Alternative 2A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 2A, the effects described under Alternative 2A (Impacts AQUA-147 through AQUA-150) also appropriately characterize the effects for white sturgeon under Alternative 2B.

Impact AQUA-147: Effects of Water Operations on Entrainment of White Sturgeon

Impact AQUA-148: Effects of Water Operations on Spawning and Egg Incubation Habitat for White Sturgeon

Impact AQUA-149: Effects of Water Operations on Rearing Habitat for White Sturgeon

Impact AQUA-150: Effects of Water Operations on Migration Conditions for White Sturgeon

NEPA Effects: As discussed above under Alternative 2A, the impact mechanisms listed above would not be generally adverse for white sturgeon. However, there is a positive correlation between white sturgeon year class strength and river/Delta flow, such that changes in water operations could result in an adverse effect on white sturgeon migration conditions (Impact AQUA-150). While there is uncertainty regarding the particular responsible mechanisms, this uncertainty will be addressed through targeted research and monitoring conducted in the years leading up to the initiation of north Delta facilities operations. The results of these efforts would be used to determine if changes in flow under Alternative 2B are likely to result in adverse effects, as well as to guide an adaptive management process to minimize or avoid such effects.

CEQA Conclusion: With a few exceptions, these impact mechanisms listed above would be less than significant, and no mitigation would be required. As discussed for Impact AQUA-149 under Alternative 2A, if the expected operational effects are adjusted to exclude sea level rise and climate change, it would not in itself result in a significant impact on rearing habitat for white sturgeon. Therefore, this impact is less than significant and no mitigation is required. However, due to the uncertainty regarding effects of flow changes on migration conditions for white sturgeon (Impact AQUA-150), research and monitoring efforts and an associated adaptive management process is proposed. These efforts are expected to identify any significant effects and develop appropriate mitigation to reduce the effect to be less than significant.

Restoration and Conservation Measures

The potential effects of restoration measures and other conservation measures on white sturgeon would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 1A (Impact AQUA-151 through AQUA-162), the fish effects described under Alternative 1A appropriately characterize effects for white sturgeon under Alternative 2B.

Impact AQUA-151: Effects of Construction of Restoration Measures on White Sturgeon

Impact AQUA-152: Effects of Contaminants Associated with Restoration Measures on White Sturgeon

Impact AQUA-153: Effects of Restored Habitat Conditions on White Sturgeon

Impact AQUA-154: Effects of Methylmercury Management on White Sturgeon (CM12)

Impact AQUA-155: Effects of Invasive Aquatic Vegetation Management on White Sturgeon (CM13)

Impact AQUA-156: Effects of Dissolved Oxygen Level Management on White Sturgeon (CM14)

Impact AQUA-157: Effects of Localized Reduction of Predatory Fish on White Sturgeon (CM15)

Impact AQUA-158: Effects of Nonphysical Fish Barriers on White Sturgeon (CM16)

Impact AQUA-159: Effects of Illegal Harvest Reduction on White Sturgeon (CM17)

Impact AQUA-160: Effects of Conservation Hatcheries on White Sturgeon (CM18)

Impact AQUA-161: Effects of Urban Stormwater Treatment on White Sturgeon (CM19)

Impact AQUA-162: Effects of Removal/Relocation of Nonproject Diversions on White Sturgeon (CM21)

NEPA Effects: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would not be adverse to white sturgeon and would typically be beneficial. Specifically for AQUA-152, the effects of contaminants on white sturgeon with respect to copper, ammonia and pesticides would not be adverse. The effects of methylmercury and selenium on white sturgeon are uncertain.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

Pacific Lamprey

The potential effects of construction and maintenance of water conveyance facilities, operations of water conveyance facilities, restoration measures and other conservation measures on Pacific lamprey would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance activities on Pacific lamprey would be similar to those described under Alternative 1A because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 1A (Impact AQUA-163 and AQUA-164), the fish effects described for Pacific lamprey under Alternative 1A also appropriately characterize effects for Pacific lamprey under Alternative 2B.

Impact AQUA-163: Effects of Construction of Water Conveyance Facilities on Pacific Lamprey

Impact AQUA-164: Effects of Maintenance of Water Conveyance Facilities on Pacific Lamprey

NEPA Effects: While maintenance activities would generally not be adverse to Pacific lamprey, construction activities (Impact AQUA-163) could result in adverse effects from impact pile driving activities. However, the implementation of Mitigation Measures AQUA-1a and AQUA-1b would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality).

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A and 2A, Impact AQUA-163 could result in significant underwater noise effects from impact pile driving. However, implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of water conveyance operations on Pacific lamprey would be similar to those described under Alternative 2A (Impact AQUA-165 and AQUA-168). Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 2A, the fish effects described for Pacific lamprey under Alternative 2A also appropriately characterize effects for Pacific lamprey under Alternative 2B.

Impact AQUA-165: Effects of Water Operations on Entrainment of Pacific Lamprey

Impact AQUA-166: Effects of Water Operations on Spawning and Egg Incubation Habitat for Pacific Lamprey

Impact AQUA-167: Effects of Water Operations on Rearing Habitat for Pacific Lamprey

Impact AQUA-168: Effects of Water Operations on Migration Conditions for Pacific Lamprey

NEPA Effects: As discussed for Alternative 2A, these impact mechanisms would not be adverse.

CEQA Conclusion: Similar to the discussion provided above for 2A, these impact mechanisms would be less than significant, and no mitigation would be required. While analyses of Impact AQUA-166 and AQUA-167 indicate that the differences between Existing Conditions and Alternative 2A could be significant because of substantial reductions in suitable spawning and rearing habitat and increased egg mortality. However, these differences are generally due to climate change, sea level rise, and future demand, and not the alternative. The impacts of Alternative 2B would be similar, are would therefore be less than significant and no mitigation is required.

Restoration and Conservation Measures

The potential effects of restoration measures and other conservation measures on Pacific lamprey would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 1A (Impact AQUA-169 and through AQUA-180), the fish effects described for Pacific lamprey under Alternative 1A also appropriately characterize effects for Pacific lamprey under Alternative 2B.

Impact AQUA-169: Effects of Construction of Restoration Measures on Pacific Lamprey

Impact AQUA-170: Effects of Contaminants Associated with Restoration Measures on Pacific Lamprey

Impact AQUA-171: Effects of Restored Habitat Conditions on Pacific Lamprey

Impact AQUA-172: Effects of Methylmercury Management on Pacific Lamprey (CM12)

Impact AQUA-173: Effects of Invasive Aquatic Vegetation Management on Pacific Lamprey (CM13)

Impact AQUA-174: Effects of Dissolved Oxygen Level Management on Pacific Lamprey (CM14)

Impact AQUA-175: Effects of Localized Reduction of Predatory Fish on Pacific Lamprey (CM15)

Impact AQUA-176: Effects of Nonphysical Fish Barriers on Pacific Lamprey (CM16)

Impact AQUA-177: Effects of Illegal Harvest Reduction on Pacific Lamprey (CM17)

Impact AQUA-178: Effects of Conservation Hatcheries on Pacific Lamprey (CM18)

Impact AQUA-179: Effects of Urban Stormwater Treatment on Pacific Lamprey (CM19)

Impact AQUA-180: Effects of Removal/Relocation of Nonproject Diversions on Pacific Lamprey (CM21)

NEPA Effects: Similar to the discussion provided above for Alternative 1A these impact mechanisms would generally not be adverse, and would typically be beneficial to Pacific lamprey.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A and 2A, these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

River Lamprey

The potential effects of construction and maintenance of water conveyance facilities, operations of water conveyance facilities, restoration measures and other conservation measures on river lamprey would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance activities on river lamprey would be similar to those described under Alternative 1A because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 1A (Impact AQUA-181 and AQUA-182), the fish effects described for river lamprey under Alternative 1A also appropriately characterize effects for river lamprey under Alternative 2B.

Impact AQUA-181: Effects of Construction of Water Conveyance Facilities on River Lamprey

Impact AQUA-182: Effects of Maintenance of Water Conveyance Facilities on River Lamprey

NEPA Effects: While construction activities (Impact AQUA-181) could result in adverse effects from impact pile driving activities, the implementation of Mitigation Measures AQUA-1a and AQUA-1b would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality). Therefore, as discussed for Alternative 1A, these impact mechanisms would not be adverse to river lamprey.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, Impact AQUA-181 could result in significant underwater noise effects from impact pile driving, implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant. Therefore, the overall effects of these impact mechanisms would be less than significant, so no additional mitigation would be required.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of water conveyance facility operations on river lamprey would be similar to those described under Alternative 2A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 2A (Impact AQUA-183 through AQUA-186), the fish effects described for river lamprey under Alternative 2A also appropriately characterize effects for river lamprey under Alternative 2B.

Impact AQUA-183: Effects of Water Operations on Entrainment of River Lamprey

Impact AQUA-184: Effects of Water Operations on Spawning and Egg Incubation Habitat for River Lamprey

Impact AQUA-185: Effects of Water Operations on Rearing Habitat for River Lamprey

Impact AQUA-186: Effects of Water Operations on Migration Conditions for River Lamprey

NEPA Effects: As discussed for Alternative 2A, these impact mechanisms would not be adverse to river lamprey.

CEQA Conclusion: Similar to the discussion provided above for Alternative 2A for river lamprey, analyses of Impact AQUA-184, AQUA-185, and AQUA-186 indicate that the differences between Existing Conditions and Alternative 2A could be significant because of substantial reductions in suitable spawning, incubation, rearing, and migration conditions. However, these differences are generally due to climate change, sea level rise, and future water demands, and not the alternative. Thus, the effects of these impact mechanisms under Alternative 2B would be similar to those discussed under Alternative 2A, and therefore would be less than significant and no mitigation is required.

Restoration and Conservation Measures

The potential effects of restoration measures and other conservation measures on river lamprey would be similar to those described under Alternative 1A, as no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B (Impact AQUA-187 through AQUA-198), the fish effects described for river lamprey under Alternative 1A also appropriately characterize effects for river lamprey under Alternative 2B.

Impact AQUA-187: Effects of Construction of Restoration Measures on River Lamprey

Impact AQUA-188: Effects of Contaminants Associated with Restoration Measures on River Lamprey

Impact AQUA-189: Effects of Restored Habitat Conditions on River Lamprey

Impact AQUA-190: Effects of Methylmercury Management on River Lamprey (CM12)

Impact AQUA-191: Effects of Invasive Aquatic Vegetation Management on River Lamprey (CM13)

Impact AQUA-192: Effects of Dissolved Oxygen Level Management on River Lamprey (CM14)

Impact AQUA-193: Effects of Localized Reduction of Predatory Fish on River Lamprey (CM15)

Impact AQUA-194: Effects of Nonphysical Fish Barriers on River Lamprey (CM16)

Impact AQUA-195: Effects of Illegal Harvest Reduction on River Lamprey (CM17)

Impact AQUA-196: Effects of Conservation Hatcheries on River Lamprey (CM18)

Impact AQUA-197: Effects of Urban Stormwater Treatment on River Lamprey (CM19)

Impact AQUA-198: Effects of Removal/Relocation of Nonproject Diversions on River Lamprey (CM21)

NEPA Effects: As discussed for Alternative 1A, these restoration and conservation measure impact mechanisms would not be adverse, and would typically be beneficial to river lamprey.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

Non-Covered Aquatic Species of Primary Management Concern

The potential effects of construction and maintenance of water conveyance facilities, operations of water conveyance facilities, restoration measures and other conservation measures on non-covered species would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance activities on non-covered species would be similar to those described under Alternative 1A because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 1A (Impact AQUA-199 and AQUA-200), the fish effects described for non-covered aquatic species of primary management concern under Alternative 1A also appropriately characterize effects for non-covered aquatic species of primary management concern under Alternative 2B.

Impact AQUA-199: Effects of Construction of Water Conveyance Facilities on Non-Covered Aquatic Species of Primary Management Concern

Impact AQUA-200: Effects of Maintenance of Water Conveyance Facilities on Non-Covered Aquatic Species of Primary Management Concern

NEPA Effects: While construction activities (Impact AQUA-199) could result in adverse effects from impact pile driving activities, the implementation of Mitigation Measures AQUA-1a and AQUA-1b, would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality).

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, while Impact AQUA-199 could result in significant underwater noise effects from impact pile driving, implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant. The other impact mechanism would be less than significant, so no additional mitigation would be required.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of water conveyance facility operations on non-covered species would be similar to those described under Alternative 1A, as no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B (Impact AQUA-201 through AQUA-204). Therefore, effects discussed in detail under Alternative 1A also appropriately characterize effects for non-covered aquatic species of primary management concern under Alternative 2B.

Impact AQUA-201: Effects of Water Operations on Entrainment of Non-Covered Aquatic Species of Primary Management Concern

Impact AQUA-202: Effects of Water Operations on Spawning and Egg Incubation Habitat for Non-Covered Aquatic Species of Primary Management Concern

Impact AQUA-203: Effects of Water Operations on Rearing Habitat for Non-Covered Aquatic Species of Primary Management Concern

Impact AQUA-204: Effects of Water Operations on Migration Conditions for Non-Covered Aquatic Species of Primary Management Concern

NEPA Effects: As discussed for Alternative 2A, the expected effects of Impact AQUA-203 on rearing habitat for several non-covered fish species of primary management concern under Alternative 2B, would be reduced, but would not be adverse. These species are Sacramento tule perch, largemouth bass, hardhead and Sacramento-San Joaquin roach. The other impact mechanisms would not be adverse.

CEQA Conclusion: Similar to the discussion provided above for Alternative 2A, most of these impact mechanisms would be beneficial or less than significant, and no mitigation would be required. However, Impact AQUA-203 could result in significant, but unavoidable effects on rearing habitat conditions for several fish species of primary management concern. There are also no feasible mitigation measures available to mitigate for these impacts. The other impact mechanisms would be less than significant, so no additional mitigation would be required.

Restoration and Conservation Measures

The potential effects of restoration measures and other conservation measures on non-covered species would be similar to those described under Alternative 1A, as no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B (Impact AQUA-205 through AQUA-217). Therefore, the fish effects described for non-covered aquatic species of primary management concern under Alternative 1A also appropriately characterize effects for non-covered aquatic species of primary management concern under Alternative 2B.

Impact AQUA-205: Effects of Construction of Restoration Measures on Non-Covered Aquatic Species of Primary Management Concern

Impact AQUA-206: Effects of Contaminants Associated with Restoration Measures on Non-Covered Aquatic Species of Primary Management Concern

Impact AQUA-207: Effects of Restored Habitat Conditions on Non-Covered Aquatic Species of Primary Management Concern

Impact AQUA-208: Effects of Methylmercury Management on Non-Covered Aquatic Species of Primary Management Concern (CM12)

Impact AQUA-209: Effects of Invasive Aquatic Vegetation Management on Non-Covered Aquatic Species of Primary Management Concern (CM13)

Impact AQUA-210: Effects of Dissolved Oxygen Level Management on Non-Covered Aquatic Species of Primary Management Concern (CM14)

Impact AQUA-211: Effects of Localized Reduction of Predatory Fish on Non-Covered Aquatic Species of Primary Management Concern (CM15)

Impact AQUA-212: Effects of Nonphysical Fish Barriers on Non-Covered Aquatic Species of Primary Management Concern (CM16)

Impact AQUA-213: Effects of Illegal Harvest Reduction on Non-Covered Aquatic Species of Primary Management Concern (CM17)

Impact AQUA-214: Effects of Conservation Hatcheries on Non-Covered Aquatic Species of Primary Management Concern (CM18)

Impact AQUA-215: Effects of Urban Stormwater Treatment on Non-Covered Aquatic Species of Primary Management Concern (CM19)

Impact AQUA-216: Effects of Removal/Relocation of Nonproject Diversions on Non-Covered Aquatic Species of Primary Management Concern (CM21)

NEPA Effects: As discussed for Alternative 1A, these impact mechanisms would not be adverse to the non-covered species of primary management concern.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Upstream Reservoirs

Impact AQUA-217: Effects of Water Operations on Reservoir Coldwater Fish Habitat

NEPA Effects: Similar to the description for Alternative 2A, this effect would not be adverse because coldwater fish habitat in the CVP and SWP upstream reservoirs under Alternative 2B would not be substantially reduced when compared to NAA.

CEQA Conclusion: Similar to the description for Alternative 2A, Alternative 2B would reduce the quantity of coldwater fish habitat in the CVP and SWP. However, if adjusted to exclude sea level rise and climate change, similar to the NEPA conclusion, the effect would not in itself result in a significant impact on coldwater habitat in upstream reservoirs. Therefore, this impact is found to be less than significant and no mitigation is required.

11.3.4.7 Alternative 2C—Dual Conveyance with West Alignment and Intakes W1–W5 (15,000 cfs; Operational Scenario B)

Alternative 2C would have the same physical/structural water conveyance components and west alignment as Alternative 1C. Overall construction impacts from Alternative 2C would be similar to Alternative 1A but with additional in-water work such as culvert siphons and bridge crossings that are described under Alternative 1C. However, implementation of mitigation measures (described below) and environmental commitments (Appendix 3B, *Environmental Commitments)* would reduce impacts as described under Alternative 1A. Water supply and conveyance operations would follow the guidelines described for Alternative 2A (Operational Scenario B); consequently, the analysis under Alternative 2A is applicable to Alternative 2C.

CM2–CM22 would be implemented under this alternative, and these conservation measures would be identical to those under Alternative 1A. See Chapter 3, *Description of Alternatives*, for additional details on Alternative 2C.

Delta Smelt

Construction and Maintenance of CM1

Construction of Alternative 2C infrastructure would occur in the same general area as described for Alternative 1A, which includes designated delta smelt critical habitat. Small numbers of delta smelt eggs, larvae, and adults could be present in the in-water construction areas in June and July (see Table 11-4).

Impact AQUA-1: Effects of Construction of Water Conveyance Facilities on Delta Smelt

NEPA Effects: The potential effects of construction of water conveyance facilities on delta smelt or critical habitat would be similar to those described under Alternative 1A, Impact AQUA-1. As concluded in Alternative 1A, Impact AQUA-1, the effect would not be adverse for delta smelt.

CEQA Conclusion: As described in Impact AQUA-1 under Alternative 1A for delta smelt, the impact of the construction of water conveyance facilities on delta smelt or critical habitat would not be significant except for construction noise associated with pile driving. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Alternative 1A, Impact AQUA-1.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Alternative 1A, Impact AQUA-1.

Impact AQUA-2: Effects of Maintenance of Water Conveyance Facilities on Delta Smelt

NEPA Effects: The potential effects of the maintenance of water conveyance facilities under Alternative 2C would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-2). As concluded under Alternative 1A, Impact AQUA-2, the impact would not be adverse for delta smelt or critical habitat.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-2 for delta smelt, the impact of the maintenance of water conveyance facilities on delta smelt or critical habitat would be less than significant and no mitigation is required.

Water Operations of CM1

Operational Scenario B, under Alternative 2C, would be the same as for Alternative 2A. As a result, there would be no substantial differences between these two alternatives in upstream of the Delta river flows or reservoir operations, Delta inflow, and hydrodynamics in the Delta. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2C compared to those described in detail for Alternative 2A (Impact AQUA-3 through AQUA-6), the fish effects described for Alternative 2A also appropriately characterize effects under Alternative 2C.

The following impacts are those presented under Alternative 2A, which are identical for Alternative 2C.

Impact AQUA-3: Effects of Water Operations on Entrainment of Delta Smelt

Impact AQUA-4: Effects of Water Operations on Spawning and Egg Incubation Habitat for Delta Smelt

Impact AQUA-5: Effects of Water Operations on Rearing Habitat for Delta Smelt

Impact AQUA-6: Effects of Water Operations on Migration Conditions for Delta Smelt

NEPA Effects: With the exception of Impact AQUA-5, the other impact mechanisms listed above, would not be adverse to delta smelt under Alternative 2C. This is the same conclusion as described in detail under Alternatives 1A and 2A, and is based on the expected overall limited or slightly beneficial impacts. However, the overall effect of Impact AQUA-5 on delta smelt rearing habitat would remain adverse because there likely would still be a loss of suitable habitat even with BDCP restoration efforts (see Alternative 1A, AQUA-5 for details on expected effects), although the implementation of restoration and conservation measures may reduce these effects to some extent.

CEQA Conclusion: The effects of three of the above listed impact mechanisms would be less than significant, or slightly beneficial to delta smelt, and no mitigation would be required. The effects of Impact AQUA-5 would also be considered less than significant, because it would not substantially reduce rearing habitat. Therefore, no mitigation would be required for any of the impact mechanisms listed above. Detailed discussions regarding these conclusions are presented in Alternatives 1A and 2A.

Restoration and Conservation Measures

Alternative 2C has the same restoration and conservation measures as Alternative 1A. Because no substantial differences in fish effects are anticipated anywhere in the affected environment under

Alternative 2C compared to those described in detail for Alternative 1A, the effects described for Alternative 1A (Impact AQUA-7 through AQUA-18) also appropriately characterize effects under Alternative 2C.

The following impacts are those presented under Alternative 1A that are identical for Alternative 2C.

Impact AQUA-7: Effects of Construction of Restoration Measures on Delta Smelt

Impact AQUA-8: Effects of Contaminants Associated with Restoration Measures on Delta Smelt

Impact AQUA-9: Effects of Restored Habitat Conditions on Delta Smelt

Impact AQUA-10: Effects of Methylmercury Management on Delta Smelt (CM12)

Impact AQUA-11: Effects of Invasive Aquatic Vegetation Management on Delta Smelt (CM13)

Impact AQUA-12: Effects of Dissolved Oxygen Level Management on Delta Smelt (CM14)

Impact AQUA-13: Effects of Localized Reduction of Predatory Fish on Delta Smelt (CM15)

Impact AQUA-14: Effects of Nonphysical Fish Barriers on Delta Smelt (CM16)

Impact AQUA-15: Effects of Illegal Harvest Reduction on Delta Smelt (CM17)

Impact AQUA-16: Effects of Conservation Hatcheries on Delta Smelt (CM18)

Impact AQUA-17: Effects of Urban Stormwater Treatment on Delta Smelt (CM19)

Impact AQUA-18: Effects of Removal/Relocation of Nonproject Diversions on Delta Smelt (CM21)

NEPA Effects: As described in Alternative 1A, none of these impact mechanisms (Impact AQUA-7 through AQUA-18) would be adverse to delta smelt, and most would be at least slightly beneficial. Specifically for AQUA-8, the effects of contaminants on delta smelt with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on delta smelt are uncertain.

CEQA Conclusion: All of the impact mechanisms listed above would be at least slightly beneficial, or less than significant, and no mitigation is required.

Longfin Smelt

The potential effects of construction and maintenance of water conveyance facilities, operations of water conveyance facilities, restoration measures and other conservation measures on longfin smelt would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance activities on longfin smelt would be similar to those described under Alternative 1A because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2C compared to those described in detail for Alternative 1A (Impact AQUA-19 and AQUA-20), the effects described for longfin smelt under Alternative 1A also appropriately characterize effects for longfin smelt under Alternative 2C.

The following impacts on longfin smelt are those presented under Alternative 1A that are identical for Alternative 2C.

Impact AQUA-19: Effects of Construction of Water Conveyance Facilities on Longfin Smelt

Impact AQUA-20: Effects of Maintenance of Water Conveyance Facilities on Longfin Smelt

NEPA Effects: As discussed under Alternative 1A, the effects of construction activities (Impact AQUA-19) could result in adverse effects from impact pile driving activities, although implementation of Mitigation Measures AQUA-1a and AQUA-1b would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality).

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A and 2A, Impact AQUA-19 could result in significant underwater noise effects from impact pile driving, although implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of water conveyance facility operations on longfin smelt would be similar to those described under Alternative 2A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2C compared to those described in detail for Alternative 2A (Impact AQUA-21 through AQUA-24), the effects described for longfin smelt under Alternative 1A also appropriately characterize effects under Alternative 2C.

Impact AQUA-21: Effects of Water Operations on Entrainment of Longfin Smelt

Impact AQUA-22: Effects of Water Operations on Spawning, Egg Incubation, and Rearing Habitat for Longfin Smelt

Impact AQUA-23: Effects of Water Operations on Rearing Habitat for Longfin Smelt

Impact AQUA-24: Effects of Water Operations on Migration Conditions for Longfin Smelt

NEPA Effects: As presented under Alternative 2A, the effects of Alternative 2A operations would be expected to result in 5–6% lower longfin smelt abundance compared to NAA, for all years combined. Longfin smelt may benefit from habitat restoration actions (*CM2 Yolo Bypass Fisheries Enhancement* *and CM4 Tidal Natural Communities Restoration*, which are intended to provide additional food production and export to longfin smelt rearing areas in Suisun Marsh, West Delta, and Cache Slough ROAs.

CEQA Conclusion: As presented under Alternative 2A, the effects of Alternative 2C operations would be less than significant for spawning and rearing conditions. The effects on longfin smelt from reduced entrainment and predation would be beneficial. No mitigation would be required.

Restoration and Conservation Measures

The potential effects of restoration and other conservation measures on longfin smelt would be similar to those described under Alternative 2A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2C compared to those described in detail for Alternative 2A (Impact AQUA-25 and through AQUA-36), the effects described for longfin smelt under Alternative 2A also appropriately characterize effects under Alternative 2C.

Impact AQUA-25: Effects of Construction of Restoration Measures on Longfin Smelt

Impact AQUA-26: Effects of Contaminants Associated with Restoration Measures on Longfin Smelt

Impact AQUA-27: Effects of Restored Habitat Conditions on Longfin Smelt

Impact AQUA-28: Effects of Methylmercury Management on Longfin Smelt (CM12)

Impact AQUA-29: Effects of Invasive Aquatic Vegetation Management on Longfin Smelt (CM13)

Impact AQUA-30: Effects of Dissolved Oxygen Level Management on Longfin Smelt (CM14)

Impact AQUA-31: Effects of Localized Reduction of Predatory Fish on Longfin Smelt (CM15)

Impact AQUA-32: Effects of Nonphysical Fish Barriers on Longfin Smelt (CM16)

Impact AQUA-33: Effects of Illegal Harvest Reduction on Longfin Smelt (CM17)

Impact AQUA-34: Effects of Conservation Hatcheries on Longfin Smelt (CM18)

Impact AQUA-35: Effects of Urban Stormwater Treatment on Longfin Smelt (CM19)

Impact AQUA-36: Effects of Removal/Relocation of Nonproject Diversions on Longfin Smelt (CM21)

NEPA Effects: As discussed under Alternative 1A and 2A, the effects of these impact mechanisms would not be adverse to longfin smelt, and would typically be beneficial. Specifically for AQUA-26, the effects of contaminants on longfin smelt with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on longfin smelt are uncertain.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

Winter-Run Chinook Salmon

The potential effects of construction and maintenance of water conveyance facilities, operations of water conveyance facilities, restoration measures and other conservation measures on winter-run Chinook salmon would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance activities on winter-run Chinook salmon because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2C compared to those described in detail for Alternative 1A (Impact AQUA-37 and AQUA-38), the effects described for winter-run Chinook salmon under Alternative 1A also appropriately characterize effects under Alternative 2C.

Impact AQUA-37: Effects of Construction of Water Conveyance Facilities on Chinook Salmon (Winter-Run ESU)

Impact AQUA-38: Effects of Maintenance of Water Conveyance Facilities on Chinook Salmon (Winter-Run ESU)

NEPA Effects: These impact mechanisms would not be adverse to winter-run Chinook salmon. While construction activities (Impact AQUA-37) could result in adverse effects from impact pile driving activities, the implementation of Mitigation Measures AQUA-1a and AQUA-1b, would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality).

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, Impact AQUA-37 could result in significant underwater noise effects from impact pile driving, although implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of water conveyance facility operations on winter-run Chinook salmon would be similar to those described under Alternative 2A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2C compared to those described in detail for Alternative 2A (Impact AQUA-39 and through AQUA-42), the effects on winter-run Chinook salmon described for Alternative 2A, also appropriately characterize effects under Alternative 2C.

Impact AQUA-39: Effects of Water Operations on Entrainment of Chinook Salmon (Winter-Run ESU)

Impact AQUA-40: Effects of Water Operations on Spawning and Egg Incubation Habitat for Chinook Salmon (Winter-Run ESU)

Impact AQUA-41: Effects of Water Operations on Rearing Habitat for Chinook Salmon (Winter-Run ESU)

Impact AQUA-42: Effects of Water Operations on Migration Conditions for Chinook Salmon (Winter-Run ESU)

NEPA Effects: As discussed for Alternative 2A, the impact mechanisms listed above could be adverse to winter-run Chinook salmon under Alternative 2C. The effects could be adverse because of the potential to substantially reduce suitable spawning and rearing habitat, the number of fish as a result of egg mortality, as well as overall migration conditions. These effects are a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this effect to a level that is not adverse would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this would be an unavoidable adverse effect because there is no feasible mitigation available. However, implementing Mitigation Measure AQUA-40a through AQUA-40c and AQUA-41a through AQUA-41c has the potential to reduce the severity of impact though not necessarily to a not adverse level.

CEQA Conclusion: As discussed in detail under Alternative 2A, the effects under Alternative 2C would be significant because it has the potential to substantially reduce suitable spawning and rearing habitat, reduce the number of fish as a result of egg mortality, and reducing the overall migration habitat conditions. These effects are a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this impact to a less-than-significant level would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this impact is significant and unavoidable because there is no feasible mitigation available. Even so, proposed below is mitigation that has the potential to reduce the severity of impact though not necessarily to a less-than-significant level.

Mitigation Measure AQUA-40a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Winter-Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Spawning Habitat

Please refer to Mitigation Measure AQUA-40a under Impact AQUA-40 of Alternative 2A.

Mitigation Measure AQUA-40b: Conduct Additional Evaluation and Modeling of Impacts on Winter-Run Chinook Salmon Spawning Habitat Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-40b under Impact AQUA-40 of Alternative 2A.

Mitigation Measure AQUA-40c: Consult with NMFS, USFWS, and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Winter-Run Chinook Salmon Spawning Habitat Consistent with CM1

Please refer to Mitigation Measure AQUA-40c under Impact AQUA-40 of Alternative 2A.

Mitigation Measure AQUA-41a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Winter-Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Rearing Habitat

Please refer to Mitigation Measure AQUA-41a under Impact AQUA-41 of Alternative 2A.

Mitigation Measure AQUA-41b: Conduct Additional Evaluation and Modeling of Impacts on Winter-Run Chinook Salmon Rearing Habitat Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-41b under Impact AQUA-41 of Alternative 2A.

Mitigation Measure AQUA-41c: Consult with NMFS, USFWS, and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Winter-Run Chinook Salmon Rearing Habitat Consistent with CM1

Please refer to Mitigation Measure AQUA-41c under Impact AQUA-41 of Alternative 2A.

Restoration and Conservation Measures

The potential effects of restoration measures and other conservation measures on winter-run Chinook salmon would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 1A (Impact AQUA-43 through AQUA-54), the effects described for winter-run Chinook salmon under Alternative 1A also appropriately characterize effects under Alternative 2C.

Impact AQUA-43: Effects of Construction of Restoration Measures on Chinook Salmon (Winter-Run ESU)

Impact AQUA-44: Effects of Contaminants Associated with Restoration Measures on Chinook Salmon (Winter-Run ESU)

Impact AQUA-45: Effects of Restored Habitat Conditions on Chinook Salmon (Winter-Run ESU)

Impact AQUA-46: Effects of Methylmercury Management on Chinook Salmon (Winter-Run ESU) (CM12)

Impact AQUA-47: Effects of Invasive Aquatic Vegetation Management on Chinook Salmon (Winter-Run ESU) (CM13)

Impact AQUA-48: Effects of Dissolved Oxygen Level Management on Chinook Salmon (Winter-Run ESU) (CM14)

Impact AQUA-49: Effects of Localized Reduction of Predatory Fish on Chinook Salmon (Winter-Run ESU) (CM15)

Impact AQUA-50: Effects of Nonphysical Fish Barriers on Chinook Salmon (Winter-Run ESU) (CM16)

Impact AQUA-51: Effects of Illegal Harvest Reduction on Chinook Salmon (Winter-Run ESU) (CM17)

Impact AQUA-52: Effects of Conservation Hatcheries on Chinook Salmon (Winter-Run ESU) (CM18)

Impact AQUA-53: Effects of Urban Stormwater Treatment on Chinook Salmon (Winter-Run ESU) (CM19)

Impact AQUA-54: Effects of Removal/Relocation of Nonproject Diversions on Chinook Salmon (Winter-Run ESU) (CM21)

NEPA Effects: As discussed for Alternative 1A and 2A, the restoration and conservation measure impact mechanisms would not be adverse, and would typically be beneficial to winter-run Chinook salmon. Specifically for AQUA-44, the effects of contaminants on winter-run Chinook salmon with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on winter-run Chinook salmon are uncertain.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A and 2A, these restoration and conservation measure impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

Spring-Run Chinook Salmon

The potential effects of construction and maintenance of water conveyance facilities, operations of water conveyance facilities, restoration measures and other conservation measures on spring-run Chinook salmon would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance activities on spring-run Chinook salmon would be similar to those described under Alternative 1A because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2C compared to those described in detail for Alternative 1A (Impact AQUA-55 and AQUA-56), the effects described for spring-run Chinook salmon under Alternative 1A also appropriately characterize effects under Alternative 2C.

Impact AQUA-55: Effects of Construction of Water Conveyance Facilities on Chinook Salmon (Spring-Run ESU)

Impact AQUA-56: Effects of Maintenance of Water Conveyance Facilities on Chinook Salmon (Spring-Run ESU)

NEPA Effects: These impact mechanisms would not be adverse to spring-run Chinook salmon. While construction activities (Impact AQUA-55) could result in adverse effects from impact pile driving activities, the implementation of Mitigation Measures AQUA-1a and AQUA-1b, would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality).

CEQA Conclusion: Similar to the discussion provided above for Alternatives 1A and 2A, Impact AQUA-55 could result in significant underwater noise effects from impact pile driving, although implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of water conveyance facility operations on spring-run Chinook salmon would be similar to those described under Alternative 2A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2C compared to Alternative 2A (Impact AQUA-57 through AQUA-60), the fish effects described for spring-run Chinook salmon under Alternatives 2A also appropriately characterize effects under Alternative 2C.

Impact AQUA-57: Effects of Water Operations on Entrainment of Chinook Salmon (Spring-Run ESU)

Impact AQUA-58: Effects of Water Operations on Spawning and Egg Incubation Habitat for Chinook Salmon (Spring-Run ESU)

Impact AQUA-59: Effects of Water Operations on Rearing Habitat for Chinook Salmon (Spring-Run ESU)

Impact AQUA-60: Effects of Water Operations on Migration Conditions for Chinook Salmon (Spring-Run ESU)

NEPA Effects: As discussed in detail for Alternative 2A, except for Impact AQUA-60, the impact mechanisms listed above would not be adverse to spring-run Chinook salmon under Alternative 2C. However, adverse effects would occur from Impact AQUA-60 because habitat and migration conditions for juvenile spring-run Chinook salmon would be substantially reduced, and because it has the potential to substantially increase predation and remove important instream habitat as the result of the presence of five north Delta intake structures. The implementation of conservation and mitigation measures would reduce the severity of effects, although not necessarily to a not adverse level.

CEQA Conclusion: Similar to the discussion provided above for Alternative 2A, three of the impact mechanisms listed above would be less than significant under Alternative 2C, so no additional mitigation would be required. However, Impact AQUA-60 would result in significant reductions in migration habitat conditions. In addition to the benefits provided by the implementation of CM6 and CM15, the mitigation measures identified below would provide an adaptive management process, for assessing impacts and developing appropriate minimization measures. This process may be implemented as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6). However, the overall effect of Impact AQUA-60 would still be considered significant and unavoidable.

Mitigation Measure AQUA-60a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Spring-Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Migration Conditions

Please refer to Mitigation Measure AQUA-60a under Alternative 1A (Impact AQUA-60) for spring-run Chinook salmon.

Mitigation Measure AQUA-60b: Conduct Additional Evaluation and Modeling of Impacts on Spring-Run Chinook Salmon Migration Conditions Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-60b under Alternative 1A (Impact AQUA-60) for spring-run Chinook salmon.

Mitigation Measure AQUA-60c: Consult with USFWS, and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Spring-Run Chinook Salmon Migration Conditions Consistent with CM1

Please refer to Mitigation Measure AQUA-60c under Alternative 1A (Impact AQUA-60) for spring-run Chinook salmon.

Restoration and Conservation Measures

The potential effects of restoration measures and other conservation measures on spring-run Chinook salmon would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2C, compared to those described in detail for Alternative 1A (Impact AQUA-61 through AQUA-72). Therefore, the effects on spring-run Chinook salmon under Alternative 1A also appropriately characterize effects for spring-run Chinook salmon under Alternative 2C.

Impact AQUA-61: Effects of Construction of Restoration Measures on Chinook Salmon (Spring-Run ESU)

Impact AQUA-62: Effects of Contaminants Associated with Restoration Measures on Chinook Salmon (Spring-Run ESU)

Impact AQUA-63: Effects of Restored Habitat Conditions on Chinook Salmon (Spring-Run ESU)

Impact AQUA-64: Effects of Methylmercury Management on Chinook Salmon (Spring-Run ESU) (CM12)

Impact AQUA-65: Effects of Invasive Aquatic Vegetation Management on Chinook Salmon (Spring-Run ESU) (CM13)

Impact AQUA-66: Effects of Dissolved Oxygen Level Management on Chinook Salmon (Spring-Run ESU) (CM14)

Impact AQUA-67: Effects of Localized Reduction of Predatory Fish on Chinook Salmon (Spring-Run ESU) (CM15)

Impact AQUA-68: Effects of Nonphysical Fish Barriers on Chinook Salmon (Spring-Run ESU) (CM16)

Impact AQUA-69: Effects of Illegal Harvest Reduction on Chinook Salmon (Spring-Run ESU) (CM17)

Impact AQUA-70: Effects of Conservation Hatcheries on Chinook Salmon (Spring-Run ESU) (CM18)

Impact AQUA-71: Effects of Urban Stormwater Treatment on Chinook Salmon (Spring-Run ESU) (CM19)

Impact AQUA-72: Effects of Removal/Relocation of Nonproject Diversions on Chinook Salmon (Spring-Run ESU) (CM21)

NEPA Effects: As discussed for Alternative 1A and 2A, with the implementation of environmental commitments and conservation measures (Impact AQUA-61 through AQUA-72), the effects would typically be beneficial to spring-run Chinook salmon. Specifically for AQUA-62, the effects of contaminants on spring-run Chinook salmon with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on spring-run Chinook salmon are uncertain.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A and 2A, these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

Fall-/Late Fall–Run Chinook Salmon

The potential effects of construction and maintenance of water conveyance facilities, operations of water conveyance facilities, restoration measures and other conservation measures on fall- and late fall-run Chinook salmon would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance activities on fall- and late fall-run Chinook salmon would be similar to those described under Alternative 1A because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2C compared to those described in detail for Alternative 1A (Impact AQUA-73 through AQUA-74), the effects described for fall- and late fall-run Chinook salmon under Alternative 1A also appropriately characterize effects under Alternative 2C.

Impact AQUA-73: Effects of Construction of Water Conveyance Facilities on Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-74: Effects of Maintenance of Water Conveyance Facilities on Chinook Salmon (Fall-/Late Fall–Run ESU)

NEPA Effects: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would not be adverse to fall- and late fall-run Chinook salmon. While construction activities (Impact

AQUA-73) could result in adverse effects from impact pile driving activities, the implementation of Mitigation Measures AQUA-1a and AQUA-1b, would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality).

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, Impact AQUA-73 could result in significant underwater noise effects from impact pile driving, although implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of operations of water conveyance facilities on fall- and late fall-run Chinook salmon would be similar to those described for Alternative 2A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2C compared to those described in detail for Alternative 2A (Impacts AQUA-75 through AQUA-78), the fish effects described for fall- and late fall-run Chinook salmon also appropriately characterize the effects for Alternative 2C.

Impact AQUA-75: Effects of Water Operations on Entrainment of Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-76: Effects of Water Operations on Spawning and Egg Incubation Habitat for Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-77: Effects of Water Operations on Rearing Habitat for Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-78: Effects of Water Operations on Migration Conditions for Chinook Salmon (Fall-/Late Fall–Run ESU)

NEPA Effects: Overall, the effects of water operations vary by location. Similar to effects described in detail under Alternative 2A, Alternative 2C would have an adverse effect on fall-/late fall-run Chinook salmon juvenile survival due to habitat and predation losses at the NDD intakes. Through-delta conditions on the Sacramento River would substantially affect migration conditions relative to NAA while through-Delta conditions on the San Joaquin River would be positive. However, upstream of the Delta, Alternative 2C conditions relative to NAA would not substantially affect migration conditions. The implementation of the conservation and mitigation measures listed below, would reduce the overall effects, but they would still likely remain adverse.

CEQA Conclusion: As described for Alternative 2A, the differences between the CEQA baseline and Alternative 2C vary, depending on location. Through-Delta conditions on the Sacramento River would substantially impact migration conditions relative to Existing Conditions while through-Delta conditions on the San Joaquin River would be positive relative to Existing Conditions. Upstream of the Delta conditions relative to Existing Conditions would be reduced although the impacts are related to climate change. Alternative 2C also has the potential to substantially increase predation and remove important instream habitat as the result of the presence of five NDD structures.

Implementation of *CM6 Channel Margin Enhancement* and *CM15 Localized Reduction of Predatory Fishes (Predator Control)* would address habitat and predation losses, therefore, would potentially minimize impacts to some extent but not to a less than significant level.

CM6 Channel Margin Enhancement. CM6 would entail restoration of 20 linear miles of channel margin by improving channel geometry and restoring riparian, marsh, and mudflat habitats on the waterside side of levees along channels that provide rearing and outmigration habitat for juvenile salmonids.

CM15 Localized Reduction of Predatory Fishes (Predator Control). CM15 would seek to reduce populations of predatory fishes at specific locations or modify holding habitat at selected locations of high predation risk (i.e., predation “hotspots”), including the NDD intakes. This conservation measure seeks to reduce mortality rates of juvenile migratory salmonids that are particularly vulnerable to predatory fishes. Because of uncertainties regarding treatment methods and efficacy, implementation of CM15 would involve discrete pilot projects and research actions coupled with an adaptive management and monitoring program to evaluate effectiveness.

As with the conservation measures, the implementation of the mitigation measures listed below also has the potential to reduce the severity of the impact though not necessarily to a less-than-significant level. These mitigation measures would provide an adaptive management process, that may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6), for assessing impacts and developing appropriate minimization measures.

Mitigation Measure AQUA-78a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Fall-/Late Fall–Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Migration Conditions

Please refer to Mitigation Measure AQUA-78a under Alternative 1A (Impact AQUA-78) for fall/late fall-run Chinook salmon.

Mitigation Measure AQUA-78b: Conduct Additional Evaluation and Modeling of Impacts on Fall-/Late Fall–Run Chinook Salmon Migration Conditions Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-78b under Alternative 1A (Impact AQUA-78) for fall/late fall-run Chinook salmon.

Mitigation Measure AQUA-78c: Consult with USFWS and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Fall-/Late Fall–Run Chinook Salmon Migration Conditions Consistent with CM1

Please refer to Mitigation Measure AQUA-78c under Alternative 1A (Impact AQUA-78) for fall/late fall-run Chinook salmon.

Restoration and Conservation Measures

The potential effects of restoration measures and other conservation measures on fall- and late fall-run Chinook salmon would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2C compared to those described in detail for Alternative 1A (Impact AQUA-79 through AQUA-90), the fish effects under Alternative 1A also appropriately characterize effects for fall- and late fall-run Chinook salmon under Alternative 2C.

Impact AQUA-79: Effects of Construction of Restoration Measures on Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-80: Effects of Contaminants Associated with Restoration Measures on Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-81: Effects of Restored Habitat Conditions on Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-82: Effects of Methylmercury Management on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM12)

Impact AQUA-83: Effects of Invasive Aquatic Vegetation Management on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM13)

Impact AQUA-84: Effects of Dissolved Oxygen Level Management on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM14)

Impact AQUA-85: Effects of Localized Reduction of Predatory Fish on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM15)

Impact AQUA-86: Effects of Nonphysical Fish Barriers on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM16)

Impact AQUA-87: Effects of Illegal Harvest Reduction on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM17)

Impact AQUA-88: Effects of Conservation Hatcheries on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM18)

Impact AQUA-89: Effects of Urban Stormwater Treatment on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM19)

Impact AQUA-90: Effects of Removal/Relocation of Nonproject Diversions on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM21)

NEPA Effects: As discussed in detail for Alternative 1A, these restoration and conservation commitment impact mechanisms (Impact AQUA-79 through AQUA-90) would not be adverse, and would typically be beneficial to fall- and late fall-run Chinook salmon. Specifically for AQUA-80, the effects of contaminants on fall- and late fall-run Chinook salmon with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on fall- and late fall-run Chinook salmon are uncertain.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A and 2A, these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

Steelhead

The potential effects of construction and maintenance of water conveyance facilities, operations of water conveyance facilities, restoration measures and other conservation measures on steelhead would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance activities on steelhead would be similar to those described under Alternative 1A because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2C compared to those described in detail for Alternative 1A (Impact AQUA-91 through AQUA-108), the fish effects described for steelhead under Alternative 1A also appropriately characterize effects for steelhead under Alternative 2C.

Impact AQUA-91: Effects of Construction of Water Conveyance Facilities on Steelhead

Impact AQUA-92: Effects of Maintenance of Water Conveyance Facilities on Steelhead

NEPA Effects: These impact mechanisms would typically not be adverse to steelhead. While construction activities (Impact AQUA-91) could result in adverse effects from impact pile driving activities, the implementation of Mitigation Measures AQUA-1a and AQUA-1b, would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality).

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, Impact AQUA-91 could result in significant underwater noise effects from impact pile driving, although implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of` water conveyance facility operations on steelhead would be similar to those described above under Alternative 2A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2C compared to those described in detail for Alternative 2A (Impact AQUA-93 through AQUA-96), the effects described for steelhead under Alternative 2A also appropriately characterize effects under Alternative 2C.

Impact AQUA-93: Effects of Water Operations on Entrainment of Steelhead

Impact AQUA-94: Effects of Water Operations on Spawning and Egg Incubation Habitat for Steelhead

Impact AQUA-95: Effects of Water Operations on Rearing Habitat for Steelhead

Impact AQUA-96: Effects of Water Operations on Migration Conditions for Steelhead

NEPA Effects: As discussed in detail for Alternative 2A for the above listed impact mechanisms (Impact AQUA-93 through AQUA-96) flow reductions and temperature increases under Alternative 2C would affect the quantity and quality of juvenile rearing habitat and would contribute to reduced survival and increased stress. This impact is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this impact would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. However, implementing Mitigation Measures AQUA-95a through AQUA-95c has the potential to reduce the severity of impact though not necessarily to a not adverse level.

CEQA Conclusion: Similar to the detailed discussion provided above for Alternative 2A, flow reductions and temperature increases would have a significant and unavoidable impact on the quantity and quality of juvenile rearing habitat and would contribute to reduced survival and increased stress. Applying mitigation to reduce this impact to a less-than-significant level would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this impact is significant and unavoidable because there is no feasible mitigation available. Even so, proposed below is mitigation that has the potential to reduce the severity of impact though not necessarily to a less-than-significant level.

Mitigation Measure AQUA-95a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Steelhead to Determine Feasibility of Mitigation to Reduce Impacts to Rearing Habitat.

Please refer to Mitigation Measure AQUA-95a under Alternative 2A for winter-run Chinook salmon.

Mitigation Measure AQUA-95b: Conduct Additional Evaluation and Modeling of Impacts on Steelhead Rearing Habitat Following Initial Operations of CM1.

Please refer to Mitigation Measure AQUA-95b under Alternative 2A for winter-run Chinook salmon.

Mitigation Measure AQUA-95c: Consult with NMFS, USFWS and CDFW to Identify Potentially Feasible Means to Minimize Effects on Steelhead Habitat Consistent with CM1

Please refer to Mitigation Measure AQUA-95c under Alternative 2A for winter-run Chinook salmon.

Restoration and Conservation Measures

The potential effects of restoration measures and other conservation measures on steelhead would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2C, compared to those described in detail for Alternative 1A (Impact AQUA-97 through AQUA-108), the effects described for steelhead also appropriately characterize the effects under Alternative 2C.

Impact AQUA-97: Effects of Construction of Restoration Measures on Steelhead

Impact AQUA-98: Effects of Contaminants Associated with Restoration Measures on Steelhead

Impact AQUA-99: Effects of Restored Habitat Conditions on Steelhead

Impact AQUA-100: Effects of Methylmercury Management on Steelhead (CM12)

Impact AQUA-101: Effects of Invasive Aquatic Vegetation Management on Steelhead (CM13)

Impact AQUA-102: Effects of Dissolved Oxygen Level Management on Steelhead (CM14)

Impact AQUA-103: Effects of Localized Reduction of Predatory Fish on Steelhead (CM15)

Impact AQUA-104: Effects of Nonphysical Fish Barriers on Steelhead (CM16)

Impact AQUA-105: Effects of Illegal Harvest Reduction on Steelhead (CM17)

Impact AQUA-106: Effects of Conservation Hatcheries on Steelhead (CM18)

Impact AQUA-107: Effects of Urban Stormwater Treatment on Steelhead (CM19)

Impact AQUA-108: Effects of Removal/Relocation of Nonproject Diversions on Steelhead (CM21)

NEPA Effects: As discussed in detail for Alternative 1A and 2A, these impact mechanisms would not be adverse, and would typically be beneficial to steelhead. Specifically for AQUA-98, the effects of contaminants on steelhead with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on steelhead are uncertain.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A and 2A, these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

Sacramento Splittail

The potential effects of construction and maintenance of water conveyance facilities, operations of water conveyance facilities, restoration measures and other conservation measures on Sacramento splittail would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance activities on Sacramento splittail would be similar to those described under Alternative 1A because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2C compared to those described in detail for Alternative 1A (Impact AQUA-109 and AQUA-110), the fish effects described for Sacramento splittail under Alternative 1A also appropriately characterize effects for Sacramento splittail under Alternative 2C.

Impact AQUA-109: Effects of Construction of Water Conveyance Facilities on Sacramento Splittail

Impact AQUA-110: Effects of Maintenance of Water Conveyance Facilities on Sacramento Splittail

NEPA Effects: These impact mechanisms would generally not be adverse to Sacramento splittail. While construction activities (Impact AQUA-109) could result in adverse effects from impact pile driving activities, the implementation of Mitigation Measures AQUA-1a and AQUA-1b would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality).

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, Impact AQUA-109 could result in significant underwater noise effects from impact pile driving, although implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant. The effects of Impact AQUA-110 would be less than significant, so no additional mitigation would be required.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of water conveyance facility operations on Sacramento splittail would be similar to those described for Alternative 2A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2C, compared to those described in detail for Alternative 2A (Impacts AQUA-111 through AQUA-114), the fish effects described would also appropriately characterize the effects under Alternative 2C.

Impact AQUA-111: Effects of Water Operations on Entrainment of Sacramento Splittail

Impact AQUA-112: Effects of Water Operations on Spawning and Egg Incubation Habitat for Sacramento Splittail

Impact AQUA-113: Effects of Water Operations on Rearing Habitat for Sacramento Splittail

Impact AQUA-114: Effects of Water Operations on Migration Conditions for Sacramento Splittail

NEPA Effects: As discussed in detail for Alternative 2A, the operations impact mechanisms would not be adverse to Sacramento splittail.

CEQA Conclusion: Similar to the discussion provided above for Alternative 2A, these impact mechanisms would be less than significant, and no mitigation would be required.

Restoration and Conservation Measures

The potential effects of restoration measures and other conservation measures on Sacramento splittail would be similar to those described for Alternative 2A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2C compared to those described in detail for Alternative 2A (Impacts AQUA-115 through AQUA-126), the fish effects described also appropriately characterize the effects under Alternative 2C.

Impact AQUA-115: Effects of Construction of Restoration Measures on Sacramento Splittail

Impact AQUA-116: Effects of Contaminants Associated with Restoration Measures on Sacramento Splittail

Impact AQUA-117: Effects of Restored Habitat Conditions on Sacramento Splittail

Impact AQUA-118: Effects of Methylmercury Management on Sacramento Splittail (CM12)

Impact AQUA-119: Effects of Invasive Aquatic Vegetation Management on Sacramento Splittail (CM13)

Impact AQUA-120: Effects of Dissolved Oxygen Level Management on Sacramento Splittail (CM14)

Impact AQUA-121: Effects of Localized Reduction of Predatory Fish on Sacramento Splittail (CM15)

Impact AQUA-122: Effects of Nonphysical Fish Barriers on Sacramento Splittail (CM16)

Impact AQUA-123: Effects of Illegal Harvest Reduction on Sacramento Splittail (CM17)

Impact AQUA-124: Effects of Conservation Hatcheries on Sacramento Splittail (CM18)

Impact AQUA-125: Effects of Urban Stormwater Treatment on Sacramento Splittail (CM19)

Impact AQUA-126: Effects of Removal/Relocation of Nonproject Diversions on Sacramento Splittail (CM21)

NEPA Effects: As discussed in detail for Alternative 1A and 2A, the restoration and conservation measure impact mechanisms would not be adverse, and would typically be beneficial to Sacramento splittail. Specifically for AQUA-116, the effects of contaminants on Sacramento splittail with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on Sacramento splittail are uncertain.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A and 2A, these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

Green Sturgeon

The potential effects of construction and maintenance of water conveyance facilities, operations of water conveyance facilities, restoration measures and other conservation measures on green sturgeon would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance activities on green sturgeon would be similar to those described under Alternative 1A because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2C compared to those described in detail for Alternative 1A (Impact AQUA-127 and AQUA-128), the effects described for green sturgeon under Alternative 1A also appropriately characterize effects for green sturgeon under Alternative 2C.

Impact AQUA-127: Effects of Construction of Water Conveyance Facilities on Green Sturgeon

Impact AQUA-128: Effects of Maintenance of Water Conveyance Facilities on Green Sturgeon

NEPA Effects: While the maintenance impact mechanism (Impact AQUA-128) would not be adverse to green sturgeon, construction activities (Impact AQUA-127) could result in adverse effects from impact pile driving activities. However, the implementation of Mitigation Measures AQUA-1a and AQUA-1b, would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality).

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, Impact AQUA-127 could result in significant underwater noise effects from impact pile driving, although implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant. The other impact mechanism would be less than significant, so no additional mitigation would be required.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of operations of water conveyance facilities on green sturgeon would be similar to those described for Alternative 2A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2C compared to those described in detail for Alternative 2A (Impacts AQUA-129 through AQUA-132), the fish effects described for green sturgeon also appropriately characterize the effects under Alternative 2C.

Impact AQUA-129: Effects of Water Operations on Entrainment of Green Sturgeon

Impact AQUA-130: Effects of Water Operations on Spawning and Egg Incubation Habitat for Green Sturgeon

Impact AQUA-131: Effects of Water Operations on Rearing Habitat for Green Sturgeon

Impact AQUA-132: Effects of Water Operations on Migration Conditions for Green Sturgeon

NEPA Effects: As discussed for Alternative 2A, the expected effects of Impact AQUA-130 and Impact AQUA-132 on green sturgeon spawning and migration habitat under Alternative 2C would be limited, although adverse effects would still be expected from Impact AQUA-132, because it has the potential to substantially interfere with the movement of green sturgeon. This effect is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this effect to a level that is not adverse would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. Therefore, this would be an unavoidable adverse effect because there is no feasible mitigation available, although the implementation of Mitigation Measures AQUA-132a through AQUA-132c, is expected to reduce the overall effects.

As discussed for Alternative 2A, the expected effects of Alternative 2C on green sturgeon entrainment and rearing habitat (Impact AQUA-129 and Impact AQUA-131) would not be adverse.

CEQA Conclusion: As discussed in detail for Alternative 2A, Impact AQUA-130 through AQUA-132 could result in significant, but unavoidable, effects on water temperature, and green sturgeon rearing and migration habitat conditions under Alternative 2C. These impacts are a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this impact to a less-than-significant level would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, these impacts are significant and unavoidable because there is no feasible mitigation available. Even so, proposed below is mitigation (Mitigation Measure 132a through 132c) that has the potential to reduce the severity of impact though not necessarily to a less-than-significant level.

Mitigation Measure AQUA-132a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Green Sturgeon to Determine Feasibility of Mitigation to Reduce Impacts to Migration Conditions

Please refer to Mitigation Measure AQUA-132a under Alternative 2A.

Mitigation Measure AQUA-132b: Conduct Additional Evaluation and Modeling of Impacts on Green Sturgeon Migration Conditions Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-132b under Alternative 2A.

Mitigation Measure AQUA-132c: Consult with NMFS, USFWS, and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Green Sturgeon Migration Conditions Consistent with CM1

Please refer to Mitigation Measure AQUA-132c under Alternative 2A.

Restoration and Conservation Measures

The potential effects of restoration measures and other conservation measures on green sturgeon would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2C compared to those described in detail for Alternative 1A (Impact AQUA-133 through AQUA-144), the fish effects under Alternative 1A would appropriately characterize effects under Alternative 2C.

Impact AQUA-133: Effects of Construction of Restoration Measures on Green Sturgeon

Impact AQUA-134: Effects of Contaminants Associated with Restoration Measures on Green Sturgeon

Impact AQUA-135: Effects of Restored Habitat Conditions on Green Sturgeon

Impact AQUA-136: Effects of Methylmercury Management on Green Sturgeon (CM12)

Impact AQUA-137: Effects of Invasive Aquatic Vegetation Management on Green Sturgeon (CM13)

Impact AQUA-138: Effects of Dissolved Oxygen Level Management on Green Sturgeon (CM14)

Impact AQUA-139: Effects of Localized Reduction of Predatory Fish on Green Sturgeon (CM15)

Impact AQUA-140: Effects of Nonphysical Fish Barriers on Green Sturgeon (CM16)

Impact AQUA-141: Effects of Illegal Harvest Reduction on Green Sturgeon (CM17)

Impact AQUA-142: Effects of Conservation Hatcheries on Green Sturgeon (CM18)

Impact AQUA-143: Effects of Urban Stormwater Treatment on Green Sturgeon (CM19)

Impact AQUA-144: Effects of Removal/Relocation of Nonproject Diversions on Green Sturgeon (CM21)

NEPA Effects: Similar to the discussion provided above for Alternative 1A, the restoration and conservation measure impact mechanisms listed above would not be adverse, and would typically be beneficial to green sturgeon. Specifically for AQUA-134, the effects of contaminants on green sturgeon with respect to copper, ammonia and pesticides would not be adverse. The effects of methylmercury and selenium on green sturgeon are uncertain.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, the impact mechanisms related to restoration and conservation measures would be beneficial or less than significant, and no mitigation would be required.

White Sturgeon

The potential effects of construction and maintenance of water conveyance facilities, operations of water conveyance facilities, restoration measures and other conservation measures on white sturgeon would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance activities on white sturgeon would be similar to those described under Alternative 1A because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2C compared to those described in detail for Alternative 1A (Impact AQUA-145 and AQUA-146), the fish effects described for white sturgeon under Alternative 1A also appropriately characterize effects under Alternative 2C.

Impact AQUA-145: Effects of Construction of Water Conveyance Facilities on White Sturgeon

Impact AQUA-146: Effects of Maintenance of Water Conveyance Facilities on White Sturgeon

NEPA Effects: These impact mechanisms would generally not be adverse to white sturgeon. However, construction activities (Impact AQUA-145) could result in adverse effects from impact pile driving activities, although the implementation of Mitigation Measures AQUA-1a and AQUA-1b would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality).

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, Impact AQUA-145 could result in significant underwater noise effects from impact pile driving, implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of water conveyance operations on white sturgeon would be similar to those described for Alternative 2A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2C compared to those described in detail for Alternative 2A, the effects described under Alternative 2A (Impacts AQUA-147 through AQUA-150) also appropriately characterize the effects for white sturgeon under Alternative 2C.

Impact AQUA-147: Effects of Water Operations on Entrainment of White Sturgeon

Impact AQUA-148: Effects of Water Operations on Spawning and Egg Incubation Habitat for White Sturgeon

Impact AQUA-149: Effects of Water Operations on Rearing Habitat for White Sturgeon

Impact AQUA-150: Effects of Water Operations on Migration Conditions for White Sturgeon

NEPA Effects: As discussed above under Alternative 2A, the impact mechanisms listed above would not be generally adverse for white sturgeon. However, there is a positive correlation between white sturgeon year class strength and river/Delta flow, such that changes in water operations could result in an adverse effect on white sturgeon migration conditions (Impact AQUA-150). While there is uncertainty regarding the particular responsible mechanisms, this uncertainty will be addressed through targeted research and monitoring conducted in the years leading up to the initiation of north Delta facilities operations. The results of these efforts would be used to determine if changes in flow under Alternative 2C are likely to result in adverse effects, as well as to guide an adaptive management process to minimize or avoid such effects.

CEQA Conclusion: With a few exceptions, these impact mechanisms listed above would be less than significant, and no mitigation would be required. As discussed for Impact AQUA-149 under Alternative 2A, if the expected operational effects are adjusted to exclude sea level rise and climate change, it would not in itself result in a significant impact on rearing habitat for white sturgeon. Therefore, this impact is less than significant and no mitigation is required. However, due to the uncertainty regarding effects of flow changes on migration conditions for white sturgeon (Impact AQUA-150), research and monitoring efforts and an associated adaptive management process is proposed. These efforts are expected to identify any significant effects and develop appropriate mitigation to reduce the effect to be less than significant.

Restoration and Conservation Measures

The potential effects of restoration measures and other conservation measures on white sturgeon would be similar to those described under Alternative 1A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2C compared to those described in detail for Alternative 1A (Impact AQUA-151 through AQUA-162), the effects described under Alternative 1A appropriately characterize effects for white sturgeon under Alternative 2C.

Impact AQUA-151: Effects of Construction of Restoration Measures on White Sturgeon

Impact AQUA-152: Effects of Contaminants Associated with Restoration Measures on White Sturgeon

Impact AQUA-153: Effects of Restored Habitat Conditions on White Sturgeon

Impact AQUA-154: Effects of Methylmercury Management on White Sturgeon (CM12)

Impact AQUA-155: Effects of Invasive Aquatic Vegetation Management on White Sturgeon (CM13)

Impact AQUA-156: Effects of Dissolved Oxygen Level Management on White Sturgeon (CM14)

Impact AQUA-157: Effects of Localized Reduction of Predatory Fish on White Sturgeon (CM15)

Impact AQUA-158: Effects of Nonphysical Fish Barriers on White Sturgeon (CM16)

Impact AQUA-159: Effects of Illegal Harvest Reduction on White Sturgeon (CM17)

Impact AQUA-160: Effects of Conservation Hatcheries on White Sturgeon (CM18)

Impact AQUA-161: Effects of Urban Stormwater Treatment on White Sturgeon (CM19)

Impact AQUA-162: Effects of Removal/Relocation of Nonproject Diversions on White Sturgeon (CM21)

NEPA Effects: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would not be adverse to white sturgeon and would typically be beneficial. Specifically for AQUA-152, the effects of contaminants on white sturgeon with respect to copper, ammonia and pesticides would not be adverse. The effects of methylmercury and selenium on white sturgeon are uncertain.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

Pacific Lamprey

The potential effects of construction and maintenance of water conveyance facilities, operations of water conveyance facilities, restoration measures and other conservation measures on Pacific lamprey would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance activities on Pacific lamprey would be similar to those described under Alternative 1A because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2C compared to those described in detail for Alternative 1A (Impact AQUA-163 and AQUA-164), the fish effects described for Pacific lamprey under Alternative 1A also appropriately characterize effects for Pacific lamprey under Alternative 2C.

Impact AQUA-163: Effects of Construction of Water Conveyance Facilities on Pacific Lamprey

Impact AQUA-164: Effects of Maintenance of Water Conveyance Facilities on Pacific Lamprey

NEPA Effects: While maintenance activities would generally not be adverse to Pacific lamprey, construction activities (Impact AQUA-163) could result in adverse effects from impact pile driving activities. However, the implementation of Mitigation Measures AQUA-1a and AQUA-1b would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality).

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A and 2A, Impact AQUA-163 could result in significant underwater noise effects from impact pile driving. However, implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of water conveyance operations on Pacific lamprey would be similar to those described under Alternative 2A (Impact AQUA-165 and AQUA-168). Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2C compared to those described in detail for Alternative 2A, the effects described for Pacific lamprey under Alternative 2A also appropriately characterize effects for Pacific lamprey under Alternative 2C.

Impact AQUA-165: Effects of Water Operations on Entrainment of Pacific Lamprey

Impact AQUA-166: Effects of Water Operations on Spawning and Egg Incubation Habitat for Pacific Lamprey

Impact AQUA-167: Effects of Water Operations on Rearing Habitat for Pacific Lamprey

Impact AQUA-168: Effects of Water Operations on Migration Conditions for Pacific Lamprey

NEPA Effects: As discussed for Alternative 2A, these impact mechanisms would not be adverse to Pacific lamprey.

CEQA Conclusion: Similar to the discussion provided above for 2A, these impact mechanisms would be less than significant, and no mitigation would be required. While analyses of Impact AQUA-166 and AQUA-167 indicate that the differences between Existing Conditions and Alternative 2A could be significant because of substantial reductions in suitable spawning and rearing habitat and increased egg mortality. However, these differences are generally due to climate change, sea level rise, and future demand, and not the alternative. The impacts of Alternative 2C would be similar, and would therefore be less than significant and no mitigation is required.

Restoration and Conservation Measures

The potential effects of restoration measures and other conservation measures on Pacific lamprey would be similar to those described under Alternative 1A. Because no differences in effects are anticipated anywhere in the affected environment under Alternative 2C compared to those described in detail for Alternative 1A (Impact AQUA-169 and through AQUA-180), the effects described for Pacific lamprey under Alternative 1A also appropriately characterize effects for Pacific lamprey under Alternative 2C.

Impact AQUA-169: Effects of Construction of Restoration Measures on Pacific Lamprey

Impact AQUA-170: Effects of Contaminants Associated with Restoration Measures on Pacific Lamprey

Impact AQUA-171: Effects of Restored Habitat Conditions on Pacific Lamprey

Impact AQUA-172: Effects of Methylmercury Management on Pacific Lamprey (CM12)

Impact AQUA-173: Effects of Invasive Aquatic Vegetation Management on Pacific Lamprey (CM13)

Impact AQUA-174: Effects of Dissolved Oxygen Level Management on Pacific Lamprey (CM14)

Impact AQUA-175: Effects of Localized Reduction of Predatory Fish on Pacific Lamprey (CM15)

Impact AQUA-176: Effects of Nonphysical Fish Barriers on Pacific Lamprey (CM16)

Impact AQUA-177: Effects of Illegal Harvest Reduction on Pacific Lamprey (CM17)

Impact AQUA-178: Effects of Conservation Hatcheries on Pacific Lamprey (CM18)

Impact AQUA-179: Effects of Urban Stormwater Treatment on Pacific Lamprey (CM19)

Impact AQUA-180: Effects of Removal/Relocation of Nonproject Diversions on Pacific Lamprey (CM21)

NEPA Effects: Similar to the discussion provided above for Alternative 1A, these impact mechanisms would not be adverse, and would typically be beneficial to Pacific lamprey.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A and 2A, most of these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

River Lamprey

The potential effects of construction and maintenance of water conveyance facilities, operations of water conveyance facilities, restoration measures and other conservation measures on river lamprey would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance activities on river lamprey would be similar to those described under Alternative 1A because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2C compared to those described in detail for Alternative 1A (Impact AQUA-181 and AQUA-182), the fish effects described for river lamprey under Alternative 1A also appropriately characterize effects for river lamprey under Alternative 2C.

Impact AQUA-181: Effects of Construction of Water Conveyance Facilities on River Lamprey

Impact AQUA-182: Effects of Maintenance of Water Conveyance Facilities on River Lamprey

NEPA Effects: While construction activities (Impact AQUA-181) could result in adverse effects from impact pile driving activities, the implementation of Mitigation Measures AQUA-1a and AQUA-1b would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality). Therefore, as discussed for Alternative 1A, these impact mechanisms would not be adverse to river lamprey.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, Impact AQUA-181 could result in significant underwater noise effects from impact pile driving, implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant. Therefore, the overall effects of these impact mechanisms would be less than significant, so no additional mitigation would be required.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of water conveyance facility operations on river lamprey would be similar to those described under Alternative 2A. Because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2C compared to those described in detail for Alternative 2A (Impact AQUA-183 through AQUA-186), the effects described for river lamprey under Alternative 2A also appropriately characterize effects for river lamprey under Alternative 2C.

Impact AQUA-183: Effects of Water Operations on Entrainment of River Lamprey

Impact AQUA-184: Effects of Water Operations on Spawning and Egg Incubation Habitat for River Lamprey

Impact AQUA-185: Effects of Water Operations on Rearing Habitat for River Lamprey

Impact AQUA-186: Effects of Water Operations on Migration Conditions for River Lamprey

NEPA Effects: As discussed for Alternative 2A, these impact mechanisms would not be adverse to river lamprey.

CEQA Conclusion: Similar to the discussion provided above under Alternative 2A for river lamprey, analyses of Impact AQUA-184, AQUA-185, and AQUA-186 indicate that the differences between Existing Conditions and Alternative 2A could be significant because of substantial reductions in suitable spawning, incubation, rearing, and migration conditions. However, these differences are generally due to climate change, sea level rise, and future water demands, and not the alternative. Thus, the effects of these impact mechanisms under Alternative 2C would be similar to those discussed above under Alternative 2A, and therefore would be less than significant and no mitigation is required.

Restoration and Conservation Measures

The potential effects of restoration measures and other conservation measures on river lamprey would be similar to those described under Alternative 1A, as no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2C (Impact AQUA-187 through AQUA-198), the effects described for river lamprey under Alternative 1A also appropriately characterize effects for river lamprey under Alternative 2C.

Impact AQUA-187: Effects of Construction of Restoration Measures on River Lamprey

Impact AQUA-188: Effects of Contaminants Associated with Restoration Measures on River Lamprey

Impact AQUA-189: Effects of Restored Habitat Conditions on River Lamprey

Impact AQUA-190: Effects of Methylmercury Management on River Lamprey (CM12)

Impact AQUA-191: Effects of Invasive Aquatic Vegetation Management on River Lamprey (CM13)

Impact AQUA-192: Effects of Dissolved Oxygen Level Management on River Lamprey (CM14)

Impact AQUA-193: Effects of Localized Reduction of Predatory Fish on River Lamprey (CM15)

Impact AQUA-194: Effects of Nonphysical Fish Barriers on River Lamprey (CM16)

Impact AQUA-195: Effects of Illegal Harvest Reduction on River Lamprey (CM17)

Impact AQUA-196: Effects of Conservation Hatcheries on River Lamprey (CM18)

Impact AQUA-197: Effects of Urban Stormwater Treatment on River Lamprey (CM19)

Impact AQUA-198: Effects of Removal/Relocation of Nonproject Diversions on River Lamprey (CM21)

NEPA Effects: As discussed for Alternative 1A and 2A, these restoration and conservation measure impact mechanisms would not be adverse, and would typically be beneficial to river lamprey.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A and 2A, these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

Non-Covered Aquatic Species of Primary Management Concern

The potential effects of construction and maintenance of water conveyance facilities, operations of water conveyance facilities, restoration measures and other conservation measures on non-covered species would be similar to those described under Alternative 1A.

Construction and Maintenance of CM1

The potential effects of construction and maintenance activities on non-covered species would be similar to those described under Alternative 1A because no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2C compared to those described in detail for Alternative 1A (Impact AQUA-199 and AQUA-200), the fish effects described for non-covered aquatic species of primary management concern under Alternative 1A also appropriately characterize effects for non-covered aquatic species of primary management concern under Alternative 2C.

Impact AQUA-199: Effects of Construction of Water Conveyance Facilities on Non-Covered Aquatic Species of Primary Management Concern

Impact AQUA-200: Effects of Maintenance of Water Conveyance Facilities on Non-Covered Aquatic Species of Primary Management Concern

NEPA Effects: While construction activities (Impact AQUA-199) could result in adverse effects from impact pile driving activities, the implementation of Mitigation Measures AQUA-1a and AQUA-1b, would minimize or eliminate adverse effects from impact pile driving (e.g., injury or mortality).

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A, while Impact AQUA-199 could result in significant underwater noise effects from impact pile driving, implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce the severity of impacts to less than significant. The other impact mechanism would be less than significant, so no additional mitigation would be required.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in delta smelt.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in delta smelt.

Water Operations of CM1

The potential effects of water conveyance facility operations on non-covered species would be similar to those described under Alternative 1A, as no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2C (Impact AQUA-201 through AQUA-204). Therefore, effects discussed in detail under Alternative 1A also appropriately characterize effects for non-covered aquatic species of primary management concern under Alternative 2C.

Impact AQUA-201: Effects of Water Operations on Entrainment of Non-Covered Aquatic Species of Primary Management Concern

Impact AQUA-202: Effects of Water Operations on Spawning and Egg Incubation Habitat for Non-Covered Aquatic Species of Primary Management Concern

Impact AQUA-203: Effects of Water Operations on Rearing Habitat for Non-Covered Aquatic Species of Primary Management Concern

Impact AQUA-204: Effects of Water Operations on Migration Conditions for Non-Covered Aquatic Species of Primary Management Concern

NEPA Effects: As discussed for Alternative 2A, the expected effects of Impact AQUA-203 on rearing habitat for several non-covered fish species of primary management concern under Alternative 2C, would be reduced, but would not be adverse. These species are Sacramento tule perch, largemouth bass, hardhead and Sacramento-San Joaquin roach. The other impact mechanisms would not be adverse.

CEQA Conclusion: Similar to the discussion provided above for Alternative 2A, most of these impact mechanisms would be beneficial or less than significant, and no mitigation would be required. However, Impact AQUA-203 could result in significant, but unavoidable effects on rearing habitat conditions for several fish species of primary management concern. There are also no feasible mitigation measures available to mitigate for these impacts. The other impact mechanisms would be less than significant, so no additional mitigation would be required.

Restoration and Conservation Measures

The potential effects of restoration measures and other conservation measures on non-covered species would be similar to those described under Alternative 1A, as no differences in fish effects are anticipated anywhere in the affected environment under Alternative 2C (Impact AQUA-205 through AQUA-217). Therefore, the fish effects described for non-covered aquatic species of primary management concern under Alternative 1A also appropriately characterize effects for non-covered aquatic species of primary management concern under Alternative 2C.

Impact AQUA-205: Effects of Construction of Restoration Measures on Non-Covered Aquatic Species of Primary Management Concern

Impact AQUA-206: Effects of Contaminants Associated with Restoration Measures on Non-Covered Aquatic Species of Primary Management Concern

Impact AQUA-207: Effects of Restored Habitat Conditions on Non-Covered Aquatic Species of Primary Management Concern

Impact AQUA-208: Effects of Methylmercury Management on Non-Covered Aquatic Species of Primary Management Concern (CM12)

Impact AQUA-209: Effects of Invasive Aquatic Vegetation Management on Non-Covered Aquatic Species of Primary Management Concern (CM13)

Impact AQUA-210: Effects of Dissolved Oxygen Level Management on Non-Covered Aquatic Species of Primary Management Concern (CM14)

Impact AQUA-211: Effects of Localized Reduction of Predatory Fish on Non-Covered Aquatic Species of Primary Management Concern (CM15)

Impact AQUA-212: Effects of Nonphysical Fish Barriers on Non-Covered Aquatic Species of Primary Management Concern (CM16)

Impact AQUA-213: Effects of Illegal Harvest Reduction on Non-Covered Aquatic Species of Primary Management Concern (CM17)

Impact AQUA-214: Effects of Conservation Hatcheries on Non-Covered Aquatic Species of Primary Management Concern (CM18)

Impact AQUA-215: Effects of Urban Stormwater Treatment on Non-Covered Aquatic Species of Primary Management Concern (CM19)

Impact AQUA-216: Effects of Removal/Relocation of Nonproject Diversions on Non-Covered Aquatic Species of Primary Management Concern (CM21)

NEPA Effects: As discussed for Alternative 1A, these impact mechanisms would not be adverse to the non-covered species of primary management concern, and with the implementation of environmental commitments and conservation measures, the effects would typically be beneficial.

CEQA Conclusion: Similar to the discussion provided above for Alternative 1A and 2A, most of these impact mechanisms would be beneficial or less than significant, and no mitigation would be required.

Upstream Reservoirs

Impact AQUA-217: Effects of Water Operations on Reservoir Coldwater Fish Habitat

NEPA Effects: Similar to the description for Alternative 2A, this effect would not be adverse because coldwater fish habitat in the CVP and SWP upstream reservoirs under Alternative 2C would not be substantially reduced when compared to NAA.

CEQA Conclusion: Similar to the description for Alternative 2A, Alternative 2C would reduce the quantity of coldwater fish habitat in the CVP and SWP. However, if adjusted to exclude sea level rise and climate change, similar to the NEPA conclusion, the effect would not in itself result in a significant impact on coldwater habitat in upstream reservoirs. Therefore, this impact is found to be less than significant and no mitigation is required.

11.3.4.8 Alternative 3—Dual Conveyance with Pipeline/Tunnel and Intakes 1 and 2 (6,000 cfs; Operational Scenario A)

Alternative 3 would result in the same potential construction impacts as Alternative 1A, except that only Intakes 1 and 2 would be constructed. Consequently, the intensity and extent of impacts related to the construction of the intakes would be similar but less under Alternative 3 compared to those under Alternative 1A. The total permanent in-water footprint of the two intakes would be about 8.3 acres (13.5 acres smaller under Alternative 3 than under Alternative 1A), and the total length of permanent bank protection would be approximately 4,450 feet (7,450 feet less than Alternative 1A) (See Table 11-7). The six barge landings under Alternative 3 would be in the same locations, and operate the same as the landings under Alternative 1A. The effects of the landing construction and operation would be identical to those described for Alternative 1A. All other upland construction, except for the pipelines between Intakes 1 and 2 and the intermediate forebay, are identical to Alternative 1A. The conveyance system would be the same under Alternative 3 as under Alternative 1A; therefore, all impacts related to construction of the conveyance tunnel and pipelines, including those associated with barge landings would be the same. All other aspects of construction would be similar but typically less than for Alternative 3 as for Alternative 1A.

The Sacramento River channel and bank would be affected by construction of the two north Delta intake facilities (Intakes 1 and 2) between RM 44 (south of Freeport) and approximately RM 39 (at the town of Courtland). The locations, dimensions, and construction footprints of the intakes considered in Alternative 3 are presented in Table 11-5.

The number of barge trips required under Alternative 3 would be somewhat less than the estimated 3,000 barge trips under Alternative 1A, because two intake facilities would be constructed under Alternative 3 compared to five intakes under Alternative 1A. All other aspects of construction would typically be less under Alternative 3 as described for Alternative 1A.

Delta Smelt

Construction and Maintenance of CM1

Impact AQUA-1: Effects of Construction of Water Conveyance Facilities on Delta Smelt

The potential effects of construction of water conveyance facilities on delta smelt or designated critical habitat under Alternative 3 would be the same as those described for Alternative 1A (see Impact AQUA-1), except that Alternative 3 would include two intakes compared to five intakes under Alternative 1A, so the effects would be proportionally less under this alternative. This would convert about 4,450 lineal feet of existing shoreline habitat into intake facility structures and would require about 10.2 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. The effects related to temporary increases in turbidity, accidental spills, underwater noise, in-water work activities, and disturbance of contaminated sediments would be similar to Alternative 1A and the same environmental commitments and mitigation measures (described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*) would be available to avoid and minimize potential effects.

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-1, environmental commitments and mitigation measures would be available to avoid and minimize potential effects, and the effect would not be adverse for delta smelt or critical habitat.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-1, the impact of the construction of water conveyance facilities on delta smelt or critical habitat would be less than significant except for construction noise associated with pile driving. Potential pile driving impacts would be less than Alternative 1A because only two intakes would be constructed rather than five. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce the noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in the discussion of Alternative 1A.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in the discussion of Alternative 1A.

Impact AQUA-2: Effects of Maintenance of Water Conveyance Facilities on Delta Smelt

NEPA Effects: The potential effects of the maintenance of water conveyance facilities under Alternative 3 would be the same as those described for Alternative 1A (see Impact AQUA-2) except that only two intakes would need to be maintained under Alternative 3 rather than five as under Alternative 1A. As concluded in Alternative 1A, Impact AQUA-2, the effect on delta smelt or critical habitat would not be adverse.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-2, the impact of the maintenance of water conveyance facilities on delta smelt would be less than significant and no mitigation would be required.

Water Operations of CM1

Impact AQUA-3: Effects of Water Operations on Entrainment of Delta Smelt

Water Exports from SWP/CVP South Delta Facilities

Under Alternative 3, average proportional entrainment would increase for larvae and juveniles (Figure 11-3-1), and decrease for adults (Figure 11-3-2).

Proportional entrainment of larval/juvenile delta smelt (March-June) under Alternative 3 would average 0.16(16% of the juvenile population) (Figure 11-3-1). This is an increase of 0.013 (1.3% of the juvenile population, a 9% relative increase) compared to NAA (Table 11-3-1). The greatest increase would occur in above normal years (0.024 more proportional entrainment, a 22% relative increase compared to NAA).

For adult delta smelt (December-March), average proportional entrainment would be no greater than 0.08 (i.e., 8% of the adult population) (Figure 11-3-2). Proportional entrainment under

Alternative 3 would be reduced compared to NAA for all water year types (average 0.010 lower, a 13% relative decrease), with the greatest reduction in wet (28% relative decrease) and above normal years (14% relative decrease) (Figure 11-3-2, Table 11-3-1).

Table 11-3-1. Differences in Proportional Entrainment Index of Delta Smelt at SWP/CVP South Delta Facilities

	Proportional Entrainment[a] Difference in Proportions (Relative Change in Proportions)	
Water Year Type	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Total Population (December–June)		
Wet	0.011 (10%)	-0.015 (-11%)
Above Normal	0.041 (25%)	0.013 (7%)
Below Normal	0.043 (20%)	0.014 (5%)
Dry	0.030 (11%)	0.011 (4%)
Critical	0.012 (4%)	0.013 (4%)
All Years	0.025 (13%)	0.004 (2%)
Juvenile Delta Smelt (March–June)		
Wet	0.031 (81%)	0.005 (7%)
Above Normal	0.053 (65%)	0.024 (22%)
Below Normal	0.052 (38%)	0.020 (12%)
Dry	0.034 (19%)	0.014 (7%)
Critical	0.019 (8%)	0.014 (6%)
All Years	0.037 (30%)	0.013 (9%)
Adult Delta Smelt[b] (December–March)		
Wet	-0.020 (-29%)	-0.019 (-28%)
Above Normal	-0.012 (-15%)	-0.011 (-14%)
Below Normal	-0.008 (-10%)	-0.006 (-8%)
Dry	-0.004 (-6%)	-0.003 (-4%)
Critical	-0.007 (-9%)	-0.001 (-2%)
All Years	-0.012 (-15%)	-0.010 (-13%)

Shading indicates 5% or more increase in entrainment.

Note: Negative values indicate lower entrainment loss under Alternative than under existing biological conditions.

[a] Proportional entrainment index calculated in accordance with USFWS BiOp (U.S. Fish and Wildlife Service 2008a).

[b] Adult proportional entrainment adjusted according to Kimmerer (2011).

Water Exports from SWP/CVP North Delta Intake Facilities

As described for Alternative 1A, potential entrainment and impingement risks at the proposed north Delta facilities would be limited since delta smelt rarely occur in the vicinity of the proposed intake site. The intake would be screened to exclude fish larger than 15 mm SL. Alternative 3 would have only two intakes, and therefore potential entrainment and impingement risks would be even lower than for Alternative 1A with five intakes (0–2% particle entrainment).

Water Exports with a Dual Conveyance for the SWP North Bay Aqueduct

Potential entrainment of larval delta smelt at the NBA, as estimated by particle tracking modeling, was low, averaging 1.3% under Alternative 3 compared to 2.0% under NAA (a 35% relative decrease) (Table 11-3-2).

Table 11-3-2. Average Percentage (and Difference) of Particles Representing Larval Delta Smelt Entrained by the North Bay Aqueduct under Alternative 3 and Baseline Scenarios

Average Percent Particles Entrained at NBA			Difference (and Relative Difference)	
EXISTING CONDITIONS	NAA	A3_LLT	A3_LLT vs. EXISTING CONDITIONS	A3_LLT vs. NAA
2.1	2.0	1.3	-0.80 (-38%)	-0.70 (-35%)

Note: 60-day DSM2-PTM simulation. Negative difference indicates lower entrainment under the alternative compared to the baseline scenario.

Predation Associated with Entrainment

Pre-screen loss of delta smelt at the south Delta facilities is typically attributed to predation (as described in Impact AQUA-3 for Alternative 1) and is expected to change commensurate with changes in entrainment. Predation risk at the proposed north Delta intake screens and structures would be very low because delta smelt rarely occur this far upstream and risk associated with the dual conveyance option of the NBA would likely be low because this alternative intake on the Sacramento is located upstream of the main delta smelt range.

NEPA Effects: In summation, under Alternative 3 average proportional entrainment at the south Delta facilities would increase slightly for larval/juvenile delta smelt and decrease for adults, but this change would be a small proportion of the population. Any potential effects would be reduced by real-time monitoring and adaptive management response by the Real-Time Response Team. Entrainment and impingement could potentially occur at the proposed north Delta intakes, but the risk would be low due to the location, design, and operation of intakes, and offset by reduced entrainment at the south Delta facilities.

Overall, the effect of Alternative 3 on entrainment at SWP/CVP facilities would not be adverse due to the minimal amount and risk.

CEQA Conclusion: Under Alternative 3, average proportional entrainment for adults would decrease 0.012 (15% relative decrease), with the greatest decrease in wet years (0.020 less, 29% relative decrease) (Table 11-3-1, Figure 11-3-2). Average larval/juvenile proportional entrainment and associated predation loss at the south Delta facilities would increase 0.037 (a 30% relative increase) compared to Existing Conditions, with greatest increase in above normal (0.053 more, 65% relative increase) and wet years (0.031 more, 81% relative increase) (Table 11-3-1, Figure 11-3-1). However, this represents a small proportion of the larval/juvenile population (3.7% on average, 5.3% in above normal years). Furthermore, as described for Alternative 1A (Impact AQUA-3), monitoring and adaptive management by the Real-Time Response Team would reduce such modeled potential impacts.

Note that the CEQA interpretation of the larval/juvenile proportional entrainment differs from the NEPA analysis, which is likely due to different modeling assumptions (as described in Section 11.3.3

and Alternative 1A Impact AQUA-3). Because the action alternative modeling does not partition the effects of implementation of the alternative from the effects of sea level rise, climate change and future water demands, the comparison to Existing Conditions may not offer a clear understanding of the impact of the alternative on the environment. Note that the analysis for larvae and juveniles includes both OMR flows and X2 as predictors of proportional entrainment; primarily because of sea level rise assumptions, X2 would be further upstream in the ELT and LLT even with similar water operations, so that the comparison of the action alternative in the ELT and LLT to Existing Conditions is confounded.

Therefore, the impact analysis is better informed by the results from the NEPA analysis presented above, which accounts for sea level rise by considering the NAA in the LLT. When climate change is factored in, larval-juvenile delta smelt proportional entrainment would still increase compared to conditions without BDCP, but to a smaller degree: 0.013 more entrainment (a 9% relative increase) averaged across all years, and 0.024 more entrainment (22% relative increase) in above normal years (Table 11-2A-1). This represents a small proportion of the modeled larval-juvenile population (1.3% average, 2.4% in above normal water years)

The proposed north Delta intake facilities have the potential for entrainment and impingement, but this risk would be minimized due to low abundances of delta smelt in the vicinity, fewer intakes (two intakes for Alternative 3), and state-of-the-art screens. Potential entrainment of larvae would be slightly decreased (1%) at the NBA compared to Existing Conditions (Table 11-3-2).

Overall, the impact is considered less than significant because overall entrainment of delta smelt would be similar to conditions without BDCP, and only a small proportion of the population would be affected. Furthermore, any potential impacts would be reduced by monitoring and adaptive management by the Real-Time Response Team. No mitigation would be required.

Impact AQUA-4: Effects of Water Operations on Spawning and Egg Incubation Habitat for Delta Smelt

NEPA Effects: The effects of operations under Alternative 3 on abiotic spawning habitat would be about the same as described for Alternative 1A (Impact AQUA-4). Flow reductions below the north Delta intakes would not reduce available spawning habitat. In-Delta water temperatures, which can affect spawning timing, would not change across alternatives, because they would be in thermal equilibrium with atmospheric conditions and not strongly influenced by the flow changes. The effect of Alternative 3 operations on spawning would not be adverse, because there would be little change in abiotic spawning conditions for delta smelt.

CEQA Conclusion: Operations under Alternative 3 would not reduce abiotic spawning habitat availability or change spawning temperatures for delta smelt (see discussion in Alternative 1A, Impact AQUA-4). Consequently, the impact would be less than significant, and no mitigation would be required.

Impact AQUA-5: Effects of Water Operations on Rearing Habitat for Delta Smelt

NEPA Effects: As described for Alternative 1A (Impact AQUA-5), rearing habitat conditions for juvenile delta smelt are considered with respect to a fall abiotic habitat index with and without the assumption that habitat restoration benefits are realized. Similar to Alternative 1A, Alternative 3 does not include the USFWS BiOp Fall X2 requirements. The average abiotic habitat index under Alternative 3 without restoration (A3_LLT would be 21% less, relative to NAA (Table 11-3-3).

However, habitat restoration has the potential to increase spawning and rearing habitat and is expected to supplement food production and export to rearing areas. With habitat restoration, Alternative 3 could provide delta smelt with additional habitat (CM2, CM4,), particularly in the Suisun Marsh, West Delta, and Cache Slough ROAs, which are closer to delta smelt's main range. The average abiotic habitat index for Alternative 3 with habitat restoration would be about the same as NAA assuming 100% habitat occupancy by delta smelt. Under Alternative 3 the delta smelt abiotic habitat index without restoration would remain fairly constant (~5,000 hectares) across wet to below normal water year types (Figure 11-3-3).

Assuming habitat benefits are realized, the abiotic habitat index under Alternative 3 would be 25% lower than NAA in wet water year types, 8% lower in above normal water year types, but 24–35% greater than baseline in other water year types (Table 11-3-3).

CEQA Conclusion: As discussed under Alternative 1A, Alternative 3 would not result in less rearing habitat area, compared to Existing Conditions. However, without BDCP habitat restoration efforts, the delta smelt fall abiotic habitat index under Alternative 3 would be similar under most water year types (about 4% difference) compared to Existing Conditions. In wet water years, the abiotic habitat index would decrease 13% in wet water years, but would be the same or slightly increased relative to Existing Conditions in all other water year types. With the implementation of the BDCP habitat restoration actions, the average abiotic habitat index under Alternative 3 would increase by 22% compared to Existing Conditions. The abiotic habitat index would increase 22% on average (10–32% more in wetter years and 24–32% more in drier years) compared to Existing Conditions.

Note that the CEQA analysis predicts a greater increase in the abiotic habitat index relative to baseline than the NEPA analysis. It is unclear whether this increase under Alternative 3 compared to Existing Conditions is a function of Project operations, or attributable to differences in modeling assumptions (Existing Conditions does not include Fall X2). The NEPA analysis is a better approach for isolating the effect of the Alternative from the effects of sea level rise, climate change, future water demands, and implementation of required actions under the BiOps. When compared to the NAA and informed by the NEPA analysis, the average delta smelt abiotic habitat index under Alternative 3 without restoration would be 21% lower to NAA, and similar to NAA with restoration (Table 11-3-3).

Overall, there would be a minor beneficial impact on the species compared to existing conditions without Fall X2, primarily from implementation of habitat restoration. The benefits of restored habitat for this species will depend on the success of restoration in creating physical habitat for smelt and in fostering ecological conditions that favor good feeding conditions and production of food upon which smelt can feed. The magnitude of restored habitat benefits is uncertain. As such, BDCP water operations will be subject to adjustment via adaptive management, in order to ensure the impacts of water operations on rearing habitat for delta smelt are not significant and to support a contribution to recovery of this species. The Adaptive Management Program will evaluate the effects of water operations and habitat restoration on the delta smelt population, including adjustments as appropriate to improve water supply reliability. In conclusion, the impact of Alternative 3 without habitat restoration on delta smelt rearing habitat would be considered less than significant, because the amount of abiotic habitat would be similar to Existing Conditions. The impact would be less than significant and may be beneficial when habitat restoration is included. No mitigation would be required.

Table 11-3-3. Differences in Delta Smelt Fall Abiotic Index (hectares) between Alternative 3 and Existing Biological Conditions Scenarios, with Habitat Restoration, Averaged by Prior Water Year Type

	Without Restoration		With Restoration	
Water Year	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
All	-147 (-4%)	-1,033 (-21%)	867 (22%)	-18 (0%)
Wet	-632 (-13%)	-2,828 (-41%)	462 (10%)	-1,734 (-25%)
Above Normal	135 (4%)	-1,533 (-28%)	1,224 (32%)	-443 (-8%)
Below Normal	-3 (0%)	146 (4%)	1,130 (27%)	1,278 (32%)
Dry	157 (4%)	249 (7%)	1,132 (32%)	1,224 (35%)
Critical	18 (1%)	17 (1%)	713 (24%)	713 (24%)
	Shading indicates >5% decrease in estimated abiotic habitat acres from baseline.			

Note: Negative values indicate lower habitat indices under preliminary proposal scenarios. Water year 1922 was omitted because water year classification for prior year was not available.

Impact AQUA-6: Effects of Water Operations on Migration Conditions for Delta Smelt

NEPA Effects: As described for previous alternatives, Alternative 3 may decrease sediment supply to the estuary by 8 to 9%, with the potential for decreased habitat suitability for delta smelt in some locations.

***CEQA Conclusion*:** Operations under Alternative 3 would not substantially alter the turbidity cues associated with winter flush events that may initiate migration, nor would there be appreciable changes in water temperatures (see Alternative 1A, Impact AQUA-6). Consequently, the impact on adult delta smelt migration conditions would be less than significant, and no mitigation would be required.

Restoration Measures (CM2, CM4–CM7, and CM10)

Alternative 3 has the same restoration measures as Alternative 1A. Because no substantial differences in restoration-related effects on fish are anticipated anywhere in the affected environment under Alternative 3 compared to those described in detail for Alternative 1A, the effects of restoration measures on fish as described for delta smelt under Alternative 1A (Impact AQUA-7 through AQUA-9) also appropriately characterize effects under Alternative 3.

The following impacts are those presented under Alternative 1A that are identical for Alternative 3.

Impact AQUA-7: Effects of Construction of Restoration Measures on Delta Smelt

Impact AQUA-8: Effects of Contaminants Associated with Restoration Measures on Delta Smelt

Impact AQUA-9: Effects of Restored Habitat Conditions on Delta Smelt

NEPA Effects: All of these impact mechanisms have been determined to result in no adverse effects on delta smelt, for the reasons identified for Alternative 1A. Specifically for AQUA-8, the effects of contaminants on delta smelt with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on delta smelt are uncertain.

CEQA Conclusion: All of these impact mechanisms would be considered less than significant, for the reasons identified for Alternative 1A, and no mitigation would be required.

Other Conservation Measures (CM12–CM19 and CM21)

Alternative 3 has the same other conservation measures as Alternative 1A. Because no substantial differences in other conservation-related effects on fish are anticipated anywhere in the affected environment under Alternative 3 compared to those described in detail for Alternative 1A, the effects of other conservation measures on fish described for delta smelt under Alternative 1A (Impact AQUA-10 through AQUA-18) also appropriately characterize effects under Alternative 3.

The following impacts are those presented under Alternative 1A that are identical for Alternative 3.

Impact AQUA-10: Effects of Methylmercury Management on Delta Smelt (CM12)

Impact AQUA-11: Effects of Invasive Aquatic Vegetation Management on Delta Smelt (CM13)

Impact AQUA-12: Effects of Dissolved Oxygen Level Management on Delta Smelt (CM14)

Impact AQUA-13: Effects of Localized Reduction of Predatory Fish on Delta Smelt (CM15)

Impact AQUA-14: Effects of Nonphysical Fish Barriers on Delta Smelt (CM16)

Impact AQUA-15: Effects of Illegal Harvest Reduction on Delta Smelt (CM17)

Impact AQUA-16: Effects of Conservation Hatcheries on Delta Smelt (CM18)

Impact AQUA-17: Effects of Urban Stormwater Treatment on Delta Smelt (CM19)

Impact AQUA-18: Effects of Removal/Relocation of Nonproject Diversions on Delta Smelt (CM21)

NEPA Effects: The nine impact mechanisms have been determined to range from no effect, to no adverse effect, or beneficial effects on delta smelt for NEPA purposes, for the reasons identified for Alternative 1A.

CEQA Conclusion: The nine impact mechanisms would be considered to range from no impact, to less than significant, or beneficial on delta smelt, for the reasons identified for Alternative 1A, and no mitigation is required.

Longfin Smelt

Construction and Maintenance of CM1

Impact AQUA-19: Effects of Construction of Water Conveyance Facilities on Longfin Smelt

The potential effects of construction of water conveyance facilities on longfin smelt under Alternative 3 would be similar to those described for Alternative 1A (see Impact AQUA-19) except that Alternative 3 would include two intakes compared to five intakes under Alternative 1A, so the effects would be proportionally less under this alternative. This would convert about 4,450 lineal feet of existing shoreline habitat into intake facility structures and would require about 10.2 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. The effects related to temporary increases in turbidity, accidental spills, underwater noise, in-water work activities, and disturbance of contaminated sediments would be similar to Alternative 1A and the same environmental commitments and mitigation measures (described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*) would be available to avoid and minimize potential effects.

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-19, environmental commitments and mitigation measures would be available to avoid and minimize potential effects, and the effect would not be adverse for longfin smelt.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-19, the impact of the construction of water conveyance facilities on longfin smelt would be less than significant except for construction noise associated with pile driving which would only occur for two intakes rather than five. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce the noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in the discussion of Alternative 1A.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in the discussion of Alternative 1A.

Impact AQUA-20: Effects of Maintenance of Water Conveyance Facilities on Longfin Smelt

NEPA Effects: The potential effects of the maintenance of water conveyance facilities under Alternative 3 would be the same as those described for Alternative 1A except that only two intakes would need to be maintained under Alternative 3 instead of five as under Alternative 1A (see Impact AQUA-20). As concluded in Alternative 1A, Impact AQUA-20, the effect on longfin smelt would not be adverse.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-20, the impact of the maintenance of water conveyance facilities on longfin smelt would be less than significant and no mitigation would be required.

Water Operations of CM1

Impact AQUA-21: Effects of Water Operations on Entrainment of Longfin Smelt

Water Exports from SWP/CVP South Delta Facilities

For larval longfin smelt, entrainment risk was simulated using particle tracking modeling. Entrainment loss of longfin smelt larvae to the south Delta facilities under the wetter starting distribution was 1.1% for Alternative 3 compared to 1.6% for NAA, a 35% decrease in relative terms (Table 11-3-4). Under the drier starting distribution, average entrainment was 1.4% under Alternative 3 compared to 2.2% for NAA, a 38% relative decline. Overall, larval longfin smelt entrainment at the south Delta intakes would be reduced under Alternative 3 compared to baseline conditions (NAA).

Table 11-3-4. Percentage of Particles (and Difference) Representing Longfin Smelt Larvae Entrained by the South Delta Facilities under Alternative 3 and Baseline Scenarios

	Percent Particles Entrained			Difference (and Relative Difference)	
Starting Distribution	EXISTING CONDITIONS	NAA	A3_LLT	A3_LLT vs. EXISTING CONDITIONS	A3_LLT vs. NAA
Wetter	1.9	1.6	1.1	-0.77 (-41%)	-0.59 (-35%)
Drier	2.5	2.2	1.4	-1.13 (-45%)	-0.86 (-38%)

For juvenile longfin smelt, entrainment at the south Delta facilities (salvage index, averaged across all water year types) would increase under Alternative 3 by 61% (compared to NAA) (Table 11-3-5). The increase in juvenile entrainment is related to substantial increases in reverse OMR flows in April and May during dry and wetter water year types. Under Alternative 3, juvenile entrainment would be highest in dry water year types. In critical water year types, juvenile entrainment would be reduced 11% compared to NAA.

For adult longfin smelt, entrainment at the south Delta facilities (salvage index, averaged across all water year types) would be reduced by 29% compared to NAA (Table 11-3-5). The reduction in entrainment for adult longfin smelt is due to substantial reductions in reverse OMR flows during January–March under Alternative 3 (Figure 11-3-1). For adult longfin smelt, the reduction in entrainment is 1–2 orders of magnitude greater in critical years. Under Alternative 3, adult entrainment in critical water year types would be reduced 22% compared to NAA.

Table 11-3-5. Longfin Smelt Entrainment Index[a] at the SWP and CVP Salvage Facilities—Differences (Absolute and Percentage) between Model Scenarios for Alternative 3

Life Stage	Water Year Types	Absolute Difference (Percent Difference) EXISTING CONDITIONS vs. A3_LLT	Absolute Difference (Percent Difference) NAA vs. A3_LLT
Juvenile (March–June)	Wet	56,797 (89%)	51,355 (74%)
	Above Normal	5,808 (128%)	5,519 (115%)
	Below Normal	2,311 (75%)	2,103 (64%)
	Dry	186,501 (35%)	128,194 (22%)
	Critical	-127,067 (-22%)	-53,197 (-11%)
	All Years	202,565 (76%)	177,554 (61%)
Adult (Dec–March)	Wet	-38 (-30%)	-42 (-31%)
	Above Normal	-85 (-13%)	-125 (-18%)
	Below Normal	-143 (-7%)	-66 (-4%)
	Dry	-170 (-14%)	-105 (-9%)
	Critical	-6,958 (-29%)	-4,824 (-22%)
	All Years	-1,059 (-29%)	-1,024 (-29%)
	Shading indicates >5% increase in entrainment index.		

[a] Estimated annual number of fish lost, based on normalized data.

Water Exports from SWP/CVP North Delta Intake Facilities

The proposed north Delta intakes could increase entrainment potential and locally attract piscivorous fish predators, but entrainment and predation losses of longfin smelt at the north Delta would be extremely low because this species is not expected to occur this far upstream.

Water Export with a Dual Conveyance for the SWP North Bay Aqueduct

Particle entrainment at the NBA, representing potential larval longfin smelt entrainment, was low for both starting distributions (wetter and drier), averaged 0.13-0.16% under Alternative 3, which was 0.05% less than NAA, or 47-56% lower in relative terms (Table 11-3-6).

Table 11-3-6. Average Percentage (and Difference) of Particles Representing Larval Longfin Smelt Entrained by the North Bay Aqueduct under Alternative 3 and Baseline Scenarios

	Percent Particles Entrained			Difference (and Relative Difference)	
Distribution	EXISTING CONDITIONS	NAA	A3_LLT	A3_LLT vs. EXISTING CONDITIONS	A3_LLT vs. NAA
Wetter	0.20	0.08	0.13	-0.08 (-38.4%)	0.05 (56.1%)
Drier	0.25	0.11	0.16	-0.09 (-36.7%)	0.05 (47.1%)

Note: 60-day runs of PTM. Negative difference values indicate lower entrainment under the alternative compared to the baseline scenario.

In summation, at the SWP/CVP south Delta facilities juvenile longfin smelt entrainment would increase substantially under Alternative 3 compared to NAA. Adult entrainment at the south Delta facilities would be reduced, especially in critical water year types when longfin smelt distribution extends further into the Delta. Longfin smelt entrainment to the NBA would increase negligibly compared to NAA. Entrainment loss of longfin smelt at the proposed north Delta intakes would be low since longfin smelt would occur only rarely in that area of the Sacramento River.

Predation Associated with Entrainment

Under Alternative 3, pre-screen loss of juvenile longfin smelt at the south Delta facilities, typically attributed to predation (as described for Impact AQUA-3 for Alternative 1), is expected to increase for juveniles and decrease for adults commensurate with entrainment. Predation loss at the proposed north Delta intakes and the alternate NBA intake would be limited because longfin smelt only rarely occur that far upstream.

NEPA Effects: Overall, the effect of water operations on entrainment and entrainment-related predation loss of longfin smelt under Alternative 3 would be adverse, particularly because of the substantial increase in south Delta entrainment and predation loss of juvenile longfin smelt.

CEQA Conclusion**:** The results of the PTM model indicate slightly lower larval entrainment at the south Delta facilities, agricultural diversions, and the NBA for all distributions (wetter and drier) compared to Existing Conditions. At the south Delta facilities, juvenile entrainment would increase 76% while adult entrainment would be reduced 29% compared to Existing Conditions. Entrainment to the north Delta intakes would be low since longfin smelt would not occur in the vicinity of the intakes.

Predation loss of juveniles would be increased 76% compared to Existing Conditions (based on salvage data) while predation loss of adults would be reduced by 29%. Predation risk at the SWP/CVP north Delta intakes would be low because longfin smelt rarely occur in that vicinity.

Under Alternative 3, the impact of water operations on longfin smelt would be significant because the increase in entrainment and predation loss for juveniles would be much greater than the reduction predicted for adult longfin smelt. As a result, this impact is significant and unavoidable. Even so, proposed below is mitigation that has the potential to reduce the severity of impact though not necessarily to a less-than-significant level.

Mitigation Measure AQUA-21a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Longfin Smelt to Determine Feasibility of Mitigation to Reduce Entrainment Impacts

Although analysis conducted as part of the EIR/EIS determined that Alternative 3 would have significant and unavoidable adverse effects on entrainment of longfin smelt, this conclusion was based on the best available scientific information at the time and may prove to have been overstated. Upon the commencement of operations of CM1 and continuing through the life of the permit, the BDCP proponents will monitor effects on entrainment in order to determine whether such effects would be as extensive as concluded at the time of preparation of this document and to determine any potentially feasible means of reducing the severity of such effects. This mitigation measure requires a series of actions to accomplish these purposes, consistent with the operational framework for Alternative 3.

The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 3 operations only. Development of mitigation actions for the incremental impacts on entrainment attributable to climate change/sea level rise, are not required because these changed conditions would occur with or without implementation of Alternative 3.

Mitigation Measure AQUA-21b: Conduct Additional Evaluation and Modeling of Impacts on Longfin Smelt Entrainment Following Initial Operations of CM1

Following commencement of initial operations of CM1 and continuing through the life of the permit, the BDCP proponents will conduct additional evaluations to define the extent to which modified operations could reduce impacts to entrainment under Alternative 3. The analysis required under this measure may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6).

Mitigation Measure AQUA-21c: Consult with USFWS and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Longfin Smelt Entrainment Consistent with CM1

In order to determine the feasibility of reducing the effects of CM1 operations on longfin smelt, the BDCP proponents will consult with USFWS and CDFW to identify and implement any feasible operational means to minimize effects on entrainment Any such action will be developed in conjunction with the ongoing monitoring and evaluation of habitat conditions required by Mitigation Measure AQUA-21a.

If feasible means are identified to reduce impacts on entrainment consistent with the overall operational framework of Alternative 3 without causing new significant adverse impacts on other covered species, such means shall be implemented. If sufficient operational flexibility to reduce effects on longfin smelt habitat is not feasible under Alternative 3 operations, achieving further impact reduction pursuant to this mitigation measure would not be feasible under this Alternative, and the impact on longfin smelt would remain significant and unavoidable.

Impact AQUA-22: Effects of Water Operations on Spawning, Egg Incubation, and Rearing Habitat for Longfin Smelt

NEPA Effects: Predicted average longfin smelt relative abundance would be reduced under Alternative 3, resulting in 7% less (based on Fall Midwater Trawl estimates) to 8% less (based on Bay Otter Trawl estimates) compared to NAA (Table 11-3-7). Under Alternative 3 longfin smelt relative abundance would be reduced 14–17% in above normal water year types, and reduced 13–15% in below normal water year types compared to NAA.

Table 11-3-7. Estimated Differences between Scenarios for Longfin Smelt Relative Abundance in the Fall Midwater Trawl or Bay Otter Trawl

	Fall Midwater Trawl Relative Abundance		Bay Otter Trawl Relative Abundance	
Water Year Type	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
All	-1,724 (-33%)	-247 (-7%)	-5,518 (-39%)	-763 (-8%)
Wet	-6,441 (-35%)	-77 (-1%)	-26,449 (-41%)	-300 (-1%)
Above Normal	-3,650 (-43%)	-817 (-14%)	-12,781 (-49%)	-2,736 (-17%)
Below Normal	-1,685 (-39%)	-386 (-13%)	-5,154 (-45%)	-1,134 (-15%)
Dry	-601 (-28%)	-108 (-7%)	-1,621 (-33%)	-284 (-8%)
Critical	-169 (-18%)	-34 (-4%)	-393 (-21%)	-79 (-5%)
	Shading indicates10% or greater decrease in relative abundance.			
Note: Based on the X2-Relative Abundance Regressions of Kimmerer et al. (2009).				

The differences in predicted abundance described above result from differences in predicted Delta outflow in January through June between Alternative 3 and NAA. Averaged across all water years, predicted Delta outflow under Alternative 3 showed <10% difference relative to NAA during the peak larval longfin smelt transport period from January-March. During April-June however, Delta outflows would be reduced 15–25% compared to NAA. The largest differences would occur in above and below normal water years in April (23–25% reduction in outflow) and in wet, above normal, and below normal water years in May (25–31% reduction in outflow).

Longfin smelt may benefit from habitat restoration which includes *CM2 Yolo Bypass Fisheries Enhancement* for smelt present in Cache Slough region, and *CM4 Tidal Natural Communities Restoration* for smelt in the west Delta and Suisun Bay*.* This restored habitat is intended to provide additional food production and export to rearing areas, which may provide benefits to longfin smelt, particularly from Suisun Marsh, West Delta, and Cache Slough ROAs.

CEQA Conclusion: Under Alternative 3, average Delta outflows would be increased 7% in January and February, similar to Existing Conditions in March, and reduced in spring (15-16% decrease in April and June, 25% decrease in May) compared to Existing Conditions.

Average relative longfin smelt abundance, based on Kimmerer et al.2009, decreased 33–39% compared to Existing Conditions (Table 11-3-7). Relative longfin smelt abundances decreased under Alternative 3 in all water year types, with the largest reduction (35–49% decrease) in wet, above normal, and below normal water year types, based on Bay Otter Trawl indices.

It is worth noting that this CEQA analysis predicts a greater decrease in juvenile relative abundance than estimated under the NEPA analysis set forth above. This interpretation of the biological modeling is likely attributable to different modeling assumptions for four factors: sea level rise, climate change, future water demands, and implementation of the alternative. As discussed above (Section 11.3.3), because of differences between the CEQA and NEPA baselines, it is sometimes possible for CEQA and NEPA significance conclusions to vary between one another under the same impact discussion. The baseline for the CEQA analysis is Existing Conditions at the time the NOP was prepared. Both the action alternative and the NEPA baseline (NAA) models anticipated future conditions that would occur in 2060 (LLT implementation period), including the projected effects of climate change (precipitation patterns), sea level rise and future water demands, as well as implementation of required actions under the 2008 USFWS BiOp and the 2009 NMFS BiOp. Because the action alternative modeling does not partition the effects of implementation of the alternative from the effects of sea level rise, climate change and future water demands, the comparison to Existing Conditions may not offer a clear understanding of the impact of the alternative on the environment. This suggests that the NEPA analysis, which compares results between the alternative and NAA, is a better approach because it isolates the effect of the alternative from those of sea level rise, climate change, and future water demands.

When compared to NAA and informed by the NEPA analysis, above, the average longfin smelt abundance, based on Kimmerer et al. (2009), under Alternative 3 decreased 7–8% compared to NAA (Table 11-3-7), with the greatest reduction (13-17%) in above normal and below normal water year types. These results represent the increment of change attributable to the alternative, and address the limitations of the comparison the CEQA baseline (Existing Conditions).

Overall, Alternative 3 could have a significant impact because reduced Delta outflows in the spring would have the potential to contribute to reductions in longfin smelt abundances. As a result, this impact is considered significant, and mitigation would be required. Implementation of Mitigation Measures AQUA-22a through 22c, habitat restoration and adaptive management would reduce this impact to less than significant.

Mitigation Measure AQUA-22a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Longfin Smelt to Determine Feasibility of Mitigation to Reduce Impacts to Rearing Habitat

Although analysis conducted as part of the EIR/EIS determined that Alternative 3 would have significant and unavoidable adverse effects on rearing habitat, this conclusion was based on the best available scientific information at the time and may prove to have been overstated. Upon the commencement of operations of CM1 and continuing through the life of the permit, the BDCP proponents will monitor effects on rearing habitat in order to determine whether such effects would be as extensive as concluded at the time of preparation of this document and to determine any potentially feasible means of reducing the severity of such effects. This mitigation measure requires a series of actions to accomplish these purposes, consistent with the operational framework for Alternative 3.

The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 3 operations only. Development of mitigation actions for the incremental impact on rearing habitat attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 3.

Mitigation Measure AQUA-22b: Conduct Additional Evaluation and Modeling of Impacts on Longfin Smelt Rearing Habitat Following Initial Operations of CM1

Following commencement of initial operations of CM1 and continuing through the life of the permit, the BDCP proponents will conduct additional evaluations to define the extent to which modified operations could reduce impacts to rearing habitat under Alternative 3. The analysis required under this measure may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6).

Mitigation Measure AQUA-22c: Consult with USFWS and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Longfin Smelt Rearing Habitat Consistent with CM1

In order to determine the feasibility of reducing the effects of CM1 operations on longfin smelt habitat, the BDCP proponents will consult with NMFS, USFWS and CDFW to identify and implement any feasible operational means to minimize effects on rearing habitat. Any such action will be developed in conjunction with the ongoing monitoring and evaluation of habitat conditions required by Mitigation Measure AQUA-22a.

If feasible means are identified to reduce impacts on rearing habitat consistent with the overall operational framework of Alternative 3 without causing new significant adverse impacts on other covered species, such means shall be implemented. If sufficient operational flexibility to reduce effects on longfin smelt habitat is not feasible under Alternative 3 operations, achieving further impact reduction pursuant to this mitigation measure would not be feasible under Alternative 3, and the impact on longfin smelt would remain significant and unavoidable.

Impact AQUA-23: Effects of Water Operations on Rearing Habitat for Longfin Smelt

The analysis, NEPA Effects and CEQA Conclusion for effects of water operations on rearing habitat for longfin smelt is included in Impact AQUA-22: Effects of Water Operations on Spawning, Egg Incubation, and Rearing Habitat for Longfin Smelt.

Impact AQUA-24: Effects of Water Operations on Migration Conditions for Longfin Smelt

The analysis, NEPA Effects and CEQA Conclusion for effects of water operations on migration conditions for longfin smelt is included in Impact AQUA-22: Effects of Water Operations on Spawning, Egg Incubation, and Rearing Habitat for Longfin Smelt.

Restoration Measures (CM2, CM4–CM7, and CM10)

Alternative 3 has the same restoration measures as Alternative 1A. Because no substantial differences in restoration-related effects on fish are anticipated anywhere in the affected environment under Alternative 3 compared to those described in detail for Alternative 1A, the effects of restoration measures on longfin smelt described under Alternative 1A (Impact AQUA-25 through AQUA-27) also appropriately characterize effects under Alternative 3.

The following impacts are those presented under Alternative 1A that are identical for Alternative 3.

Impact AQUA-25: Effects of Construction of Restoration Measures on Longfin Smelt

Impact AQUA-26: Effects of Contaminants Associated with Restoration Measures on Longfin Smelt

Impact AQUA-27: Effects of Restored Habitat Conditions on Longfin Smelt

NEPA Effects: All of these effects have been determined to result in no adverse effects on longfin smelt. Specifically for AQUA-26, the effects of contaminants on longfin smelt with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on longfin smelt are uncertain.

CEQA Conclusions: The overall effects of the restoration measures is considered less than significant for CEQA purposes for the reasons identified for Alternative 1A.

Other Conservation Measures (CM12–CM19 and CM21)

Alternative 3 has the same other conservation measures as Alternative 1A. Because no substantial differences in other conservation-related effects on fish are anticipated anywhere in the affected environment under Alternative 3 compared to those described in detail for Alternative 1A, the effects of other conservation measures on longfin smelt described under Alternative 1A (Impact AQUA-28 through AQUA-36) also appropriately characterize effects under Alternative 3.

The following impacts are those presented under Alternative 1A that are identical for Alternative 3.

Impact AQUA-28: Effects of Methylmercury Management on Longfin Smelt (CM12)

Impact AQUA-29: Effects of Invasive Aquatic Vegetation Management on Longfin Smelt (CM13)

Impact AQUA-30: Effects of Dissolved Oxygen Level Management on Longfin Smelt (CM14)

Impact AQUA-31: Effects of Localized Reduction of Predatory Fish on Longfin Smelt (CM15)

Impact AQUA-32: Effects of Nonphysical Fish Barriers on Longfin Smelt (CM16)

Impact AQUA-33: Effects of Illegal Harvest Reduction on Longfin Smelt (CM17)

Impact AQUA-34: Effects of Conservation Hatcheries on Longfin Smelt (CM18)

Impact AQUA-35: Effects of Urban Stormwater Treatment on Longfin Smelt (CM19)

Impact AQUA-36: Effects of Removal/Relocation of Nonproject Diversions on Longfin Smelt (CM21)

NEPA Effects: The nine impact mechanisms have been determined to range from no effect, to no adverse effect, or beneficial effects on longfin smelt, for the reasons identified for Alternative 1A.

CEQA Conclusions: The nine impact mechanisms would be considered to range from no impact, to less than significant, or beneficial on longfin smelt, for the reasons identified for Alternative 1A, and no mitigation is required.

Winter-Run Chinook Salmon

Construction and Maintenance of CM1

Impact AQUA-37: Effects of Construction of Water Conveyance Facilities on Chinook Salmon (Winter-Run ESU)

The potential effects of construction of water conveyance facilities on Chinook salmon under Alternative 3 would be similar to those described for Alternative 1A (see Impact AQUA-37) except that Alternative 3 would include two intakes compared to five intakes under Alternative 1A, so the effects would be proportionally less under this alternative. This would convert about 4,450 lineal feet of existing shoreline habitat into intake facility structures and would require about 10.2 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. The effects related to temporary increases in turbidity, accidental spills, underwater noise, in-water work activities, and disturbance of contaminated sediments would be similar to Alternative 1A and the same environmental commitments and mitigation measures (described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*) would be available to avoid and minimize potential effects.

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-37, environmental commitments and mitigation measures would be available to avoid and minimize potential effects, and the effect would not be adverse for Chinook salmon.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-37, the impact of the construction of water conveyance facilities on Chinook salmon would be less than significant except for construction noise associated with pile driving which would only occur for two intakes rather than five. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in the discussion of Alternative 1A.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in the discussion of Alternative 1A.

Impact AQUA-38: Effects of Maintenance of Water Conveyance Facilities on Chinook Salmon (Winter-Run ESU)

NEPA Effects: The potential effects of the maintenance of water conveyance facilities under Alternative 3 would be the similar to those described for Alternative 1A except that only two intakes would need to be maintained under Alternative 3 instead of five under Alternative 1A (see Impact AQUA-2, delta smelt). As concluded in Alternative 1A, Impact AQUA-38, the effect would not be adverse for Chinook salmon.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-38, the impact of the maintenance of water conveyance facilities on Chinook salmon would be less than significant and no mitigation would be required.

Water Operations of CM1

Impact AQUA-39: Effects of Water Operations on Entrainment of Chinook Salmon (Winter-Run ESU)

Water Exports from SWP/CVP South Delta Facilities

Alternative 3 would reduce the overall entrainment of juvenile winter-run Chinook salmon at the south Delta export facilities. Average entrainment would decrease 22% across all water year types compared to NAA (Table 11-3-8), with the greatest reductions in wetter years (18% to 33% less compared to NAA). Pre-screen losses, typically attributed to predation, would be expected to decrease commensurate with decreased entrainment at the south Delta facilities.

Table 11-3-8. Juvenile Chinook Salmon Annual Entrainment Index[a] at the SWP and CVP Salvage Facilities—Differences between Model Scenarios for Alternative 3

	Absolute Difference (Percent Difference)	
Water Year Type	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Winter-Run Chinook Salmon		
Wet	-3,467 (-30%)	-3,888 (-33%)
Above Normal	-1,582 (-24%)	-1,707 (-25%)
Below Normal	-1,626 (-23%)	-1,202 (-18%)
Dry	-337 (-9%)	-30 (-1%)
Critical	-195 (-15%)	-56 (-5%)
All Years	-1,546 (-23%)	-1,486 (-22%)
	Shading indicates entrainment increased 5% or more.	

[a] Estimated annual number of fish lost, based on normalized data.

Water Exports from SWP/CVP North Delta Intake Facilities

As described under Alternative 1A (Impact AQUA-39), potential entrainment of juvenile salmonids at the north Delta intakes would be greater than baseline, but the effects would be minimal because the north Delta intakes would have state-of-the-art screens to exclude juvenile fish.

Water Export with a Dual Conveyance for the SWP North Bay Aqueduct

As described under Alternative 1A (Impact AQUA-39), potential entrainment and impingement effects for juvenile salmonids would be minimal because intakes would have state-of-the-art screens installed.

NEPA Effects: In conclusion, Alternative 3 would reduce the overall entrainment of juvenile winter Chinook salmon compared to baseline conditions, which would be a beneficial impact.

***CEQA Conclusion*:** As discussed above, entrainment losses of juvenile winter-run Chinook salmon at the south Delta export facilities would decrease under Alternative 3 compared to Existing Conditions (Table 11-3-8). Impacts at the north Delta intake facilities would be similar to Alternative 1A but less because Alternative 3 has only two intakes. Overall, impacts would be less than significant and may be beneficial due to reductions in entrainment at the south Delta export facilities and at the north Delta intake facilities. No mitigation would be required.

The impact and conclusion for predation associated with entrainment is the same as described above, because although combined predation losses at the south Delta and the proposed north Delta intakes would increase for all races of juveniles, there would not be substantial effects on population levels. The impacts would be less than significant, no mitigation would be required.

Impact AQUA-40: Effects of Water Operations on Spawning and Egg Incubation Habitat for Chinook Salmon (Winter-Run ESU)

In general, effects of Alternative 3 on spawning and egg incubation habitat for winter-run Chinook salmon relative to NAA are uncertain.

Flows in the Sacramento River between Keswick and upstream of Red Bluff Diversion Dam were examined during the May through September winter-run Chinook salmon spawning period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Lower flows can reduce the instream area available for spawning and egg incubation. Flows under A3_LLT during May through July would generally be similar to or greater than flows under NAA except in dry years during July (9% at both locations). Flows during August and September under A3_LLT would be mostly lower than flows under NAA (up to 45% lower depending on month, location, and water year type).

Shasta Reservoir storage volume at the end of May influences flow rates below the dam during the May through September winter-run spawning and egg incubation period. May Shasta storage volume under A3_LLT would be similar to or greater than storage under NAA for all water year types except below normal (8% lower) and dry (6% lower) (Table 11-3-9).

These results indicate that there would be small to moderate effects of Alternative 3 relative to NAA.

Table 11-3-9. Difference and Percent Difference in May Water Storage Volume (thousand acre-feet) in Shasta Reservoir for Model Scenarios

Water Year Type	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Wet	-78 (-2%)	-44 (-1%)
Above Normal	-161 (-4%)	-75 (-2%)
Below Normal	-518 (-13%)	-320 (-8%)
Dry	-634 (-17%)	-190 (-6%)
Critical	-593 (-24%)	-9 (0%)

Water temperatures in the Sacramento River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-40, which indicates that there would generally be no effects on water temperature in the Sacramento River.

The Reclamation egg mortality model predicts that winter-run Chinook salmon egg mortality in the Sacramento River under A3_LLT would be similar to mortality under NAA in wet and critical years (<5% difference). Egg mortality under A3_LLT would be 12% to 97% greater than mortality under NAA in above normal, below normal, and dry water years, although these increases represent a 0.3 to 2% absolute scale change in the winter-run Chinook salmon population (Table 11-3-10). Therefore, this effect is considered negligible to the winter-run population. These results indicate that climate change would cause the majority of the increase in winter-run egg mortality.

Table 11-3-10. Difference and Percent Difference in Percent Mortality of Winter-Run Chinook Salmon Eggs in the Sacramento River (Egg Mortality Model)

Water Year Type	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Wet	1 (270%)	-0.03 (-2%)
Above Normal	2 (413%)	0.3 (13%)
Below Normal	3 (267%)	2 (97%)
Dry	7 (440%)	1 (12%)
Critical	43 (159%)	-1 (-2%)
All	9 (190%)	0.3 (2%)

SacEFT predicts that there would be a 22% decrease in the percentage of years with good spawning availability, measured as weighted usable area, under A3_LLT relative to NAA (Table 11-3-11). This reduction would be 7% on an absolute scale and, therefore, is considered a small effect. SacEFT predicts that the percentage of years with good (lower) redd scour risk under A3_LLT would be identical to the percentage of years under NAA. SacEFT predicts that the percentage of years with good egg incubation conditions under A3_LLT would be similar to (<5% difference) that under NAA. SacEFT predicts that the percentage of years with good (lower) redd dewatering risk under A3_LLT would be 10% lower than risk under NAA, which is negligible (3%) on an absolute scale.

The biological significance of a reduction in available suitable spawning habitat varies at the population level in response to a number of factors, including adult escapement. For those years when adult escapement is less than the carrying capacity of the spawning habitat, a reduction in area would have little or no population level effect. In years when escapement exceeds carrying capacity of the reduced habitat, competition among spawners for space (e.g., increased redd superimposition) would increase, resulting in reduced reproductive success. The reduction in the frequency of years in which spawning habitat availability is considered to be good by SacEFT could result in reduced reproductive success and abundance of winter-run Chinook salmon if the number of spawners is limited by spawning habitat quantity

Table 11-3-11. Difference and Percent Difference in Percentage of Years with "Good" Conditions for Winter-Run Chinook Salmon Habitat Metrics in the Upper Sacramento River (from SacEFT)

Metric	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Spawning WUA	-33 (-57%)	-7 (-22%)
Redd Scour Risk	0 (0%)	0 (0%)
Egg Incubation	-25 (-26%)	-2 (-3%)
Redd Dewatering Risk	1 (4%)	-3 (-10%)
Juvenile Rearing WUA	-10 (-20%)	15 (60%)
Juvenile Stranding Risk	-14 (-70%)	-25 (-81%)
WUA = Weighted Usable Area.		

NEPA Effects: Available analytical tools show conflicting results regarding the temperature effects of relatively small changes in predicted summer and fall flows. Several models (CALSIM, SRWQM, and Reclamation Egg Mortality Model) generally show no change in upstream conditions as a result of Alternative 3. However, one model, SacEFT, shows adverse effects under some conditions. After extensive investigation of these results, they appear to be a function of high model sensitivity to relatively small changes in estimated upstream conditions, which may or may not accurately predict adverse effects. The new NDD structures allow for spring time deliveries of water south of the Delta that are currently constrained under the NAA. For this reason, additional spring storage criteria may be necessary to ensure Shasta Reservoir operations similar to what was modeled. These discussions will occur in the Section 7 consultation with Reclamation on Shasta Reservoir and system-wide operations, which is outside the scope of BDCP. In conclusion, Alternative 3 modeling results support a finding that effects are uncertain, but modeled results are mixed and operations that match the CALSIM modeling are not assured. Model results will be submitted to independent peer review to confirm that adverse effects are not reasonably anticipated to occur.

CEQA Conclusion: In general, Alternative 3 would not affect spawning and egg incubation habitat for winter-run Chinook salmon relative to the Existing Conditions.

CALSIM flows in the Sacramento River between Keswick and upstream of Red Bluff were examined during the May through September winter-run spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT during May through July would generally be similar to or greater than flows under Existing Conditions, except in wet years during May (14% to 18% lower depending on location) and in dry and critical years during July (6% to 11% lower depending on month and location) and August (21% to 25% lower depending on location). Flows under A3_LLT during August and September would generally be lower than flows under Existing Conditions by up to 27% depending on month, water year type, and location.

Shasta Reservoir storage volume at the end of May under A3_LLT would be similar to Existing Conditions in wet and above normal water years, but lower by 13% to 24% in below normal, dry, and critical water years (Table 11-3-9). This indicates that there would be a small to moderate effect of Alternative 3 on flows during the spawning and egg incubation period.

Water temperatures in the Sacramento River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-40, which indicates that there would be increased exceedances of NMFS temperature thresholds in the Sacramento River relative to Existing Conditions.

The Reclamation egg mortality model predicts that winter-run Chinook salmon egg mortality in the Sacramento River under A3_LLT would be 159% to 440% greater than mortality under Existing Conditions depending on water year type (Table 11-3-10). These increases would only affect the winter-run population during dry and critical years, in which the absolute percent increase of the winter-run population would be 7% and 43%, respectively. These results indicate that Alternative 3 would cause substantially increased winter-run Chinook salmon mortality in drier years in the Sacramento River.

SacEFT predicts that there would be a 57% decrease in the percentage of years with good spawning availability, measured as weighted usable area, under A3_LLT relative to Existing Conditions (Table 11-3-11). SacEFT predicts that the percentage of years with good (lower) redd scour risk under A3_LLT would be identical to the percentage of years under Existing Conditions. SacEFT predicts that the percentage of years with good egg incubation conditions under A3_LLT would be 26% lower than under Existing Conditions. SacEFT predicts that the percentage of years with good (lower) redd dewatering risk under A3_LLT would be similar (<5% difference) to the percentage of years under Existing Conditions. These results indicate that Alternative 3 would cause moderate to substantial reductions in spawning WUA and egg incubation conditions.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-40 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 3 could be significant because, when compared to the CEQA baseline, the alternative could substantially reduce suitable spawning habitat and substantially reduce the number of fish as a result of egg mortality, contrary to the NEPA conclusion set forth above. Flows and water temperature conditions would be degraded in the Sacramento River under Alternative 3 relative to Existing Conditions. Egg mortality in drier years, during which winter-run Chinook salmon would already be stressed due to reduced flows and increased temperatures, would be up to 43% greater (on an absolute scale) due to Alternative 3 compared to the Existing Conditions (Table 11-3-10). Further, the extent of spawning habitat would be 33% lower (absolute scale) and egg incubation would be reduced by 25% (absolute scale) under Alternative 3 compared to the Existing Conditions (Table 11-3-11), which represent a substantial reductions spawning and egg incubation conditions for winter-run Chinook salmon.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow and reservoir storage outputs between Existing Conditions in the late long-term implementation period and Alternative 3 indicates that flows and reservoir storage in the locations and during the months analyzed above would generally be similar between future conditions without the alternative (NAA) and Alternative 3. This indicates that the differences between Existing Conditions and Alternative 3 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 3, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on spawning habitat for winter-run Chinook salmon. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-41: Effects of Water Operations on Rearing Habitat for Chinook Salmon (Winter-Run ESU)

In general, Alternative 3 would reduce the quality of rearing habitat for fry and juvenile winter-run Chinook salmon relative to NAA.

Sacramento River flows upstream of Red Bluff were examined for the juvenile winter-run Chinook salmon rearing period (August through December) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Lower flows can lead to reduced extent and quality of fry and juvenile rearing habitat. Flows under A3_LLT would generally be similar to or greater than flows under NAA during October and December, but up to 43% lower than flows under NAA during August, September, and November depending on month and water year type. This indicates that both climate change and

Alternative 3 would cause small to moderate reductions in flows in the Sacramento River during most months of the winter-run upstream fry and juvenile rearing period.

Water temperatures in the Sacramento River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-41, which indicates that there would be no effect on mean monthly temperatures during the winter-run juvenile rearing period.

SacEFT predicts that the percentage of years with good juvenile rearing habitat availability, measured as weighted usable area, under A3_LLT would be 60% greater (15% higher on an absolute scale) than that under NAA (Table 11-3-10). In addition, the percentage of years with good (low) juvenile stranding risk under A3_LLT is predicted to be 81% lower (25% lower on an absolute scale) than that under NAA. This indicates that, although the quantity of juvenile rearing habitat in the Sacramento River under Alternative 3 would be substantially similar to or higher than NAA, the quality of this habitat, measured as stranding risk, would be substantially lower.

SALMOD predicts that mean winter-run smolt equivalent habitat-related mortality under A3_LLT would be similar (<5% difference) to mortality under NAA.

NEPA Effects: Collectively, these results indicate that the effect would be adverse because it has the potential to substantially reduce the amount of suitable rearing habitat. Under Alterative 3, there would be large flow reductions during 3 months of the 5-month the larval and juvenile rearing period. Also, stranding risk of larvae and juveniles would be substantially higher under Alternative 3relative to NAA (Table 11-3-11). This effect is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this effect to a level that is not adverse would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this would be an unavoidable adverse effect. Even so, proposed mitigation (Mitigation Measure AQUA-41a through AQUA-41c) has the potential to reduce the severity of impact, although not necessarily to a not adverse level.

CEQA Conclusion: In general, Alternative 3 would reduce the quantity and quality of fry and juvenile rearing habitat for winter-run Chinook salmon relative to the Existing Conditions.

Sacramento River flows upstream of Red Bluff were examined for the juvenile winter-run Chinook salmon rearing period (August through December) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). During September, October, and December, flows under A3_LLT would generally be similar to or greater than flows under Existing Conditions, except in wet and dry water years during September (23% and 20% lower, respectively). During August and November, flow would be nearly always lower than under Existing Conditions by up to 24% depending on month and water year type.

Water temperatures in the Sacramento River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-41, which indicates that there would be small temperature increases under Alternative 1A during some months in the Sacramento River.

SacEFT predicts that the percentage of years with good juvenile rearing habitat availability, measured as weighted usable area, under A3_LLT would be 20% lower than under Existing Conditions (Table 11-3-11). In addition, the percentage of years with good (low) juvenile stranding risk under A3_LLT is predicted to be 70% lower than under Existing Conditions. These results indicate that there would be a small reduction in the amount of juvenile rearing habitat and a moderate reduction in the quality of juvenile rearing habitat in the Sacramento River, measured as stranding risk, under Alternative 3 relative to Existing Conditions.

SALMOD predicts that winter-run smolt equivalent habitat-related mortality under A3_LLT would be 9% higher than under Existing Conditions.

Summary of CEQA Conclusion

These results indicate that the impact would be significant because it has the potential to substantially reduce the amount of suitable habitat and substantially interfere with the movement of fish. Differences in flows are moderately large during August and November. Temperatures would increase in the Sacramento River during the winter-run rearing period under Alternative 3. Further, a 20% reduction (10% on an absolute scale) in rearing habitat quantity and 70% increase (14% on an absolute scale) in stranding risk would reduce upstream habitat conditions for winter-run fry and juveniles. SALMOD predicts that habitat-related mortality will increase due to Alternative 3. This impact is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this impact to a less-than-significant level would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this impact is significant and unavoidable because there is no feasible mitigation available. Even so, proposed below is mitigation that has the potential to reduce the severity of impact though not necessarily to a less-than-significant level.

Mitigation Measure AQUA-41a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Winter-Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Rearing Habitat

Although analysis conducted as part of the EIR/EIS determined that Alternative 3 would have significant and unavoidable adverse effects on rearing habitat, this conclusion was based on the best available scientific information at the time and may prove to have been overstated. Upon the commencement of operations of CM1 and continuing through the life of the permit, the BDCP proponents will monitor effects on rearing habitat in order to determine whether such effects would be as extensive as concluded at the time of preparation of this document and to determine any potentially feasible means of reducing the severity of such effects. This mitigation measure requires a series of actions to accomplish these purposes, consistent with the operational framework for Alternative 3.

The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 3 operations only. Development of mitigation actions for the incremental impact on spawning habitat attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 3.

Mitigation Measure AQUA-41b: Conduct Additional Evaluation and Modeling of Impacts on Winter-Run Chinook Salmon Rearing Habitat Following Initial Operations of CM1

Following commencement of initial operations of CM1 and continuing through the life of the permit, the BDCP proponents will conduct additional evaluations to define the extent to which modified operations could reduce impacts to rearing habitat under Alternative 3. The analysis required under this measure may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6).

Mitigation Measure AQUA-41c: Consult with NMFS, USFWS, and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Winter-Run Chinook Salmon Rearing Habitat Consistent with CM1

In order to determine the feasibility of reducing the effects of CM1 operations on Chinook salmon habitat, the BDCP proponents will consult with NMFS, USFWS, and CDFW to identify and implement any feasible operational means to minimize effects on rearing habitat. Any such action will be developed in conjunction with the ongoing monitoring and evaluation of habitat conditions required by Mitigation Measure AQUA-41a.

If feasible means are identified to reduce impacts on rearing habitat consistent with the overall operational framework of Alternative 3 without causing new significant adverse impacts on other covered species, such means shall be implemented. If sufficient operational flexibility to reduce effects on winter-run Chinook salmon habitat is not feasible under Alternative 3 operations, achieving further impact reduction pursuant to this mitigation measure would not be feasible under this Alternative, and the impact on winter-run Chinook salmon would remain significant and unavoidable.

Impact AQUA-42: Effects of Water Operations on Migration Conditions for Chinook Salmon (Winter-Run ESU)

In general, Alternative 3 would reduce migration conditions for winter-run Chinook salmon relative to NAA.

Upstream of the Delta

Flows in the Sacramento River upstream of Red Bluff were examined for the July through November juvenile emigration period. A reduction in flow may reduce the ability of juvenile winter-run Chinook salmon to migrate effectively down the Sacramento River. Flows under A3_LLT would generally be similar to flows under NAA during July, up to 43% lower under NAA during July, August, and November, and up to 33% greater during October (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). This indicates that Alternative 3 would cause small to moderate reductions in flows in the Sacramento River during the majority of months during the winter-run migration period.

Flows in the Sacramento River upstream of Red Bluff were examined during the adult winter-run Chinook salmon upstream migration period (December through August). A reduction in flows may reduce the olfactory cues needed by adult winter-run Chinook salmon to return to natal spawning grounds in the upper Sacramento River. Flows under A3_LLT would generally be similar to flows under NAA, except during May, in which flows would be up to 15% greater, and during August, in which flows would be up to 43% lower.

Water temperatures in the Sacramento River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-42, which indicates there would be no differences in water temperatures between NAA and Alternative 1A.

Through-Delta

The effects on through-Delta migration were evaluated using the approach described in Alternative 1A, Impact AQUA-42.

Juveniles

Juvenile salmonids migrating down the Sacramento River would generally experience lower flows below the north Delta intakes by up to 26% averaged over all water year types compared to baseline conditions. The two intake structures of Alternative 3 would replace aquatic habitat and likely attract piscivorous fish around the intake structures, as described above in Impact AQUA-42. The two intakes would remove or modify habitat along that portion of the migration corridor (8.3 acres aquatic habitat and 4,450 linear feet of shoreline). Potential predation losses at the north Delta intakes, as estimated by the bioenergetics model for two intakes with median density of predators (119 striped bass per 1,000 feet of intake), would be 0.7% of the annual juvenile production estimated for the Sacramento Valley (Table 11-3-12). A conservative assumption of 5% loss per intake would yield a cumulative loss of 8% of juvenile winter-run Chinook that reach the north Delta. This assumption is uncertain and represents an upper bound estimate.

Table 11-3-12. Chinook Salmon Predation Loss at the Proposed North Delta Diversion Intakes for Alternative 3 (Two Intakes)

Striped Bass Numbers		Estimated Number of Juvenile Salmon Consumed				Percentage of Annual Juvenile Production (%) Consumed			
Per 1,000 ft. of Intake	Total Bass	Winter	Spring	Fall	Late Fall	Winter	Spring	Fall	Late Fall
18 (Low)	52	2,651	3,709	56,870	10,760	0.10%	0.09%	0.09%	0.25%
119 (Median)	345	17,525	24,520	375,972	71,138	0.67%	0.58%	0.61%	1.65%
219 (High)	635	32,252	45,125	691,916	130,918	1.24%	1.07%	1.12%	3.04%

Through-Delta survival by emigrating juvenile winter-run Chinook salmon under Alternative 3 (A3_LLT) l would be similar to NAA (Table 11-3-13).

Table 11-3-13. Through-Delta Survival (%) of Emigrating Juvenile Winter-Run Chinook Salmon under Alternative 3

	Percentage Survival			Difference in Percentage Survival (Relative Difference)	
Month	EXISTING CONDITIONS	NAA	A3_LLT	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Wetter Years	46.3	46.1	45.3	-1.0 (-2%)	-0.8 (-2%)
Drier Years	28.0	27.1	26.4	-1.6 (-6%)	-0.7 (-3%)
All Years	34.9	34.2	33.5	-1.4 (-4%)	-0.7 (-2%)

Note: Delta Passage Model results for survival to Chipps Island.
Wetter = Wet and Above Normal WYs (6 years).
Drier = Below Normal, Dry and Critical WYs (10 years).

Adults

Adult salmonids migrating through the Delta use flow and olfactory cures for navigation to their natal streams (Marston et al. 2012). Attraction flow, as estimated by the percentage of Sacramento River water at Collinsville (DSM2 fingerprinting), would decrease less than 10% compared to NAA during the adult winter-run upstream migration from December-July (Table 11-3-14). The reductions in percentage are small in comparison with the magnitude of change in dilution (20%) reported to cause a significant change in migration by Fretwell (1989) and, therefore, are not expected to affect adult Chinook salmon migration. Therefore, it is expected that olfactory cues for adult winter-run Chinook salmon from the Sacramento River would be adequate and not substantially affected by flow operations under Alternative 3. However, uncertainty remains with regard to adult salmon behavioral response to anticipated changes in lower Sacramento River flow percentages. This topic is discussed further in Impact AQUA-42 for Alternative 1A.

Table 11-3-14. Percentage (%) of Water at Collinsville that Originated in the Sacramento River and San Joaquin River during the Adult Chinook Migration Period for Alternative 3

Month	EXISTING CONDITIONS	NAA	A3_LLT	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Sacramento River					
September	60	65	54	-6	-11
October	60	68	66	6	-2
November	60	66	63	3	-3
December	67	66	64	-3	-2
January	76	75	73	-3	-2
February	75	72	69	-6	-3
March	78	76	69	-9	-7
April	77	75	69	-8	-6
May	69	65	63	-6	-2
San Joaquin River					
September	0.3	0.1	0.8	0.5	0.7
October	0.2	0.3	0.9	0.7	0.6
November	0.4	1.0	1.8	1.4	0.8
December	0.9	1.0	1.1	0.2	0.1
January	1.6	1.7	2.2	0.6	0.5
February	1.4	1.5	2.4	1.0	0.9
March	2.6	2.8	4.5	1.9	1.7
April	6.3	6.6	7.3	1.0	0.7
	Shading indicates 10% or greater absolute difference.				

NEPA Effects: Overall, the results indicate that the effect of Alternative 3 is adverse because it has the potential to substantially decrease winter-run Chinook salmon migration habitat conditions in the Sacramento River.

Upstream of the Delta in the Sacramento River, flows would be up to 43% lower during the majority of the juvenile migration period. These reductions in flow may impact the condition and survival of juvenile winter-run Chinook salmon as they migrate downstream. There would be no differences between Alternative 3 and NAA in upstream flows during the adult migration period or in water temperatures during both juvenile and adult migration periods.

Adult attraction flows in the Delta under Alternative 3 would be lower than those under NAA, but adult attraction flows are expected to be adequate to provide olfactory cues for migrating adults.

Near-field effects of Alternative 3 NDD on winter-run Chinook salmon related to impingement and predation associated with three new intake structures could result in negative effects on juvenile migrating winter-run Chinook salmon, although there is high uncertainty regarding the overall effects. It is expected that the level of near-field impacts would be directly correlated to the number of new intake structures in the river and thus the level of impacts associated with 2 new intakes would be considerably lower than those expected from having 5 new intakes in the river. Estimates within the effects analysis range from very low levels of effects (<1% mortality) to more significant effects (~ 8% mortality above current baseline levels). CM15 would be implemented with the intent of providing localized and temporary reductions in predation pressure at the NDD. Additionally, several pre-construction surveys to better understand how to minimize losses associated with the 2 new intake structures will be implemented as part of the final NDD screen design effort. Alternative 3 also includes an Adaptive Management Program and Real-Time Operational Decision-Making Process to evaluate and make limited adjustments intended to provide adequate migration conditions for winter-run Chinook. However, at this time, due to the absence of comparable facilities anywhere in the lower Sacramento River/Delta, the degree of mortality expected from near-field effects at the NDD remains highly uncertain.

Two recent studies (Newman 2003 and Perry 2010) indicate that far-field effects associated with the new intakes could cause a reduction in smolt survival in the Sacramento River downstream of the NDD intakes due to reduced flows in this area. The analyses of other elements of Alternative 3 predict improvements in smolt condition and survival associated with increased access to the Yolo Bypass, reduced interior Delta entry, and reduced south Delta entrainment. The overall magnitude of each of these factors and how they might interact and/or offset each other in affecting salmonid survival through the plan area is uncertain, and remains an area of active investigation for the BDCP.

The DPM is a flow-based model being developed for BDCP which attempts to combine the effects of all of these elements of BDCP operations and conservation measures to predict smolt migration survival throughout the entire Plan Area. The current draft of this model predicts that smolt migration survival under Alternative 3 would be similar to those estimated for NAA. Further refinement and testing of the DPM, along with several ongoing and planned studies related to salmonid survival at and downstream of, the NDD are expected to be completed in the foreseeable future. These efforts are expected to improve our understanding of the relationships and interactions among the various factors affecting salmonid survival, and reduce the uncertainty around the potential effects of BDCP implementation on migration conditions for Chinook salmon.

Because upstream effects would be adverse, it is concluded that the overall effect of Alternative 3 on winter-run Chinook salmon migration conditions would be adverse.

This effect is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this impact to a level that is not adverse would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this effect is adverse and unavoidable because there is no feasible mitigation available.

CEQA Conclusion: In general, Alternative 3 would not affect migration conditions for winter-run Chinook salmon relative to the Existing Conditions.

Upstream of the Delta

Flows in the Sacramento River upstream of Red Bluff were examined during the July through November juvenile emigration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT for juvenile migrants would generally be greater than or similar to flows under Existing Conditions during August and November, in which flows would be up to 24% lower depending on month and water year type.

Flows in the Sacramento River upstream of Red Bluff were examined during the December through August adult migration period. Flows under A3_LLT would generally be similar to or greater than flows under Existing Conditions, except during August in which flows would be up to 24% lower under A3_LLT.

Water temperatures in the Sacramento River under Alternative3 would be the same as those under Alternative 1A, Impact AQUA-42, which indicates that there would be small increase in water temperatures under Alternative 3 during large portions of the juvenile and adult migration periods, compared to Existing Conditions.

Through-Delta

Through-Delta survival of juvenile winter-run Chinook salmon would be similar compared to Existing Conditions when averaged across all water years (<4% relative decrease) (Table 11-3-13. Predation of migrating juveniles would increase at the north Delta intakes, with loss hypothetically estimated of 0.7% to 8% of juveniles reaching the Delta. Attraction flows and olfactory cues for migrating adult winter-run Chinook salmon under Alternative 3, as indicated by the proportion of Sacramento River flows (54–73% of Delta water), would be similar (<10% difference) to Existing Conditions for (Table 11-3-14).

Summary of CEQA Conclusion

Due to the similarity in migration flows and water temperatures between Alternative 3 and the CEQA baseline for all months except November, upstream habitat and movement conditions are not substantially reduced for juvenile or adult winter-run Chinook salmon. Through-Delta survival of juvenile winter-run Chinook salmon would be similar compared to Existing Conditions. Further, based on the proportion of Sacramento River flows, olfactory cues would be similar (<10% difference) to Existing Conditions for adult winter-run Chinook salmon migrating through the Delta. Therefore, the overall impact of Alternative 3 on winter-run Chinook salmon would be less than significant, and no mitigation would be required.

Restoration Measures (CM2, CM4–CM7, and CM10)

Alternative 3 has the same restoration measures as Alternative 1A. Because no substantial differences in restoration-related fish effects are anticipated anywhere in the affected environment under Alternative 3 compared to those described in detail for Alternative 1A, the fish effects of restoration measures described for winter-run Chinook salmon under Alternative 1A (Impact AQUA-43 through AQUA-45) also appropriately characterize effects under Alternative 3.

The following impacts are those presented under Alternative 1A that are identical for Alternative 3.

Impact AQUA-43: Effects of Construction of Restoration Measures on Chinook Salmon (Winter-Run ESU)

Impact AQUA-44: Effects of Contaminants Associated with Restoration Measures on Chinook Salmon (Winter-Run ESU)

Impact AQUA-45: Effects of Restored Habitat Conditions on Chinook Salmon (Winter-Run ESU)

NEPA Effects: All of these effects have been determined to result in no adverse effects on winter-run Chinook salmon for NEPA purposes. Specifically for AQUA-44, the effects of contaminants on winter-run Chinook salmon with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on winter-run Chinook salmon are uncertain.

CEQA Conclusions: As described under Alternative 1A, the overall effect of these restoration measures would be considered less than significant for CEQA purposes for the reasons identified for Alternative 1A.

Other Conservation Measures (CM12–CM19 and CM21)

Alternative 3 has the same other conservation measures as Alternative 1A. Because no substantial differences in other conservation-related effects on fish are anticipated anywhere in the affected environment under Alternative 3 compared to those described in detail for Alternative 1A, the effects of other conservation measures on winter-run Chinook salmon as described under Alternative 1A (Impact AQUA-46 through AQUA-54) also appropriately characterize effects under Alternative 3.

The following impacts are those presented under Alternative 1A that are identical for Alternative 3.

Impact AQUA-46: Effects of Methylmercury Management on Chinook Salmon (Winter-Run ESU) (CM12)

Impact AQUA-47: Effects of Invasive Aquatic Vegetation Management on Chinook Salmon (Winter-Run ESU) (CM13)

Impact AQUA-48: Effects of Dissolved Oxygen Level Management on Chinook Salmon (Winter-Run ESU) (CM14)

Impact AQUA-49: Effects of Localized Reduction of Predatory Fish on Chinook Salmon (Winter-Run ESU) (CM15)

Impact AQUA-50: Effects of Nonphysical Fish Barriers on Chinook Salmon (Winter-Run ESU) (CM16)

Impact AQUA-51: Effects of Illegal Harvest Reduction on Chinook Salmon (Winter-Run ESU) (CM17)

Impact AQUA-52: Effects of Conservation Hatcheries on Chinook Salmon (Winter-Run ESU) (CM18)

Impact AQUA-53: Effects of Urban Stormwater Treatment on Chinook Salmon (Winter-Run ESU) (CM19)

Impact AQUA-54: Effects of Removal/Relocation of Nonproject Diversions on Chinook Salmon (Winter-Run ESU) (CM21)

NEPA Effects: The nine impact mechanisms have been determined to range from no effect, to no adverse effect, or beneficial effects on winter-run Chinook salmon for NEPA purposes, for the reasons identified for Alternative 1A.

CEQA Conclusions: The nine impact mechanisms would be considered to range from no impact, to less than significant, or beneficial on winter-run Chinook salmon, for the reasons identified for Alternative 1A, and no mitigation is required.

Spring-Run Chinook Salmon

Construction and Maintenance of CM1

Impact AQUA-55: Effects of Construction of Water Conveyance Facilities on Chinook Salmon (Spring-Run ESU)

The potential effects of construction of water conveyance facilities on spring-run Chinook salmon under Alternative 3 would be similar to those described for Alternative 1A (see Impact AQUA-55) except that Alternative 3 would include two intakes compared to five intakes under Alternative 1A, so the effects would be proportionally less under this alternative. This would convert about 4,450 lineal feet of existing shoreline habitat into intake facility structures and would require about 10.2 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. The effects related to temporary increases in turbidity, accidental spills, underwater noise, in-water work activities, and disturbance of contaminated sediments would be similar to Alternative 1A and the same environmental commitments and mitigation measures (described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*) would be available to avoid and minimize potential effects.

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-55, environmental commitments and mitigation measures would be available to avoid and minimize potential effects, and the effect would not be adverse for spring-run Chinook salmon.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-55, the impact of the construction of water conveyance facilities on spring-run Chinook salmon would be less than significant except for construction noise associated with pile driving. Potential pile driving impacts would be less than Alternative 1A because only two intakes would be constructed rather than five. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in the discussion of Alternative 1A.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in the discussion of Alternative 1A.

Impact AQUA-56: Effects of Maintenance of Water Conveyance Facilities on Chinook Salmon (Spring-Run ESU)

The maintenance-related effects of Alternative 3 would be identical for all four Chinook salmon ESUs. Accordingly, for a discussion of the impacts, please refer to the discussion for winter-run Chinook salmon (Alternative 3, Impact AQUA-38).

Water Operations of CM1

Impact AQUA-57: Effects of Water Operations on Entrainment of Chinook Salmon (Spring-Run ESU)

Water Exports from SWP/CVP South Delta Facilities

Alternative 3 would increase overall entrainment of juvenile spring-run Chinook salmon at the south Delta export facilities, estimated as salvage density, by 45% (Table 11-3-15) across all water years compared to NAA. Entrainment would be highest in above normal years and lowest in critical years. Under Alternative 3, entrainment would increase 143% in above normal water years and increase 107% in below normal water years compared to NAA. Pre-screen losses, typically attributed to predation, would be expected to increase commensurate with increased entrainment at the south Delta facilities.

The average proportion of the annual spring-run Chinook salmon population (assumed to be 750,000 juveniles approaching the Delta) lost at the south Delta facilities would increase about 2% under Alternative 3 compared to NAA.

Table 11-3-15. Juvenile Spring-Run Chinook Salmon Annual Entrainment Index[a] at the SWP and CVP Salvage Facilities—Differences between Model Scenarios for Alternative 3

	Absolute Difference (Percent Difference)	
Water Year Type	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Spring-Run Chinook Salmon		
Wet	16,688 (19%)	13,060 (14%)
Above Normal	37,640 (141%)	34,571 (116%)
Below Normal	6,782 (106%)	5,987 (84%)
Dry	9,577 (58%)	8,383 (48%)
Critical	-626 (-5%)	995 (10%)
All Years	19,379 (51%)	17,769 (45%)

Shading indicates entrainment increased 10% or more.

[a] Estimated annual number of fish lost, based on normalized data.

Water Exports from SWP/CVP North Delta Intake Facilities

As described for winter-run Chinook salmon under Alternative 1A (Impact AQUA-39), potential entrainment of juvenile salmonids at the north Delta intakes would be greater than baseline, but the effects would be minimal because the north Delta intakes would have state-of-the-art screens to exclude juvenile fish.

Water Export with a Dual Conveyance for the SWP North Bay Aqueduct

As described for winter-run Chinook salmon under Alternative 1A (Impact AQUA-39), potential entrainment and impingement effects for juvenile salmonids would be minimal because intakes would have state-of-the-art screens installed.

NEPA Effects: In conclusion, due to increased entrainment (average 45% increase) of juvenile spring-run Chinook salmon at the south Delta facilities, the effect of Alternative 3 would be adverse.

CEQA Conclusion: Due to increased entrainment (average 51% increase) compared to Existing Conditions, the impact of Alternative 3 on spring-run Chinook entrainment would be significant.

Impact AQUA-58: Effects of Water Operations on Spawning and Egg Incubation Habitat for Chinook Salmon (Spring-Run ESU)

In general, Alternative 3 would reduce spawning and egg incubation habitat for spring-run Chinook salmon relative to NAA.

Sacramento River

Flows in the Sacramento River upstream of Red Bluff were examined during the spring-run Chinook salmon spawning and incubation period (September through January). Flows under A3_LLT would be generally greater than and similar to flows NAA in October, December, and January, except in critical water years during January (8% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

Shasta Reservoir storage volume at the end of September influences flows downstream of the dam during the spring-run spawning and egg incubation period (September through January). Storage volume at the end of September would be 9% lower than under NAA in below normal water years, but would be similar to or greater than storage under NAA in other water year types depending on water year type (Table 11-3-16).

Table 11-3-16. Difference and Percent Difference in September Water Storage Volume (thousand acre-feet) in Shasta Reservoir for Model Scenarios

Water Year Type	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Wet	-286 (-9%)	226 (8%)
Above Normal	-484 (-15%)	131 (5%)
Below Normal	-587 (-20%)	-233 (-9%)
Dry	-544 (-22%)	-33 (-2%)
Critical	-392 (-33%)	-10 (-1%)

Water temperatures in the Sacramento River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-58, which indicates that there would generally be no effects of Alternative 3 on water temperatures during the spring-run spawning and egg incubation period in the Sacramento River, compared to NAA.

The Reclamation egg mortality model predicts that spring-run Chinook salmon egg mortality in the Sacramento River under A3_LLT would be lower than or similar to mortality under NAA in dry and critical years, but greater in wet (39% greater), above normal (20% greater), and below normal (33% greater) water years (Table 11-3-17).

Table 11-3-17. Difference and Percent Difference in Percent Mortality of Spring-Run Chinook Salmon Eggs in the Sacramento River (Egg Mortality Model)

Water Year Type	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Wet	24 (241%)	10 (39%)
Above Normal	29 (219%)	7 (20%)
Below Normal	43 (361%)	14 (33%)
Dry	55 (278%)	-2 (-3%)
Critical	22 (30%)	0 (0%)
All	35 (155%)	6 (12%)

SacEFT predicts that there would be a 69% increase in the percentage of years with good spawning availability, measured as weighted usable area, under A3_LLT relative to NAA (Table 11-3-18). SacEFT predicts that there would be no differences in the percentage of years with good (lower) redd scour risk under A3_LLT relative to NAA. SacEFT predicts that there would be a 41% decrease in the percentage of years with good (lower) egg incubation conditions under A3_LLT relative to NAA. SacEFT predicts that there would be an 18% increase in the percentage of years with good (lower) redd dewatering risk under A3_LLT relative to NAA. These results indicate that all spawning and egg habitat metrics except egg incubation conditions would improve or not change under Alternative 3 relative to NAA.

Table 11-3-18. Difference and Percent Difference in Percentage of Years with "Good" Conditions for Spring-Run Chinook Salmon Habitat Metrics in the Upper Sacramento River (from SacEFT)

Metric	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Spawning WUA	13 (19%)	34 (69%)
Redd Scour Risk	0 (0%)	0 (0%)
Egg Incubation	-66 (-77%)	-14 (-41%)
Redd Dewatering Risk	-9 (-18%)	6 (18%)
Juvenile Rearing WUA	-2 (-9%)	-2 (-9%)
Juvenile Stranding Risk	-5 (-26%)	0 (0%)

WUA = Weighted Usable Area.

Clear Creek

Flows in Clear Creek were examined during the spring-run Chinook salmon spawning and egg incubation period (September through January). Flows under A3_LLT would be similar to or greater than flows under NAA except in critical years during September (13% decrease) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

The potential risk of spring-run Chinook salmon redd dewatering in Clear Creek was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in September when spawning is assumed to occur. The greatest reduction in flows under A3_LLT would be the same or of a lower magnitude as that under NAA in all water year types (Table 11-3-19).

Water temperatures were not modeled in Clear Creek.

Table 11-3-19. Difference and Percent Difference in Greatest Monthly Reduction (Percent Change) in Instream Flow in Clear Creek below Whiskeytown Reservoir during the September through January Spawning and Egg Incubation Period[a]

Water Year Type	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Wet	0 (NA)	0 (NA)
Above Normal	-27 (NA)	0 (0%)
Below Normal	53 (100%)	0 (NA)
Dry	-67 (NA)	0 (0%)
Critical	-33 (-50%)	0 (0%)

NA = could not be calculated because the denominator was 0.

[a] Redd dewatering risk not applicable for months when flows during the egg incubation period were at or greater than flows in September, when spawning is assumed to occur. A negative value indicates that the greatest monthly reduction would be of greater magnitude (worse) under the alternative than under the baseline.

Feather River

Flows were examined in the Feather River low-flow channel (upstream of Thermalito Afterbay) where spring-run primarily spawn during September through January (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows under A3_LLT would not differ from NAA because minimum Feather River flows are included in the FERC settlement agreement and would be met for all model scenarios (California Department of Water Resources 2006).

Oroville Reservoir storage volume at the end of September influence flows downstream of the dam during the spring-run spawning and egg incubation period. Storage under A3_LLT would be 17% to 32% greater than storage under NAA depending on water year type (Table 11-3-20).

Table 11-3-20. Difference and Percent Difference in September Water Storage Volume (thousand acre-feet) in Oroville Reservoir for Model Scenarios

Water Year Type	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Wet	-477 (-16%)	537 (28%)
Above Normal	-482 (-20%)	309 (20%)
Below Normal	-372 (-18%)	237 (17%)
Dry	-30 (-2%)	323 (32%)
Critical	-40 (-4%)	148 (19%)

The potential risk of redd dewatering in the Feather River low-flow channel was evaluated by comparing the magnitude of flow reduction each month over the egg incubation period compared to the flow in September when spawning is assumed to occur. Minimum flows in the low-flow channel during October through January were identical among A3_LLT and NAA (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Therefore, there would be no effect of Alternative 3 on redd dewatering in the Feather River low-flow channel.

Water temperatures in the Feather River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-58, which indicates that there would be no effect of Alternative 3 on water temperatures in the Feather River relative to NAA during the spring-run spawning and egg incubation period, compared to NAA.

NEPA Effects: Collectively, these results indicate that the effect is adverse because it has the potential to substantially reduce the quantity and quality of spawning and egg incubation habitat. Although comparisons of mean flows and water temperatures in the Sacramento River indicate that there would not be differences between NAA and Alternative 3, the Reclamation egg mortality model predicts that spring-run Chinook salmon egg mortality in the Sacramento River under Alternative 3 would be higher than mortality under NAA by up to 14% (absolute scale) depending on water year type and by 6% (absolute scale) with all water years combined (Table 11-3-17). Further, SacEFT predicts that the number of years with good egg incubation conditions would decline under Alternative 3 by 41% (14% on an absolute scale) (Table 11-3-18). There would be no biologically meaningful effects on spring-run Chinook salmon in Clear Creek or the Feather River.

This effect is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this effect to a level that is not adverse would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this would be an unavoidable adverse effect because there is no feasible mitigation available. Even so, proposed mitigation (Mitigation Measure AQUA-58a through AQUA-58c) has the potential to reduce the severity of impact, although not necessarily to a not adverse level.

CEQA Conclusion: In general, Alternative 3 would reduce spawning and egg incubation habitat conditions for spring-run Chinook salmon relative to the Existing Conditions.

Sacramento River

Flows in the Sacramento River upstream of Red Bluff were examined during the spring-run Chinook salmon spawning and incubation period (September through January). Flows under A3_LLT would be similar to or greater than flows under Existing Conditions during October, December, and January (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows under A3_LLT would be mostly lower by up to 23% than those under Existing Conditions during September and November depending on water year type.

Shasta Reservoir Storage volume at the end of September under A3_LLT would be 9% to 33% lower relative to Existing Conditions depending on water year type (Table 11-3-16).

Water temperatures in the Sacramento River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-58, which indicates that there would be substantial increases in the exceedances of NMFS temperature thresholds under Alternative 3 relative to Existing Conditions.

The Reclamation egg mortality model predicts that spring-run Chinook salmon egg mortality in the Sacramento River under A3_LLT would be 30% to 361% greater than mortality under Existing Conditions depending on water year type (Table 11-3-17).

SacEFT predicts that there would be a 19% increase in the percentage of years with good spawning availability, measured as weighted usable area, under A3_LLT relative to Existing Conditions (Table 11-3-18). SacEFT predicts that there would be no difference in the percentage of years with good (lower) redd scour risk under A3_LLT relative to Existing Conditions. SacEFT predicts that there would be a 77% decrease in the percentage of years with good (lower) egg incubation conditions under A3_LLT relative to Existing Conditions, respectively. SacEFT predicts that there would be an 18% decrease in the percentage of years with good (lower) redd dewatering risk under A3_LLT relative to Existing Conditions. These results indicate that spawning and egg habitat conditions for spring-run Chinook salmon would be better for some metrics and worse for other metrics under Alternative 3 relative to the Existing Conditions.

Clear Creek

Water temperatures were not modeled in Clear Creek.

Flows in Clear Creek during the spring-run Chinook salmon spawning and egg incubation period (September through January) under A3_LLT would generally be similar to or greater than flows under Existing Conditions except in critical years during September (37% reduction) (*Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis*).

The potential risk of spring-run Chinook salmon redd dewatering in Clear Creek was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in September when spawning is assumed to occur. The greatest reduction in flows under A3_LLT would be similar to or lower magnitude than that under Existing Conditions in wet and below normal water years (Table 11-3-19). The greatest reduction in flows under A3_LLT would be 27–67% lower (more negative) than Existing Conditions in above normal, dry, and critical water years.

Feather River

Water temperatures in the Feather River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-58, which indicates that there would be increases in the exceedances of NMFS temperature thresholds under Alternative 3 relative to Existing Conditions.

Flows in the Feather River low-flow channel under A3_LLT are not different from Existing Conditions during the spring-run spawning and egg incubation period (September through January) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows in October through January (800 cfs) would be equal to or greater than the spawning flows in September (773 cfs) for all model scenarios.

Oroville Reservoir storage volume at the end of September under A3_LLT would be similar to storage under Existing Conditions in dry and critical years but 16–20% lower in wet, above normal, and below normal years depending on water year type (Table 11-3-20).

The potential risk of redd dewatering in the Feather River low-flow channel was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in September when spawning is assumed to occur. Minimum flows in the low-flow channel during October through January were identical between A3_LLT and Existing Conditions (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Therefore, Alternative 3 would have no impact on redd dewatering in the Feather River low-flow channel.

Summary of CEQA Conclusion

Collectively, these results indicate that the effect is significant because it has the potential to substantially reduce the quantity and quality of spawning and egg incubation habitat. The Reclamation egg mortality model predicts that egg mortality would increase in the Sacramento River by up to 22% to 55% (absolute scale) depending on water year type (Table 11-3-17). SacEFT predicts that the number of years with good egg incubation conditions would decline under Alternative 3 by 77% (66% on an absolute scale) (Table 11-3-18). There would be no biologically meaningful effects in Clear Creek or the Feather River.

This impact is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this impact to a less-than-significant level would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this impact is significant and unavoidable because there is no feasible mitigation available. Even so, proposed below is mitigation that has the potential to reduce the severity of impact though not necessarily to a less-than-significant level.

Mitigation Measure AQUA-58a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Spring-Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Spawning Habitat.

Although analysis conducted as part of the EIR/EIS determined that Alternative 3 would have significant and unavoidable adverse effects on spawning habitat, this conclusion was based on the best available scientific information at the time and may prove to have been overstated. Upon the commencement of operations of CM1 and continuing through the life of the permit, the BDCP proponents will monitor effects on rearing habitat in order to determine whether such effects would be as extensive as concluded at the time of preparation of this document and to determine any potentially feasible means of reducing the severity of such effects. This mitigation measure requires a series of actions to accomplish these purposes, consistent with the operational framework for Alternative 3.

The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 3 operations only. Development of mitigation actions for the incremental impact on spawning habitat attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 3.

Mitigation Measure AQUA-58b: Conduct Additional Evaluation and Modeling of Impacts on Spring-Run Chinook Salmon Spawning Habitat Following Initial Operations of CM1.

Following commencement of initial operations of CM1 and continuing through the life of the permit, the BDCP proponents will conduct additional evaluations to define the extent to which modified operations could reduce impacts to spawning habitat under Alternative 3. The analysis required under this measure may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6).

Mitigation Measure AQUA-58c: Consult With NMFS, USFWS and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Spring-Run Chinook Salmon Spawning Habitat Consistent With CM1

In order to determine the feasibility of reducing the effects of CM1 operations on spring-run Chinook salmon habitat, the BDCP proponents will consult with NMFS, USFWS, and CDFW to identify and implement any feasible operational means to minimize effects on spawning habitat. Any such action will be developed in conjunction with the ongoing monitoring and evaluation of habitat conditions required by Mitigation Measure AQUA-58a Alternative 3.

If feasible means are identified to reduce impacts on spawning habitat consistent with the overall operational framework of Alternative 3 without causing new significant adverse impacts on other covered species, such means shall be implemented. If sufficient operational flexibility to reduce effects on steelhead habitat is not feasible under Alternative 3 operations, achieving further impact reduction pursuant to this mitigation measure would not be feasible under this Alternative, and the impact on spring-run Chinook salmon would remain significant and unavoidable.

Impact AQUA-59: Effects of Water Operations on Rearing Habitat for Chinook Salmon (Spring-Run ESU)

In general, Alternative 3 would not affect the quantity and quality of rearing habitat for fry and juvenile spring-run Chinook salmon relative to NAA.

Sacramento River

Flows were evaluated during the November through March larval and juvenile spring-run Chinook salmon rearing period in the Sacramento River between Keswick Dam and just upstream of Red Bluff (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows during November are lower than under NAA in both locations and generally similar to those under NAA in all other months.

As reported in Impact AQUA-40, May Shasta storage volume under A3_LLT would similar to or greater than storage under NAA for all water year types except below normal (8% lower) and dry (6% lower) (Table 11-3-9).

As reported in Impact AQUA-58, September Shasta storage volume under A3_LLT would be 9% lower than under NAA in below normal water years, but would be similar to or greater than storage under NAA in other water year types depending on water year type (Table 11-3-16).

Water temperatures in the Sacramento River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-59, which indicates that there would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 3 in any month or water year type throughout the period.

SacEFT predicts that the percentage of years with good juvenile rearing WUA conditions under A3_LLT would be 9% lower (2% on an absolute scale) than that under NAA (Table 11-3-18). The percentage of years with good (lower) juvenile stranding risk conditions under A3_LLT would not be different than the percentage of years under NAA. These results indicate that there would be no effect on juvenile rearing habitat.

SALMOD predicts that spring-run smolt equivalent habitat-related mortality would be similar (<5% difference) between A3_LLT and NAA.

Clear Creek

Flows in Clear Creek during the November through March rearing period under A3_LLT would generally be similar to or greater than flows under NAA, except in below normal water years during March (6% lower) and critical years in February (6% lower) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

Water temperatures were not modeled in Clear Creek.

Feather River

Flows in the Feather River both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) during November through June were reviewed to determine flow-related effects on larval and juvenile spring-run Chinook salmon rearing period (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Relatively constant flows in the low-flow channel throughout this period under A3_LLT would not differ from those under NAA. In the high-flow channel, flows under A3_LLT would be generally be similar to or greater than flows under NAA except in above normal water years during November (8% lower) and in critical years during January (20% lower).

May Oroville storage under A3_LLT would be similar to (<5% difference) storage under NAA in all water year types (Table 11-3-21).

As reported in Impact AQUA-58, September Oroville storage volume would be 17% to 32% greater than storage under NAA depending on water year type (Table 11-3-20).

Table 11-3-21. Difference and Percent Difference in May Water Storage Volume (thousand acre-feet) in Oroville Reservoir for Model Scenarios

Water Year Type	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Wet	-83 (-2%)	-37 (-1%)
Above Normal	-217 (-6%)	-61 (-2%)
Below Normal	-343 (-11%)	10 (0%)
Dry	-444 (-16%)	76 (3%)
Critical	-255 (-14%)	61 (4%)

Water temperatures in the Feather River under Alternative 3 would be the same as those under Alternative 1A Impact AQUA-59, which indicates that mean monthly water temperatures would generally be similar between NAA and Alternative 3 during the period.

NEPA Effects: Collectively, these results indicate that the effect is not adverse because habitat would not be substantially reduced. There would be no effect of Alternative 3 compared to NAA on flows in the Sacramento and Feather Rivers or in Clear Creek. Further, there would be no effects of Alternative 3 compared to NAA on water temperatures in the Sacramento or Feather Rivers.

CEQA Conclusion: In general, Alternative 3 would not affect the quantity and quality of rearing habitat for fry and juvenile spring-run Chinook salmon relative to Existing Conditions.

Sacramento River

Flows were evaluated during the November through March larval and juvenile spring-run Chinook salmon rearing period in the Sacramento River between Keswick Dam and just upstream of Red Bluff (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows under A3_LLT would be generally similar to or greater than those under Existing Conditions with some exceptions, although flows during November would be lower (up to 27% lower depending on month, water year type, and location) than those under Existing Conditions.

As reported in Impact AQUA-40, Shasta Reservoir storage volume at the end of May under A3_LLT would be similar to Existing Conditions in wet and above normal water years, but lower by 13% to 24% in below normal, dry, and critical water years (Table 11-3-9). As reported in Impact AQUA-59, storage volume at the end of September under A3_LLT would be 9% to 33% lower relative to Existing Conditions depending on water year type (Table 11-3-16).

Water temperatures in the Sacramento River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-59, which indicates that there would be no differences in mean monthly water temperature between Existing Conditions and Alternative 3.

SacEFT predicts that the percentage of years with good juvenile rearing WUA conditions under A3_LLT would be 9% lower (2% on an absolute scale) than that under Existing Conditions, which would be negligible (Table 11-3-18). The percentage of years with good (lower) juvenile stranding risk conditions under A3_LLT would be 26% lower (5% reduction on an absolute scale) than under Existing Conditions, which would be a small effect.

SALMOD predicts that spring-run smolt equivalent habitat-related mortality under A3_LLT would be 7% greater than under Existing Conditions.

Clear Creek

Flows in Clear Creek during the November through March rearing period under A3_LLT would generally be similar to or greater than flows under Existing Conditions (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis).

Water temperatures were not modeled in Clear Creek.

Feather River

Flows in the Feather River both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) during November through June were reviewed to determine flow-related effects on larval and juvenile spring-run rearing period (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Relatively constant flows in the low flow channel throughout this period under A3_LLT would not differ from those under Existing Conditions. In the high flow channel, flows under A3_LLT would generally be greater than or similar to flows under Existing Conditions with some exceptions, during which flows would be up to 36% lower under A3_LLT.

May Oroville storage volume under A3_LLT would be 6% to 16% lower than storage under Existing Conditions in all but wet years, in which storage would be similar to Existing Conditions (Table 11-3-21).

As reported in Impact AQUA-58, Oroville Reservoir storage volume at the end of September under A3_LLT would be similar to storage under Existing Conditions in dry and critical years but 16% to 20% lower in wet, above normal, and below normal years depending on water year type (Table 11-3-20).

Collectively, these results indicate that the impact would be less than significant and no mitigation would be necessary because habitat would not be substantially reduced. Although rearing habitat conditions in the Sacramento River would be slightly reduced by Alternative 3as predicted by SacEFT and SALMOD, there would be no other effects of Alternative 3 in any waterway.

Impact AQUA-60: Effects of Water Operations on Migration Conditions for Chinook Salmon (Spring-Run ESU)

Upstream of the Delta

In general, the effects of Alternative 3 on spring-run Chinook salmon migration conditions relative to the NAA are uncertain.

Sacramento River

Flows in the Sacramento River upstream of Red Bluff were evaluated during the December through May juvenile Chinook salmon spring-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be similar to or greater than flows under NAA, except in critical years during January (8% lower).

Flows in the Sacramento River upstream of Red Bluff were evaluated during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows during April through July under A3_LLT would generally be similar to or greater than NAA except in dry water years during July (14% lower). Flows during August under A3_LLT would generally be lower than NAA by up to 18%.

Water temperatures in the Sacramento River under Alternative 3 would be the same as those under Alternative 1A Impact AQUA-60, which indicates that there would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 3.

Clear Creek

Flows in Clear Creek during the November through May juvenile Chinook salmon spring-run migration period under A3_LLT would generally be similar to or greater than flows under NAA except in critical water years during February and below normal water years during March (6% lower in both) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flows in Clear Creek during the April through August adult spring-run Chinook salmon upstream migration period under A3_LLT would be similar to or greater than flows under NAA in all months and water year types (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Water temperatures were not modeled in Clear Creek.

Feather River

Flows in the Feather River at the confluence with the Sacramento River were examined during the November through May juvenile Chinook salmon spring-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would generally be greater than or similar to flows under NAA, except in above normal water years during November (6% lower) and in critical water years during January (8% lower).

Flows in the Feather River at the confluence with the Sacramento River were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT during April through June would generally be similar to or greater than flows under NAA, except in critical years during June (8% lower). Flows under A3_LLT during July and August would be lower than flows under NAA by up to 48% regardless of water year type.

Water temperatures in the Feather River under Alternative 3 would be the same as those under Alternative 1A Impact AQUA-60, which indicates that there would be no differences in mean monthly water temperature between NAA and Alternative 3.

Through-Delta

The effects on through-Delta migration were evaluated using the approach described in Alternative 1A, Impact AQUA-42.

Juveniles

Juvenile salmonids migrating down the Sacramento River would generally experience lower flows below the north Delta intakes compared to baseline conditions. The two intake structures of Alternative 3 would replace aquatic habitat and likely attract piscivorous fish around the intake structures, as described above in Impact AQUA-42. Potential predation losses, as estimated by the bioenergetics model, would be 0.6% of the annual juvenile production estimated for the Sacramento Valley (Impact AQUA-42, Table 11-3-12). A conservative assumption of 5% loss per intake would yield a cumulative loss of 8.3% of juvenile spring-run Chinook that reach the north Delta. This assumption is uncertain and represents an upper bound estimate.

Through-Delta survival to Chipps Island (DPM) by emigrating juvenile spring-run Chinook salmon under Alternative 3 would average 29.5% across all years, 24.1% in drier years, and 38.3% in wetter years (Table 11-3-22). Compared to NAA, juvenile survival would be similar or slightly lower under Alternative 3 (up to 2.1% lower in wetter years, a 5% relative decrease).

Table 11-3-22. Through-Delta Survival (%) of Emigrating Juvenile Spring-Run Chinook Salmon under Alternative 3

	Percentage Survival			Difference in Percentage Survival (Relative Difference)	
Month	EXISTING CONDITIONS	NAA	A3_LLT	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Wetter Years	42.1	40.4	38.3	-3.8 (-9%)	-2.1 (-5%)
Drier Years	24.8	24.3	24.1	-0.6 (-2%)	-0.2 (-1%)
All Years	31.3	30.3	29.5	-1.8 (-6%)	-0.9 (-3%)

Note: Delta Passage Model results for survival to Chipps Island.
Wetter = Wet and Above Normal WYs (6 years).
Drier = Below Normal, Dry and Critical WYs (10 years).

Adults

During the overall spring-run upstream migration from March-June, the proportion of Sacramento River in the Delta would be similar to NAA throughout the adult migration period (Table 11-3-14). Olfactory cues for spring-run Chinook salmon adults would be strong, as the proportion of Sacramento River under Alternative 3 would represent 61–69% of Delta outflows. This topic is discussed further in Impact AQUA-42 for Alternative 1A.

NEPA Effects: Upstream of the Delta, these results indicate that the effect would not be adverse because it does not have the potential to substantially interfere with the movement of fish. There would be decreases in flows during 2 of 5 months of the adult upstream migration period in the Feather River. However, there would be no other effects of Alternative 3 in the Feather River and no effects on flows or temperatures in the Sacramento River and in Clear Creek.

Near-field effects of Alternative 3 NDD on spring-run Chinook salmon related to impingement and predation associated with three new intake structures could result in negative effects on juvenile migrating spring-run Chinook salmon, although there is high uncertainty regarding the overall effects. It is expected that the level of near-field impacts would be directly correlated to the number of new intake structures in the river and thus the level of impacts associated with 2 new intakes would be considerably lower than those expected from having 5 new intakes in the river. Estimates within the effects analysis range from very low levels of effects (<1% mortality) to more significant effects (~ 8% mortality above current baseline levels). CM15 would be implemented with the intent of providing localized and temporary reductions in predation pressure at the NDD. Additionally, several pre-construction surveys to better understand how to minimize losses associated with the 2 new intake structures will be implemented as part of the final NDD screen design effort. Alternative 3 also includes an Adaptive Management Program and Real-Time Operational Decision-Making Process to evaluate and make limited adjustments intended to provide adequate migration conditions for spring-run Chinook. However, at this time, due to the absence of comparable facilities anywhere in the lower Sacramento River/Delta, the degree of mortality expected from near-field effects at the NDD remains highly uncertain.

Two recent studies (Newman 2003 and Perry 2010) indicate that far-field effects associated with the new intakes could cause a reduction in smolt survival in the Sacramento River downstream of the NDD intakes due to reduced flows in this area. The analyses of other elements of Alternative 3 predict improvements in smolt condition and survival associated with increased access to the Yolo Bypass, reduced interior Delta entry, and reduced south Delta entrainment. The overall magnitude of each of these factors and how they might interact and/or offset each other in affecting salmonid survival through the plan area is uncertain, and remains an area of active investigation for the BDCP.

The DPM is a flow-based model being developed for BDCP which attempts to combine the effects of all of these elements of BDCP operations and conservation measures to predict smolt migration survival throughout the entire Plan Area. The current draft of this model predicts that smolt migration survival under Alternative 3 would be similar to those estimated for NAA. Further refinement and testing of the DPM, along with several ongoing and planned studies related to salmonid survival at and downstream of, the NDD are expected to be completed in the foreseeable future. These efforts are expected to improve our understanding of the relationships and interactions among the various factors affecting salmonid survival, and reduce the uncertainty around the potential effects of BDCP implementation on migration conditions for Chinook salmon. However, until these efforts are completed and their results are fully analyzed, the overall cumulative effect of Alternative 3 on spring-run Chinook salmon migration remains uncertain.

CEQA Conclusion: In general, under Alternative 3 water operations, the quantity and quality of migration habitat for spring-run Chinook salmon would not be affected relative to the CEQA baseline.

Upstream of the Delta

Sacramento River

Flows in the Sacramento River upstream of Red Bluff were evaluated during the December through May juvenile Chinook salmon spring-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would generally be similar to or greater than flows under Existing Conditions except in wet water years during May (14% lower).

Flows in the Sacramento River upstream of Red Bluff were evaluated during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows during April through July under A3_LLT would generally be similar to or greater than Existing Conditions, except in wet years during May (14% lower) and in dry and critical water years during July (6% and 10% lower, respectively). Flows under A3_LLT during August are mostly lower than Existing Conditions by up to 24%.

Water temperatures in the Sacramento River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-60, which indicates that there would be negligible differences in mean monthly water temperature between NAA and Alternative 1A.

Clear Creek

Flows in Clear Creek during the November through May juvenile Chinook salmon spring-run migration period under A3_LLT would be similar to or greater than flows under Existing Conditions in all water year types (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flows in Clear Creek during the April through August adult spring-run Chinook salmon upstream migration period under A3_LLT would generally be similar to or greater than flows under Existing Conditions with exceptions during August of critical water years (17% reduction) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Water temperatures were not modeled in Clear Creek.

Feather River

Flows were examined for the Feather River at the confluence with the Sacramento River during the November through May juvenile Chinook salmon spring-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would generally be similar to or greater than flows under Existing Conditions, except in wet years during November and May (12% and 24% lower, respectively) and in below normal water years during November, January, and March (11%, 10%, and 12% lower, respectively).

Flows were examined for the Feather River at the confluence with the Sacramento River during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows during April and May under A3_LLT would generally be similar to or greater than flows under Existing Conditions except in wet years during May (24% lower). Flows during June through August would generally be lower than flows under Existing Conditions by up to 54%.

Water temperatures in the Feather River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-60, which indicates that there would be negligible differences in mean monthly water temperature between Existing Conditions and Alternative 1A.

Through-Delta

Please see the *CEQA Conclusion* above for winter-run Chinook salmon (Alternative 3, Impact AQUA-42). As described above for adult Chinook salmon winter-run upstream migration, the impact on emigrating spring-run Chinook salmon juveniles through the Delta under Alternative 3 would be less than significant.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-60 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 3 could be significant because, under the CEQA baseline, the alternative could substantially reduce migration habitat and substantially interfere with the movement of fish, contrary to the NEPA conclusion set forth above. There would generally be no effects of Alternative 3 on flows in the Sacramento River and Clear Creek and temperatures in the Sacramento and Feather rivers. However, flows in the Feather River would be up to 54% lower during 3 of the 5 months of the adult migration period. There would also be no substantial effects of Alternative 3 on through-Delta migration conditions for winter-run Chinook salmon.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 3 indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 3. This indicates that the differences between Existing Conditions and Alternative 3 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 3, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on migration habitat for winter-run Chinook salmon. This impact is found to be less than significant and no mitigation is required.

Restoration Measures (CM2, CM4–CM7, and CM10)

Alternative 3 has the same restoration measures as Alternative 1A. Because no substantial differences in restoration-related fish effects are anticipated anywhere in the affected environment under Alternative 3 compared to those described in detail for Alternative 1A, the fish effects of restoration measures described for spring-run Chinook salmon under Alternative 1A (Impact AQUA-61 through AQUA-63) also appropriately characterize effects under Alternative 3.

The following impacts are those presented under Alternative 1A that are identical for Alternative 3.

Impact AQUA-61: Effects of Construction of Restoration Measures on Chinook Salmon (Spring-Run ESU)

Impact AQUA-62: Effects of Contaminants Associated with Restoration Measures on Chinook Salmon (Spring-Run ESU)

Impact AQUA-63: Effects of Restored Habitat Conditions on Chinook Salmon (Spring-Run ESU)

NEPA Effects: All of these effects have been determined to result in no adverse effects on spring-run Chinook salmon for NEPA purposes, for the reasons identified for Alternative 1A. Specifically for AQUA-62, the effects of contaminants on spring-run Chinook salmon with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on spring-run Chinook salmon are uncertain.

CEQA Conclusions**:** Overall the effects would be considered less than significant for CEQA purposes for the reasons identified for Alternative 1A.

Other Conservation Measures (CM12–CM19 and CM21)

Alternative 3 has the same other conservation measures as Alternative 1A. Because no substantial differences in other conservation-related fish effects are anticipated anywhere in the affected environment under Alternative 3 compared to those described in detail for Alternative 1A, the fish effects of other conservation measures described for spring-run Chinook salmon under Alternative 1A (Impact AQUA-64 through AQUA-72) also appropriately characterize effects under Alternative 3.

The following impacts are those presented under Alternative 1A that are identical for Alternative 3.

Impact AQUA-64: Effects of Methylmercury Management on Chinook Salmon (Spring-Run ESU) (CM12)

Impact AQUA-65: Effects of Invasive Aquatic Vegetation Management on Chinook Salmon (Spring-Run ESU) (CM13)

Impact AQUA-66: Effects of Dissolved Oxygen Level Management on Chinook Salmon (Spring-Run ESU) (CM14)

Impact AQUA-67: Effects of Localized Reduction of Predatory Fish on Chinook Salmon (Spring-Run ESU) (CM15)

Impact AQUA-68: Effects of Nonphysical Fish Barriers on Chinook Salmon (Spring-Run ESU) (CM16)

Impact AQUA-69: Effects of Illegal Harvest Reduction on Chinook Salmon (Spring-Run ESU) (CM17)

Impact AQUA-70: Effects of Conservation Hatcheries on Chinook Salmon (Spring-Run ESU) (CM18)

Impact AQUA-71: Effects of Urban Stormwater Treatment on Chinook Salmon (Spring-Run ESU) (CM19)

Impact AQUA-72: Effects of Removal/Relocation of Nonproject Diversions on Chinook Salmon (Spring-Run ESU) (CM21)

NEPA Effects: The nine impact mechanisms have been determined to range from no effect, to no adverse effect, or beneficial effects on spring-run Chinook salmon for NEPA purposes, for the reasons identified for Alternative 1A.

CEQA Conclusions: The nine impact mechanisms would be considered to range from no impact, to less than significant, or beneficial on spring-run Chinook salmon, for the reasons identified for Alternative 1A, and no mitigation is required.

Fall-/Late Fall–Run Chinook Salmon

Construction and Maintenance of CM1

Impact AQUA-73: Effects of Construction of Water Conveyance Facilities on Chinook Salmon (Fall-/Late Fall–Run ESU)

The potential effects of construction of water conveyance facilities on fall-run/late fall run Chinook salmon under Alternative 3 would be similar to those described for Alternative 1A (see Impact AQUA-73) except that Alternative 3 would include two intakes compared to five intakes under Alternative 1A, so the effects would be proportionally less under this alternative. This would convert about 4,450 lineal feet of existing shoreline habitat into intake facility structures and would require about 10.2 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. The effects related to temporary increases in turbidity, accidental spills, underwater noise, in-water work activities, and disturbance of contaminated sediments would be similar to Alternative 1A and the same environmental commitments and mitigation measures (described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*) would be available to avoid and minimize potential effects.

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-73, environmental commitments and mitigation measures would be available to avoid and minimize potential effects, and the effect would not be adverse for fall-run/late fall run Chinook salmon.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-73, the impact of construction of the water conveyance facilities on fall-run/late fall-run Chinook salmon would be less than significant except for construction noise associated with pile driving. Potential pile driving impacts would be less than Alternative 1A because only two intakes would be constructed under Alternative 3 rather than five. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in the discussion of Alternative 1A.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in the discussion of Alternative 1A.

Impact AQUA-74: Effects of Maintenance of Water Conveyance Facilities on Chinook Salmon (Fall-/Late Fall–Run ESU)

The maintenance-related effects of Alternative 3 would be identical for all four Chinook salmon ESUs. Accordingly, for a discussion of the impacts, please refer to the discussion for winter-run Chinook (Alternative 3, Impact AQUA-38).

Water Operations of CM1

Impact AQUA-75: Effects of Water Operations on Entrainment of Chinook Salmon (Fall-/Late Fall–Run ESU)

Fall-Run Chinook Salmon

Water Exports from SWP/CVP South Delta Facilities

Entrainment at Delta export facilities would increase 19% (11,000 more fish entrained) across all water year types compared to NAA (Table 11-3-23). When compared to NAA entrainment would be highest in above normal water years, increasing by 52–58%, and lowest in critical water year types, decreasing by 11–18% (Table 11-3-23). Pre-screen losses, typically attributed to predation, would be expected to change commensurate with entrainment at the south Delta facilities.

Under the assumption that the annual number of juvenile fall-run Chinook salmon juveniles approaching the Delta was 23 million fish, the percentage of the population lost to entrainment across all years averaged 0.24% under baseline scenarios and increased slightly (0.05%) under Alternative 3.

Water Exports from SWP/CVP North Delta Intake Facilities

As described for winter-run Chinook salmon under Alternative 1A (Impact AQUA-39), potential entrainment of juvenile salmonids at the north Delta intakes would be greater than baseline, but the effects would be minimal because the north Delta intakes would have state-of-the-art screens to exclude juvenile fish.

Water Export with a Dual Conveyance for the SWP North Bay Aqueduct

As described for winter-run Chinook salmon under Alternative 1A (Impact AQUA-39), potential entrainment and impingement effects for juvenile salmonids would be minimal because intakes would have state-of-the-art screens installed.

Late Fall–Run Chinook Salmon

Water Exports from SWP/CVP South Delta Facilities

Alternative 3 would reduce the overall entrainment of juvenile late fall–run Chinook salmon at the south Delta export facilities by 14% (~260 fish) across all water year types compared to NAA (Table 11-3-23). Entrainment for late fall–run Chinook salmon would be greatest in wet years and one to two orders of magnitude less in other water year types (Table 11-3-23). Under Alternative 3, entrainment of juvenile late fall–run Chinook salmon in wet years would decrease 20% compared to NAA. The greatest relative reductions for late fall–run Chinook salmon would occur in critical water years (decreased by 22%). Pre-screen loss at the south Delta facilities, which is typically attributed to predation, would decrease commensurate with reductions in entrainment.

The proportion of the annual late fall–run Chinook population (assumed to be 1 million juveniles approaching the Delta) lost at the south Delta facilities would be very low and similar under baseline (0.2%) and Alternative 3 (0.2%).

Table 11-3-23. Juvenile Chinook Salmon Annual Entrainment Index at the SWP and CVP Salvage Facilities—Differences between Model Scenarios for Alternative 3

	Absolute Difference (Percent Difference)	
Water Year Type	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Fall-Run Chinook Salmon		
Wet	-4,379 (-3%)	-4,556 (-4%)
Above Normal	17,981 (55%)	17,507 (52%)
Below Normal	4,718 (35%)	4,359 (31%)
Dry	8,768 (45%)	7,120 (33%)
Critical	-9,249 (-23%)	-4,071 (-11%)
All Years	10,718 (20%)	10,662 (19%)
Late Fall–Run Chinook Salmon		
Wet	-1,244 (-21%)	-1,157 (-20%)
Above Normal	-89 (-15%)	-75 (-13%)
Below Normal	-3 (-6%)	0.4 (1%)
Dry	-8 (-6%)	8 (6%)
Critical	-46 (-28%)	-34 (-22%)
All Years	-342 (-18%)	-261 (-14%)

Shading indicates entrainment increased 10% or more.

[a] Estimated annual number of fish lost, based on normalized data.

Water Exports from SWP/CVP North Delta Intake Facilities

As described for winter-run Chinook salmon under Alternative 1A (Impact AQUA-39), potential entrainment of juvenile salmonids at the north Delta intakes would be greater than baseline, but the effects would be minimal because the north Delta intakes would have state-of-the-art screens to exclude juvenile fish.

Water Export with a Dual Conveyance for the SWP North Bay Aqueduct

As described for winter-run Chinook salmon under Alternative 1A (Impact AQUA-39), potential entrainment and impingement effects for juvenile salmonids would be minimal because intakes would have state-of-the-art screens installed.

NEPA Effects: Under Alternative 3 the entrainment losses at the south Delta facilities would increase for fall-run Chinook salmon and decrease for late fall–run Chinook salmon compared to baseline conditions. This effect would be adverse for fall-run.

CEQA Conclusion: Entrainment losses of juvenile fall-run Chinook salmon at the south Delta export facilities would increase by approximately 20% across all water year types under Alternative 3 compared to Existing Conditions (Table 11-3-23). However, entrainment of juvenile late fall–run Chinook salmon is expected to decrease by approximately 18% across all water year types under Alternative 3 compared to Existing Conditions (Table 11-3-23). Relative impacts at the north Delta intakes and the North Bay Aqueduct would be the same as under Alternative 1A. Overall, impacts would be significant for fall-run Chinook salmon and may be beneficial for late fall–run.

Impact AQUA-76: Effects of Water Operations on Spawning and Egg Incubation Habitat for Chinook Salmon (Fall-/Late Fall–Run ESU)

In general, Alternative 3 would have negligible effects on the quantity and quality of spawning and egg incubation habitat for fall-/late fall–run Chinook salmon relative to NAA.

Sacramento River

Fall-Run

Sacramento River flows upstream of Red Bluff were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows under A3_LLT would generally be greater than or similar to NAA during October, December, and January, except for critical water years during January (8% lower). Flows during November would be lower by up to 29% in all water years.

Shasta Reservoir storage at the end of September would affect flows during the fall-run spawning and egg incubation period. Storage under A3_LLT would be 9% lower than under NAA in below normal water years, but would be similar to or greater than storage under NAA in other water year types depending on water year type (Table 11-3-16).

Water temperatures in the Sacramento River for Alternative 3 are not different from those for Alternative 1A, Impact AQUA-76, which indicates there would be no differences in mean monthly water temperature between NAA and Alternative 1A.

The Reclamation egg mortality model predicts that fall-run Chinook salmon egg mortality in the Sacramento River under A3_LLT would lower than or similar to mortality under NAA in all water year types except below normal years (21% greater, and absolute increase of 5% of fall-run population) (Table 11-3-24). These results indicate that climate change would increase fall-run Chinook salmon egg mortality, but Alternative 3 would have small to negligible effects.

Table 11-3-24. Difference and Percent Difference in Percent Mortality of Fall-Run Chinook Salmon Eggs in the Sacramento River (Egg Mortality Model)

Water Year Type	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Wet	10 (103%)	0 (2%)
Above Normal	12 (110%)	1 (4%)
Below Normal	16 (148%)	5 (21%)
Dry	17 (120%)	1 (2%)
Critical	9 (30%)	-1 (-2%)
All	13 (91%)	1 (4%)

SacEFT predicts that there would be a 14% increase (5% absolute scale) in the percentage of years with good spawning availability for fall-run Chinook salmon, measured as weighted usable area, under A3_LLT relative to NAA (Table 11-3-25). SacEFT predicts that there would be a 12% reduction (8% absolute scale) in the percentage of years with good (lower) redd scour risk under A3_LLT, relative to NAA. SacEFT predicts that there would be no effect of A3_LLT relative to NAA. SacEFT predicts that there would be a 7% increase (2% absolute scale) in the percentage of years with good (lower) redd dewatering risk under A3_LLT relative to NAA, which is negligible. These results indicate that there would be a small increase in years in which spawning WUA would be considered "good" and small decrease in year in which redd scour risk would be considered "good".

Table 11-3-25. Difference and Percent Difference in Percentage of Years with "Good" Conditions for Fall-Run Chinook Salmon Habitat Metrics in the Upper Sacramento River (from SacEFT)

Metric	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Spawning WUA	-8 (-17%)	5 (14%)
Redd Scour Risk	-3 (-5%)	-8 (-12%)
Egg Incubation	-25 (-27%)	0 (0%)
Redd Dewatering Risk	2 (7%)	2 (7%)
Juvenile Rearing WUA	2 (6%)	-5 (-13%)
Juvenile Stranding Risk	-3 (-10%)	8 (40%)
WUA = Weighted Usable Area.		

Late Fall-Run

Sacramento River flows upstream of Red Bluff were examined for the February through May late fall–run Chinook salmon spawning and egg incubation period (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis. Flows under A3_LLT would be greater than or similar to flows under NAA throughout the period.

Shasta Reservoir storage at the end of September would affect flows during the late fall–run spawning and egg incubation period. As reported in Impact AQUA-58, end of September Shasta Reservoir storage would be 9% lower than under NAA in below normal water years, but would be similar to or greater than storage under NAA in other water year types depending on water year type (Table 11-3-16).

The Reclamation egg mortality model predicts that late fall–run Chinook salmon egg mortality in the Sacramento River under A3_LLT would be similar to mortality under NAA in all water years, including below normal water years in which, although there would be an 17% relative increase, the absolute increase would be 1% of the late fall–run population (Table 11-3-26).

Table 11-3-26. Difference and Percent Difference in Percent Mortality of Late fall–Run Chinook Salmon Eggs in the Sacramento River (Egg Mortality Model)

Water Year Type	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Wet	3 (167%)	-1 (-13%)
Above Normal	4 (155%)	-1 (-11%)
Below Normal	5 (336%)	1 (17%)
Dry	4 (160%)	-1 (-8%)
Critical	2 (127%)	0 (-7%)
All	4 (178%)	0 (-6%)

SacEFT predicts that there would be a 6% decrease (3% absolute scale) in the percentage of years with good spawning availability for late fall–run Chinook salmon, measured as weighted usable area, under A3_LLT relative to NAA (Table 11-3-27). SacEFT predicts that there would be no difference in the percentage of years with good (lower) redd scour risk under A3_LLT, relative to NAA. SacEFT predicts that there would be a negligible (<5%) difference in the percentage of years with good (lower) egg incubation conditions between A3_LLT and NAA. SacEFT predicts that there would be a 5% decrease (3% absolute scale) in the percentage of years with good (low) redd dewatering risk under A3_LLT, relative to NAA. These results indicate that there would be negligible effects of Alternative 3 on spawning and egg incubation conditions for late fall-run Chinook salmon in the Sacramento River

Table 11-3-27. Difference and Percent Difference in Percentage of Years with "Good" Conditions for Late Fall–Run Chinook Salmon Habitat Metrics in the Upper Sacramento River (from SacEFT)

Metric	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Spawning WUA	-7 (-13%)	-3 (-6%)
Redd Scour Risk	-6 (-7%)	0 (0%)
Egg Incubation	0 (0%)	0 (0%)
Redd Dewatering Risk	-8 (-13%)	-3 (-5%)
Juvenile Rearing WUA	-10 (-22%)	-28 (-44%)
Juvenile Stranding Risk	-27 (-38%)	-1 (-2%)

WUA = Weighted Usable Area.

Clear Creek

No water temperature modeling was conducted in Clear Creek.

Fall-Run

Clear Creek flows below Whiskeytown Reservoir were examined for the September through February fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows under A3_LLT would be similar to or greater than flows under NAA throughout the period.

The potential risk of redd dewatering in Clear Creek was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in September when spawning is assumed to occur. The greatest monthly reduction in Clear Creek flows during September through February under A3_LLT would be the same as the reduction under NAA in all water years (Table 11-3-28).

Table 11-3-28. Difference and Percent Difference in Greatest Monthly Reduction (Percent Change) in Instream Flow in Clear Creek below Whiskeytown Reservoir during the September through February Spawning and Egg Incubation Period[a]

Water Year Type	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Wet	0 (NA)	0 (NA)
Above Normal	-27 (NA)	0 (0%)
Below Normal	53 (100%)	0 (NA)
Dry	-67 (NA)	0 (0%)
Critical	-33 (-50%)	0 (0%)

NA = could not be calculated because the denominator was 0.

[a] Redd dewatering risk not applicable for months when flows during the egg incubation period were at or greater than flows in September, when spawning is assumed to occur. A negative value indicates that the greatest monthly reduction would be of greater magnitude (worse) under the alternative than under the baseline.

Feather River

Water temperatures in the Feather River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-76, which indicates that temperatures conditions under Alternative 1A would be similar to or better than those under NAA.

Fall-Run

Flows in the Feather River in the low flow and high flow channels were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows in the low-flow channel under A3_LLT would be identical to those under NAA. Flows in the high-flow channel under A3_LLT would generally be similar to or greater than those under NAA except in above normal water years during November (8% lower) and critical years during January (20% lower). These results indicate that Alternative 3 would generally improve flow conditions for fall-run spawning and egg incubation conditions in the Feather River high flow channel.

The potential risk of redd dewatering in the Feather River low-flow channel was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in October when spawning is assumed to occur. Minimum flows in the low-flow channel during November through January were identical between A3_LLT and NAA (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Therefore, there would be no effect of Alternative 3 on redd dewatering in the Feather River low-flow channel.

The Reclamation egg mortality model predicts that fall-run Chinook salmon egg mortality in the Feather River under A3_LLT would be similar to or lower than mortality under NAA in all water years, indicating a small beneficial effect of Alternative 3 on temperature conditions for incubating eggs in the Feather River (Table 11-3-29).

Table 11-3-29. Difference and Percent Difference in Percent Mortality of Fall-Run Chinook Salmon Eggs in the Feather River (Egg Mortality Model)

Water Year Type	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Wet	5 (390%)	-14 (-67%)
Above Normal	5 (463%)	-7 (-53%)
Below Normal	12 (683%)	-1 (-6%)
Dry	15 (690%)	-4 (-17%)
Critical	21 (437%)	-2 (-7%)
All	11 (523%)	-7 (-33%)

American River

Water temperatures in the American River under Alternative 3 would be the same as those under Alternative 1A, which indicates that there would be no differences in mean monthly water temperature between NAA and Alternative 1A.

Fall-Run

Flows in the American River at the confluence with the Sacramento River were examined during the October through January fall-run spawning and egg incubation period (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows under A3_LLT would generally be similar to or greater than flows under NAA, except for above normal water years during November (16% lower). These results indicate that these differences are primarily due to climate change and not Alternative 3.

The potential risk of redd dewatering in the American River at Nimbus Dam was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in October when spawning is assumed to occur. The greatest reduction under A3_LLT would be 18% to 53% greater than that under NAA depending on water year type (Table 11-3-30).

Table 11-3-30. Difference and Percent Difference in Greatest Monthly Reduction (Percent Change) in Instream Flow in the American River at Nimbus Dam during the October through January Spawning and Egg Incubation Period[a]

Water Year Type	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Wet	-41 (-189%)	-16 (-35%)
Above Normal	-17 (-57%)	-7 (-18%)
Below Normal	-42 (-219%)	-15 (-32%)
Dry	-6 (-12%)	-8 (-18%)
Critical	-9 (-18%)	-21 (-53%)

NA = could not be calculated because the denominator was 0.

[a] Redd dewatering risk not applicable for months when flows during the egg incubation period were at or greater than flows in October, when spawning is assumed to occur. A negative value indicates that the greatest monthly reduction would be of greater magnitude (worse) under the alternative than under the baseline.

The Reclamation egg mortality model predicts that fall-run Chinook salmon egg mortality in the American River under A3_LLT would be similar to mortality under NAA in all water years (Table 11-3-31).

Table 11-3-31. Difference and Percent Difference in Percent Mortality of Fall-Run Chinook Salmon Eggs in the American River (Egg Mortality Model)

Water Year Type	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Wet	25 (165%)	1 (3%)
Above Normal	22 (209%)	-1 (-2%)
Below Normal	20 (165%)	-2 (-5%)
Dry	16 (101%)	0 (0%)
Critical	9 (45%)	0 (-1%)
All	20 (129%)	0 (0%)

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be similar to flows under NAA throughout the period.

Water temperatures in the Stanislaus River under Alternative 3 would be the same as those under Alternative 1A, which indicates that there would be no differences (<5%) in mean monthly water temperature between NAA and Alternative 1A.

San Joaquin River

Flows in the San Joaquin River at Vernalis were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be similar to flows under NAA throughout the period.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Flows in the Mokelumne River at the Delta were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be similar to flows under NAA throughout the period.

Water temperature modeling was not conducted in the Mokelumne River.

NEPA Effects: Collectively, it is concluded that the effect is not adverse because habitat conditions are not substantially reduced. There are no reductions in flows under Alternative 3 or increases in temperatures in the rivers evaluated that would translate into biologically meaningful effects on fall-/late fall-run Chinook salmon.

CEQA Conclusion: In general, under Alternative 3 water operations, spawning and egg incubation habitat for fall-/late fall-run Chinook salmon would not be affected relative to the CEQA baseline.

Sacramento River

Water temperatures in the Sacramento River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-76, which indicates that there would be moderate to large increases in water temperatures under of Alternative 1A relative to Existing Conditions in the Sacramento River.

Fall-Run

Flows in the Sacramento River upstream of Red Bluff were examined during the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows under A3_LLT would be greater than or similar to Existing Conditions in all water year types during October, December, and January (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). However, flows in November under A3_LLT would be lower in all water year types by 5% to 21%.

As indicated in Impact AQUA-58, Shasta Reservoir Storage volume at the end of September under A3_LLT would be 9% to 33% lower relative to Existing Conditions depending on water year type (Table 11-3-16).

The Reclamation egg mortality model predicts that fall-run Chinook salmon egg mortality in the Sacramento River under A3_LLT would be 30% to 148% greater than mortality under Existing Conditions (Table 11-3-24).

SacEFT predicts that there would be an 8% increase in the percentage of years with good spawning availability, measured as weighted usable area, under A3_LLT relative to Existing Conditions (Table 11-3-25). SacEFT predicts that there would be a 5% reduction in the percentage of years with good (lower) redd scour risk under A3_LLT relative to Existing Conditions. SacEFT predicts that there would be a 27% reduction in the percentage of years with good (lower) egg incubation conditions under A3_LLT relative to Existing Conditions. SacEFT predicts that there would be a 7% increase in the percentage of years with good (lower) redd dewatering risk under A3_LLT relative to Existing Conditions.

Late Fall–Run

Flows in the Sacramento River upstream of Red Bluff were examined during the February through May late fall–run Chinook salmon spawning and egg incubation period (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows under A3_LLT would generally be greater than or similar to flows under Existing Conditions, except in wet years during May (14% lower).

Shasta Reservoir Storage volume at the end of September under A3_LLT would be 9% to 33% lower relative to Existing Conditions depending on water year type (Table 11-3-16).

The Reclamation egg mortality model predicts that late fall–run Chinook salmon egg mortality in the Sacramento River under A3_LLT would be 127% to 336% greater than mortality under Existing Conditions (Table 11-3-26). However, absolute differences in the percent of the late-fall population subject to mortality would be minimal in all but below normal years, in which there is a 5% increase.

SacEFT predicts that there would be a 13% decrease in the percentage of years with good spawning availability, measured as weighted usable area, under A3_LLT relative to Existing Conditions (Table

11-3-23). SacEFT predicts that there would be a 7% decrease in the percentage of years with good (lower) redd scour risk under A3_LLT relative to Existing Conditions. SacEFT predicts that there would be no difference in the percentage of years with good (lower) egg incubation conditions between A3_LLT and Existing Conditions. SacEFT predicts that there would be a 13% decrease in the percentage of years with good (lower) redd dewatering risk under A3_LLT relative to Existing Conditions.

Clear Creek

No water temperature modeling was conducted in Clear Creek.

Fall-Run flows in Clear Creek below Whiskeytown Reservoir were reviewed during the September through February fall-run spawning and egg incubation period (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows under A3_LLT would always be similar to or greater than flows under Existing Conditions throughout the period.

The potential risk of redd dewatering in Clear Creek was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in September when spawning occurred. The greatest monthly reduction in Clear Creek flows during October through February under A3_LLT would be similar to or lower magnitude than those under Existing Conditions in wet and below normal water years, but the reduction would be 27%, 67%, and 33% greater (absolute, not relative, differences) under A3_LLT in above normal, dry, and critical water years, respectively (Table 11-3-28).

Feather River

Water temperatures in the Feather River under Alternative 3 would be the same as those under Alternative 1A, which indicates that there would be moderate to large effects of Alternative 1A on temperatures.

Fall-Run flows in the Feather River in the low flow and high flow channels were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows in the low-flow channel A3_LLT would be identical to those under Existing Conditions. Flows in the high-flow channel during October through December under A3_LLT would be similar to or greater than flows under Existing Conditions, except in wet years during November and December (16% lower in both years) and in below normal years during October and November (7% and 13% lower, respectively). During January, flows would generally be lower by up to 36% than flows under Existing Conditions, although there would be increase flows in wet and dry years of 27% and 34%, respectively, which would outweigh reductions in other years.

The potential risk of redd dewatering in the Feather River low-flow channel was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in October when spawning is assumed to occur. Minimum flows in the low-flow channel would be identical between A3_LLT and Existing Conditions (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Therefore, there would be no effect of Alternative 3 on redd dewatering in the Feather River low-flow channel.

The Reclamation egg mortality model predicts that fall-run Chinook salmon egg mortality in the Feather River under A3_LLT would be 390% to 690% greater than mortality under Existing

Conditions, which would be a 5% to 21% increase in egg mortality on an absolute scale (Table 11-3-29).

American River

Water temperatures in the American River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-76, which indicates that there would be moderate to large effects of Alternative 1A on temperatures.

Fall-Run Flows in the American River at the confluence with the Sacramento River were examined during the October through January fall-run spawning and egg incubation period (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows during November and December in the American River at the confluence with the Sacramento River under A3_LLT would generally be lower by up to 37% than flows under NAA during November through January (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows during January would generally be similar to or greater than flows under Existing Conditions, except in dry and critical water years (12% and 17% lower, respectively).

The potential risk of redd dewatering in the American River at Nimbus Dam was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in October when spawning is assumed to occur. The greatest monthly reduction in American River flows under A3_LLT during November through January would be of greater magnitude than that under Existing Conditions in all water year types by 12% to 219% (Table 11-3-30).

The Reclamation egg mortality model predicts that fall-run Chinook salmon egg mortality in the American River under A3_LLT would be 45% to 209% greater than mortality under Existing Conditions, which would be 9% to 25% higher on an absolute scale (Table 11-3-31).

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the October through January fall-run spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would generally be up to 18% lower than those under Existing Conditions throughout the period.

Water temperatures in the Stanislaus River for Alternative 3 are not different from those for Alternative 1A, Impact AQUA-76, which indicates that there would be no effects of Alternative 1A on temperatures.

San Joaquin River

Flows in the San Joaquin River at Vernalis were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be up to 8% lower than Existing Conditions in most water years during October, similar to Existing Conditions in November and December, and up to 6% higher than Existing Conditions during January.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Flows in the Mokelumne River at the Delta were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be up to 14% lower than flows under Existing Conditions during October and November, up to 15% greater than flows under Existing Conditions during December and January.

Water temperature modeling was not conducted in the Mokelumne River.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-76 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 3 could be significant because, under the CEQA baseline, the alternative could substantially reduce the amount of suitable habitat for fish, contrary to the NEPA conclusion set forth above. There would be flow reductions and water temperature increases in the Sacramento River that would affect fall- and late fall–run Chinook salmon, as evidenced by Reclamation Egg Mortality model results for fall-run and SacEFT results for fall- and late fall–run Chinook salmon. Water temperatures would also be higher in the Feather and American Rivers under Alternative 3 than under the Existing Conditions that would lead to moderately higher egg mortality as predicted by the Reclamation Egg Mortality Model. Flows would be lower and water temperatures would be lower in the Stanislaus River under Alternative 3.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 3 indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 3. This indicates that the differences between Existing Conditions and Alternative 3 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 3, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on spawning habitat for fall-/late fall-run Chinook salmon. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-77: Effects of Water Operations on Rearing Habitat for Chinook Salmon (Fall-/Late Fall–Run ESU)

In general, Alternative 3 would not affect the quantity and quality of larval and juvenile rearing habitat for fall-/late fall–run Chinook salmon relative to NAA.

Sacramento River

Water temperatures in the Sacramento River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-77, which indicates that there would be no effects of Alternative 1A on temperature.

Fall-Run

Sacramento River flows upstream of Red Bluff were examined for the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in the Sacramento River upstream of Red Bluff under A3_LLT would be greater than or similar to flows under NAA, except in critical water years during January (8% lower).

Shasta Reservoir storage at the end of September would affect flows during the fall-run larval and juvenile rearing period. Storage volume at the end of September would be 9% lower than under NAA in below normal water years, but would be similar to or greater than storage under NAA in other water year types depending on water year type (Table 11-3-13).

SacEFT predicts that there would be a 13% reduction (5% absolute scale) in the percentage of years with good juvenile rearing availability for fall-run Chinook salmon, measured as weighted usable area, under A3_LLT relative to NAA (Table 11-3-25). SacEFT predicts that there would be a 40% increase (8% absolute scale) in the percentage of years with "good" (lower) juvenile stranding risk under A3_LLT relative to NAA.

SALMOD predicts that fall-run smolt equivalent habitat-related mortality under A3_LLT would be 7% lower than under NAA.

Late Fall–Run

Year-round Sacramento River flows upstream of Red Bluff were examined for the late fall–run Chinook salmon juvenile March through July rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows during this period under A3_LLT were generally similar to or greater than those under NAA.

Shasta Reservoir storage at the end of September and May would affect flows during the late fall–run larval and juvenile rearing period. End of September Shasta storage volume would be 9% lower than under NAA in below normal water years, but would be similar to or greater than storage under NAA in other water year types depending on water year type (Table 11-3-16).

May Shasta storage volume under A3_LLT would be similar to or greater than storage under NAA for all water year types except below normal (8% lower) and dry (6% lower) (Table 11-3-9).

SacEFT predicts that there would be a 44% decrease (28% absolute scale) in the percentage of years with good juvenile rearing availability for late fall–run Chinook salmon, measured as weighted usable area, under A3_LLT relative to NAA (Table 11-3-27). SacEFT predicts that the percentage of years with "good" (lower) juvenile stranding risk under A3_LLT would be similar (<5% difference) to NAA.

SALMOD predicts that late fall–run smolt equivalent habitat-related mortality under A3_LLT would be similar to (<5% difference) mortality under NAA.

Clear Creek

No water temperature modeling was conducted in Clear Creek.

Fall-Run

Flows in Clear Creek below Whiskeytown Reservoir were examined the January through May fall-run Chinook salmon rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would generally be similar to or greater than flows under NAA, except in critical water years during February (6% lower) and in below normal years during March (6% reduction).

Feather River

Water temperatures in the Feather River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-77, which indicates that there would be no effects of Alternative 1A on temperature.

Fall-Run

Flows in the Feather River both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) during December through June were reviewed to determine flow-related effects on larval and juvenile fall-run rearing period (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Relatively constant flows in the low flow channel throughout this period under A3_LLT would not differ from those under NAA. In the high flow channel, flows under A3_LLT would nearly always be similar to or greater than flows under NAA, except in critical water years during January (20% lower). These results indicate that Alternative 3 would provide moderate benefits to fall-run Chinook salmon in the Feather River.

As reported in Impact AQUA-59, May Oroville storage under A3_LLT would be similar to (<5% difference) storage under NAA in all water year types (Table 11-3-22).

As reported in Impact AQUA-58, September Oroville storage volume would be 17% to 32% greater than storage under NAA depending on water year type (Table 11-3-20).

American River

Water temperatures in the American River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-77, which indicates that there would be no effects on temperature, compared to NAA.

Fall-Run

Flows in the American River at the confluence with the Sacramento River were examined for the January through May fall-run larval and juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows during January through April under A3_LLT would generally be similar to or greater than flows under NAA except in dry and critical years during March (7% and 9% lower, respectively). Flows during May under A3_LLT would be mostly higher than flows under NAA (up to 36% lower).

Stanislaus River

Fall-Run

Flows in the Stanislaus River at the confluence with the San Joaquin River for Alternative 3 are not different from those under NAA, for the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Water temperatures in the Stanislaus River for Alternative 3 are not different from those for Alternative 1A, which indicates that there would be no effects on temperature or flow, relative to NAA.

San Joaquin River

Fall-Run

Flows in the San Joaquin River at Vernalis for Alternative 3 are not different from those under NAA, for the January through May fall-run larval and juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Fall-Run

Flows in the Mokelumne River at the Delta for Alternative 3 are not different from those under NAA, for the January through May fall-run larval and juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Water temperature modeling was not conducted in the Mokelumne River.

NEPA Effects: Taken together, these results indicate that the effect is not adverse because it does not have the potential to substantially reduce the amount of suitable habitat of fish. Fall-run Chinook salmon would experience beneficial effects of Alternative 3 in the Sacramento River and would not be affected in any upstream waterway. SacEFT predicts that there would be a 44% decrease (28% on an absolute scale) in the percentage of years with good juvenile rearing availability for late fall-run, although modeling outputs predict that flows, which drive rearing habitat availability, would be similar or would increase during the rearing period. In addition, the number of years with good juvenile stranding risk for late fall-run Chinook salmon as predicted by SacEFT would not differ between Alternative 3 and the NEPA baseline, nor would water temperatures or smolt equivalent habitat-related mortality as predicted by SALMOD. There are no effects of Alternative 3 on fall-run or late-fall-run Chinook salmon in other waterways.

CEQA Conclusion: In general, Alternative 3 would not affect the quantity and quality of larval and juvenile rearing habitat for fall-/late fall–run Chinook salmon relative to the Existing Conditions.

Sacramento River

Water temperatures in the Sacramento River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-77 which indicates that there would be no effects on temperatures during the evaluated period, relative to Existing Conditions.

Fall-Run

Sacramento River flows upstream of Red Bluff were examined for the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows under A3_LLT would generally be greater than or similar to flows under Existing Conditions, except in wet years during May (14% lower).

As reported in Impact AQUA-58, end of September Shasta Reservoir storage under A3_LLT would be 9% to 33% lower relative to Existing Conditions depending on water year type (Table 11-3-16).

SacEFT predicts that there would be a 6% increase in the percentage of years with good juvenile rearing availability for fall-run Chinook salmon, measured as weighted usable area, under A3_LLT relative to Existing Conditions (Table 11-3-25). SacEFT predicts that there would be a 10% reduction in the percentage of years with "good" (lower) juvenile stranding risk under A3_LLT relative to Existing Conditions.

SALMOD predicts that fall-run smolt equivalent habitat-related mortality under A3_LLT would be 14% lower than mortality under Existing Conditions.

Late Fall–Run

Year-round Sacramento River flows upstream of Red Bluff were examined for the late fall–run Chinook salmon juvenile March through July rearing period (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows during the period under A3_LLT were generally similar to or greater than those under Existing Conditions except for lower flows in some water years in July (up to 10% lower).

As reported in Impact AQUA-58, end of September Shasta Reservoir storage under A3_LLT would be 9% to 33% lower relative to Existing Conditions depending on water year type (Table 11-3-16).

As reported in Impact AQUA-40, end of May Shasta storage under A3_LLT would be similar to Existing Conditions in wet and above normal water years, but lower by 13% to 24% in below normal, dry, and critical water years (Table 11-3-9).

SacEFT predicts that there would be a 10% reduction in the percentage of years with good juvenile rearing availability for late fall–run Chinook salmon, measured as weighted usable area, under A3_LLT relative to Existing Conditions (Table 11-3-27). SacEFT predicts that there would be a 38% reduction in the percentage of years with "good" (lower) juvenile stranding risk under A3_LLT relative to Existing Conditions.

SALMOD predicts that late fall–run smolt equivalent habitat-related mortality under A3_LLT would be 7% higher than mortality under Existing Conditions.

Clear Creek

No temperature modeling was conducted in Clear Creek.

Fall-Run

Flows in Clear Creek below Whiskeytown Reservoir were examined the January through May fall-run Chinook salmon rearing period (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows under A3_LLT would be similar to or greater than flows under Existing Conditions for the entire period.

Feather River

Fall-Run

Water temperatures in the Feather River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-77, which indicates that temperatures would be higher than under Existing Conditions during substantial portions of the periods evaluated.

Fall-run flows in the Feather River both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) during December through June were reviewed to determine flow-related effects on larval and juvenile fall-run rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Relatively constant flows in the low flow channel throughout the period under A3_LLT would not differ from those under Existing Conditions. In the high flow channel, flows under A3_LLT would be mostly lower (up to 36%) during January and mostly similar to or greater than flows under NAA during December and February through June with few exceptions during which flows would be up to 33% lower under A3_LLT. Overall, the increases in flows would outweigh the reductions in flows under Alternative 3 relative to the Existing Conditions.

As reported under Impact AQUA-59, May Oroville storage volume under A3_LLT would be 6% to 16% lower than storage under Existing Conditions in all but wet years, in which storage would be similar to Existing Conditions (Table 11-3-21).

As reported in Impact AQUA-58, Oroville Reservoir storage volume at the end of September under A3_LLT would be similar to storage under Existing Conditions in dry and critical years but 16% to 20% lower in wet, above normal, and below normal years depending on water year type (Table 11-3-20).

American River

Fall-Run

Water temperatures in the American River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-77, which indicates that temperatures would be higher than under Existing Conditions in 3 months during the 5-month period evaluated.

Flows in the American River at the confluence with the Sacramento River were examined for the January through May fall-run larval and juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows during January through April under A3_LLT would generally be similar to or greater than flows under Existing Conditions, with few exceptions during which flows would be up to 17% lower. Flows during May under A3_LLT would be mostly lower (by up to 27%) than flows under Existing Conditions.

Stanislaus River

Fall-Run

Flows in the Stanislaus River at the confluence with the San Joaquin River for Alternative 3 would be up to 36% lower than Existing Conditions in January through May fall-run larval and juvenile rearing period in most water year types (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Water temperatures in the Stanislaus River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-77, which indicates that temperatures would be higher than under Existing Conditions throughout the period evaluated.

San Joaquin River

Fall-Run

Flows in the San Joaquin River at Vernalis were examined for the January through May fall-run Chinook salmon larval and juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would generally be similar to flows under Existing Conditions during January and February and lower by up to 15% during March through May, particularly in drier water year types.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Fall-Run

Flows in the Mokelumne River at the Delta were examined for January through May fall-run Chinook salmon larval and juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be up to 18% greater than those under Existing Conditions during January and February, similar to flows under Existing Conditions during March, and lower by up to 18% than flows under Existing Conditions during April and May.

Water temperature modeling was not conducted in the Mokelumne River.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-77 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 3 could be significant because, under the CEQA baseline, the alternative could substantially reduce the fall-/late fall-run Chinook salmon rearing habitat, contrary to the NEPA conclusion set forth above. Fall-run Chinook salmon would experience higher egg mortality in the Sacramento River under Alternative 3 relative to Existing Conditions. Late fall–run Chinook salmon in the Sacramento River experience small to moderate (up to 24%) reductions in flow during August, September, and November in most water year types relative to the Existing Conditions. SacEFT predicts that there would be a 22% reduction (10% on an absolute scale) in years with good late fall-run Chinook salmon juvenile rearing WUA and a 38% reduction (27% on an absolute scale) in years with low juvenile stranding risk. Despite small or intermittent flow reductions, there are no impacts of Alternative 3 on flows during the fall-run or late fall–run Chinook salmon periods in the Feather, American, San Joaquin, and Mokelumne Rivers. However, water temperatures would be increased in both the Feather and American Rivers. In the Stanislaus River, flows would be reduced and water temperatures would increase throughout the period.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 3 indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 3. This indicates that the differences between Existing Conditions and Alternative 3 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 3, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on rearing incubation habitat for fall-/late fall-run Chinook salmon. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-78: Effects of Water Operations on Migration Conditions for Chinook Salmon (Fall-/Late Fall–Run ESU)

In general, Alternative 3 would reduce migration conditions for fall-/late fall–run Chinook salmon relative to NAA.

Upstream of the Delta

Sacramento River

Water temperatures in the Sacramento River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-78, which indicates that there would be no effect on temperatures throughout the periods evaluated, relative to NAA.

Fall-Run

Fall-run flows in the Sacramento River upstream of Red Bluff were examined for juvenile fall-run migrants during February through May. Flows under A3_LLT would be similar to or greater than flows under NAA throughout the juvenile fall-run migration period in all water year types (Appendix 11C*, CALSIM II Model Results utilized in the Fish Analysis*).

Flows in the Sacramento River upstream of Red Bluff were examined during the adult fall-run Chinook salmon upstream migration period (September through October). Flows during September under A3_LLT would generally be lower by up to 43% than those under NAA. Flows during October under A3_LLT would be greater than those under NAA. Because flow reductions are negligible or small in dry and critical water years, these flow reductions would not affect fall-run Chinook salmon in a biologically meaningful way.

Late Fall–Run

Flows in the Sacramento River upstream of Red Bluff were reviewed for juvenile late fall–run migration period (January through March). Flows under A3_LLT would generally be similar to or greater than flows under NAA except in critical water years during January (8% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flows in the Sacramento River upstream of Red Bluff were reviewed for the adult late fall–run Chinook salmon upstream migration period (December through February). Flows under A3_LLT would generally be similar to or greater than flows under NAA except in critical water years during January (8% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Clear Creek

Water temperature modeling was not conducted in Clear Creek.

Fall-run flows in the Clear Creek below Whiskeytown Reservoir were examined for juvenile fall-run migrants during February through May. Flows under A3_LLT would generally be similar to or greater than flows under NAA except in critical years during February (6% lower) and in below normal water years during March (6% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flows in Clear Creek below Whiskeytown Reservoir during the adult fall-run Chinook salmon upstream migration period (September through October) under A3_LLT would be similar to or greater than those under NAA, except in critical water years during September (13% lower). (*Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis*).

Feather River

Water temperatures in the Feather River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-78, which indicates that there would be no effect on temperatures throughout the periods evaluated relative to NAA.

Fall-run Flows in the Feather River at the confluence with the Sacramento River were reviewed during the February through May fall-run juvenile migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be similar to or greater than flows under NAA throughout the February to May juvenile migration period.

Flows in the Feather River at the confluence with the Sacramento River were reviewed during the September through October fall-run Chinook salmon adult migration period. Flows in September under A3_LLT would generally be up to 84% lower than flows under NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows during October under A3_LLT would be similar to or greater than flows under NAA in all water year types.

American River

Water temperatures in the American River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-78, which indicates that there would be no effect on temperatures throughout the periods evaluated relative to NAA.

Fall-Run

Fall-run Flows in the American River at the confluence with the Sacramento River were examined during the February through May juvenile Chinook salmon fall-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT during February through May would be generally similar to or greater than flows under NAA, except for dry and critical water years during March (7% and 9% lower, respectively).

Flows in the American River at the confluence with the Sacramento River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows during September under A3_LLT would be up to 58% lower than flows under NAA. During October, flows under A3_LLT would be 40% greater than flows under NAA.

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be similar to those under NAA in all months and water year types throughout the period.

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be similar to those under NAA in all months and water year types throughout the period.

Water temperatures in the Stanislaus River for Alternative 3 are not different from those for Alternative 1A, which indicates that there would be no effect on temperatures throughout the period evaluated, relative to NAA.

San Joaquin River

Flows in the San Joaquin River at Vernalis were examined during the February through May juvenile Chinook salmon fall-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be similar to those under NAA in all months and water year types throughout the period.

Flows in the San Joaquin River at Vernalis were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be similar to those under NAA in all months and water year types throughout the period.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Flows in the Mokelumne River at the Delta were examined during the February through May juvenile Chinook salmon fall-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be similar to those under NAA in all months and water year types throughout the period.

Flows in the Mokelumne River at the Delta were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be similar to those under NAA in all months and water year types throughout the period.

Water temperature modeling was not conducted in the Mokelumne River.

Through-Delta

Sacramento River

Fall-Run

Juveniles

Juvenile salmonids migrating down the Sacramento River would generally experience lower flows below the north Delta intakes compared to Existing Conditions. The two intakes would replace aquatic habitat and likely attract piscivorous fish around the intake structures. Estimates of potential predation losses ranged from 0.6% (bioenergetics model, Table 11-1A-17) up to 8.8% (conservative assumption of 5% loss per intake) of fall-run annual production. Through-Delta survival by juvenile fall-run Chinook salmon under Alternative 3 was similar to NAA (Table 11-3-32).

Table 11-3-32. Through-Delta Survival (%) of Emigrating Juvenile Fall-Run Chinook Salmon under Alternative 3

	Percentage Survival			Difference in Percentage Survival (Relative Difference)	
Month	EXISTING CONDITIONS	NAA	A3_LLT	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Sacramento River					
Wetter Years	34.5	31.1	29.5	-5.1 (-15%)	-1.7 (-5%)
Drier Years	20.6	20.8	21.7	1.1 (5%)	0.9 (4%)
All Years	25.8	24.7	24.6	-1.2 (-5%)	-0.1 (<-1%)
Mokelumne River					
Wetter Years	17.2	15.7	14.7	-2.5 (-15%)	-1.1 (-7%)
Drier Years	15.6	15.9	15.4	-0.2 (-1%)	-0.6 (-4%)
All Years	16.2	15.9	15.1	-1.1 (-7%)	-0.7 (-5%)
San Joaquin River					
Wetter Years	19.3	20.3	20.9	1.6 (8%)	0.7 (3%)
Drier Years	10.0	9.5	10.6	0.7 (7%)	1.1 (11%)
All Years	13.5	13.6	14.5	1.0 (8%)	0.9 (7%)

Note: Delta Passage Model results for survival to Chipps Island.
Wetter = Wet and Above Normal WYs (6 years).
Drier = Below Normal, Dry and Critical WYs (10 years).

Adults

River water in the Delta under Alternative 3 would be similar (<10% change) to NAA from October to December, but would be reduced by 13% in September (Table 11-3-14). Although reduction in the proportion of Sacramento River flows during September would be substantial, it would not occur during the peak migration period (October–December), and olfactory cues for fall-run adults would still be strong. The proportion of Sacramento River under Alternative 3 would still represent 54–66% of Delta outflows. The reductions in percentage are less than the magnitude of change in dilution reported to cause a significant change in migration by Fretwell (1989) and, therefore, are not expected to affect adult Chinook salmon migration. However, uncertainty remains with regard to adult salmon behavioral response to anticipated changes in lower Sacramento River flow percentages. This topic is discussed further in Impact AQUA-42 for Alternative 1A.

Mokelumne River

Fall-Run

Juveniles

Through-Delta survival by juvenile fall-run Chinook salmon under Alternative 3 averaged across years would be 15.1% from the Mokelumne River, which is 0.7% less (5% relative decrease) compared to NAA (Table 11-2A-32). In wetter years, mean survival would be 1.1% lower (7% relative decrease) compared to NAA.

San Joaquin River

Fall-Run

Juveniles

The only changes to San Joaquin River flows at Vernalis would result from the modeled effects of climate change on inflows to the river downstream of Friant Dam and reduced tributary inflows. Through-Delta survival of juvenile fall-run Chinook salmon emigrating from the San Joaquin river under Alternative 3 averaged 14.5% across all years, which is 0.9% greater (7% relative increase) compared to NAA (Table 11-4-32).

Adults

Alternative 3 would slightly increase the proportion of San Joaquin River water in the Delta in September through December by 1.2 % (compared to NAA) (Table 11-3-14). The proportion of San Joaquin River water would be slightly increased compared NAA. Therefore migration conditions under Alternative 3 would be slightly improved.

Late Fall–Run

Juveniles

Through-Delta survival by emigrating juvenile late fall–run Chinook salmon under Alternative 3 (A3_LLT) would average 23% across all years, ranging from 21% in drier years to 26% in wetter years. Under Alternative 3, juvenile survival would increase slightly in drier years (0.4% greater survival, or 12% more in relative percentage) compared to NAA (Table 11-3-33).

Table 11-3-33. Through-Delta Survival (%) of Emigrating Juvenile Late Fall-Run Chinook Salmon under Alternative 3

	Percentage Survival			Difference in Percentage Survival (Relative Difference)	
Month	EXISTING CONDITIONS	NAA	A3_LLT	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Wetter Years	28.8	27.3	27.7	-1.1 (-4%)	0.3 (1%)
Drier Years	18.8	20.2	20.6	1.9 (10%)	0.4 (2%)
All Years	22.5	22.9	23.3	0.8 (3%)	0.4 (2%)

Note: Delta Passage Model results for survival to Chipps Island.
Wetter = Wet and Above Normal WYs (6 years).
Drier = Below Normal, Dry and Critical WYs (10 years).

Adults

The adult late fall–run migration is from November through March, peaking in January through March. The proportion of Sacramento River water in the Delta would be similar (<10%) to NAA throughout the migration period (Table 11-3-14).

Because the proportion of Sacramento River water in the Delta would not substantially change during much of the adult and juvenile fall-run Chinook salmon migration periods under Alternative 3, it would not have an adverse effect on Sacramento or San Joaquin River fall-run Chinook salmon migration success through the Delta. Similarly, Alternative 3 would not have an adverse effect on adult or juvenile late fall–run Chinook salmon migration or survival.

NEPA Effects: Collectively, these results indicate that the effect would be adverse because it has the potential to substantially reduce the availability of suitable migration habitat or substantially interfere with the movement of fish. Flows in the Feather and American rivers during one of the two months of the fall-run Chinook salmon adult migration period would be substantially lower (up to 84% and up to 58%, respectively).Flows in other upstream waterways under Alternative 3 would generally be similar to or greater than those under NAA during juvenile fall- and late fall-run Chinook salmon migration periods.

Near-field effects of Alternative 3 NDD on fall- and late fall-run Chinook salmon related to impingement and predation associated with three new intake structures could result in negative effects on juvenile migrating fall- and late fall-run Chinook salmon, although there is high uncertainty regarding the overall effects. It is expected that the level of near-field impacts would be directly correlated to the number of new intake structures in the river and thus the level of impacts associated with 2 new intakes would be considerably lower than those expected from having 5 new intakes in the river. Estimates within the effects analysis range from very low levels of effects (<1% mortality) to more significant effects (~ 9% mortality above current baseline levels). CM15 would be implemented with the intent of providing localized and temporary reductions in predation pressure at the NDD. Additionally, several pre-construction surveys to better understand how to minimize losses associated with the 2 new intake structures will be implemented as part of the final NDD screen design effort. Alternative 3 also includes an Adaptive Management Program and Real-Time Operational Decision-Making Process to evaluate and make limited adjustments intended to provide adequate migration conditions for fall- and late fall-run Chinook. However, at this time, due to the absence of comparable facilities anywhere in the lower Sacramento River/Delta, the degree of mortality expected from near-field effects at the NDD remains highly uncertain.

Two recent studies (Newman 2003 and Perry 2010) indicate that far-field effects associated with the new intakes could cause a reduction in smolt survival in the Sacramento River downstream of the NDD intakes due to reduced flows in this area. The analyses of other elements of Alternative 3 predict improvements in smolt condition and survival associated with increased access to the Yolo Bypass, reduced interior Delta entry, and reduced south Delta entrainment. The overall magnitude of each of these factors and how they might interact and/or offset each other in affecting salmonid survival through the plan area is uncertain, and remains an area of active investigation for the BDCP.

The DPM is a flow-based model being developed for BDCP which attempts to combine the effects of all of these elements of BDCP operations and conservation measures to predict smolt migration survival throughout the entire Plan Area. The current draft of this model predicts that smolt migration survival under Alternative 3 would be similar to those estimated for NAA. Further refinement and testing of the DPM, along with several ongoing and planned studies related to salmonid survival at and downstream of, the NDD are expected to be completed in the foreseeable future. These efforts are expected to improve our understanding of the relationships and interactions among the various factors affecting salmonid survival, and reduce the uncertainty around the potential effects of BDCP implementation on migration conditions for Chinook salmon.

Because upstream effects would be adverse, it is concluded that the overall effect of Alternative 3 on fall-/late fall-run Chinook salmon migration conditions would be adverse.

This effect is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this effect to a level that is not adverse would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this would be an unavoidable adverse effect because there is no feasible mitigation available. Even so, proposed mitigation (Mitigation Measure AQUA-78a through AQUA-78c) has the potential to reduce the severity of impact, although not necessarily to a not adverse level.

CEQA Conclusion: In general, Alternative 3 would reduce migration conditions for fall-/late fall-run Chinook salmon relative to Existing Conditions

Upstream of the Delta

Sacramento River

Water temperatures in the Sacramento River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-78, which indicates that temperatures would generally not change relative to Existing Conditions during the periods evaluated.

Fall-Run

Flows in the Sacramento River upstream of Red Bluff for juvenile fall-run migrants were evaluated during February through May under A3_LLT. Results indicate that flows would generally be similar to or greater than those under Existing Conditions, except in wet years during May (14% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flows in the Sacramento River upstream of Red Bluff were evaluated during the adult fall-run Chinook salmon upstream migration period (September through October). Flows under A3_LLT would generally be similar to or greater than those under Existing Conditions by except in wet and dry water years during September (23% and 20% lower, respectively) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Late Fall–Run

Flows in the Sacramento River upstream of Red Bluff were examined for juvenile late fall–run migrants (January through March). Flows under A3_LLT during this period would be similar to or greater than flows under Existing Conditions in all months and water year types (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flows in the Sacramento River upstream of Red Bluff were examined during the adult late fall–run Chinook salmon upstream migration period (December through February). Flows under A3_LLT during this period would be similar to or greater than flows under Existing Conditions in all months and water year types (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Clear Creek

Water temperature modeling was not conducted in Clear Creek.

Fall-Run

Flows in Clear Creek below Whiskeytown Reservoir during the juvenile fall-run Chinook salmon upstream migration period (February through May) under A3_LLT would be similar to or greater than those under Existing Conditions throughout the period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*.

Flows in Clear Creek below Whiskeytown Reservoir during the adult fall-run Chinook salmon upstream migration period (September through October) under A3_LLT would generally be similar to or greater than those under Existing Conditions except in critical years during September (37% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Feather River

Water temperatures in the Feather River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-78, which indicates that there would be no differences in temperatures during the periods evaluated, compared to Existing Conditions.

Fall-Run

Flows in the Feather River at the confluence with the Sacramento River were evaluated during the fall-run juvenile migration period (February through May) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would generally be similar to or greater than flows under Existing Conditions during February through April, except in below normal years during March (12% lower) and in wet years during May (24% lower).

Flows in the Feather River at the confluence with the Sacramento River were evaluated during the September through October fall-run Chinook salmon adult migration period. Flows during September under A3_LLT would generally be lower than flows under Existing Conditions by up to 24% (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Although flow reductions would be moderate, they would occur in the majority of years, including dry and below normal years when flow reductions have a larger effect on Chinook salmon. Flows during October under A3_LLT would generally be similar to or greater than flows under Existing Conditions except in below normal water years (6% lower).

American River

Water temperatures in the American River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-78, which indicates that temperatures would be higher relative to Existing Conditions during substantial portions of the periods evaluated.

Fall-Run

Flows in the American River at the confluence with the Sacramento River were examined during the February through May juvenile Chinook salmon fall-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis* Flows under A3_LLT during February through April would generally be similar to or greater than flows under Existing Conditions, except for critical years during February and March (14% and 12% lower, respectively) and in above normal years during April (8% lower). Flows under A3_LLT during May would generally be lower than flows under Existing Conditions by up to 27%.

Flows in the American River at the confluence with the Sacramento River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT during September would be 44% to 55% lower than flows under Existing Conditions. Flows under A3_LLT during October would be 9% to 30% greater than those under Existing Conditions.

Stanislaus River

Fall-Run

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT throughout this period would generally be lower than Existing Conditions (up to 36% lower), except for March in wet water years (7% greater).

Water temperatures in the Stanislaus River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-78, which indicates that temperatures would be higher than under Existing Conditions during substantial portions of the juvenile migration period evaluated.

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would generally be similar to flows under Existing Conditions during September, except in wet and above normal years (17% and 6% lower, respectively). During October, flows would be 6% to 11% lower depending on water year type.

Water temperatures in the Stanislaus River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-78, which indicates that temperatures would be higher than under Existing Conditions during September, but not October.

San Joaquin River

Fall-Run

Flows in the San Joaquin River at Vernalis were examined during the February through May juvenile Chinook salmon fall-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be similar to Existing Conditions but with 8% to 13% lower flows in two water years during February, and would be lower than Existing Conditions by up to 16% during March, April, and May.

Flows in the San Joaquin River at Vernalis were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be lower than Existing Conditions by up to 11% during both months.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Fall-Run

Flows in the Mokelumne River at the Delta were examined during the February through May juvenile Chinook salmon fall-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be similar to or greater than those under Existing Conditions during February and March, but up to 18% lower than flows under Existing Conditions during April and May.

Flows in the Mokelumne River at the Delta were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be up to 29% lower than those under Existing Conditions depending on the month and water year type.

Water temperature modeling was not conducted in the Mokelumne River.

Through-Delta

Through-Delta survival of juvenile fall-run Chinook salmon under Alternative 3 compared to Existing Conditions would be slightly increased in drier years (5% relative increase) and decreased in wetter years (15% relative decrease) from the Sacramento River, decreased from the Mokelumne River, especially in wetter years (15% relative decrease); and increased for juveniles from the San Joaquin River (8% relative increase) (Table 11-3-32).

Patterns in adult attraction flow would be similar (within 3% to 6%) for Sacramento River adults, and increased slightly for San Joaquin River adults compared to Existing Conditions (Table 11-3-14).

Summary of CEQA Conclusion

Collectively, the results indicate that Alternative 3 would be significant because the alternative would substantially reduce the fall-/late fall-run Chinook salmon migration habitat and substantially interfere with the movement of fish. There would be flow reductions under Alternative 3 relative to Existing Conditions during substantial portions of the migration periods evaluated in the Feather, American, Stanislaus, and San Joaquin Rivers. Further, there would be water temperature increases during substantial portions of the periods evaluated in the American and Stanislaus Rivers. There would be negligible effects of Alternative 3 on juvenile and adult fall-/late fall-run Chinook salmon migration through the Delta.

Although the CEQA analyses indicate some significant effects of water operations on juvenile fall-/late fall-run Chinook salmon migrations, the implementation of the mitigation measures listed below has the potential to reduce the severity of the impact, although not necessarily to a less-than-significant level. These mitigation measures would provide an adaptive management process, that may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6), for assessing impacts and developing appropriate minimization measures.

Mitigation Measure AQUA-78a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Fall-/Late Fall–Run Chinook Salmon to Determine Feasibility of Mitigation to Reduce Impacts to Migration Conditions

Please refer to Mitigation Measure AQUA-78a under Alternative 1A (Impact AQUA-78) for fall/late fall-run Chinook salmon.

Mitigation Measure AQUA-78b: Conduct Additional Evaluation and Modeling of Impacts on Fall-/Late Fall–Run Chinook Salmon Migration Conditions Following Initial Operations of CM1

Please refer to Mitigation Measure AQUA-78b under Alternative 1A (Impact AQUA-78) for fall/late fall-run Chinook salmon.

Mitigation Measure AQUA-78c: Consult with USFWS and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Fall-/Late Fall–Run Chinook Salmon Migration Conditions Consistent with CM1

Please refer to Mitigation Measure AQUA-78c under Alternative 1A (Impact AQUA-78) for fall/late fall-run Chinook salmon.

Restoration Measures (CM2, CM4–CM7, and CM10)

Alternative 3 has the same restoration measures as Alternative 1A. Because no substantial differences in restoration-related fish effects are anticipated anywhere in the affected environment under Alternative 3 compared to those described in detail for Alternative 1A, the fish effects of restoration measures described for fall- and late fall–run Chinook salmon under Alternative 1A (Impact AQUA-79 through AQUA-81) also appropriately characterize effects under Alternative 3.

The following impacts are those presented under Alternative 1A that are identical for Alternative 3.

Impact AQUA-79: Effects of Construction of Restoration Measures on Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-80: Effects of Contaminants Associated with Restoration Measures on Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-81: Effects of Restored Habitat Conditions on Chinook Salmon (Fall-/Late Fall–Run ESU)

NEPA Effects: All of these effects have been determined to result in no adverse effects on fall-run/late fall-run Chinook salmon for NEPA purposes, for the reasons identified for Alternative 1A. Specifically for AQUA-80, the effects of contaminants on fall- and late fall-run Chinook salmon with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on fall- and late fall-run Chinook salmon are uncertain.

CEQA Conclusion: All of these effects would be considered less than significant for CEQA purposes, for the reasons identified for Alternative 1A.

Other Conservation Measures (CM12–CM19 and CM21)

Alternative 3 has the same other conservation measures as Alternative 1A. Because no substantial differences in other conservation-related fish effects are anticipated anywhere in the affected environment under Alternative 3 compared to those described in detail for Alternative 1A, the fish effects of other conservation measures described for fall- and late fall–run Chinook salmon under Alternative 1A (Impact AQUA-82 through AQUA-90) also appropriately characterize effects under Alternative 3.

The following impacts are those presented under Alternative 1A that are identical for Alternative 3.

Impact AQUA-82: Effects of Methylmercury Management on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM12)

Impact AQUA-83: Effects of Invasive Aquatic Vegetation Management on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM13)

Impact AQUA-84: Effects of Dissolved Oxygen Level Management on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM14)

Impact AQUA-85: Effects of Localized Reduction of Predatory Fish on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM15)

Impact AQUA-86: Effects of Nonphysical Fish Barriers on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM16)

Impact AQUA-87: Effects of Illegal Harvest Reduction on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM17)

Impact AQUA-88: Effects of Conservation Hatcheries on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM18)

Impact AQUA-89: Effects of Urban Stormwater Treatment on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM19)

Impact AQUA-90: Effects of Removal/Relocation of Nonproject Diversions on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM21)

NEPA Effects: The nine impact mechanisms have been determined to range from no effect, to no adverse effect, or beneficial effects on fall- and late fall-run Chinook salmon for NEPA purposes, for the reasons identified for Alternative 1A.

CEQA Conclusions: The nine impact mechanisms would be considered to range from no impact, to less than significant, or beneficial on fall- and late fall-run Chinook salmon, for the reasons identified for Alternative 1A, and no mitigation is required.

Steelhead

Construction and Maintenance of CM1

Impact AQUA-91: Effects of Construction of Water Conveyance Facilities on Steelhead

The potential effects of construction of water conveyance facilities steelhead under Alternative 3 would be similar to those described for Alternative 1A (see Impact AQUA-91) except that Alternative 3 would include two intakes compared to five intakes under Alternative 1A, so the effects would be proportionally less under this alternative. This would convert about 4,450 lineal feet of existing shoreline habitat into intake facility structures and would require about 10.2 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. The effects related to temporary increases in turbidity, accidental spills, underwater noise, in-water work activities, and disturbance of contaminated sediments would be similar to Alternative 1A and the same environmental commitments and mitigation measures (described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*) would be available to avoid and minimize potential effects.

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-91, environmental commitments and mitigation measures would be available to avoid and minimize potential effects, and the effect would not be adverse for steelhead.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-91, the impact of the construction of the water conveyance facilities on steelhead would be less than significant except for construction noise associated with pile driving. Potential pile driving impacts would be less than Alternative 1A because only two intakes would be constructed rather than five. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in the discussion of Alternative 1A.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in the discussion of Alternative 1A.

Impact AQUA-92: Effects of Maintenance of Water Conveyance Facilities on Steelhead

NEPA Effects: The potential impacts of the maintenance of water conveyance facilities under Alternative 3 would be similar to those described for Alternative 1A except that only two intakes would need to be maintained under Alternative 3 instead of five under Alternative 1A (see Impact

AQUA-92). As concluded in Alternative 1A, Impact AQUA-92, the effect would not be adverse for steelhead.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-92, the impact of the maintenance of water conveyance facilities on steelhead would be less than significant and no mitigation would be required.

Water Operations of CM1

Impact AQUA-93: Effects of Water Operations on Entrainment of Steelhead

Water Exports from SWP/CVP South Delta Facilities

Alternative 3 would reduce entrainment losses of juvenile steelhead at the SWP/CVP south Delta facilities, similar to Alternative 1A (Impact AQUA-93). Entrainment, estimated as salvage density, would be highest in above normal and below normal water year types, but would decrease 20–22% (~2,000 fish; Table 11-3-34) across all water year types compared to NAA. Under Alternative 3, entrainment in above and below normal water years would decrease 17–22% (~1,900–2,600 fish) compared to NAA. The greatest relative reductions would occur in wet years (~1,800 fish; decrease 27–28%). This effect is not adverse and may be beneficial to steelhead.

Water Exports from SWP/CVP North Delta Intake Facilities

The effect would be similar in type to Alternative 1A (with five intakes), but the degree is less because Alternative 3 has only two intakes. Therefore, under Alternative 3 there would be a 60% reduction in impingement and predation risk associated with the north Delta facilities relative to Alternative 1A. The conclusions are the same as for Alternative 1A, Impact AQUA-93, and the effect would not be adverse.

Water Export with a Dual Conveyance for the SWP North Bay Aqueduct

The effects and conclusion are the same as for Impact AQUA-93 for Alternative 1A. Entrainment and impingement effects on juvenile steelhead would be minimal for Alternative 3 because intakes would have state-of-the-art screens installed. Overall, the effect on steelhead under Alternative 3 would not be adverse and may provide a small benefit to the species because entrainment would be reduced, especially at the south Delta facilities.

Predation Associated with Entrainment

Steelhead predation loss at the south Delta facilities is assumed to be proportional to entrainment loss. Average pre-screen predation loss for steelhead entrained at the Clifton Court Forebay is about 80% (Clark et al. 2009) while predation loss for fish entrained at the CVP is assumed to be 15%. Predation loss at the south Delta for steelhead would be reduced by 20–22% compared to NAA. The effects and conclusion for the risk of predation associated with the NPB structures would be the same as described for Alternative 1A (Impact AQUA-93).

Predation at the north Delta would be increased due to the construction of the proposed SWP/CVP water export facilities on the Sacramento River. It is assumed that per capita steelhead predation losses would be similar to those predicted for spring-run Chinook salmon, although slightly reduced because of the larger size of steelhead outmigrants. Bioenergetics modeling with a median predator density of 0.12 predators per foot (0.39 predators per meter) of intake predicts a predation loss of about 0.6% of the juvenile spring-run juvenile population (Table 11-3-12).

NEPA Effects: The overall predation and entrainment losses would likely have a very minor impact on the overall steelhead population, Therefore, the effect under Alternative 3 would not be adverse.

CEQA Conclusion: Entrainment losses of juvenile steelhead would be less under Alternative 3 compared to Existing Conditions (Table 11-3-34). Impacts of water operations on entrainment of steelhead would be less than significant and may be beneficial to the species because of the reduction in entrainment loss and mortality. No mitigation would be required.

Table 11-3-34. Juvenile Steelhead Annual Entrainment Index[a] at the SWP and CVP Salvage Facilities—Differences between Model Scenarios for Alternative 3

	Absolute Difference (Percent Difference)	
Water Year	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Wet	-1,644 (-26%)	-1,736 (-27%)
Above Normal	-2,117 (-16%)	-2,461 (-18%)
Below Normal	-2,586 (-22%)	-1,856 (-17%)
Dry	-267 (-4%)	324 (5%)
Critical	-678 (-12%)	-327 (-6%)
All Years	-1,919 (-21%)	-1,777 (-20%)

[a] Estimated annual number of fish lost, based on non-normalized data.

The impact and conclusion for predation associated with entrainment would be the same as described above as predation loss would be reduced at the south Delta (21% compared to Existing Conditions), but increased slightly at the north Delta intakes. There would likely be a minor increase in predation loss under Alternative 3, but the population level effect would likely be small (<1% of the population). Therefore, the impact would be less than significant and no mitigation would be required.

Impact AQUA-94: Effects of Water Operations on Spawning and Egg Incubation Habitat for Steelhead

In general, the effects of Alternative 3 on steelhead spawning conditions would be negligible relative to NAA.

Sacramento River

Water temperatures in the Sacramento River for Alternative 3 are not different from those for Alternative 1A, Impact AQUA-94, which indicates that temperatures would be similar to those under NAA.

Flows in the Sacramento River between Keswick and upstream of Red Bluff Diversion Dam, where the majority of steelhead spawning occurs, were examined during the primary steelhead spawning and egg incubation period of January through April (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Lower flows can reduce the instream area available for spawning and egg incubation, and rapid reductions in flow can expose redds, leading to mortality. Flows under A3_LLT throughout the period would generally be similar to those under NAA except during January during critical water years (8% lower flow).

SacEFT predicts that there would be a 6% decrease (3% on an absolute scale) in the percentage of years with good spawning availability, measured as weighted usable area, under A3_LLT relative to NAA (Table 11-3-35). SacEFT predicts that there would be negligible (<5%) differences between NAA and A3_LLT in the percentage of years with good (lower) redd scour risk, good (lower) egg incubation conditions, and good (lower) redd dewatering risk. These results indicate that there would be no effect of Alternative 3 on spawning habitat quantity, redd scour risk or temperature-related egg incubation conditions.

Water temperatures in the Sacramento River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-94. Conclusions for Alternative 1A are that the predicted magnitude and frequency of water temperatures potentially affecting the quantity and quality of spawning and incubation habitat under Alternative 1A and baseline conditions would be comparable and would therefore not affect long-term habitat conditions relative to baseline conditions.

Overall, these results indicate that the effects of Alternative 3 on steelhead spawning and egg incubation habitat in the Sacramento River would be negligible.

Table 11-3-35. Difference and Percent Difference in Percentage of Years with "Good" Conditions for Steelhead Habitat Metrics in the Upper Sacramento River (from SacEFT)

Metric	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Spawning WUA	0 (0%)	-3 (-6%)
Redd Scour Risk	-3 (-4%)	0 (0%)
Egg Incubation	0 (0%)	0 (0%)
Redd Dewatering Risk	-1 (-2%)	2 (4%)
Juvenile Rearing WUA	-3 (-7%)	-7 (-16%)
Juvenile Stranding Risk	-17 (-50%)	-3 (-15%)

WUA = Weighted Usable Area.

Clear Creek

No water temperature modeling was conducted in Clear Creek.

Flows in Clear Creek were examined during the steelhead spawning and egg incubation period (January through April). Flows under A3_LLT would generally be similar to flows under NAA throughout the period, except in critical years during February (6% lower), below normal years during March (6% lower), and critical years during January (7% higher) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Results of the flow analyses for the risk of redd dewatering for Clear Creek indicate that the greatest monthly flow reduction would be identical between NAA and A3_LLT for all water year types except for substantial flow reductions in some critical years (100% reduction, to 0 cfs) (Table 11-3-36), which would pose substantial redd dewatering risk for that time-frame.

Overall, these results indicate that the effects of Alternative 3 on steelhead spawning and egg incubation habitat in Clear Creek would be negligible except in some critical years.

Table 11-3-36. Comparisons of Greatest Monthly Reduction (Percent Change) in Instream Flow under Model Scenarios in Clear Creek during the January–April Steelhead Spawning and Egg Incubation Period[a]

Water Year Type	A3_LLT vs. EXISTING CONDITIONS	A3_LLT vs. NAA
Wet	-25 (-38%)	0 (0%)
Above Normal	0 (NA)	0 (NA)
Below Normal	0 (NA)	0 (NA)
Dry	0 (NA)	0 (NA)
Critical	-100 (NA)	-100 (NA)

NA = could not be calculated because the denominator was 0.

[a] Redd dewatering risk not applicable for months when flows during the egg incubation period were at or greater than flows in the month when spawning is assumed to occur. A negative value indicates that the greatest monthly reduction would be of greater magnitude (worse) under the alternative than under the baseline.

Feather River

Flows were examined in the Feather River low-flow channel (upstream of Thermalito Afterbay) and high-flow channel (at Thermalito Afterbay) during the steelhead spawning and egg incubation period (January through April) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in the low-flow channel under A3_LLT would not differ from NAA because minimum Feather River flows are included in the FERC settlement agreement and would be met for all model scenarios (California Department of Water Resources 2006). Flows under A3_LLT at Thermalito Afterbay would generally be much greater than flows under NAA (5% to 70%), except for the occurrence of a decrease in critical years during January (20% lower).

Oroville Reservoir storage volume at the end of September and end of May influences flows downstream of the dam during the steelhead spawning and egg incubation period. Storage volume at the end of September under A3_LLT would be up to 32% greater than storage under NAA depending on water year type (Table 11-3-20). May Oroville storage under A3_LLT would be similar to storage under NAA (Table 11-3-21).

Water temperatures in the Feather River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-94. Conclusions for Alternative 1A are that water temperatures would be comparable and would therefore not affect long-term habitat conditions relative to NAA.

Overall, these results indicate that the effects of Alternative 3 on steelhead spawning and egg incubation habitat in the Feather River would be beneficial.

American River

Flows in the American River at the confluence with the Sacramento River were examined for the January through April steelhead spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would generally be similar to flows under NAA during the period except in dry and critical years during March (7% and 9% lower, respectively) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*.

Water temperatures in the American River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-94, which indicates that there would be no effects of Alternative 3 on temperatures during the periods evaluated.

Overall, these results indicate that the effects of Alternative 3 on steelhead spawning and egg incubation habitat in the American River would be negligible.

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the January through April steelhead spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT throughout this period would generally be identical to flows under NAA.

Water temperatures in the American River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-94, which indicates that there would be no effects on temperatures during the periods evaluated, relative to NAA.

San Joaquin River

The mainstem San Joaquin River does not provide habitat for steelhead spawning or egg incubation.

Mokelumne River

Flows in the Mokelumne River at the Delta were examined during the January through April steelhead spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT throughout this period would generally be identical to flows under NAA.

Water temperature modeling was not conducted in the Mokelumne River.

NEPA Effects: Collectively, these results indicate that the effect of Alternative 3 would not be adverse because it would not substantially reduce suitable spawning or egg incubation habitat or substantially reduce the number of fish as a result of egg mortality. Project-related effects on steelhead egg incubation and spawning conditions based on mean monthly flow consist primarily of negligible effects (<5%), small decreases in mean monthly flow (to -12%) that would not adversely affect steelhead spawning conditions in any of the locations analyzed. There would be beneficial effects from substantial increases in mean monthly flow for some months and water year types in the Feather River (primarily of increases in mean monthly flow ranging from 5% to 70% throughout the spawning period). SacEFT predicts there would be no effects of Alternative 3 on spawning and egg incubation habitat in the Sacramento River.

CEQA Conclusion: In general, Alternative 3 would not reduce the quantity and quality of steelhead spawning habitat relative to the Existing Conditions.

Sacramento River

Flows in the Sacramento River between Keswick and upstream of Red Bluff Diversion Dam, where the majority of steelhead spawning occurs, were examined during the primary steelhead spawning and egg incubation period of January through April. (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Lower flows can reduce the instream area available for spawning and egg incubation, and rapid reductions in flow can expose redds, leading to mortality. At Keswick, flows under A3_LLT would generally be similar to flows under Existing Conditions in March and April, and higher than flows under Existing Conditions in January and February with some exceptions. Upstream of Red Bluff Diversion Dam, flows would generally be similar between Existing Conditions and A3_LLT throughout the period with somewhat better conditions in January.

SacEFT predicts no differences in spawning habitat and egg incubation and negligible changes (<5%) in redd scour and dewatering risk between Existing Conditions and Alternative 3 (Table 11-3-35).

Water temperatures in the Sacramento River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-94. Conclusions for Alternative 1A are that water temperatures under NAA and Alternative 1A would be comparable and would therefore not affect long-term habitat conditions relative to NAA.

Overall, these results indicate that the effects of Alternative 3 on steelhead spawning and egg incubation habitat in the Sacramento River would be negligible

Clear Creek

Flows in Clear Creek were examined during the steelhead spawning and egg incubation period (January through April). Flows under A3_LLT would be similar to or greater than flows under Existing Conditions throughout the period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Results of the flow analyses for the risk of redd dewatering for Clear Creek indicate that the greatest monthly flow reduction would be identical between Existing Conditions and A3_LLT for all water year types except wet, in which the greatest reduction would be 38% lower (worse) under A3_LLT than under Existing Conditions (Table 11-3-36).

No water temperature modeling was conducted in Clear Creek.

Overall, these results indicate that the effects of A3_LLT on steelhead spawning and egg incubation habitat in Clear Creek would be negligible.

Feather River

Flows were examined in the Feather River low-flow channel (upstream of Thermalito Afterbay) and high-flow channel (at Thermalito Afterbay) during the steelhead spawning and egg incubation period (January through April) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in the low-flow channel under A3_LLT would not differ from Existing Conditions because minimum Feather River flows are included in the FERC settlement agreement and would be met for all model scenarios (California Department of Water Resources 2006). Flows under A3_LLT at Thermalito Afterbay would generally be greater than flows under Existing Conditions, except in above and below normal water years during January (6% and 36% lower, respectively), below normal years during February and March (22% and 33% lower, respectively), and wet water years during April (30% lower).

Oroville Reservoir storage volume at the end of September and end of May influences flows downstream of the dam during the steelhead spawning and egg incubation period. Oroville Reservoir storage volume at the end of September would be 2% to 20% lower under A3_LLT relative to Existing Conditions depending on water year type (Table 11-3-20). May Oroville storage volume under A3_LLT would be lower than Existing Conditions by 2% to 16% depending on water year type (Table 11-3-21).

Water temperatures in the Feather River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-94 which indicates that there would be substantial increases in temperatures relative to Existing Conditions during portions of the periods evaluated.

Overall, these results indicate that there would be negligible effects of Alternative 3 on mean monthly flows in the low-flow channel, but that flows in the high-flow channel would be substantially lower in some water year types and months. Alternative 3 would increase exposure of spawning steelhead and their eggs to critical water temperatures, in some water years, a result of reduced coldwater pool availability in Oroville Reservoir.

American River

Flows in the American River at the confluence with the Sacramento River were examined for the January through April steelhead spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would generally be similar to or greater than flows under Existing Conditions in January through April except that they would be substantially lower in dry and critical years in January, critical years in February and March and above normal years in April. Overall, these results indicate that the effects of Alternative 3 on steelhead spawning and egg incubation habitat in the American River would be negligible to minor.

Water temperatures in the American River under Alternative 3 would be the same as those under Alternative 1A, which indicates that there would be substantial increases in temperatures during the periods evaluated, compared to Existing Conditions.

Stanislaus River

Flows in the Stanislaus River for Alternative 3 are substantially below those under Existing Conditions in all months.

Water temperatures in the Stanislaus River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-94, which indicates that temperatures would be greater than those under Existing Conditions during the entire period evaluated.

San Joaquin River

The mainstem San Joaquin River does not provide habitat for steelhead spawning or egg incubation.

Mokelumne River

Flows in the Mokelumne River for Alternative 3 would be similar to or higher than under Existing Conditions in January and February (up to 18% higher), similar to Existing Conditions in March except for being lower in dry years (8% lower), and substantially lower in most water year types in April (up to 14%).

Water temperature modeling was not conducted in the Mokelumne River.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-94 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 3 could be significant because, under the CEQA baseline, the alternative could substantially reduce suitable spawning habitat and substantially reduce the number of fish as a result of egg mortality, contrary to the NEPA conclusion set forth above. Flows under Alternative 3 would be similar to flows under Existing Conditions in all rivers except the Stanislaus River, Mokelumne River and in the Feather River high flow channel. However, only a small number of steelhead spawn in this reach of the Feather River (Cavallo et al. 2003). The majority of steelhead spawning occurs in Hatchery Ditch and the low-flow channel in the general vicinity of the Feather River Hatchery. In addition, there would be substantial negative effects on water temperatures in the Feather, American, and Stanislaus Rivers.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 3 indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 3. This indicates that the differences between Existing Conditions and Alternative 3 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 3, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on spawning habitat for steelhead. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-95: Effects of Water Operations on Rearing Habitat for Steelhead

In general, Alternative 3 would reduce the quantity and quality of steelhead rearing habitat relative to NAA.

Sacramento River

Juvenile steelhead rear within the Sacramento River for 1 to 2 years before migrating downstream to the ocean. Lower flows can reduce the instream area available for rearing and rapid reductions in flow can strand fry or juveniles leading to mortality. Year-round Sacramento River flows within the reach where the majority of steelhead spawning and juvenile rearing occurs (Keswick Dam to upstream of RBDD) were evaluated (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows during September, October, and between December and July under A3_LLT would generally be similar to or greater than those under NAA. Flows during August and November would generally be lower under A3_LLT than under NAA.

SacEFT predicts that the percentage of years with good juvenile steelhead rearing WUA conditions under A3_LLT would be 16% lower (7% on an absolute scale) than that under NAA (Table 11-3-35). Also, the percentage of years with good (lower) juvenile stranding risk conditions under A3_LLT would be 15% lower (3% on an absolute scale) than under NAA. These results indicate that Alternative 3 would cause a small decrease in rearing habitat availability in the Sacramento River.

Water temperatures in the Sacramento River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-95. Conclusions for Alternative 1A are that the predicted magnitude and frequency of water temperatures potentially affecting the quantity and quality of rearing habitat under NAA and Alternative 1A would be comparable and would therefore not affect long-term habitat conditions relative to NAA.

Clear Creek

No water temperature modeling was conducted in Clear Creek.

Flows in Clear Creek below Whiskeytown during the year-round steelhead rearing period under A3_LLT would generally be similar to or greater than flows under NAA, except for critical years in February, October and December and above normal years in March in which flows would be 6% to 9% lower (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).Water temperatures were not modeled in Clear Creek.

It was assumed that habitat for juvenile steelhead rearing would be constrained by the month having the lowest instream flows. Juvenile rearing habitat is assumed to increase as instream flows increase, and therefore the lowest monthly instream flow was used as an index of habitat constraints for juvenile rearing. Results of the analysis indicate that juvenile steelhead rearing habitat, based on minimum instream flows, is comparable for Alternative 3 relative to NAA in wet, above normal, below normal and dry water year types (Table 11-3-37). Minimum flows would be 10% higher in critical years.

Denton (1986) developed flow recommendations for steelhead in Clear Creek using IFIM (Figure 11-1A-4). The current Clear Creek management regime uses flows slightly lower than those recommended by Denton. Results from a new IFIM study on Clear Creek are currently being analyzed. Depending on results of this study the flow regime could be adjusted in the future. We expect that the modeled flows will be suitable for the existing steelhead populations in Clear Creek. No change in effect on steelhead in Clear Creek is anticipated.

Table 11-3-37. Minimum Monthly Instream Flow (cfs) for Model Scenarios in Clear Creek during the Year-Round Juvenile Steelhead Rearing Period

Water Year Type	A3_LLT vs. EXISTING CONDITIONS	A3_LLT vs. NAA
Wet	0 (0%)	0 (0%)
Above Normal	0 (0%)	0 (0%)
Below Normal	0 (0%)	0 (0%)
Dry	0 (0%)	0 (0%)
Critical	-7 (-8%)	7 (10%)

Note: Minimum flows occurred between October and March.

Feather River

Year-round flows in the Feather River both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were reviewed to determine flow-related effects on steelhead juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). The low-flow channel is the primary reach of the Feather River utilized by steelhead spawning and rearing (Cavallo et al. 2003). Relatively constant flows in the low flow channel throughout the year under A3_LLT would not differ from those under NAA. In the high flow channel, flows under A3_LLT would be mostly lower (up to 84%) during July through September and in critical water years during January and mostly greater (up to 72%) than flows under Existing Conditions in other months.

May Oroville storage under A3_LLT would be similar to storage under NAA (Table 11-3-21). September Oroville storage volume would be greater, up to 28% higher than under NAA depending on water year type (Table 11-3-20).

Water temperatures in the Feather River low-flow and high-flow channel under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-95. Conclusions for Alternative 1A are that water temperatures potentially affecting the quantity and quality of rearing habitat under NAA and Alternative 1A would be comparable and would therefore not affect long-term habitat conditions relative to NAA.

American River

Flows in the American River at the confluence with the Sacramento River were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would generally be similar to flows under NAA during January through April and October through December, greater than flows under NAA during May, June and October, and lower than flows under NAA during July through September.

Water temperatures in the American River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-95. Conclusions for Alternative 1A are that the predicted magnitude and frequency of water temperatures potentially affecting the quantity and quality of rearing habitat under NAA and Alternative 1A would be comparable and would therefore not affect long-term habitat conditions relative to NAA.

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be similar to flows under NAA for the entire year except for increases in dry and critical water years during June.

Water temperatures in the American River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-95, which indicates that there would be no effect, relative to NAA, during the period evaluated.

San Joaquin River

Flows in the San Joaquin River at Vernalis were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be similar to flows under NAA throughout the period.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Flows in the Mokelumne River for Alternative 3 were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) and the flows are not different from those under NAA.

NEPA Effects: Collectively, these results indicate the effect would be adverse because it has the potential to substantially reduce rearing habitat for larval and juvenile steelhead. SacEFT predicts that there would be a reduction in rearing habitat availability in the Sacramento River. Further, there would be reductions during July through September in instream flows in the Sacramento, Feather, and American Rivers under Alternative 3 relative to the NEPA baseline, which would reduce the quality and quantity of rearing habitat for larval and juvenile steelhead. There would be no effects on temperatures in the Sacramento, Feather, American, or Stanislaus Rivers. There would be no effects on flows in the Stanislaus, San Joaquin, or Mokelumne Rivers. There would be beneficial effects from increases in mean monthly flow for some months and water year types in Clear Creek, the Feather River, and the American River. However, these would not offset the negative effects of more persistent and/or more critically timed reductions in flow (e.g., during summer months and/or in drier water year types). This effect is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this effect to a level that is not adverse would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this would be an unavoidable adverse effect because there is no feasible mitigation available. Even so, proposed mitigation (Mitigation Measure AQUA-95a through AQUA-95c) has the potential to reduce the severity of impact, although not necessarily to a not adverse level.

CEQA Conclusion: In general, Alternative 3 would not affect the quantity and quality of steelhead rearing habitat relative to the Existing Conditions.

Sacramento River

Year-round Sacramento River flows within the reach where the majority of steelhead spawning and juvenile rearing occurs (Keswick Dam to upstream of RBDD) were evaluated (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows during October and between December and June under A3_LLT would generally be similar to or greater than those under Existing Conditions. Flows during August, September and November would generally be lower under A3_LLT than under Existing Conditions.

SacEFT predicts that there would be a 7% decrease in the percentage of years with good rearing availability, measured as weighted usable area, under A3_LLT relative to Existing Conditions (Table 11-3-35). SacEFT predicts that there would be a substantial reduction (-50%) in the number of years with good (lower) juvenile stranding risk under A3_LLT relative Existing Conditions.

Water temperatures in the Sacramento River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-95, which indicates that temperatures would generally not be affected by Alternative 3 relative to Existing Conditions.

Clear Creek

Flows in Clear Creek during the year-round rearing period under A3_LLT would generally be similar to or greater than flows under Existing Conditions, except for critical years in August and September in which flows would be 17% to 37% lower (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

No temperature modeling was conducted in Clear Creek.

Juvenile rearing habitat is assumed to increase in Clear Creek as instream flows increase, and therefore the use of the lowest monthly instream flow as an index of habitat constraints for juvenile rearing was selected for use in this analysis. Results of the analysis of minimum monthly instream flows affecting juvenile rearing habitat are shown in Table 11-3-37. Results indicate that Alternative 3 would have no effect on juvenile rearing habitat, based on minimum instream flows, compared to Existing Conditions in wet, above normal, below normal and dry water years. Minimum flows would be 8% lower in critical years (reduction from 50 cfs to 43 cfs).

Denton (1986) developed flow recommendations for steelhead in Clear Creek using IFIM (Figure 11-1A-4). The current Clear Creek management regime uses flows slightly lower than those recommended by Denton. Results from a new IFIM study on Clear Creek are currently being analyzed. Depending on results of this study the flow regime could be adjusted in the future. We expect that the modeled flows will be suitable for the existing steelhead populations in Clear Creek. No change in effect on steelhead in Clear Creek is anticipated.

Feather River

Water temperatures in the Feather River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-95 which indicate that temperatures would increase relative to Existing Conditions during the year-round period.

The low-flow channel is the primary reach of the Feather River utilized by steelhead spawning and rearing (Cavallo et al. 2003). There would be no change in flows for Alternative 3 relative to Existing Conditions in the low-flow channel during the year-round steelhead juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). In the high flow channel (at Thermalito Afterbay), flows under A3_LLT would be lower (up to 51%) during July and August and some water year types in November, and mostly greater (up to 149%) than flows under Existing Conditions in other months.

May Oroville storage volume under A3_LLT would be lower than Existing Conditions by 2% to 16% depending on water year type (Table 11-3-21). September Oroville storage volume would be 2% to 20% lower under A3_LLT relative to Existing Conditions depending on water year type (Table 11-3-20).

American River

Water temperatures in the American River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-95, which indicates that temperatures would increase relative to Existing Conditions during the year-round period.

Flows in the American River at the confluence with the Sacramento River were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be up to 28% greater than to flows under Existing Conditions during February, March, and October, similar to flows under Existing Conditions during April, and up to 58% lower than flows under Existing Conditions during the remaining eight months of the year.

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be similar to flows under Existing Conditions during August, September, and November and up to 26% lower than flows under Existing Conditions during the remaining 9 months.

Water temperatures in the Stanislaus River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-95, which indicates that temperatures would increase relative to Existing Conditions during most of the year-round period.

San Joaquin River

Flows in the San Joaquin River at Vernalis were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be up to 6% higher than Existing Conditions during January, generally similar to Existing Conditions during February except for being lower in two water years, lower in most water years than Existing Conditions during March through October (up to 38% lower), and similar to Existing Conditions during November and December.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Flows in the Mokelumne River at the Delta were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be similar to flows under Existing Conditions during January through March, up to 15% greater than flows under Existing Conditions during December, and up to 52% lower than flows under Existing Conditions during the remaining 8 months.

Water temperature modeling was not conducted in the Mokelumne River.

Summary of CEQA Conclusion

Collectively, these results indicate that the impact on rearing habitat for steelhead would be significant because there would be the potential to substantially reduce rearing habitat and substantially reduce the number of fish as a result of mortality. Alternative 3 would cause reductions in mean monthly flow (to -58%) for much of the rearing period in most locations analyzed that would affect the quantity and quality of juvenile rearing habitat and would contribute to reduced survival and increased stress. Alternative 3 would have negative effects on water temperature conditions during the year-round steelhead rearing period in the Feather, American, and Stanislaus Rivers relative to Existing Conditions, but not in the Sacramento River. This impact is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this impact to a less-than-significant level would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this impact is significant and unavoidable because there is no feasible mitigation available. Even so, proposed below is mitigation that has the potential to reduce the severity of impact though not necessarily to a less-than-significant level.

Mitigation Measure AQUA-95a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Steelhead to Determine Feasibility of Mitigation to Reduce Impacts to Rearing Habitat.

Although analysis conducted as part of the EIR/EIS determined that Alternative 3 would have significant and unavoidable adverse effects on rearing habitat, this conclusion was based on the best available scientific information at the time and may prove to have been overstated. Upon the commencement of operations of CM1 and continuing through the life of the permit, the BDCP proponents will monitor effects on rearing habitat in order to determine whether such effects would be as extensive as concluded at the time of preparation of this document and to determine any potentially feasible means of reducing the severity of such effects. This mitigation measure requires a series of actions to accomplish these purposes, consistent with the operational framework for Alternative 3.

The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 3 operations only. Development of mitigation actions for the incremental impact on spawning habitat attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 3.

Mitigation Measure AQUA-95b: Conduct Additional Evaluation and Modeling of Impacts on Steelhead Rearing Habitat Following Initial Operations of CM1.

Following commencement of initial operations of CM1 and continuing through the life of the permit, the BDCP proponents will conduct additional evaluations to define the extent to which modified operations could reduce impacts to rearing habitat under Alternative 3. The analysis required under this measure may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6).

Mitigation Measure AQUA-95c: Consult With NMFS, USFWS and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Steelhead Rearing Habitat Consistent With CM1

In order to determine the feasibility of reducing the effects of CM1 operations on steelhead habitat, the BDCP proponents will consult with NMFS, USFWS, and CDFW to identify and implement any feasible operational means to minimize effects on rearing habitat. Any such action will be developed in conjunction with the ongoing monitoring and evaluation of habitat conditions required by Mitigation Measure AQUA-95a Alternative 3.

If feasible means are identified to reduce impacts on rearing habitat consistent with the overall operational framework of Alternative 3 without causing new significant adverse impacts on other covered species, such means shall be implemented. If sufficient operational flexibility to reduce effects on steelhead habitat is not feasible under Alternative 3 operations, achieving further impact reduction pursuant to this mitigation measure would not be feasible under this Alternative, and the impact on steelhead would remain significant and unavoidable.

Impact AQUA-96: Effects of Water Operations on Migration Conditions for Steelhead

In general, the effects of Alternative 3 on steelhead migration conditions relative to the NAA are uncertain.

Upstream of the Delta

Sacramento River

Water temperatures in the Sacramento River under Alternative 3 would be the same as those under Alternative 1A, which indicates that temperatures would not be different during the periods evaluated relative to NAA.

Juveniles

Flows in the Sacramento River upstream of Red Bluff were evaluated during the October through May juvenile steelhead migration period. Flows under A3_LLT would be 10% to 37% lower than flows under NAA during November depending on water year type, they would be up to 22% higher during October, December, April, and May (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT in the January and February would be similar to flows under NAA with some higher and lower flows in certain water years.

Water temperatures in the Sacramento River under Alternative 3 would be the same as those under Alternative 1A, which indicates that temperatures would not be different during the periods evaluated relative to NAA.

Adults

Flows in the Sacramento River upstream of Red Bluff were evaluated during the September through March steelhead adult upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be lower than flows under NAA during September depending on water year type, lower by 10% to 37% in November, and generally similar to flows under NAA in the remaining six months of the period.

Kelts

Flows in the Sacramento River upstream of Red Bluff were evaluated during the March and April steelhead kelt downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows during March would be similar to NAA flows but higher in below normal, critical and above normal years (up to 13% higher) and flow would be higher during April (up to 13% higher) except for being similar to NAA in critical years.

Overall in the Sacramento River, Alternative 3 would not result in biologically meaningful effects on juvenile, adult, or kelt steelhead migration based on mean monthly flows and water temperatures.

Clear Creek

Water temperature modeling was not conducted in Clear Creek.

Juveniles

Flows in Clear Creek during the October through May juvenile steelhead migration period under A3_LLT would be similar to flows under NAA except in critical years during October, November and January (7%, 9% and 7% higher, respectively), in critical years in February (6% lower), and in below normal years in March (6% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Adults

Flows in Clear Creek during the September through March adult steelhead migration period under A3_LLT would similar to flows under NAA except in critical years during September, October, November and January (13%, 7%, 9% and 7% higher, respectively), in critical years in February (6% lower), and in below normal years in March (6% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Kelts

Flows in Clear Creek during the March through April steelhead kelt downstream migration period under A3_LLT would be similar to or greater flows under NAA except for lower flows in below normal years in March (6% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Overall in Clear Creek, Alternative 3 would not have biologically meaningful effects on juvenile, adult, or kelt steelhead migration.

Feather River

Water temperatures in the Feather River under Alternative 3 would be the same as those under Alternative 1A, which indicates that temperatures would not be different during the periods evaluated relative to NAA.

Juveniles

Flows in the Feather River at the confluence with the Sacramento River were examined during the October through May juvenile steelhead migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be similar to or greater than flows under NAA in all months and water years except during October in above normal years (6% lower) and January in critical years (8% lower).

Adults

Flows in the Feather River at the confluence with the Sacramento River were examined during the September through March adult steelhead upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be similar to or greater than flows under NAA in all months and water years except during September in below normal years (31% lower), October in above normal years (6% lower) and January in critical years (8% lower).

Kelts

Flows in the Feather River at the confluence with the Sacramento River were examined during the March and April steelhead kelt downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would generally be greater than those under NAA in both months (up to 22% higher).

Overall in the Feather River, project-related effects of Alternative 3 consist of negligible changes in water temperature, and negligible effects (<5%) on mean monthly flow or increases in flow that would have a beneficial effect on migration conditions for juvenile, adult and kelt steelhead.

American River

Water temperatures in the American River under Alternative 3 would be the same as those under Alternative 1A, which indicates that temperatures would not be different during the periods evaluated relative to NAA.

Juveniles

Flows in the American River at the confluence with the Sacramento River were evaluated during the October through May juvenile steelhead migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be similar to or greater than flows under NAA during the entire period except for lower flows in dry and critical years in March (7% and 9% lower).

Adults

Flows in the American River at the confluence with the Sacramento River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be similar to or greater than flows under NAA during the entire period except for lower flows in dry and critical years in March (7% and 9% lower) and would be lower during September for all water year types except dry and critical years (16% to 50% lower).

Kelts

Flows in the American River at the confluence with the Sacramento River were evaluated for the March and April kelt migration period. Flows under A3_LLT would generally be similar to flows under NAA except in dry and critical years during March (7% and 9% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Overall in the American River, results indicate that project-related effects of Alternative 3 consist of negligible effects on temperature, negligible effects (<5%) on flow or increases in flow that would have beneficial effects on migration conditions, with decreases in flow that would be infrequent, of small magnitude, or would occur in wetter water years that would not have biologically meaningful effects on juvenile, adult, or kelt steelhead migration conditions in the American River.

Stanislaus River

Water temperatures in the Stanislaus River under Alternative 3 would be the same as those under Alternative 1A, which indicates that temperatures would not be different during the periods evaluated relative to NAA.

Juveniles

Flows in the Stanislaus River at the confluence with the San Joaquin River were evaluated during the October through May juvenile steelhead migration period. Flows under A3_LLT would be similar to flows under NAA during the entire period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Adults

Flows in the Stanislaus River at the confluence with the San Joaquin River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be similar flows under NAA during the entire period.

Kelts

Flows in the Stanislaus River at the confluence with the San Joaquin River were evaluated for the March and April kelt migration period. Flows under A3_LLT would be similar to under NAA for both months (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Overall in the Stanislaus River, there would be no effects of Alternative 3 on flows or water temperatures during the juvenile, adult, or kelt steelhead migration periods.

San Joaquin River

Water temperature modeling was not conducted in the San Joaquin River.

Juveniles

Flows in the San Joaquin River at Vernalis were evaluated during the October through May juvenile steelhead migration period. Flows under A3_LLT would be similar to flows under NAA during the entire period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Adults

Flows in the San Joaquin River at Vernalis were evaluated during the September through March steelhead adult upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be similar flows under NAA during the entire period.

Kelts

Flows in the San Joaquin River at Vernalis were evaluated for the March and April kelt migration period. Flows under A3_LLT would be similar to under NAA for both months (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mokelumne River

Water temperature modeling was not conducted in the Mokelumne River.

Juveniles

Flows in the Mokelumne River were evaluated during the October through May juvenile steelhead migration period. Flows under A3_LLT would be similar to flows under NAA during the entire period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Adults

Flows in the Mokelumne River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be similar flows under NAA during the entire period.

Kelts

Flows in the Mokelumne River were evaluated for the March and April kelt migration period. Flows under A3_LLT would be similar to under NAA for both months (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

The through-Delta methodology for assessing steelhead Delta migration habitat conditions is fully described in the analysis of Alternative 1A.

Sacramento River

Juveniles

Based on DPM results for Chinook salmon (Impact AQUA-42 for Alternative 3), steelhead survival would not be expected to decrease more than 0.5% under Alternative 3.

Adults

The upstream adult steelhead migration occurs from September–March, peaking during December-February. The steelhead kelt downstream migration occurs from January–April. The proportion of Sacramento River water in the Delta under Alternative 3 would to be similar (<10% difference) to NAA during the majority (October–March) of the adult steelhead upstream migration, including during the peak migration months (Table 11-3-14). The proportion of Sacramento River water decreases in September compared to NAA (13%). Based on the overall similarity in Sacramento River flow olfactory cues, especially during the adult upstream and kelt downstream migration periods, the effects would be expected to be similar. Alternative 3 would not have an adverse effect on adult and kelt steelhead migration through the Delta.

San Joaquin River

Juveniles

The only changes to San Joaquin River flows at Vernalis would result from the modeled effects of climate change on inflows to the river downstream of Friant Dam and reduced tributary inflows. There no flow changes associated with the Alternatives. Alternative 3 would have no effect on steelhead migration success through the Delta.

Adults

Alternative 3 would slightly increase the proportion of San Joaquin River water in the Delta in September through December by 1.9% compared to NAA (Table 11-3-14). Therefore, Alternative 3 would have no effect on the adult steelhead and kelt migration because olfactory cues and flow conditions would be relatively unchanged.

Based on DPM, through-Delta juvenile steelhead survival would not be expected to decrease more than 0.5% under Alternative 3. Alternative 3 would also not have an adverse effect on Sacramento River adult and kelt steelhead migration through the Delta. Alternative 3 would also have no effect on the San Joaquin River juvenile and adult steelhead and kelt through-Delta migrations because olfactory cues and flow conditions would be relatively unchanged.

NEPA Effects: Upstream of the Delta, the results indicate that the effect would not be adverse because the alternative does not have the potential to substantially reduce migration habitat or substantially interfere with the movement of fish. Alternative 3 would have negligible effects on water temperatures in the Sacramento, Feather, American, and Stanislaus Rivers, and effects on flow would consist of negligible effects (<5% difference), beneficial effects (increases in flow to 84%), or reductions in flow that would not have biologically meaningful effects on migration conditions based on the infrequency of occurrence throughout a relatively long migration period (to -68%), moderate magnitude (i.e., more routine reductions in flow to -16%), and/or timing of the reduction (i.e., larger reductions in wetter water years when effects on migration would not be critical).

Near-field effects of Alternative 3 NDD on Sacramento River steelhead related to impingement and predation associated with three new intake structures could result in negative effects on juvenile migrating steelhead, although there is high uncertainty regarding the overall effects. It is expected that the level of near-field impacts would be directly correlated to the number of new intake structures in the river and thus the level of impacts associated with 2 new intakes would be considerably lower than those expected from having 5 new intakes in the river. Estimates within the effects analysis range from very low levels of effects (<1% mortality) to more significant effects (~ 12% mortality above current baseline levels). CM15 would be implemented with the intent of providing localized and temporary reductions in predation pressure at the NDD. Additionally, several pre-construction surveys to better understand how to minimize losses associated with the 2 new intake structures will be implemented as part of the final NDD screen design effort. Alternative 3 also includes an Adaptive Management Program and Real-Time Operational Decision-Making Process to evaluate and make limited adjustments intended to provide adequate migration conditions for steelhead. However, at this time, due to the absence of comparable facilities anywhere in the lower Sacramento River/Delta, the degree of mortality expected from near-field effects at the NDD remains highly uncertain.

Two recent studies (Newman 2003 and Perry 2010) indicate that far-field effects associated with the new intakes could cause a reduction in smolt survival in the Sacramento River downstream of the NDD intakes due to reduced flows in this area. The analyses of other elements of Alternative 3 predict improvements in smolt condition and survival associated with increased access to the Yolo Bypass, reduced interior Delta entry, and reduced south Delta entrainment. The overall magnitude of each of these factors and how they might interact and/or offset each other in affecting salmonid survival through the plan area is uncertain, and remains an area of active investigation for the BDCP.

The DPM is a flow-based model being developed for BDCP which attempts to combine the effects of all of these elements of BDCP operations and conservation measures to predict smolt migration survival throughout the entire Plan Area. The current draft of this model predicts that smolt migration survival under Alternative 3 would be similar to those estimated for NAA. Further refinement and testing of the DPM, along with several ongoing and planned studies related to salmonid survival at and downstream of, the NDD are expected to be completed in the foreseeable future. These efforts are expected to improve our understanding of the relationships and interactions among the various factors affecting salmonid survival, and reduce the uncertainty around the potential effects of BDCP implementation on migration conditions for steelhead. However, until these efforts are completed and their results are fully analyzed, the overall cumulative effect of Alternative 3 on steelhead migration remains uncertain.

CEQA Conclusion: In general, under Alternative 3, migration conditions for steelhead would not be reduced relative to Existing Conditions.

Upstream of the Delta

Sacramento River

Water temperatures in the Sacramento River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-96, which indicates that temperatures would not be different during the periods evaluated relative to Existing Conditions.

Juveniles

Flows in the Sacramento River upstream of Red Bluff were evaluated during the October through May juvenile steelhead migration period. Flows under A3_LLT would be 9% to 27% lower than flows under Existing Conditions during November depending on water year type and would be up to 22% higher during January and May (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT in the remaining five months of the migration period would be similar to flows under Existing Conditions.

Adults

Flows in the Sacramento River upstream of Red Bluff were evaluated during the September through March steelhead adult upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be lower than flows under Existing Conditions during September depending on water year type, lower by 7% to 27% in November, and similar to flows under Existing Conditions in the remaining six months of the period.

Kelts

Flows in the Sacramento River upstream of Red Bluff were evaluated during the March and April steelhead kelt downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows during these two months would not differ between Existing Conditions and A3_LLT except for being higher by 13% in critical years in March and being 18% lower in wet years in April.

Overall in the Sacramento River, effects of Alternative 3 on water temperatures and mean monthly flow conditions during the applicable migration periods would not have biologically meaningful effects on migration.

Clear Creek

Water temperature modeling was not conducted in Clear Creek.

Juveniles

Flows in Clear Creek during the October through May juvenile steelhead migration period under A3_LLT would be similar to or greater than flows under Existing Conditions except in critical years during February (6% lower), and in below normal years in March (6% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Adults

Flows in Clear Creek during the September through March adult steelhead migration period under A3_LLT would generally be similar to or greater than flows under Existing Conditions except in critical years during September (37% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Kelts

Flows in Clear Creek during the March through April steelhead kelt downstream migration period under A3_LLT would be similar to or greater flows under Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Overall in Clear Creek, Alternative 3 would have primarily negligible effects (<5%) on flows or would cause increases in mean monthly flow that would be beneficial for juvenile, adult, and kelt migration conditions.

Feather River

Water temperatures in the Feather River under Alternative 3 would be the same as those under Alternative 1A, which indicates that temperatures would not be different during the periods evaluated relative to Existing Conditions.

Juveniles

Flows in the Feather River at the confluence with the Sacramento River were examined during the October through May juvenile steelhead migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be similar to or greater than flows under Existing Conditions in all months and water years except during October, November, January and March in below normal years (6%,11%, 10%, and 12% lower, respectively), and during April and May in wet years (24% and 19% lower, respectively).

Adults

Flows in the Feather River at the confluence with the Sacramento River were examined during the September through March adult steelhead upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be up to 24% lower than flows under Existing Conditions during September, 6% lower than flows under Existing Conditions during October in below normal years, 11% lower than flows under Existing Conditions during November in below normal years, 10% lower than flows under Existing Conditions during January in below normal years and generally greater than flows under Existing Conditions in all other water years and months of the period.

Kelts

Flows in the Feather River at the confluence with the Sacramento River were examined during the March and April steelhead kelt downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be greater than those under Existing Conditions in both months except for being 12% lower in below normal years during March and 24% lower in wet year during April.

Overall in the Feather River, effects of Alternative 3 on flow would not have biologically meaningful effects on juvenile, adult or kelt migration conditions above Thermalito Afterbay or at the confluence with the Sacramento River.

American River

Water temperatures in the American River under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-96, which indicates that temperatures would be higher during substantial portions of the juvenile and adult migration periods relative to Existing Conditions.

Juveniles

Flows in the American River at the confluence with the Sacramento River were evaluated during the October through May juvenile steelhead migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be greater than flows under Existing Conditions in and October (up to 30% higher), generally higher in January, February, March and April except for dry and critical years in January, critical years in February and March, and above normal years in April. Flows would be lower than under Existing Conditions in November during all water year types (up to 35% lower), and in December under all water year types (up to21% lower) except for wet and below normal years. Flow in January would be greater than flows under Existing Conditions in wet, above normal, and below normal years and below Existing Conditions in dry and critical years.

Adults

Flows in the American River at the confluence with the Sacramento River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be greater than flows under Existing Conditions in and October (up to 30% higher), generally higher in January, February, March and April except for dry and critical years in January, critical years in February and March, and above normal years in April. Flows would be lower than under Existing Conditions in September and November during all water year types (up to 55% and 35% lower, respectively), and in December under all water year types (up to21% lower) except for wet and below normal years. Flow in January would be greater than flows under Existing Conditions in wet, above normal, and below normal years and below Existing Conditions in dry and critical years.

Kelts

Flows in the American River at the confluence with the Sacramento River were evaluated for the March and April kelt migration period. Flows under A3_LLT would generally be greater than flows under Existing Conditions except in critical years during March (12% lower) and in above normal years in April (8% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Overall in the American River, Alternative 3 would have significant impacts on juvenile and adult migration conditions through persistent and moderate to substantial flow reductions during drier water years. Alternative 3 would not affect kelt migration. Increases in mean monthly flow for some months and water year types would have beneficial impacts on steelhead for a portion of the migration period for juveniles and adults.

Stanislaus River

Flows in the Stanislaus River for Alternative 3 are substantially below those under Existing Conditions for juveniles, adults, or kelts (e.g., 36% lower in dry water years in February).

Water temperatures in the Stanislaus River under Alternative 3 would be the same as those under Alternative 1A, which indicates that temperatures would not be different during substantial portions of the periods evaluated relative to Existing Conditions.

San Joaquin River

Flows in the San Joaquin River for Alternative 3 are substantially below those under Existing Conditions for juveniles, adults or kelts (e.g., 16% lower in below normal years in March) except for similar flow conditions in November and December and somewhat higher flow conditions in some water years for January (up to 10% higher).

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Flows in the Mokelumne River for Alternative 3 are substantially below those under Existing Conditions for juveniles, adults or kelts (e.g., 18% lower in dry years in May) except for somewhat higher flow conditions in some water years for January and February (up to 18% higher) and generally higher flows for all water years in December (up to 15% higher).

Water temperature modeling was not conducted in the Mokelumne River.

Through-Delta

Based on DPM results for Chinook salmon (see Impact AQUA-42), steelhead survival would not be expected to decrease more than 0.5%.

The proportion of Sacramento River water in the Delta under Alternative 3 would to be similar to Existing Conditions (<10% difference) during the entire adult steelhead upstream and kelt downstream migrations.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-96 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 3 could be significant because, under the CEQA baseline, the alternative could substantially reduce the availability of suitable migration habitat and interfere with the movement of fish, contrary to the NEPA conclusion set forth above. Relative to the CEQA baseline, Alternative 3 would degrade migration conditions in the American and Stanislaus rivers (based on persistent flow reductions and water temperature increases) and in the San Joaquin and Mokelumne rivers (based on persistent flow reductions). However, Alternative 3 would not have biologically meaningful impacts on juvenile, adult, or kelt migration in the Sacramento River, Clear Creek, or the Feather River. There would be no effects on through-Delta migration conditions because changes in juvenile survival and adult olfactory cues would be negligible.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 3 indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 3. This indicates that the differences between Existing Conditions and Alternative 3 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 3, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on migration conditions for steelhead. This impact is found to be less than significant and no mitigation is required.

Restoration Measures (CM2, CM4–CM7, and CM10)

Alternative 3 has the same restoration measures as Alternative 1A. Because no substantial differences in restoration-related fish effects are anticipated anywhere in the affected environment under Alternative 3 compared to those described in detail for Alternative 1A, the fish effects of restoration measures described for steelhead under Alternative 1A (Impact AQUA-97 through AQUA-99) also appropriately characterize effects under Alternative 3.

The following impacts are those presented under Alternative 1A that are identical for Alternative 3.

Impact AQUA-97: Effects of Construction of Restoration Measures on Steelhead

Impact AQUA-98: Effects of Contaminants Associated with Restoration Measures on Steelhead

Impact AQUA-99: Effects of Restored Habitat Conditions on Steelhead

NEPA Effects: All of these effects have been determined to result in no adverse effects on steelhead for NEPA purposes for the reasons identified for Alternative 1A. Specifically for AQUA-98, the effects of contaminants on steelhead with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on steelhead are uncertain.

CEQA Conclusions: All of these effects would be considered less than significant for CEQA purposes for the reasons identified for Alternative 1A.

Other Conservation Measures (CM12–CM19 and CM21)

Alternative 3 has the same other conservation measures as Alternative 1A. Because no substantial differences in other conservation-related fish effects are anticipated anywhere in the affected environment under Alternative 3 compared to those described in detail for Alternative 1A, the fish effects of other conservation measures described for steelhead under Alternative 1A (Impact AQUA-100 through AQUA-108) also appropriately characterize effects under Alternative 3.

The following impacts are those presented under Alternative 1A that are identical for Alternative 3.

Impact AQUA-100: Effects of Methylmercury Management on Steelhead (CM12)

Impact AQUA-101: Effects of Invasive Aquatic Vegetation Management on Steelhead (CM13)

Impact AQUA-102: Effects of Dissolved Oxygen Level Management on Steelhead (CM14)

Impact AQUA-103: Effects of Localized Reduction of Predatory Fish on Steelhead (CM15)

Impact AQUA-104: Effects of Nonphysical Fish Barriers on Steelhead (CM16)

Impact AQUA-105: Effects of Illegal Harvest Reduction on Steelhead (CM17)

Impact AQUA-106: Effects of Conservation Hatcheries on Steelhead (CM18)

Impact AQUA-107: Effects of Urban Stormwater Treatment on Steelhead (CM19)

Impact AQUA-108: Effects of Removal/Relocation of Nonproject Diversions on Steelhead (CM21)

NEPA Effects: The nine impact mechanisms have been determined to range from no effect, to no adverse effect, or beneficial effects on steelhead for NEPA purposes, for the reasons identified for Alternative 1A.

CEQA Conclusions: The nine impact mechanisms would be considered to range from no impact, to less than significant, or beneficial on steelhead, for the reasons identified for Alternative 1A, and no mitigation is required.

Sacramento Splittail

Construction and Maintenance of CM1

Impact AQUA-109: Effects of Construction of Water Conveyance Facilities on Sacramento Splittail

The potential effects of construction of water conveyance facilities on Sacramento splittail under Alternative 3 would be similar to those described for Alternative 1A (see Impact AQUA-109) except that Alternative 3 would include two intakes compared to five intakes under Alternative 1A, so the effects would be proportionally less under this alternative. This would convert about 4,450 lineal feet of existing shoreline habitat into intake facility structures and would require about 10.2 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. The effects related to temporary increases in turbidity, accidental spills, underwater noise, in-water work activities, and disturbance of contaminated sediments would be similar to Alternative 1A and the same environmental commitments and mitigation measures (described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*) would be available to avoid and minimize potential effects.

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-109, environmental commitments and mitigation measures would be available to avoid and minimize potential effects, and the effect would not be adverse for Sacramento splittail.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-109 for Sacramento splittail, the impact of the construction of water conveyance facilities on Sacramento splittail would be less than significant except for construction noise associated with pile driving. Potential pile driving impacts would be less than Alternative 1A because only two intakes would be constructed rather than five. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in the discussion of Alternative 1A.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in the discussion of Alternative 1A.

Impact AQUA-110: Effects of Maintenance of Water Conveyance Facilities on Sacramento Splittail

NEPA Effects: The potential effects of the maintenance of water conveyance facilities under Alternative 3 would be similar to those described for Alternative 1A (see Impact AQUA-110) except that only two intakes would require maintenance under Alternative 3 rather than five under Alternative 1A. As concluded in Alternative 1A, Impact AQUA-110, the effect would not be adverse for Sacramento splittail.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-110, the impact of the maintenance of water conveyance facilities on Sacramento splittail would be less than significant. No mitigation would be required.

Water Operations of CM1

Impact AQUA-111: Effects of Water Operations on Entrainment of Sacramento Splittail

Water Exports from SWP/CVP South Delta Facilities

Under Alternative 3, total entrainment of juvenile splittail at the south Delta facilities (based on Yolo Bypass inundation) would be 569% greater compared to NAA (Table 11-3-38). The greatest increase in total entrainment would be in above normal (1,906% increase) and below normal (749% increase) water year types. However, this effect is related to the expected increase in overall juvenile splittail abundance resulting from additional floodplain habitat in wetter years. The average per capita rate of splittail entrainment across all years would be reduced 29% for juveniles (Table 11-3-39) and reduced 31% for adults (Table 11-3-40). This overall reduction in per capita salvage of splittail would be due to strict reductions in south Delta exports, especially during the winter and spring months. The relative impact of entrainment at the south Delta facilities on the splittail population would be reduced under Alternative 3 because the per capita entrainment risk would be lower compared to NAA.

Table 11-3-38. Juvenile Sacramento Splittail Entrainment Index[a] (Yolo Bypass Days of Inundation Method) at the SWP and CVP Salvage Facilities and Differences between Model Scenarios for Alternative 3

	Absolute Difference (Percent Difference)	
Water Year	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Wet	6,489,911 (676%)	6,303,252 (550%)
Above Normal	699,812 (1,529%)	708,417 (1,906%)
Below Normal	21,912 (641%)	22,344 (749%)
Dry	1,804 (63%)	2,149 (85%)
Critical	-339 (-22%)	112 (10%)
All Years	2,164,276 (693%)	2,106,566 (569%)

Shading indicates entrainment increased 10% or more.

a Estimated annual number of fish lost, based on normalized data, estimated from Yolo Bypass Inundation Method.

Table 11-3-39. Juvenile Sacramento Splittail Entrainment Index[a] (Per Capita Method) at the SWP and CVP Salvage Facilities and Differences between Model Scenarios for Alternative 3

	Absolute Difference (Percent Difference)	
Water Year	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Wet	-878,606 (-44%)	-554,287 (-33%)
Above Normal	7,377 (6%)	25,209 (22%)
Below Normal	4,763 (48%)	5,080 (53%)
Dry	-1,050 (-52%)	-559 (-37%)
Critical	-543 (-41%)	-285 (-27%)
All Years	-231,843 (-42%)	-130,296 (-29%)

Shading indicates entrainment increased 10% or more.

a Estimated annual number of fish lost, based on normalized data, estimated from delta inflow.

Table 11-3-40. Adult Sacramento Splittail Entrainment Index[a] (Salvage Density Method) at the SWP and CVP Salvage Facilities and Differences between Model Scenarios for Alternative 3

	Absolute Difference (Percent Difference)	
Water Year	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Wet	-2,050 (-52%)	-2,185 (-53%)
Above Normal	-1,278 (-27%)	-1,294 (-27%)
Below Normal	-922 (-27%)	-658 (-21%)
Dry	-278 (-11%)	-113 (-5%)
Critical	-490 (-15%)	-267 (-9%)
All Years	-1,138 (-33%)	-1,060 (-31%)

Shading indicates entrainment increased 10% or more.

a Estimated annual number of fish lost, based on normalized data. Average (December–March).

Water Exports from SWP/CVP North Delta Intake Facilities

The effect would be similar in type to Alternative 1A (with five intakes), but the degree would be less because Alternative 3 has only two intakes. Therefore, the risk of impingement and predation at the north Delta intakes under Alternative 3 would be 40% of the risk relative to Alternative 1A (Impact AQUA-111).

Water Export with a Dual Conveyance for the SWP North Bay Aqueduct

The effect of implementing dual conveyance for the NBA with an alternative Sacramento River intake would be the same as described under Alternative 1A (Impact AQUA-111). Reduced pumping from Barker Slough could reduce entrainment losses of larval splittail produced in the Yolo Bypass. There would be potential for increased predation and impingement risk associated with the alternative intake. Screens on the Barker Slough pumping plant currently exclude fish greater than 25 mm, and the alternate intake on the Sacramento River would be screened to exclude splittail greater than 10 mm in length.

Predation Associated with Entrainment

Splittail predation loss at the south Delta facilities is assumed to be proportional to entrainment loss. Per capita splittail entrainment and associated predation at the south Delta would decrease 29% under Alternative 3 compared to NAA.

Predation at the north Delta would increase due to the construction of the proposed water export facilities on the Sacramento River, as described for Alternative 1A (Impact AQUA-111). Potential predation at the north Delta would be partially offset by reduced predation loss at the SWP/CVP south Delta intakes and the increased production of juvenile splittail resulting from CM2 actions (Yolo Bypass Fisheries Enhancement). Further, the fishery agencies concluded that the predation was not a factor currently limiting splittail abundance. Thus this level of predation loss would not be expected to adversely affect the splittail population.

NEPA Effects: In conclusion, the effect of Alternative 3 on entrainment and predation loss would not be adverse and may provide a benefit, because the magnitude of potential entrainment and predation losses at the north Delta intakes would likely be more than offset by the substantial reduction in per capita south Delta entrainment losses and the increased production of juvenile splittail from *CM2 Yolo Bypass Fisheries Enhancement*.

CEQA Conclusion: Under Alternative 3, total juvenile entrainment (based on Yolo Bypass inundation) averaged across water years would be 533% greater compared to Existing Conditions. However, operational activities associated with reduced south Delta water exports would result in an overall decrease in the proportion of splittail population entrained for all water year types. Average per capita entrainment under Alternative 3 would be 22% decreased for juveniles and 33% reduced for adult splittail relative to Existing Conditions. Entrainment of splittail would be reduced at the NBA. The impact and conclusion for predation associated with entrainment would be the same as described above.

In conclusion, the impact on Sacramento splittail from entrainment and predation loss would be less than significant and may provide a benefit because the increase in predation loss at the north Delta under Alternative 3 would likely be more than offset by the substantial reduction in south Delta facilities entrainment and predation loss and the increased production of juvenile splittail from CM2, *Yolo Bypass Fisheries Enhancement*, actions. No mitigation would be required.

Impact AQUA-112: Effects of Water Operations on Spawning and Egg Incubation Habitat for Sacramento Splittail

In general, Alternative 3 would have beneficial effects on splittail spawning habitat relative to NAA due to substantial increases in the quantity and quality of suitable spawning habitat in the Yolo Bypass. There would also be beneficial effects on channel margin and side-channel spawning habitats due to moderate increases in mean monthly flow in the Sacramento River and the Feather River.

Sacramento splittail spawn in floodplains and channel margins and in side-channel habitat upstream of the Delta, primarily in the Sacramento River and Feather River. Floodplain spawning overwhelmingly dominates production in wet years. During low-flow years when floodplains are not inundated, spawning in side channels and channel margins would be much more critical.

Floodplain Habitat

Effects of Alternative 3 on floodplain spawning habitat were evaluated for Yolo Bypass. Increased flows into Yolo Bypass may reduce flooding and flooded spawning habitat to some extent in the Sutter Bypass (the upstream counterpart to Yolo Bypass) but this effect was not quantified. Effects in Yolo Bypass were evaluated using a habitat suitability approach based on water depth (2 meter threshold) and inundation duration (minimum of 30 days). Effects of flow velocity were ignored because flow velocity was generally very low throughout the modeled area for most conditions, with generally 80 to 90% of the total available area having flow velocities of 0.5 foot per second or less (a reasonable critical velocity for early life stages of splittail) (Young and Cech 1996).

The proposed changes to the Fremont Weir would increase the frequency and duration of Yolo Bypass inundation events compared to NAA; the changes are attributable to the influence of the Fremont Weir notch at lower flows. For the drier type years (below normal, dry, and critical), Alternative 3 results in an increase in frequency of inundation events greater than 30 days compared to NAA. For wet and above normal year types, Alternative 3 generally results in a reduced frequency of shorter-duration events and an increased frequency of the longest-duration events (≥70 days) (Figure 11-3-4, Table 11-3-41). For below normal years, Alternative 3 would result in the occurrence of two inundation events ≥70 days, compared to no such events for NAA; and five more inundation events of 30-49 days and one more inundation event of 50-69 days, compared to NAA. In dry and critical years there would be one more inundation event of 30–49 days under Alternative 3, compared to NAA. For dry and critical years, project-related increases are for 30–49 day duration events only as there are no events of longer duration. These results indicate that overall project-related effects consist of an increase in occurrence of longer-duration inundation events that would be beneficial for splittail spawning by creating better spawning habitat conditions.

There would be increases in area of suitable splittail habitat in Yolo Bypass under A3_LLT ranging from 5 to 954 acres relative to NAA. Areas under A3_LLT would be 57%, 64%, and 285% greater than areas under NAA in wet, above normal, and below normal water years, respectively (Table 11-3-42). There would be increases in area under A3_LLT in dry and critical years relative to NAA, but they would be minimal (9 and 5 acres, respectively). These results indicate that there would be increases in inundated acreage in each water year type which would result in increased habitat and have a beneficial effect on splittail spawning.

A potential adverse effect of Alternative 3 that is not included in the modeling is reduced inundation of the Sutter Bypass as a result of increased flow diversion at the Fremont Weir. Potential effects on habitat and uncertainties in predicting the magnitude of such effects would be about the same as described for Alternative 1A. Conclusions are that Alternative 3 has the potential to reduce some of the habitat benefits of Yolo Bypass inundation on splittail production due to effects on Sutter Bypass inundation, but these effects have not been quantified.

Overall, these results that despite the potential for reductions in suitable spawning habitat in Sutter Bypass, the increased occurrence of longer-duration inundation events and increased inundation acreages in all water year types would have beneficial effects on splittail spawning habitat.

Table 11-3-41. Differences in Frequencies of Inundation Events (for 82-Year Simulations) of Different Durations on the Yolo Bypass under Different Scenarios and Water Year Types, February through June, from 15 2-D and Daily CALSIM II Modeling Runs

Number of Days of Continuous Inundation	Change in Number of Inundation Events for Each Scenario	
	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
30–49 Days		
Wet	-4	-2
Above Normal	0	0
Below Normal	5	5
Dry	1	1
Critical	1	1
50–69 Days		
Wet	-5	-5
Above Normal	-1	-1
Below Normal	1	1
Dry	0	0
Critical	0	0
≥70 Days		
Wet	6	5
Above Normal	3	3
Below Normal	2	2
Dry	0	0
Critical	0	0

Table 11-3-42. Increase in Splittail Weighted Habitat Area (Acres and Percent) in Yolo Bypass from Existing Biological Conditions to Alternative 3 by Water Year Type from 15 2-D and Daily CALSIM II Modeling Runs

Water Year Type	A3_LLT vs. EXISTING CONDITIONS	A3_LLT vs. NAA
Wet	1,093 (71%)	954 (57%)
Above Normal	746 (65%)	737 (64%)
Below Normal	357 (272%)	362 (285%)
Dry	9 (NA)	9 (NA)
Critical	5 (NA)	5 (NA)

NA = could not be calculated because the denominator was 0.

Channel Margin and Side-Channel Habitat

Splittail spawning and larval and juvenile rearing also occur in channel margin and side-channel habitat upstream of the Delta. These habitats are likely to be especially important during dry years, when flows are too low to inundate the floodplains (Sommer et al. 2007). Side-channel habitats are affected by changes in flow because greater flows cause more flooding, thereby increasing availability of such habitat, and because rapid reductions in flow dewater the habitats, potentially stranding splittail eggs and rearing larvae. Effects of the BDCP on flows in years with low-flows are expected to be most important to the splittail population because in years of high-flows, when most production comes from floodplain habitats, the upstream side-channel habitats contribute relatively little production.

Effects on channel margin and side-channel habitat were evaluated by comparing flow conditions for the Sacramento River at Wilkins Slough and the Feather River at the confluence with the Sacramento River for the time-frame February through June. These are the most important months for splittail spawning and larval rearing (Sommer pers. comm.), and juveniles likely emigrate from the side-channel habitats during May and June if conditions become unfavorable.

Differences between model scenarios for monthly average flows during February through June by water-year type were determined for the Sacramento River at Wilkins Slough and for the Feather River at the confluence (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

For the Sacramento River at Wilkins Slough, flows during February through March under A3_LLT would be similar to flows under NAA. During April and June flows would be higher in most water years and in May they would be higher in all water years under NAA, resulting in a beneficial effect on rearing conditions. These results indicate that there would be some increases in flow (up to 24%) that would have beneficial effects on splittail rearing conditions in the Sacramento River.

Modeling indicated no differences in project-related effects on water temperature for Alternative 3 relative to Alternative 1A in any of the rivers analyzed for splittail effects. Modeling results for Alternative 1A show that Sacramento splittail spawning temperature tolerances would not be exceeded in the Sacramento River and would rarely be exceeded in the Feather River. Therefore, effects of Alternative 3 on water temperatures would not affect splittail spawning habitat conditions.

Stranding Potential

As indicated above, rapid reductions in flow can dewater channel margin and side-channel habitats, potentially stranding splittail eggs and rearing larvae. Due to a lack of quantitative tools and historical data to evaluate possible stranding effects, potential effects have been evaluated with a narrative summary. Effects for Alternative 3 would be as described for Alternative 1A, which concludes that Yolo Bypass improvements would be designed, in part, to further reduce the risk of stranding by allowing water to inundate certain areas of the bypass to maximize biological benefits, while keeping water away from other areas to reduce stranding in isolated ponds.

NEPA Effects: Collectively, these results indicate the effect on spawning habitat for Sacramento splittail would not be adverse because it would not substantially reduce suitable spawning habitat or substantially reduce the number of fish as a result of egg mortality. Alternative 3 would result in increased spawning habitat in Yolo Bypass, would have negligible effects (<5% difference) or beneficial effects (based on increases in mean monthly flow to 32%) on channel margin and side-channel rearing habitats, and would have negligible effects on spawning conditions based on stranding potential (flow reductions) and changes in water temperature.

CEQA Conclusion: In general, Alternative 3 would have beneficial effects on splittail spawning habitat relative to the Existing Conditions based on substantial increases in the quantity and quality of suitable spawning habitat in the Yolo Bypass. There would also be beneficial impacts on channel margin and side-channel spawning habitat due to moderate increases in mean monthly flow in the Sacramento River and the Feather River.

Floodplain Habitat

Comparisons of Yolo Bypass inundation events with durations longer than 30 days under Alternative 3 relative to Existing Conditions (Table 11-3-41) indicate only small differences that would not likely have biologically meaningful effects on spawning conditions. In terms of acreage of suitable splittail spawning habitat in Yolo Bypass under Alternative 3 compared to Existing Conditions (Table 11-3-42), there would be substantial increases in acreages in all water year types, with increases of between 5 and 1,093 acres of suitable spawning habitat depending on water year type. Increased areas for wet, above normal, and below normal water years are predicted to be 71%, 65%, and 272%, respectively, for Alternative 3. Comparisons for dry and critical water years indicate project-related increases of 9 and 5 acres of suitable spawning habitat, respectively, compared to 0 acres for Existing Conditions. These results indicate that Alternative 3 would have beneficial effects on splittail habitat through increasing spawning habitats by up to 272%.

Channel Margin and Side-Channel Habitat

Modeled flows were in the Sacramento River at Wilkins Slough (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for February to June splittail spawning and early life stage rearing period (Appendix 11C, *CALSIM II Model Results Utilized in the Fish Analysis*). Results indicate that Alternative 3 would have negligible effects (<5%) during February and March, small to moderate increases in flow (to 16%) during April, larger increases during May and June (to 39%) and only one small reduction in flow (-13%) during May in wet years. These results indicate that effects of Alternative 3 on flows would generally have beneficial effects on splittail spawning and rearing conditions in the upper Sacramento River.

Flows in the Feather River at the confluence with the Sacramento River were evaluated during February through June. Flows during this period would show variable effects of A3_LLT compared to Existing Conditions depending on month and water year type, with primarily negligible effects (<5%) or increases in flow (to 27%) that would have beneficial effects on rearing conditions. There would be occurrences of small (-11%) to moderate (-24%) decreases in mean monthly flow under Alternative 3, including in drier water year types during March (-12% in below normal years) and most of June (-11% and -17% in dry and critical years) when effects of flow reductions would be more critical for rearing conditions. These results indicate that for the majority of the rearing period, Alternative 3 would result in increased flow in the Feather River that would have a positive effect on splittail rearing in channel margin and side-channel habitats. Flow reductions in drier water years would be infrequent and of relatively small magnitude and would not have biologically meaningful effects on splittail spawning success.

Modeling results indicate no differences in project-related effects on water temperature for Alternative 3 relative to Alternative 1A in any of the rivers analyzed for splittail effects. Modeling results for Alternative 1A show that Sacramento splittail spawning temperature tolerances would not be exceeded in the Sacramento River and rarely exceeded in the Feather River. Therefore, impacts on spawning habitat for Sacramento splittail would not be biologically meaningful.

Stranding Potential

As described in the NEPA effects section above, rapid reductions in flow can dewater channel margin and side-channel habitats, potentially stranding splittail eggs and rearing larvae. Due to a lack of quantitative tools and historical data to evaluate possible stranding effects, potential effects have been evaluated with a narrative summary. Effects for Alternative 3 would be as described for Alternative 1A, which concludes that Yolo Bypass improvements would be designed, in part, to further reduce the risk of stranding by allowing water to inundate certain areas of the bypass to maximize biological benefits, while keeping water away from other areas to reduce stranding in isolated ponds.

Summary of CEQA Conclusion

Collectively, these results indicate the impact on spawning habitat for Sacramento splittail would be less than significant because it would not substantially reduce suitable spawning habitat or substantially reduce the number of fish as a result of egg mortality. No mitigation would be necessary. Alternative 3 would result in increased spawning habitat in Yolo Bypass, and would have negligible effects on spawning conditions based on stranding potential (flow reductions) and changes in water temperature. Effects of Alternative 3 on mean monthly flows would consist of less-than-significant impacts (<5% difference), beneficial impacts based on increases in mean monthly flow to 27%, and infrequent small (-11%) to moderate (-24%) decreases in flow that would not have biologically meaningful impacts on channel margin and side-channel rearing habitats.

Impact AQUA-113: Effects of Water Operations on Rearing Habitat for Sacramento Splittail

In general, Alternative 3 would have beneficial effects on splittail rearing habitat relative to NAA based on the beneficial effects on floodplain habitat in the Yolo Bypass and channel margin and side-channel habitats in the Sacramento River and the Feather River described in the previous impact discussion, Impact AQUA-112. Sacramento splittail rear in floodplain and main-channel environments; the analyses of splittail weighted habitat area in Yolo Bypass and effects of flow conditions on channel margin and side-channel habitats provided in the previous impact apply to rearing as well as spawning habitat for splittail.

NEPA Effects: Effects of Alternative 3 on flow would not have meaningful negative effects on the availability of channel margin and main-channel habitat, and would have beneficial effects from increases in mean monthly flow. Increased flows into Yolo Bypass may reduce flooding and flooded rearing habitat to some extent in the Sutter Bypass but would create habitat in the Yolo Bypass that would have a beneficial effect on rearing conditions.

CEQA Conclusion: In general, operations under Alternative 3 would have beneficial impacts on splittail rearing habitat relative to the Existing Conditions based on the beneficial impacts on floodplain habitat in the Yolo Bypass and channel margin and side-channel habitats in the Sacramento River and the Feather River described in Impact AQUA-112. Impacts on splittail rearing habitat are about the same as described for spawning habitat in Impact AQUA-112. As concluded above, the impact would be less than significant and no mitigation would be required. Effects of Alternative 3 on flow would not have meaningful negative impacts on the availability of channel margin and main-channel habitat, and would have beneficial impacts from increases in mean monthly flow. Increased flows into Yolo Bypass may reduce flooding and flooded rearing habitat to some extent in the Sutter Bypass but would create habitat in the Yolo Bypass that would have a beneficial impact on rearing conditions.

Impact AQUA-114: Effects of Water Operations on Migration Conditions for Sacramento Splittail

In general, effects of Alternative 3 on splittail migration conditions would be beneficial relative to NAA based on increases in mean monthly flow in the Sacramento River and the Feather River.

Effects of Alternative 3 on migration conditions for Sacramento splittail would be about the same as described above for channel margin and side-channel environments (Impact AQUA-112).

NEPA Effects: As concluded above, the effect is not adverse. Effects of Alternative 3 on flow would not have meaningful negative effects on the availability of channel margin and main-channel habitat, and would have beneficial effects on migration conditions from increases in mean monthly flow.

CEQA Conclusion: In general, the impact of Alternative 3 on splittail migration conditions would be beneficial relative to the Existing Conditions based on increases in mean monthly flow in the Sacramento River and the Feather River.

Effects of Alternative 3 on migration conditions for Sacramento splittail would be about the same as described above for channel margin and side-channel environments (Impact AQUA-112). As concluded above, the impact would be less than significant and no mitigation would be necessary. Effects of Alternative 3 on flow would not have meaningful negative impacts on the availability of channel margin and main-channel habitat, and would have beneficial impacts on migration conditions from increases in mean monthly flow.

Restoration Measures (CM2, CM4–CM7, and CM10)

Alternative 3 has the same restoration measures as Alternative 1A. Because no substantial differences in restoration-related fish effects are anticipated anywhere in the affected environment under Alternative 3 compared to those described in detail for Alternative 1A, the fish effects of restoration measures described for Sacramento splittail under Alternative 1A (Impact AQUA-115 through AQUA-117) also appropriately characterize effects under Alternative 3.

The following impacts are those presented under Alternative 1A that are identical for Alternative 3.

Impact AQUA-115: Effects of Construction of Restoration Measures on Sacramento Splittail

Impact AQUA-116: Effects of Contaminants Associated with Restoration Measures on Sacramento Splittail

Impact AQUA-117: Effects of Restored Habitat Conditions on Sacramento Splittail

NEPA Effects: All three of these effects have been determined to result in no adverse effects on Sacramento splittail. Specifically for AQUA-116, the effects of contaminants on Sacramento splittail with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on Sacramento splittail are uncertain.

CEQA Conclusion: These three impacts would be considered less than significant for the reasons identified for Alternative 1A.

Other Conservation Measures (CM12–CM19 and CM21)

Alternative 3 has the same other conservation measures as Alternative 1A. Because no substantial differences in other conservation-related fish effects are anticipated anywhere in the affected environment under Alternative 3 compared to those described in detail for Alternative 1A, the fish effects of other conservation measures described for Sacramento splittail under Alternative 1A (Impact AQUA-118 through AQUA-126) also appropriately characterize effects under Alternative 3.

The following impacts are those presented under Alternative 1A that are identical for Alternative 3.

Impact AQUA-118: Effects of Methylmercury Management on Sacramento Splittail (CM12)

Impact AQUA-119: Effects of Invasive Aquatic Vegetation Management on Sacramento Splittail (CM13)

Impact AQUA-120: Effects of Dissolved Oxygen Level Management on Sacramento Splittail (CM14)

Impact AQUA-121: Effects of Localized Reduction of Predatory Fish on Sacramento Splittail (CM15)

Impact AQUA-122: Effects of Nonphysical Fish Barriers on Sacramento Splittail (CM16)

Impact AQUA-123: Effects of Illegal Harvest Reduction on Sacramento Splittail (CM17)

Impact AQUA-124: Effects of Conservation Hatcheries on Sacramento Splittail (CM18)

Impact AQUA-125: Effects of Urban Stormwater Treatment on Sacramento Splittail (CM19)

Impact AQUA-126: Effects of Removal/Relocation of Nonproject Diversions on Sacramento Splittail (CM21)

NEPA Effects: The nine impact mechanisms have been determined to range from no effect, to no adverse effect, or beneficial effects on Sacramento splittail for NEPA purposes, for the reasons identified for Alternative 1A.

CEQA Conclusion: The nine impact mechanisms would be considered to range from no impact, to less than significant, or beneficial on Sacramento splittail, for the reasons identified for Alternative 1A, and no mitigation is required.

Green Sturgeon

Construction and Maintenance of CM1

Impact AQUA-127: Effects of Construction of Water Conveyance Facilities on Green Sturgeon

The potential effects of construction of water conveyance facilities on green sturgeon under Alternative 3 would be similar to those described for Alternative 1A (see Impact AQUA-127) except that Alternative 3 includes two intakes compared to five intakes under Alternative 1A, so the effects would be proportionally less under this alternative. This would convert about 4,450 lineal feet of existing shoreline habitat into intake facility structures and would require about 10.2 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. The effects related to temporary increases in turbidity, accidental spills, underwater noise, in-water work activities, and disturbance of contaminated sediments would be similar to Alternative 1A and the same environmental commitments and mitigation measures (described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*) would be available to avoid and minimize potential effects.

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-127, environmental commitments and mitigation measures would be available to avoid and minimize potential effects, and the effect would not be adverse for green sturgeon

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-127, the impact of the construction of water conveyance facilities on green sturgeon would be less than significant except for construction noise associated with pile driving which would only occur for two intakes rather than five. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce the noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in the discussion of Alternative 1A.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in the discussion of Alternative 1A.

Impact AQUA-128: Effects of Maintenance of Water Conveyance Facilities on Green Sturgeon

NEPA Effects: The potential effects of the maintenance of water conveyance facilities under Alternative 3 would be similar to those described for Alternative 1A (see Impact AQUA-128) expect that only two intakes would need to be maintained under Alternative 3 rather than five as under Alternative 1A. As concluded in Alternative 1A, Impact AQUA-128, the effect would not be adverse for green sturgeon.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-128, the impact of the maintenance of water conveyance facilities on green sturgeon would be less than significant and no mitigation would be required.

Water Operations of CM1

Impact AQUA-129: Effects of Water Operations on Entrainment of Green Sturgeon

NEPA Effects: Alternative 3 would result in an overall reduction in entrainment of green sturgeon across all water years compared to NAA (Table 11-3-43). Similar to Alternative 1A, entrainment reductions would be greater in wet and above normal water year types (40% decrease, 47 fish) than in below normal, dry, and critical years (19% decrease, 2–10 fish) compared to NAA. Alternative 3 would not have adverse effects on juvenile green sturgeon and may be beneficial due to the reduction in entrainment at the south Delta export facilities for all water year types compared to NAA (Table 11-3-43).

Table 11-3-43. Juvenile Green Sturgeon Entrainment Index[a] at the SWP and CVP Salvage Facilities—Differences (Absolute and Percentage) between Model Scenarios for Alternative 3

	Absolute Difference (Percent Difference)	
Water Year Type[b]	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Wet and Above Normal	-44 (-39%)	-47 (-40%)
Below Normal, Dry, and Critical	-2 (-15%)	-10 (-19%)
All Years	-51 (-32%)	-56 (-34%)

Shading indicates entrainment increased 10% or more.

[a] Estimated annual number of fish lost, based on non-normalized data.

[b] Sacramento Valley water year-types.

Predation Associated with Entrainment

Juvenile green sturgeon predation loss at the south Delta facilities is assumed to be proportional to entrainment loss. The total reduction of juvenile green sturgeon entrainment, and hence predation loss, would change minimally between Alternative 3 and NAA (56 fish). The number of juvenile green sturgeon lost to predation at the south Delta facilities would change negligibly between Alternative 3 and NAA. The impact and conclusion for predation risk associated with NPB structures and the north Delta intakes would be the same as described for Alternative 1A (Impact AQUA-129). The effect on predation loss under Alternative 3 would not be adverse.

CEQA Conclusion: As described above, annual entrainment losses of juvenile green sturgeon across all years would decrease by about 51 fish, or 32% under Alternative 3 (A3_LLT) relative to Existing Conditions (Table 11-3-43). Impacts of water operations on entrainment of green sturgeon would be beneficial and no mitigation would be required.

The impact and conclusion for predation associated with entrainment would be the same as described immediately above. Since few juvenile green sturgeon are entrained at the south Delta, reductions in entrainment (32% reduction compared to Existing Conditions, representing 51 fish) under Alternative 3, would have little effect on entrainment-related predation loss. Overall, the impact would be less than significant, because there would be little change in predation loss under Alternative 3.

Impact AQUA-130: Effects of Water Operations on Spawning and Egg Incubation Habitat for Green Sturgeon

In general, Alternative 3 would reduce spawning and egg incubation habitat for green sturgeon relative to the NAA.

Mean monthly flows were examined in the Sacramento River between Keswick and upstream of Red Bluff during the March to July spawning and egg incubation period for green sturgeon. Lower flows can reduce the instream area available for spawning and egg incubation. Flows under A3_LLT would always be similar to or greater than flows under NAA, indicating there would be very few reductions in flows in the Sacramento River under Alternative 3 although flows can be lower or higher in individual months of individual years (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flows were examined in the Feather River between Thermalito Afterbay and the confluence with the Sacramento River during the February through June green sturgeon spawning and egg incubation period. Flows under A3_LLT would be similar to or greater than flows under NAA in both locations, except in critical years during June at the confluence. These results indicate that there would be very few reductions in flows in the Feather River under Alternative 3 independent of climate change (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Water temperatures in the Sacramento and Feather rivers under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-130, which indicates that there would be no effect on temperatures during the period evaluated relative to NAA.

Flows in the San Joaquin River at Vernalis under Alternative 3 during March through June would not be different from flows under NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*.

No water temperatures modeling was conducted in the San Joaquin River.

NEPA Effects: Collectively, these results indicate that the effect is not adverse because it does not have the potential to substantially reduce the amount of suitable habitat. Flows in the Sacramento, Feather, and San Joaquin Rivers and water temperatures in the Sacramento and Feather Rivers would be similar between Alternative 3 and NAA during the green sturgeon spawning and egg incubation period.

CEQA Conclusion: In general, Alternative 3 would reduce spawning and egg incubation habitat for green sturgeon relative to the Existing Conditions.

Mean monthly flows were examined in the Sacramento River between Keswick and upstream of Red Bluff during the March to July spawning and egg incubation period for green sturgeon. Flows under A3_LLT would generally be similar to or greater than those under Existing Conditions, except in wet years during May at Keswick and Red Bluff (18% and 14% lower, respectively), and in below normal years during March at Keswick (6% lower) and in dry and critical years during July at Keswick (6% and 11% lower, respectively)and Red Bluff (6% and 10% lower, respectively) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Also, flows can be lower or higher in individual months of individual years. These results indicate that there would be few reductions in flows in the Sacramento River under Alternative 3 relative to the Existing Conditions.

Flows were examined in the Feather River between Thermalito Afterbay and the confluence with the Sacramento River during the March through July green sturgeon spawning and egg incubation period. At Thermalito Afterbay, flows under A3_LLT would generally be similar to or greater than those under Existing Conditions, except in below normal years during February and March and in wet years during May, in which flows under A3_LLT would be up to 33% lower than under Existing Conditions (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). At the confluence with the Sacramento River, flows under A3_LLT would generally be similar to or greater than flows under Existing Conditions, except in below normal years during March, in wet years during May, and in most water years during June, in which flows under A3_LLT would be up to 24% lower than under Existing Conditions. These results indicate that there would be few reductions in flows in the Feather River under Alternative 3 relative to the Existing Conditions.

Water temperatures in the Sacramento and Feather Rivers under Alternative 3 would be the same as those under Alternative 1A, Impact AQUA-130, which indicates that temperatures would be higher in both rivers during the periods evaluated relative to Existing Conditions.

Flows in the San Joaquin River at Vernalis under Alternative 3 would be up to 43% lower than flows under Existing Conditions during the March through June spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

No water temperature modeling was conducted for the San Joaquin River.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-96 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 3 could be significant because, under the CEQA baseline, the alternative could substantially reduce the availability of suitable migration habitat and interfere with the movement of fish, contrary to the NEPA conclusion set forth above. Flows in the Sacramento and Feather Rivers during the green sturgeon spawning and egg incubation period would be similar between Existing Conditions and Alternative 3. However, water temperatures in both rivers would be greater under Alternative 3 relative to Existing Conditions. Temperature increases in these rivers could lead to reduced hatching success and egg mortality under Alternative 3. Further, Flows in the San Joaquin River would be substantially lower throughout the spawning and egg incubation period under Alternative 3, which could reduce habitat conditions and lead to dewatering of eggs.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 3 indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 3. This indicates that the differences between Existing Conditions and Alternative 3 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 3, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on spawning and egg incubation habitat for green sturgeon. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-131: Effects of Water Operations on Rearing Habitat for Green Sturgeon

In general, Alternative 3 would not affect the quantity and quality of green sturgeon larval and juvenile rearing habitat relative to NAA.

Water temperature was used to determine the potential effects of Alternative 3 on green sturgeon larval and juvenile rearing habitat because larvae and juveniles are benthic-oriented and, therefore, their habitat is more likely to be limited by changes in water temperature than flow rates. Water temperatures in the Sacramento River and Feather River for Alternative 3 are not different from those for Alternative 1A, which indicates that Alternative 3 would not affect temperatures relative to NAA in either river relative to NAA.

Water temperature modeling was not conducted in the San Joaquin River.

NEPA Effects: Collectively, these results indicate that this effect would not be adverse because it does not have the potential to substantially reduce the amount of suitable rearing habitat. Water temperature conditions in the Sacramento and Feather Rivers under Alternative 3 would not differ from those under the NEPA baseline during the green sturgeon juvenile rearing period.

CEQA Conclusion: In general, Alternative 3 would not affect the quantity and quality of green sturgeon larval and juvenile rearing habitat relative to Existing Conditions.

Water temperature was used to determine the potential effects of Alternative 3 on green sturgeon larval and juvenile rearing habitat because larvae and juveniles are benthic-oriented and, therefore, their habitat is more likely to be limited by changes in water temperature than flow rates. Water temperatures in the Sacramento River and Feather River for Alternative 3 are not different from those for Alternative 1A discussed in Impact AQUA-131, which indicates that there would be increase in temperatures in both rivers relative to Existing Conditions.

Water temperature modeling was not conducted in the San Joaquin River.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-96 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 3 could be significant because, under the CEQA baseline, the alternative could substantially reduce the availability of suitable migration habitat and interfere with the movement of fish, contrary to the NEPA conclusion set forth above. Water temperatures would be higher under Alternative 3 relative to Existing Conditions in the Sacramento and Feather Rivers during the green sturgeon juvenile rearing period.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 3 indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 3. This indicates that the differences between Existing Conditions and Alternative 3 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 3, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on rearing habitat for green sturgeon. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-132: Effects of Water Operations on Migration Conditions for Green Sturgeon

In general, Alternative 3 would reduce green sturgeon migration conditions relative to NAA.

Analyses for green sturgeon migration conditions focused on flows in the Sacramento River between Keswick Dam and Wilkins Slough and in the Feather River between Thermalito Afterbay and the confluence with the Sacramento River during the April through October larval migration period, the August through March juvenile migration period, and the November through June adult migration period (*Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis*). Because these periods encompass the entire year, flows during all months were compared. Reduced flows could slow or inhibit downstream migration of larvae and juveniles and reduce the ability to sense upstream migration cues and pass impediments by adults.

Sacramento River flows under A3_LLT would generally be similar to or greater than flows under NAA in all months except August, September, and November, during which flows would be up to 45% lower depending on location, month, and water year type.

Feather River flows under A3_LLT would generally be lower by up to 84% than those under NAA during July through September. Flows during other months under A3_LLT would generally be similar to or greater than flows under NAA with some exceptions.

Larval transport flows were also examined by utilizing the positive correlation between white sturgeon year class strength and Delta outflow during April and May (USFWS 1995) under the assumption that the mechanism responsible for the relationship is that Delta outflow provides improved green sturgeon larval transport that results in improved year class strength. Results for white sturgeon presented in Impact AQUA-150 below suggest that, using the positive correlation between Delta outflow and year class strength, green sturgeon year class strength would be lower under Alternative 3.

NEPA Effects: Collectively, these results indicate that the effect would be adverse because it has the potential to substantially interfere with the movement of green sturgeon. Reductions in flows in the Sacramento and Feather rivers during summer and fall months would affect the migratory abilities of larvae and juveniles by slowing or inhibiting downstream migration of larvae and juveniles.

This effect is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this effect to a level that is not adverse would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this would be an unavoidable adverse effect because there is no feasible mitigation available. Even so, proposed mitigation (Mitigation Measure AQUA-132a through AQUA-132c) has the potential to reduce the severity of impact, although not necessarily to a not adverse level.

CEQA Conclusion: In general, Alternative 3 would reduce green sturgeon migration conditions relative to the Existing Conditions.

Analyses for green sturgeon migration conditions focused on flows in the Sacramento River between Keswick Dam and Wilkins Slough and in the Feather River between Thermalito Afterbay and the confluence with the Sacramento River during the April through October larval migration period, the August through March juvenile migration period, and the November through July adult migration period (*Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis*). Because these periods encompass the entire year, flows during all months were compared. Reduced flows could slow or inhibit downstream migration of larvae and juveniles and reduce the ability to sense upstream migration cues and pass impediments by adults.

Sacramento River flows under A3_LLT would generally be similar to or greater than flows under Existing Conditions in all months except August, September, and November, during which flows would be up to 27% lower than under Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*. Flows under A3_LLT during other months would generally be similar to or greater than flows under Existing Conditions.

Flows in the Feather River under A3_LLT would generally be up to 54% lower than flows under Existing Conditions in June, July, August, and November (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*. Flows during other months under A3_LLT would generally be similar to or greater than flows under Existing Conditions.

For Delta outflow, the percent of months exceeding flow thresholds under A3_LLT would consistently be lower than those under Existing Conditions for each flow threshold, water year type, and month (14% to 60% lower on a relative scale) (see Table 11-1A-70 below).

Summary of CEQA Conclusion

Collectively, these results indicate that the impact would be significant because it has the potential to substantially interfere with the movement of fish. The reduction in flows in the Sacramento and Feather Rivers would reduce the migration periods of larval, juvenile, and adult migration, which would substantially slow or inhibit their downstream migration. This impact is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this impact to a less-than-significant level would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this impact is significant and unavoidable because there is no feasible mitigation available. Even so, proposed below is mitigation that has the potential to reduce the severity of impact though not necessarily to a less-than-significant level.

Mitigation Measure AQUA-132a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Green Sturgeon to Determine Feasibility of Mitigation to Reduce Impacts to Migration Conditions

Although analysis conducted as part of the EIR/EIS determined that Alternative 3 would have significant and unavoidable adverse effects on migration, this conclusion was based on the best available scientific information at the time and may prove to have been overstated. Upon the commencement of operations of CM1 and continuing through the life of the permit, the BDCP proponents will monitor effects on migration in order to determine whether such effects would be as extensive as concluded at the time of preparation of this document and to determine any potentially feasible means of reducing the severity of such effects. This mitigation measure requires a series of actions to accomplish these purposes, consistent with the operational framework for Alternative 3.

The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 3 operations only. Development of mitigation actions for the incremental impact on migration attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 3.

Mitigation Measure AQUA-132b: Conduct Additional Evaluation and Modeling of Impacts on Green Sturgeon Migration Conditions Following Initial Operations of CM1

Following commencement of initial operations of CM1 and continuing through the life of the permit, the BDCP proponents will conduct additional evaluations to define the extent to which modified operations could reduce impacts to migration under Alternative 3. The analysis required under this measure may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6).

Mitigation Measure AQUA-132c: Consult with NMFS, USFWS, and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Green Sturgeon Migration Conditions Consistent with CM1

In order to determine the feasibility of reducing the effects of CM1 operations on green sturgeon habitat, the BDCP proponents will consult with NMFS, USFWS, and CDFW to identify and implement any feasible operational means to minimize effects on migration. Any such action will be developed in conjunction with the ongoing monitoring and evaluation of habitat conditions required by Mitigation Measure AQUA-132a.

If feasible means are identified to reduce impacts on migration consistent with the overall operational framework of Alternative 3 without causing new significant adverse impacts on other covered species, such means shall be implemented. If sufficient operational flexibility to reduce effects on green sturgeon habitat is not feasible under Alternative 3 operations, achieving further impact reduction pursuant to this mitigation measure would not be feasible under this Alternative, and the impact on green sturgeon would remain significant and unavoidable.

Restoration Measures (CM2, CM4–CM7, and CM10)

Alternative 3 has the same restoration measures as Alternative 1A. Because no substantial differences in restoration-related fish effects are anticipated anywhere in the affected environment under Alternative 3 compared to those described in detail for Alternative 1A, the fish effects of restoration measures described for green sturgeon under Alternative 1A (Impact AQUA-133 through AQUA-135) also appropriately characterize effects under Alternative 3.

The following impacts are those presented under Alternative 1A that are identical for Alternative 3.

Impact AQUA-133: Effects of Construction of Restoration Measures on Green Sturgeon

Impact AQUA-134: Effects of Contaminants Associated with Restoration Measures on Green Sturgeon

Impact AQUA-135: Effects of Restored Habitat Conditions on Green Sturgeon

NEPA Effects: All three of these effects have been determined to result in no adverse effects on green sturgeon for the reasons identified for Alternative 1A. Specifically for AQUA-134, the effects of contaminants on green sturgeon with respect to copper, ammonia and pesticides would not be adverse. The effects of methylmercury and selenium on green sturgeon are uncertain.

CEQA Conclusion: All three of these impacts would be considered less than significant for the reasons identified for Alternative 1A.

Other Conservation Measures (CM12–CM19 and CM21)

Alternative 3 has the same other conservation measures as Alternative 1A. Because no substantial differences in other conservation-related fish effects are anticipated anywhere in the affected environment under Alternative 3 compared to those described in detail for Alternative 1A, the fish effects of other conservation measures described for green sturgeon under Alternative 1A (Impact AQUA-136 through AQUA-144) also appropriately characterize effects under Alternative 3.

The following impacts are those presented under Alternative 1A that are identical for Alternative 3.

Impact AQUA-136: Effects of Methylmercury Management on Green Sturgeon (CM12)

Impact AQUA-137: Effects of Invasive Aquatic Vegetation Management on Green Sturgeon (CM13)

Impact AQUA-138: Effects of Dissolved Oxygen Level Management on Green Sturgeon (CM14)

Impact AQUA-139: Effects of Localized Reduction of Predatory Fish on Green Sturgeon (CM15)

Impact AQUA-140: Effects of Nonphysical Fish Barriers on Green Sturgeon (CM16)

Impact AQUA-141: Effects of Illegal Harvest Reduction on Green Sturgeon (CM17)

Impact AQUA-142: Effects of Conservation Hatcheries on Green Sturgeon (CM18)

Impact AQUA-143: Effects of Urban Stormwater Treatment on Green Sturgeon (CM19)

Impact AQUA-144: Effects of Removal/Relocation of Nonproject Diversions on Green Sturgeon (CM21)

NEPA Effects: The nine impact mechanisms have been determined to range from no effect, to no adverse effect, or beneficial effects on green sturgeon for the reasons identified for Alternative 1A.

CEQA Conclusions: The nine impact mechanisms would be considered to range from no impact, to less than significant, or beneficial on green sturgeon, for the reasons identified for Alternative 1A, and no mitigation is required.

White Sturgeon

Construction and Maintenance of CM1

Impact AQUA-145: Effects of Construction of Water Conveyance Facilities on White Sturgeon

The potential effects of construction of water conveyance facilities on white sturgeon under Alternative 3 would be similar to those described for Alternative 1A (see Impact AQUA-145) except that Alternative 3 would include two intakes compared to five intakes under Alternative 1A, so the effects would be proportionally less under this alternative. This would convert about 4,450 lineal feet of existing shoreline habitat into intake facility structures and would require about 10.2 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. The effects related to temporary increases in turbidity, accidental spills, underwater noise, in-water work activities, and disturbance of contaminated sediments would be similar to Alternative 1A and the same environmental commitments and mitigation measures (described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*) would be available to avoid and minimize potential effects.

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-145, environmental commitments and mitigation measures would be available to avoid and minimize potential effects, and the effect would not be adverse for white sturgeon

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-145, the impact of the construction of water conveyance facilities on white sturgeon would be less than significant except for construction noise associated with pile driving. Potential pile driving impacts would be less than Alternative 1A because only two intakes would be constructed rather than five. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

> **Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise**
>
> Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in the discussion of Alternative 1A.
>
> **Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise**
>
> Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in the discussion of Alternative 1A.

Impact AQUA-146: Effects of Maintenance of Water Conveyance Facilities on White Sturgeon

NEPA Effects: The potential effects of the maintenance of water conveyance facilities under Alternative 3 would be similar to those described for Alternative 1A (see Impact AQUA-146) except that only two intakes would require maintenance under Alternative 3 rather than five as under

Alternative 1A. As concluded in Alternative 1A, Impact AQUA-146, the effect would not be adverse for white sturgeon.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-146, the impact of the maintenance of water conveyance facilities on white sturgeon would be less than significant and no mitigation would be required.

Water Operations of CM1

Impact AQUA-147: Effects of Water Operations on Entrainment of White Sturgeon

Alternative 3 is expected to reduce overall entrainment of juvenile white sturgeon at the south Delta export facilities, estimated as salvage density, by about 32% (105 fish) across all water year types as compared to NAA (Table 11-3-44). Similar to Alternative 1A, entrainment would be highest in wet and above normal water years. Under Alternative 3, entrainment in wet and above normal water years would be reduced 33% (96 fish), compared to NAA. Therefore, Alternative 3 would not have adverse effects on juvenile white sturgeon and may be beneficial.

Overall, the potential entrainment impacts of Alternative 3 on juvenile white sturgeon would be similar to those described for Alternative 1A for operating new SWP/CVP north Delta intakes, NPBs at the entrances to CCF and the DMC, and decommissioning agricultural diversions in ROAs. These actions have the potential to minimize or reduce entrainment, and may be beneficial to white sturgeon.

Table 11-3-44. Juvenile White Sturgeon Entrainment Index[a] at the SWP and CVP Salvage Facilities for Sacramento Valley Water Year-Types and Differences (Absolute and Percentage) between Model Scenarios for Alternative 3

	Absolute Difference (Percent Difference)	
Water Year Types[b]	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Wet and Above Normal	-74 (-28%)	-96 (-33%)
Below Normal, Dry, and Critical	-6 (-16%)	-9 (-22%)
All Years	-80 (-26%)	-105 (-32%)

Shading indicates entrainment increased 10% or more.

[a] Estimated annual number of fish lost, based on non-normalized data.
[b] Sacramento Valley water year-types.

Predation Associated with Entrainment

Juvenile white sturgeon predation loss at the south Delta facilities is assumed to be proportional to entrainment loss. The number of juvenile white sturgeon lost to predation at the south Delta facilities would change negligibly between Alternative 3 and NAA. The impact and conclusion for predation risk associated with NPB structures and the north Delta intakes would be the same as described for Alternative 1A (Impact AQUA-147).

NEPA Effects: Overall, the potential entrainment and predation impacts of Alternative 3 on juvenile white sturgeon would not be adverse, for the reasons described for Alternative 1A.

CEQA Conclusion: As described above, annual entrainment losses of juvenile white sturgeon associated with water exports from SWP/CVP south Delta facilities would result in an overall decrease in entrainment of 26% (80 fish) under Alternative 3 relative to Existing Conditions (Table 11-3-44). Impacts of water operations on entrainment of white sturgeon would be less than significant and may be beneficial. No mitigation would be required.

Impact AQUA-148: Effects of Water Operations on Spawning and Egg Incubation Habitat for White Sturgeon

In general, Alternative 3 would not affect spawning and egg incubation habitat for white sturgeon relative to NAA.

Flows in the Sacramento River at Wilkins Slough and Verona were examined during the February to May spawning and egg incubation period for white sturgeon. Flows at both locations under A3_LLT from February to May would be mostly similar to or greater than those under NAA, except in wet years during April (7% lower) at Verona (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These results indicate that there would be mostly small reductions in flows in the Sacramento River under Alternative 3.

Flows in the Feather River between Thermalito Afterbay and the confluence with the Sacramento River were examined during the February to May spawning and egg incubation period for white sturgeon (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT would be similar to or greater than flows under NAA during February to May. Flows under A3_LLT at the confluence would always be similar to or greater than flows under NAA. These results indicate that there would be very few reductions in flows in the Feather River during the white sturgeon spawning and egg incubation period under Alternative 3.

Flows in the San Joaquin River under Alternative 3 would not be different from those under NAA throughout the February through May period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*.Water temperatures in the Sacramento and Feather Rivers under Alternative 3 would not be different from those under Alternative 1A, Impact AQUA-148, which indicates that temperatures would not differ from those under NAA throughout the February through May period.

Water temperatures were not modeled in the San Joaquin River.

NEPA Effects: Collectively, these results indicate that the effect is not adverse because it does not have the potential to substantially reduce the amount of suitable habitat. Reductions in flows and increases in water temperatures under Alternative 3 are small and infrequent relative to NAA and, therefore, would not have a substantial effect on the species.

CEQA Conclusion: In general, Alternative 3 would not affect spawning and egg incubation habitat for white sturgeon relative to the Existing Conditions.

Flows in the Sacramento River at Wilkins Slough and Verona were examined during the February to May spawning and egg incubation period for white sturgeon (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). At Wilkins Slough, flows under A3_LLT would be similar to or greater than those under Existing Conditions, except in wet years during May (13% lower). At Verona, flows under A3_LLT from February to May would be generally similar to or greater than Existing Conditions, except for below normal and critical years during February (6% and 7% lower, respectively), below normal years during March (13% lower), wet and above normal years during April (8% and 7% lower, respectively), and wet years during May (19% lower). These results indicate that there would be mostly small reductions in flows in the Sacramento River under Alternative 3 relative to Existing Conditions.

Flows in the Feather River between Thermalito Afterbay and the confluence with the Sacramento River were examined during the February to May spawning and egg incubation period for white sturgeon (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows at Thermalito Afterbay from February to May under A3_LLT would generally be similar to or greater than those under Existing Conditions, except in below normal years during February and March (22% and 33% lower, respectively) and in wet years during May (30% lower). Flows at the confluence with the Sacramento River under A3_LLT would generally be similar to or greater than flows under Existing Conditions, except in below normal years during March (12% lower) and wet years during May (24% lower). These results indicate that there would be few reductions in flows in the Feather River under Alternative 3 relative to Existing Conditions.

Flows in the San Joaquin River under Alternative 3 would be similar to flows under Existing Conditions during February and up to 43% lower during March through July.

Water temperatures in the Sacramento and Feather Rivers under Alternative 3 would be generally the same as those under Alternative 1A, Impact AQUA-148, which indicates that there would no effect on temperatures relative to Existing Conditions.

Temperatures were not modeled for the San Joaquin River.

Collectively, the results of the Impact AQUA-148 CEQA analysis indicate that the difference between the Existing Conditions and Alternative 3 could be significant because, under the Existing Conditions, the alternative could substantially reduce the availability of suitable spawning and egg incubation habitat, contrary to the NEPA conclusion set forth above. There would be substantial reductions in the majority of the white sturgeon spawning and egg incubation period in the San Joaquin River under Alternative 3 relative to Existing Conditions, which would reduce the quality and quantity of habitat available for spawning and egg incubation in the river. There would be no other flow- or temperature-related effects of Alternative 3 on white sturgeon spawning and egg incubation.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 3 indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 3. This indicates that the differences between Existing Conditions and Alternative 3 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 3, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on spawning and egg incubation habitat for white sturgeon. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-149: Effects of Water Operations on Rearing Habitat for White Sturgeon

In general, Alternative 3 would not affect the quantity and quality of white sturgeon larval and juvenile rearing habitat relative to NAA.

Water temperature was used to determine the potential effects of Alternative 3 on white sturgeon larval and juvenile rearing habitat because larvae and juveniles are benthic-oriented and, therefore, their habitat is more likely to be limited by changes in water temperature than flow rates.

Water temperatures in the Sacramento and Feather Rivers under Alternative 3 would not be different from those under Alternative 1A, Impact AQUA-149, which indicates that there would be no effect on temperatures in either river relative to Existing Conditions.

Water temperatures were not modeled for the San Joaquin River.

NEPA Effects: Collectively, these results indicate that this effect would not be adverse because it does not have the potential to substantially reduce the amount of suitable rearing habitat. Water temperature conditions in the Sacramento and Feather Rivers under Alternative 3 would not differ from those under the NEPA baseline during the white sturgeon juvenile rearing period.

CEQA Conclusion: In general, Alternative 3 would not affect the quantity and quality of white sturgeon larval and juvenile rearing habitat relative to Existing Conditions.

Water temperature was used to determine the potential impacts of Alternative 3 on white sturgeon larval and juvenile rearing habitat because larvae and juveniles are benthic-oriented and, therefore, their habitat is more likely to be limited by changes in water temperature than flow rates.

Water temperatures in the Sacramento and Feather rivers under Alternative 3 would not be different from those under Alternative 1A, which indicates that there would be no effect on temperatures in the Sacramento River relative to Existing Conditions, but temperatures would be higher than those under Existing Conditions during the majority of months in the Feather River.

Water temperatures were not modeled for the San Joaquin River.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-149 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 3 could be significant because, under the CEQA baseline, the alternative could substantially reduce the availability of suitable migration habitat and interfere with the movement of fish, contrary to the NEPA conclusion set forth above. Water temperatures would be higher under Alternative 3 relative to Existing Conditions in Feather Rivers during the green sturgeon juvenile rearing period, but would be similar between Existing Conditions and Alternative 3 in the Sacramento River.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 3 indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 3. This indicates that the differences between Existing Conditions and Alternative 3 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 3, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on rearing habitat for green sturgeon. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-150: Effects of Water Operations on Migration Conditions for White Sturgeon

In general, the effects of Alternative 3 on white sturgeon migration conditions relative to NAA are uncertain.

Analyses for white sturgeon focused on the Sacramento River (north Delta to RM 143—i.e., Wilkins Slough and Verona CALSIM nodes). Larval transport flows were represented by the average number of months per year that exceeded thresholds of 17,700 cfs (Wilkins Slough) and 31,000 cfs (Verona) (Table 11-3-45). Exceedances of the 17,700 cfs threshold for Wilkins Slough under A3_LLT were generally similar to those under NAA. The number of months per year above 31,000 cfs at Verona under A3_LLT would be up to 50% lower than under NAA. On an absolute scale, all of these changes would be negligible (up to 0.2 months).

Table 11-3-45. Difference and Percent Difference in Number of Months in Which Flow Rates Exceed 17,700 and 5,300 cfs in the Sacramento River at Wilkins Slough and 31,000 cfs at Verona

	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Wilkins Slough, 17,700 cfs[a]		
Wet	-0.04 (-2%)	0 (0%)
Above Normal	0.3 (18%)	0.1 (5%)
Below Normal	-0.1 (-25%)	0 (0%)
Dry	0 (0%)	0 (0%)
Critical	0 (0%)	0 (0%)
Wilkins Slough, 5,300 cfs[b]		
Wet	-0.1 (-2%)	0.1 (1%)
Above Normal	0 (0%)	0.3 (5%)
Below Normal	0.2 (4%)	0.5 (10%)
Dry	0.6 (11%)	0.3 (5%)
Critical	0.3 (10%)	0.3 (7%)
Verona, 31,000 cfs[a]		
Wet	-0.5 (-21%)	-0.2 (-9%)
Above Normal	-0.1 (-5%)	0.1 (6%)
Below Normal	-0.2 (-43%)	-0.1 (-33%)
Dry	-0.2 (-60%)	-0.1 (-50%)
Critical	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.
[a] Months analyzed: February through May.
[b] Months analyzed: November through May.

Larval transport flows were also examined by utilizing the positive correlation between year class strength and Delta outflow during April and May (USFWS 1995) under the assumption that the mechanism responsible for the relationship is that Delta outflow provides improved larval transport that results in improved year class strength. The percentage of months exceeding flow thresholds under A3_LLT would generally be lower than those under NAA (up to 50% lower) (Table 11-3-46). These results suggest that, using the positive correlation between Delta outflow and year class strength, year class strength would be lower under Alternative 3.

Table 11-3-46. Difference and Percent Difference in Percentage of Months in Which Average Delta Outflow is Predicted to Exceed 15,000, 20,000, and 25,000 Cubic Feet per Second in April and May of Wet and Above-Normal Water Years

Flow	Water Year Type	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
April			
15,000 cfs	Wet	-15 (-16%)	-15 (-16%)
	Above Normal	-25 (-27%)	-25 (-27%)
20,000 cfs	Wet	-12 (-14%)	-12 (-14%)
	Above Normal	-33 (-44%)	-25 (-38%)
25,000 cfs	Wet	-15 (-19%)	-12 (-15%)
	Above Normal	-17 (-29%)	-8 (-17%)
May			
15,000 cfs	Wet	-15 (-17%)	-8 (-10%)
	Above Normal	-33 (-40%)	-8 (-14%)
20,000 cfs	Wet	-35 (-41%)	-12 (-19%)
	Above Normal	-25 (-60%)	-17 (-50%)
25,000 cfs	Wet	-31 (-44%)	-19 (-33%)
	Above Normal	-17 (-50%)	-8 (-33%)
April/May Average			
15,000 cfs	Wet	-15 (-16%)	-8 (-9%)
	Above Normal	-33 (-33%)	-25 (-27%)
20,000 cfs	Wet	-23 (-26%)	-19 (-23%)
	Above Normal	-17 (-25%)	0 (0%)
25,000 cfs	Wet	-19 (-24%)	-8 (-11%)
	Above Normal	-25 (-50%)	-25 (-50%)

For juveniles, year-round migration flows at Verona would be up to 54% lower under A3_LLT relative to NAA during four of 12 months (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

For adults, the average number of months per year during the November through May adult migration period in which flows in the Sacramento River at Wilkins Slough exceed 5,300 cfs was determined (Table 11-3-45). The average number of months exceeding 5,300 cfs under A3_LLT would always be similar to greater than the number of months under NAA.

NEPA Effects: Upstream flows (above north Delta intakes) are similar between Alternative 3 and NAA (Table 11-3-45). However, due to the removal of water at the north Delta intakes, there are substantial differences in through-Delta flows between Alternative 3 and NAA (Table 11-5-46). Analysis of white sturgeon year-class strength (USFWS 1995) found a positive correlation between year class strength and Delta outflow during April and May. However, this conclusion was reached in the absence of north Delta intakes and the exact mechanism that causes this correlation is not known at this time. One hypothesis suggests that the correlation is caused by high flows in the upper river resulting in improved migration, spawning, and rearing conditions in the upper river. Another hypothesis suggests that the positive correlation is a result of higher flows through the Delta triggering more adult sturgeon to move up into the river to spawn. It is also possible that some combination of these factors are working together to produce the positive correlation between high flows and sturgeon year-class strength.

The scientific uncertainty regarding which mechanisms are responsible for the positive correlation between year class strength and river/Delta flow will be addressed through targeted research and monitoring to be conducted in the years leading up to the initiation of north Delta facilities operations. If these targeted investigations determine that the primary mechanisms behind the positive correlation between high flows and sturgeon year-class strength are related to upstream conditions, then Alternative 3 would be deemed Not Adverse due to the similarities in upstream flow conditions between Alternative 3 and NAA. However, if the targeted investigations lead to a conclusion that the primary mechanisms behind the positive correlation are related to in-Delta and through-Delta flow conditions, then Alternative 3 would be deemed adverse due to the magnitude of reductions in through-Delta flow conditions in Alternative 3 as compared to NAA.

CEQA Conclusion: In general, Alternative 3 would not affect white sturgeon migration conditions relative to Existing Conditions.

The number of months per year with exceedances above the 17,700 cfs threshold for Wilkins Slough under A3_LLT would generally be similar to or greater those under Existing Conditions, except in below normal years (25% lower) (Table 11-3-45). The number of months per year above 31,000 cfs at Verona under A3_LLT would be similar to or up to 60% lower than the number under Existing Conditions.

For Delta outflow, the percent of months exceeding flow thresholds under A3_LLT would consistently be lower than those under Existing Conditions for each flow threshold, water year type, and month (14% to 60% lower on a relative sacle) (Table 11-3-46).

For juveniles, year-round migration flows at Verona would be up to 36% lower under A3_LLT relative to Existing Conditions in four of 12 months (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under A3_LLT during other months are generally similar to or greater than flows under Existing Conditions.

For adult migration, the average number of months exceeding 5,300 cfs under A3_LLT would generally be similar to the number of months under Existing Conditions (Table 11-3-45).

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-150 CEQA analysis indicate that the difference between the Existing Conditions and Alternative 3 could be significant because, under the Existing Conditions, the alternative could substantially reduce the quality of suitable rearing habitat, contrary to the NEPA conclusion set forth above. The exceedance of flow thresholds in the Sacramento River and for Delta outflow would be lower under Alternative 3 than under the Existing Conditions, although there is high uncertainty that year class strength is due to Delta outflow or if both year class strength and Delta outflows are co-variable with another unknown factor. These reduced flows could have a substantial effect on the ability of sturgeon to migrate downstream, including delaying or slowing rates of successful migration downstream, and increasing the risk of mortality.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 3 indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 3. This indicates that the differences between Existing Conditions and Alternative 3 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 3, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion of not adverse, and therefore would not in itself result in a significant impact on migration habitat of white sturgeon. Additionally, as described above in the NEPA Effects statement, further investigation is needed to better understand the association of Delta outflow to sturgeon recruitment, and if needed, adaptive management would be used to make adjustments to meet the biological goals and objectives. This impact is found to be less than significant and no mitigation is required.

Restoration Measures (CM2, CM4–CM7, and CM10)

Alternative 3 has the same restoration measures as Alternative 1A. Because no substantial differences in restoration-related fish effects are anticipated anywhere in the affected environment under Alternative 3 compared to those described in detail for Alternative 1A, the fish effects of restoration measures described for white sturgeon under Alternative 1A (Impact AQUA-151 through AQUA-153) also appropriately characterize effects under Alternative 3.

The following impacts are those presented under Alternative 1A that are identical for Alternative 3.

Impact AQUA-151: Effects of Construction of Restoration Measures on White Sturgeon

Impact AQUA-152: Effects of Contaminants Associated with Restoration Measures on White Sturgeon

Impact AQUA-153: Effects of Restored Habitat Conditions on White Sturgeon

NEPA Effects: As described in Alternative 1A, none of these impact mechanisms would be adverse to white sturgeon, and most would be at least slightly beneficial. Specifically for AQUA-152, the effects of contaminants on white sturgeon with respect to copper, ammonia and pesticides would not be adverse. The effects of methylmercury and selenium on white sturgeon are uncertain.

CEQA Conclusion: All of the impact mechanisms listed above would be at least slightly beneficial, or less than significant, and no mitigation is required.

Other Conservation Measures (CM12–CM19 and CM21)

Alternative 3 has the same other conservation measures as Alternative 1A. Because no substantial differences in other conservation-related fish effects are anticipated anywhere in the affected environment under Alternative 3 compared to those described in detail for Alternative 1A, the fish effects of other conservation measures described for white sturgeon under Alternative 1A (Impact AQUA-154 through AQUA-162) also appropriately characterize effects under Alternative 3.

The following impacts are those presented under Alternative 1A that are identical for Alternative 3.

Impact AQUA-154: Effects of Methylmercury Management on White Sturgeon (CM12)

Impact AQUA-155: Effects of Invasive Aquatic Vegetation Management on White Sturgeon (CM13)

Impact AQUA-156: Effects of Dissolved Oxygen Level Management on White Sturgeon (CM14)

Impact AQUA-157: Effects of Localized Reduction of Predatory Fish on White Sturgeon (CM15)

Impact AQUA-158: Effects of Nonphysical Fish Barriers on White Sturgeon (CM16)

Impact AQUA-159: Effects of Illegal Harvest Reduction on White Sturgeon (CM17)

Impact AQUA-160: Effects of Conservation Hatcheries on White Sturgeon (CM18)

Impact AQUA-161: Effects of Urban Stormwater Treatment on White Sturgeon (CM19)

Impact AQUA-162: Effects of Removal/Relocation of Nonproject Diversions on White Sturgeon (CM21)

NEPA Effects: The nine impact mechanisms have been determined to range from no effect, to no adverse effect, or beneficial effects on white sturgeon for the reasons identified for Alternative 1A.

CEQA Conclusion: The nine impact mechanisms would be considered to range from no impact, to less than significant, or beneficial on white sturgeon, for the reasons identified for Alternative 1A, and no mitigation is required.

Pacific Lamprey

Construction and Maintenance of CM1

Impact AQUA-163: Effects of Construction of Water Conveyance Facilities on Pacific Lamprey

The potential effects of construction of water conveyance facilities on Pacific lamprey under Alternative 3 would be similar to those described for Alternative 1A (see Impact AQUA-163) except that Alternative 3 would include two intakes compared to five intakes under Alternative 1A, so the effects would be proportionally less under this alternative. This would convert about 4,450 lineal feet of existing shoreline habitat into intake facility structures and would require about 10.2 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. The effects related to temporary increases in turbidity, accidental spills, underwater noise, in-water work activities, and disturbance of contaminated sediments would be similar to Alternative 1A and the same environmental commitments and mitigation measures (described under Impact AQUA-1 for delta smelt and in

Appendix 3B, *Environmental Commitments*) would be available to avoid and minimize potential effects.

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-163, environmental commitments and mitigation measures would be available to avoid and minimize potential effects, and the effect would not be adverse for Pacific lamprey

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-163, the impact of the construction of water conveyance facilities on Pacific lamprey would be less than significant except for construction noise associated with pile driving which would only occur for two intakes rather than five. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in the discussion of Alternative 1A.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in the discussion of Alternative 1A.

Impact AQUA-164: Effects of Maintenance of Water Conveyance Facilities on Pacific Lamprey

NEPA Effects: The potential effects of the maintenance of water conveyance facilities under Alternative 3 would be similar to those described for Alternative 1A (see Impact AQUA-164) except that only two intakes would be maintained under Alternative 3 rather than five as under Alternative 1A. As concluded in Alternative 1A, Impact AQUA-164, the effect would not be adverse for Pacific lamprey.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-164, the impact of the maintenance of water conveyance facilities on Pacific lamprey would be less than significant and no mitigation would be required.

Water Operations of CM1

Impact AQUA-165: Effects of Water Operations on Entrainment of Pacific Lamprey

The potential entrainment impacts of Alternative 3 on Pacific lamprey would be similar but less than those described above for Alternative 1A for operating new SWP/CVP north Delta intakes (Impact AQUA-165), non-physical barriers at the entrances to Clifton Court Forebay and the Delta Mendota Canal (Impact AQUA-3), and decommissioning agricultural diversions in ROAs (Impact AQUA-3).

Under Alternative 3, average annual entrainment of Pacific lamprey at the south Delta export facilities, as estimated by salvage density, would be reduced by 25% (834 fish) (Table 11-3-47) across all water year types compared to NAA. Therefore, Alternative 3 would not have adverse effects on Pacific lamprey and may be beneficial because of the potential reduction of entrainment at Delta water export facilities.

Predation Associated with Entrainment

Lamprey predation loss at the south Delta facilities is assumed to be proportional to entrainment loss. Average pre-screen predation loss for fish entrained at the south Delta is 75% at Clifton Court Forebay and 15% at the CVP. Lamprey entrainment to the south Delta would be reduced by 25% compared to NAA and predation losses would be expected to be reduced at a similar proportion. The impact and conclusion for predation risk associated with NPB structures would be the same as described for Alternative 1A.

Predation at the north Delta would be increased due to the construction of the proposed water export facilities on the Sacramento River. The effect on lamprey from predation loss at the north Delta is unknown because of the lack of knowledge about their distribution and population abundances in the Delta.

NEPA Effects: The overall effect of entrainment and predation on lamprey from Alternative 3 is considered not adverse, for the reason describe for Alternative 1A.

CEQA Conclusion: As described above, annual entrainment losses of Pacific lamprey would be decreased under Alternative 3 (A3_LLT) relative to Existing Conditions by 28% (939 fish).

Impacts of water operations on entrainment of Pacific lamprey are expected to be less than significant, and no mitigation would be required.

Table 11-3-47. Pacific Lamprey Annual Entrainment Index[a] at the SWP and CVP Salvage Facilities for Alternative 3

	Absolute Difference (Percent Difference)	
Water Year Type	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
All Years	-939 (-28%)	-834 (-25%)
	Shading indicates entrainment increased 10% or more.	

[a] Estimated annual number of fish lost, based on non-normalized data.

The impact and conclusion for predation associated with entrainment would be about the same as described above because the additional predation losses associated with the proposed north Delta intakes would be offset by the reduction in predation loss at the south Delta. The relative impact of predation loss on the lamprey population is unknown because there is little available knowledge on their distribution and abundance in the Delta. The impact would be less than significant. No mitigation would be required.

Impact AQUA-166: Effects of Water Operations on Spawning and Egg Incubation Habitat for Pacific Lamprey

In general, Alternative 3 would reduce the quantity and quality of Pacific lamprey spawning habitat relative to NAA.

Flow-related effects on Pacific lamprey spawning habitat were evaluated by estimating effects of flow alterations on redd dewatering risk and effects of water temperature. Rapid reductions in flow can dewater redds leading to mortality. Dewatering risk was analyzed for the Sacramento River at Keswick, Sacramento River at Red Bluff, Trinity River downstream of Lewiston, Feather River at

Thermalito Afterbay, and American River at Nimbus Dam and at the confluence with the Sacramento River. Pacific lamprey spawn in these rivers between January and August. Dewatering risk to redd cohorts was characterized by the number of cohorts experiencing a month-over-month reduction in flows (using CALSIM II outputs) of greater than 50%. Water temperature results from the SRWQM and the Reclamation Temperature Model were used to assess the exceedances of water temperatures under all model scenarios in the upper Sacramento, Trinity, Feather, and American Rivers.

Flows in all rivers evaluated indicate negligible effects (<5%) or an increase in redd cohorts exposed to month-over-month flow reductions between January and August for Alternative 3 compared to NAA, indicates project-related increases would only occur in the Feather River, which would consist of a 40% increase in dewatering risk. (Table 11-3-48). Project-related effects in all other locations analyzed consist of negligible effects (<5%) that would not have biologically meaningful effects or decreases in dewatering risk (to -21% in the Sacramento River) that would have beneficial effects on spawning success.

Table 11-3-48. Differences between Model Scenarios in Dewatering Risk of Pacific Lamprey Redd Cohorts[a]

Location	Comparison[b]	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Sacramento River at Keswick	Difference	11	-11
	Percent Difference	20%	-14%
Sacramento River at Red Bluff	Difference	3	-15
	Percent Difference	6%	-21%
Trinity River downstream of Lewiston	Difference	1	1
	Percent Difference	1%	1%
Feather River at Thermalito Afterbay	Difference	1	43
	Percent Difference	1%	40%
American River at Nimbus Dam	Difference	33	-4
	Percent Difference	39%	-3%
American River at Sacramento River confluence	Difference	42	2
	Percent Difference	44%	3%

[a] Difference and percent difference between model scenarios in the number of Pacific lamprey redd cohorts experiencing a month-over-month reduction in flows of greater than 50%.

[b] Positive values indicate a higher value in Alternative 3 than under the baseline (EXISTING CONDITIONS or NAA).

For evaluation of effects of Alternative 3 on water temperatures, it was determined that the effects of Alternative 3 on water temperatures for the Sacramento River, Trinity River, and the American River would be similar to that for Alternative 1A. Results from Alternative 1A, Impact AQUA-166 indicate that egg exposure would be similar to NAA at most locations, although egg exposure would substantially increase in the Feather River below Thermalito Afterbay.

NEPA Effects: Collectively, these results indicate that the effect would be adverse because it has the potential to substantially reduce suitable spawning habitat and substantially reduce the number of fish as a result of egg mortality. There would be increases in egg cohorts (exposed to redd dewatering risk (43 cohorts or 40%) and temperatures greater than 71.6°F (84 cohorts or 91%) in the Feather River below Thermalito Afterbay. Increased redd dewatering risk and exposure risk to egg cohorts below Thermalito Afterbay would reduce spawning success there. This effect is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this effect to a level that is not adverse would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this would be an unavoidable adverse effect. Even so, proposed mitigation (Mitigation Measure AQUA-166a through AQUA-166c) has the potential to reduce the severity of impact, although not necessarily to a not adverse level.

CEQA Conclusion: In general, Alternative 3 would reduce the quantity and quality of Pacific lamprey spawning habitat relative to the Existing Conditions.

Rapid reductions in flow can dewater redds leading to mortality. Predicted effects of Alternative 3 in the Sacramento River and American River are for increases in the number of redd cohorts predicted to experience a month-over-month change in flow of greater than 50% relative to Existing Conditions (Table 11-3-48). Changes would be most substantial for the American River, with increased risk of dewatering exposure to 33 cohorts or 39% at Nimbus Dam, and 42 cohorts or 44% at the confluence. Effects of Alternative 3 would be negligible (<5%) for the Trinity River and Feather River.

For evaluation of effects of Alternative 3 on water temperatures, it was determined that the effects of Alternative 3 on water temperatures for the Sacramento River, Trinity River, Feather River, and the American River would be similar to those described for Alternative 1A. Results from Alternative 1A, Impact AQUA-166 indicate that egg exposure would be greater than under Existing Conditions at the Sacramento, Feather, and American Rivers.

Summary of CEQA Conclusion

Collectively, these results indicate that the impact would be significant because it has the potential to substantially reduce suitable spawning habitat and substantially reduce the number of fish as a result of egg mortality. Effects of Alternative 3 on Pacific lamprey redd dewatering risk would be biologically meaningful in the Sacramento River (based on 20% increase in exposure risk) and the American River (based on a maximum of 44% increase in exposure risk) and would not have significant effects on dewatering risk in the Feather River and Trinity River. In addition, egg exposure to elevated temperatures would be greater than that under Existing Conditions at the Sacramento, Feather, and American Rivers.

This impact is a result of the specific reservoir operations and resulting flows associated with this alternative. Applying mitigation (e.g., changing reservoir operations in order to alter the flows) to the extent necessary to reduce this impact to a less-than-significant level would fundamentally change the alternative, thereby making it a different alternative than that which has been modeled and analyzed. As a result, this impact is significant and unavoidable because there is no feasible mitigation available. Even so, proposed below is mitigation that has the potential to reduce the severity of impact though not necessarily to a less-than-significant level.

Mitigation Measure AQUA-166a: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Impacts to Pacific Lamprey to Determine Feasibility of Mitigation to Reduce Impacts to Spawning Habitat

Although analysis conducted as part of the EIR/EIS determined that Alternative 3 would have significant and unavoidable adverse effects on spawning habitat, this conclusion was based on the best available scientific information at the time and may prove to have been overstated. Upon the commencement of operations of CM1 and continuing through the life of the permit, the BDCP proponents will monitor effects on spawning habitat in order to determine whether such effects would be as extensive as concluded at the time of preparation of this document and to determine any potentially feasible means of reducing the severity of such effects. This mitigation measure requires a series of actions to accomplish these purposes, consistent with the operational framework for Alternative 3.

The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 3 operations only. Development of mitigation actions for the incremental impact on spawning habitat attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 3.

Mitigation Measure AQUA-166b: Conduct Additional Evaluation and Modeling of Impacts on Pacific Lamprey Spawning Habitat Following Initial Operations of CM1

Following commencement of initial operations of CM1 and continuing through the life of the permit, the BDCP proponents will conduct additional evaluations to define the extent to which modified operations could reduce impacts to spawning habitat under Alternative 3. The analysis required under this measure may be conducted as a part of the Adaptive Management and Monitoring Program required by the BDCP (Chapter 3 of the BDCP, Section 3.6).

Mitigation Measure AQUA-166c: Consult with NMFS, USFWS, and CDFW to Identify and Implement Potentially Feasible Means to Minimize Effects on Pacific Lamprey Spawning Habitat Consistent with CM1

In order to determine the feasibility of reducing the effects of CM1 operations on Pacific lamprey habitat, the BDCP proponents will consult with NMFS, USFWS and CDFW to identify and implement any feasible operational means to minimize effects on spawning habitat. Any such action will be developed in conjunction with the ongoing monitoring and evaluation of habitat conditions required by Mitigation Measure AQUA-166a.

If feasible means are identified to reduce impacts on spawning habitat consistent with the overall operational framework of Alternative 3 without causing new significant adverse impacts on other covered species, such means shall be implemented. If sufficient operational flexibility to reduce effects on Pacific lamprey habitat is not feasible under Alternative 3 operations, achieving further impact reduction pursuant to this mitigation measure would not be feasible under this Alternative, and the impact on Pacific lamprey would remain significant and unavoidable.

Impact AQUA-167: Effects of Water Operations on Rearing Habitat for Pacific Lamprey

In general, effects of Alternative 3 on flow would be negligible relative to NAA.

Flow-related impacts on Pacific lamprey rearing habitat were evaluated by estimating effects of flow alterations on ammocoete stranding risk and effects of water temperatures. Ammocoete stranding risk was analyzed for the Sacramento River at Keswick and Red Bluff, the Trinity River, Feather River, and the American River at Nimbus Dam and at the confluence with the Sacramento River. Lower flows can reduce the instream area available for rearing and rapid reductions in flow can strand ammocoetes leading to mortality. The analysis of ammocoete stranding was conducted by analyzing a range of month-over-month flow reductions from CALSIM II outputs, using the range of 50%–90% in 5% increments. A cohort was considered stranded if at least one month-over-month flow reduction was greater than the flow reduction at any time during the period.

Effects of Alternative 3 on Pacific lamprey ammocoete stranding were analyzed by calculating month-over-month flow reductions for the Sacramento River at Keswick for January through August (Table 11-3-49). Results indicate primarily no effect (0%) compared to NAA, with the exception of a small increase (7%) in 65% flow reductions that would not have biologically meaningful effects on stranding conditions and a small decrease (-9%) in 80% flow reduction exposures that would have a small, beneficial effect. These results indicate that Alternative 3 would not have biologically meaningful effects on Pacific lamprey ammocoete stranding conditions at Keswick.

Table 11-3-49. Percent Difference between Model Scenarios in the Number of Pacific Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Sacramento River at Keswick

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
-50%	0	0
-55%	0	0
-60%	0	0
-65%	0	7
-70%	4	0
-75%	1	0
-80%	9	-9
-85%	4	0
-90%	NA	NA

NA = all values were 0.

[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 3.

Results of comparisons for the Sacramento River at Red Bluff provide similar conclusions, with slightly more variability in results (Table 11-3-50). Results for Alternative 3 compared to NAA indicate no change (0%), negligible to small increases (to 5%) that would not have biologically meaningful effects on stranding conditions, and small decreases (to -9%) that would have a small, beneficial effect on stranding conditions. These results indicate that Alternative 3 would not have biologically meaningful effects on Pacific lamprey ammocoete stranding conditions at Red Bluff.

Table 11-3-50. Percent Difference between Model Scenarios in the Number of Pacific Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Sacramento River at Red Bluff

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
-50%	0	0
-55%	4	0
-60%	7	5
-65%	-2	-3
-70%	9	-2
-75%	0	-9
-80%	5	-7
-85%	100	0
-90%	NA	NA

NA = could not be calculated because the denominator was 0.
[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 3.

Comparisons for the Trinity River no effect (0%) or negligible changes (<5%) attributable to the project under Alternative 3 relative to NAA (Table 11-3-51). These results indicate that Alternative 3 would not have biologically meaningful effects on Pacific lamprey ammocoete stranding conditions in the Trinity River.

Table 11-3-51. Percent Difference between Model Scenarios in the Number of Pacific Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Trinity River at Lewiston

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
-50%	0	0
-55%	0	0
-60%	0	0
-65%	0	0
-70%	0	0
-75%	21	-3
-80%	26	-1
-85%	16	-1
-90%	34	-1

[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 3.

Comparisons for the Feather River indicate no difference (0%) or negligible project-related effects (<5%) for flow reductions up to 80%, and substantial decreases in cohorts exposed to 85% flow reductions (-42%) and 90% flow reductions (-28%) under Alternative 3, compared to NAA. This would have a beneficial effect on spawning success. (Table 11-3-52). These results indicate that Alternative 3 would not have biologically meaningful effects on Pacific lamprey ammocoete stranding conditions in the Feather River.

Table 11-3-52. Percent Difference between Model Scenarios in the Number of Pacific Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Feather River at Thermalito Afterbay

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
-50%	0	0
-55%	0	0
-60%	0	0
-65%	0	0
-70%	0	0
-75%	0	0
-80%	-1	1
-85%	-24	-42
-90%	-64	-28

[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 3.

Comparisons for the American River at Nimbus Dam (Table 11-3-53) indicate negligible effects (<5%) for most flow reduction categories, a small increase (8%) in cohorts exposed to 90% flow reductions, and small decreases (to -15%) in cohorts exposed to 70%, 80%, and 85% flow reductions for Alternative 3 compared to NAA. These results would have a beneficial effect on spawning success, and Alternative 3 would not have biologically meaningful effects on Pacific lamprey ammocoete stranding conditions in the American River at Nimbus Dam.

Table 11-3-53. Percent Difference between Model Scenarios in the Number of Pacific Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, American River at Nimbus Dam

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
-50%	0	0
-55%	0	0
-60%	1	0
-65%	2	0
-70%	27	-9
-75%	80	-6
-80%	264	-4
-85%	332	-15
-90%	225	8

NA = could not be calculated because the denominator was 0.
[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 3.

Comparisons for the American River at the confluence with the Sacramento River (Table 11-3-54) (A3_LLT compared to NAA) indicates negligible effects (<5%) on cohort exposure for all flow reduction categories. These results indicate that Alternative 3 would not have biologically meaningful effects on Pacific lamprey ammocoete stranding conditions in the American River at the confluence with the Sacramento River.

Table 11-3-54. Percent Difference between Model Scenarios in the Number of Pacific Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, American River at the Confluence with the Sacramento River

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
-50%	0	0
-55%	0	0
-60%	1	0
-65%	1	0
-70%	4	-4
-75%	41	3
-80%	198	1
-85%	250	0
-90%	339	5

[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 3.

Because water temperatures under Alternative 3 would be similar to those under Alternative 1A, results of the analysis on ammocoete exposure to elevated temperatures for Alternative 3 would be similar to that for Alternative 1A. Results from Alternative 1A, Impact AQUA-167 indicate that there would be small to moderate increases and decreases in exposure relative to NAA that will balance out within rivers such that there would be no overall effect on Pacific lamprey ammocoetes.

NEPA Effects: Collectively these results indicate that effects would not be adverse because they would not substantially reduce rearing habitat or substantially reduce the number of fish as a result of ammocoete mortality. Alternative 3 would generally cause no effect (0%), negligible effects (<5%), isolated categories of flow reductions that would experience a small increase in cohort exposure but that would not have biologically meaningful adverse effects, or small decreases in stranding risk that would have beneficial effects. There would also be small, beneficial effects in the Sacramento River (decreased occurrence of month-over-month flow reductions to -12%) and more substantial beneficial effects in the Feather River (up to -15% in exposures to 70%, 80%, and 85% flow reductions) due to project-related effects of Alternative 3. There would be small to moderate increases and decreases in ammocoete exposure to elevated water temperatures relative to Existing Conditions that will balance out within rivers such that there would be no overall effect on Pacific lamprey ammocoetes.

CEQA Conclusion: In general, under Alternative 3 water operations, the quantity and quality of Pacific lamprey rearing habitat would not be affected relative to the CEQA baseline.

Comparisons of month-over-month flow reductions under Alternative 3 relative to Existing Conditions for the Sacramento River at Keswick indicate negligible changes (<5%) in occurrence of cohort exposure for all flow reduction categories with the exception of a small increase in exposure (9%) in the 80% flow reduction category (Table 11-3-49). These results indicate that effects of Alternative 3 on flow would not have biologically meaningful effects on Pacific lamprey ammocoete stranding risk in the Sacramento River at Keswick.

Comparisons of Alternative 3 to Existing Conditions for the Sacramento River at Red Bluff indicate negligible changes (<5%) in occurrence of cohort exposure for all flow reduction categories with the exception of small increases in exposure in the 60% (increase of 7%), 70% (increase of 9%), and 80% (increase of 5%) flow reduction categories, and a more substantial increase in the 90% flow reduction category (100% or from 56 to 112 cohorts exposed) (Table 11-3-49). These results indicate that effects of Alternative 3 on flow would cause increased risk of Pacific lamprey ammocoete stranding in the Sacramento River at Red Bluff but not to the extent that would be considered a biologically meaningful effect.

In the Trinity River, Alternative 3 would have no effect on cohort exposure for the lower flow reduction categories, and would cause moderate increases in cohort exposure (to 34%) for flow reductions from 75% to 90% (Table 11-3-51). The effects of Alternative 3 on flow reduction exposures are consistent for the higher flow reduction categories but of relatively small magnitude and therefore effects would not have biologically meaningful effects on rearing success.

In the Feather River, Alternative 3 would have no effect (0% difference) or negligible effects (<5%) on cohort exposure for the lower flow reduction categories, and would have a moderate increase in cohort exposure (24%) to flow reductions of 85% and a more substantial increase (64%) in exposures to flow reductions of 90% (Table 11-3-52). Based on the fact that moderate to substantial increases in cohort exposure would only occur for the two highest flow reduction categories, these results indicate that effects of Alternative 3 on flow would not have biologically meaningful effects on rearing success.

Comparisons for the American River at Nimbus Dam (Table 11-3-53) and at the confluence with the Sacramento River (Table 11-3-54) predict increased occurrence of cohort exposures under A3_LLT relative to Existing Conditions for 70% through 90% flow reduction events; predicted increases ranged from 27 to 332% for Nimbus Dam (increase from 56 to 252 cohorts exposed) and from 41 to 339% (increase from 56 to 246 cohorts exposed) for the confluence. These are substantial increases in cohort stranding exposure that would have negative effects on rearing success.

Because water temperatures under Alternative 3 would be similar to those under Alternative 1A, results of the analysis on ammocoete exposure to elevated temperatures for Alternative 3 would be similar to that for Alternative 1A. Results from Alternative 1A, Impact AQUA-167 indicate that there would be substantial increases in ammocoete exposure in all rivers relative to Existing Conditions.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-167 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 3 could be significant because, under the CEQA baseline, the alternative could substantially reduce rearing habitat and substantially reduce the number of fish as a result of ammocoete mortality, contrary to the NEPA conclusion set forth above. Alternative 3 would have biologically meaningful effects in the American River at Nimbus Dam and at the confluence with the Sacramento River based on substantial increases in the number of cohorts exposed to stranding risk due to flow reductions in each of the higher flow reduction categories (increases ranging from 27 to 332% for Nimbus Dam and from 41 to 339% for the confluence). Alternative 3 would not affect ammocoete stranding risk in the Sacramento River, Trinity River, and the Feather River (based on negligible effects, reduced occurrence of flow reduction events, or moderate increases in risk, to 34%, and/or more substantial but isolated increases in risk, to 64%, that would not have biologically meaningful effects). There would be substantial increases in ammocoete exposure to increased temperatures in all rivers evaluated.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 3 indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 3. This indicates that the differences between Existing Conditions and Alternative 3 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 3, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on rearing habitat for Pacific lamprey. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-168: Effects of Water Operations on Migration Conditions for Pacific Lamprey

In general, effects of Alternative 3 on Pacific lamprey migration conditions would be negligible relative to NAA.

Macropthalmia

After 5–7 years Pacific lamprey ammocoetes migrate downstream and become macropthalmia once they reach the Delta. Migration generally is associated with large flow pulses in winter months (December through March) (U.S. Fish and Wildlife Service unpublished data) meaning alterations in flow have the potential to affect downstream migration conditions. The effects of Alternative 3 on seasonal migration flows for Pacific lamprey macropthalmia were assessed using CALSIM II flow output. Flow rates along the migration pathways of Pacific lamprey during the likely outmigration period (December through May) were examined for the Sacramento River at Rio Vista and Red Bluff, the Feather River at the confluence with the Sacramento River, and the American River at the confluence with the Sacramento River.

Sacramento River

Effects of Alternative 3 on mean monthly flow rates for the Sacramento River at Rio Vista (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for December to May compared to NAA would be primarily negligible effects (<5%) or decreases in flow to -15%, with small increases in flow during December in dry years (7%) and during May in dry years (8%). Meaningful (>5%) project-related reductions in flow would occur in drier water years (when effects on migration would be more critical) during January (-10% in critical years), March (below normal and dry years to -13%), and April (-6% in below normal years). These project-related decreases in flow are relatively infrequent during the migration period and of small magnitude and would not have biologically meaningful effects on macropthalmia migration success.

For the Sacramento River at Red Bluff (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*), the difference in mean monthly flow rate for Alternative 3 compared to NAA for the December through May migration period indicates primarily negligible effects (<5%) or increases in flow to 15%, which would have a beneficial effect on migration conditions, and only a single occurrence of a small, project-related reduction in flow (-8%) during January in critical years. These results indicate that the effects of Alternative 3 on flow would not have biologically meaningful effects on outmigrating macropthalmia at this location.

Feather River

Comparisons for the Feather River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for December to May indicate negligible project-related effects (<5%) or increases in flow to 42% which would have beneficial effects on migration conditions, with the exception of a single, project-related decreases in flow during January in critical years (-9%). Based on the predominance of negligible effects and/or increases in flow that would be beneficial for migration, this alternative would not have negative effects on macropthalmia migration in the Feather River at the confluence, compared to NAA.

American River

Comparisons for the American River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for December through May (A3_LLT compared to NAA) indicates project-related effects consist primarily of negligible effects (<5%), with small to moderate increases in flow (to 36%) during some months/water years that would be beneficial for migration, and with small decreases in flow (to -9%) predicted to occur during March in dry and critical years. These isolated, small decreases in flow would not have biologically meaningful effects on outmigrating macropthalmia in the American River. These results indicate that Alternative 3 would not have biologically meaningful effects on macropthalmia migration in the American River.

Overall, flow-related effects of Alternative 3 on outmigrating macropthalmia are not biologically meaningful in any of the rivers analyzed. Effects on flow would consist of negligible effects (<5%), small to moderate increases in flow that would have a beneficial effect on migration conditions, or infrequent and relatively small decreases in flow which would not have biologically meaningful effects on Pacific lamprey macropthalmia migration in the rivers analyzed.

Adults

Sacramento River

For the Sacramento River at Red Bluff for the time-frame January to June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*), effects of Alternative 3 on mean monthly flow consist primarily of negligible effects (<5%) or infrequent, small increases in flow (to 13%) and a single occurrence of a small decrease in flow (-8%) during January in critical years. These results indicate that effects of Alternative 3 on flow would not have biologically meaningful effects on adult migration in the Sacramento River, relative to NAA.

Feather River

For the Feather River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) during January to June, mean monthly flows under Alternative 3 would be similar to (<5% difference) or greater than (to 32%) flows under NAA, for most months and water year types, with the exception of small decreases in flow during January in critical years (-9%) and during June in critical years (-8%). The predominance of increases in flow would have beneficial effects on migration conditions, and the few, small decreases would not have biologically meaningful effects on migration conditions. These results indicate that effects of Alternative 3 on flow would not have biologically meaningful effects on adult migration conditions in the Feather River, relative to NAA.

American River

Comparisons of mean monthly flow for the American River at the confluence with the Sacramento River for January to June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) (A3_LLT compared to NAA) indicates predominantly negligible effects (<5%) or increases in flow (to 36%) attributable to the project with the exception of small decreases in flow during March in dry (-7%) and critical (-9%) years. The predominance of increases in flow would have beneficial effects on migration conditions and the few, small decreases would not have biologically meaningful effects on migration conditions. These results indicate that effects of Alternative 3 on flow would not have biologically meaningful effects on adult migration conditions in the American River, relative to NAA.

Overall, these results indicate that project-related effects of Alternative 3 on mean monthly flows during the Pacific lamprey adult migration period would consist of negligible effects (<5%) or increases in flow (up to 36%) that would have beneficial effects on migration conditions, with a few isolated, small decreases that would not have biologically meaningful effects on migration conditions.

NEPA Effects: Collectively, these results indicate that the effect of Alternative 3 on Pacific lamprey macropthalmia and adult migration is not adverse because it would not substantially reduce rearing habitat or substantially reduce the number of fish as a result of ammocoete mortality. There would be no biologically meaningful effects of Alternative 3 on flows in any river evaluated during the Pacific lamprey macropthalmia and adult migration periods.

CEQA Conclusion: In general, Alternative 3 would not affect the quantity and quality of Pacific lamprey migration habitat relative to the CEQA baseline.

Macropthalmia

Sacramento River

Comparisons of mean monthly flow rates in the Sacramento River at Rio Vista (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for December to May for Alternative 3 relative to Existing Conditions indicate primarily negligible effects (<5%), or reductions in flow ranging from -5% to -36%. Effects in drier water year types when flow reductions would be most critical for migration conditions consist of negligible effects or small decreases (to -10%) that would not have biologically meaningful effects on migration conditions in all months during the migration period. These results indicate that Alternative 3 would not affect Pacific lamprey macropthalmia migration conditions in the Sacramento River at Rio Vista.

Comparisons for the Sacramento River at Red Bluff (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for December to May indicate negligible (<5%) effects or increases in flow (to 19%) for Alternative 3 relative to Existing Conditions for all months and water years, which would have beneficial effects on migration conditions, with the exception of a small decrease in flow (-14%) during May in wet years when it would not negatively affect migration conditions. These results indicate that effects of Alternative 3 on flow would not have biologically meaningful effects on outmigrating macropthalmia in the Sacramento River at Red Bluff.

Feather River

Comparisons for the Feather River at the confluence (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for December to May indicate effects of Alternative 3 compared to Existing Conditions consist of negligible effects (<5%) or increases in flow (to 38%) that would have beneficial effects on migration conditions, with the exception of small decreases in flow during January in below normal years (-10%) and during March in below normal years (-12%), and a slightly larger reduction during May in wet years (-24%) when effects of flow reductions on migration conditions would be less critical. Flow reductions would be infrequent, of small magnitude, and of the greatest magnitude during wet years and therefore would not have biologically meaningful negative effects. These results indicate that the effects of Alternative 3 on flow would not have negative effects on outmigrating macropthalmia in the Feather River.

American River

Comparisons for the American River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for December to May indicate variable results depending on the specific month and water year, with negligible effects (<5%) or decreases in flow (to -22%) during December, increases in wetter water years (to 28%) and decreases in drier water years (to -17%) during January through March, negligible effects (<5)% and small-scale increases or decreases (to -8%) during April, and reductions in flow (to -27%) during May in all but dry years (increase of 20%). Based on small to moderate reductions in flow (to -22%) in drier water years during most of the migration period (December through March and May), the effects of Alternative 3 on flow would affect conditions for outmigrating macropthalmia in the American River at the confluence.

Overall, flow-related effects of Alternative 3 on outmigrating macropthalmia are not biologically meaningful in the Sacramento River and Feather River (based on negligible effects on flow, increases in flow that would have beneficial effects, and isolated and/or small magnitude decreases in flow that would not have negative effects on migration conditions), but would cause negative effects on migration conditions in the American river (based on small to moderate flow reductions for most of the migration period).

Adults

Sacramento River

Comparisons of mean monthly flow for the Sacramento River at Red Bluff (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) during the Pacific lamprey adult migration period from January through June indicate primarily negligible effects (<5%) or increases in flow (to 20%) that would have a beneficial effect on migration conditions, with the exception of a small decrease in mean monthly flow in May during wet years (-14%) when effects of flow reductions on migration conditions would be less critical. These results indicate that Alternative 3 would not have biologically meaningful effects on migration conditions in the Sacramento River at Red Bluff.

Feather River

Comparisons of mean monthly flow for the Feather River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for January to June indicate effects of Alternative 3 consist primarily of negligible effects (<5%) or increases in flow (to 27%) that would have beneficial effects on migration, with the exception of small decreases (to -12%) during January and March in below normal years that would not have biologically meaningful effects on migration conditions, a moderate reduction (-24%) during May in wet years when effects of flow reductions would be less critical for migration, and more prevalent reductions (to -20% in wet, dry and critical years) during June which is late in the migration period. Based on these results, effects of Alternative 3 on flow would not have biologically meaningful negative effects on adult migration conditions in the Feather River.

American River

Comparisons of mean monthly flow for the American River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for January to June indicate variable effects of Alternative 3 depending on the month and water year type, with negligible effects (<5%) or increases in flow (to 28%) in wetter water years and decreases (to -17%) in drier water years for January through March, negligible effects or small increases or decreases in flow (to 8%) during April, reductions in flow (to -27%) in all but dry years (increase of 20%) during May and decreases in wet (-28%) and critical years (-45%) in June with increases (to 33%) in above and below normal years. Small to moderate flow reductions would occur in drier years during most of the migration period, with the most substantial reductions occurring during January, May, and June (the onset and end of the migration period), Alternative 3 would affect adult migration conditions in the American River.

Overall, effects of Alternative 3 on adult Pacific lamprey migration conditions consist of negligible effects on flow (<5%), increases in flow that would be beneficial for migration conditions, and infrequent and/or small decreases in flow that would not have biologically meaningful negative effects in the rivers analyzed. There would be more substantial reductions in flow under Alternative 3 in the Feather River and the American River; however, based on the prevalence and magnitude of the effects, and the fact that the largest flow reductions would occur late in the migration period (June), it is concluded that effects of Alternative 3 on flow would not have biologically meaningful effects on migration conditions in these locations.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-168 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 3 could be significant because, under the CEQA baseline, the alternative could substantially reduce the amount of suitable habitat and substantially interfere with the movement of fish, contrary to the NEPA conclusion set forth above. Alternative 3 would affect outmigrating macropthalmia and adult migration conditions in the American River (based on moderate flow reductions in drier years, to 22% for juvenile migration and to -45% for adult migration) during most months in the respective migration periods. Alternative 3 would not affect outmigrating macropthalmia or migrating adults in the Sacramento River and the Feather River (based on negligible effects on flow, increases in flow, to 38%, that would have beneficial effects, and decreases in flow in wet years, to -36%, or as isolated, -20%, and/or small magnitude, to -12%, decreases in flow in drier water years that would not have negative effects on migration conditions).

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 3 indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 3. This indicates that the differences between Existing Conditions and Alternative 3 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 3, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on Pacific lamprey macropthalmia and adult migration habitat. This impact is found to be less than significant and no mitigation is required.

Restoration Measures (CM2, CM4–CM7, and CM10)

Alternative 3 has the same restoration measures as Alternative 1A. Because no substantial differences in restoration-related fish effects are anticipated anywhere in the affected environment under Alternative 3 compared to those described in detail for Alternative 1A, the fish effects of restoration measures described for Pacific lamprey under Alternative 1A (Impact AQUA-169 through AQUA-171) also appropriately characterize effects under Alternative 3.

The following impacts are those presented under Alternative 1A that are identical for Alternative 3.

Impact AQUA-169: Effects of Construction of Restoration Measures on Pacific Lamprey

Impact AQUA-170: Effects of Contaminants Associated with Restoration Measures on Pacific Lamprey

Impact AQUA-171: Effects of Restored Habitat Conditions on Pacific Lamprey

NEPA Effects: As described in Alternative 1A, none of these impact mechanisms would be adverse to Pacific lamprey, and most would be at least slightly beneficial.

CEQA Conclusion: All of the impact mechanisms listed above would be at least slightly beneficial, or less than significant, and no mitigation is required.

Other Conservation Measures (CM12–CM19 and CM21)

Alternative 3 has the same other conservation measures as Alternative 1A. Because no substantial differences in other conservation-related fish effects are anticipated anywhere in the affected environment under Alternative 3 compared to those described in detail for Alternative 1A, the fish effects of other conservation measures described for Pacific lamprey under Alternative 1A (Impact AQUA-172 through AQUA-180) also appropriately characterize effects under Alternative 3.

The following impacts are those presented under Alternative 1A that are identical for Alternative 3.

Impact AQUA-172: Effects of Methylmercury Management on Pacific Lamprey (CM12)

Impact AQUA-173: Effects of Invasive Aquatic Vegetation Management on Pacific Lamprey (CM13)

Impact AQUA-174: Effects of Dissolved Oxygen Level Management on Pacific Lamprey (CM14)

Impact AQUA-175: Effects of Localized Reduction of Predatory Fish on Pacific Lamprey (CM15)

Impact AQUA-176: Effects of Nonphysical Fish Barriers on Pacific Lamprey (CM16)

Impact AQUA-177: Effects of Illegal Harvest Reduction on Pacific Lamprey (CM17)

Impact AQUA-178: Effects of Conservation Hatcheries on Pacific Lamprey (CM18)

Impact AQUA-179: Effects of Urban Stormwater Treatment on Pacific Lamprey (CM19)

Impact AQUA-180: Effects of Removal/Relocation of Nonproject Diversions on Pacific Lamprey (CM21)

NEPA Effects: The nine impact mechanisms have been determined to range from no effect, to no adverse effect, or beneficial effects on Pacific lamprey for NEPA purposes, for the reasons identified for Alternative 1A.

CEQA Conclusion: The nine impact mechanisms would be considered to range from no impact, to less than significant, or beneficial on Pacific lamprey, for the reasons identified for Alternative 1A, and no mitigation is required.

River Lamprey

Construction and Maintenance of CM1

Impact AQUA-181: Effects of Construction of Water Conveyance Facilities on River Lamprey

The potential effects of construction of water conveyance facilities on river lamprey under Alternative 3 would be similar to those described for Alternative 1A (see Impact AQUA-181) except that Alternative 3 would include two intakes compared to five intakes under Alternative 1A, so the effects would be proportionally less under this alternative. This would convert about 4,450 lineal feet of existing shoreline habitat into intake facility structures and would require about 10.2 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. The effects related to temporary increases in turbidity, accidental spills, underwater noise, in-water work activities, and disturbance of contaminated sediments would be similar to Alternative 1A and the same environmental commitments and mitigation measures (described under Impact AQUA-1 for delta smelt and in

Appendix 3B, *Environmental Commitments*) would be available to avoid and minimize potential effects.

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-181, environmental commitments and mitigation measures would be available to avoid and minimize potential effects, and the effect would not be adverse for river lamprey

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-181, the impact of the construction of water conveyance facilities on river lamprey would be less than significant except for construction noise associated with pile driving. Potential pile driving impacts would be less than Alternative 1A because only two intakes would be constructed rather than five. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in the discussion of Alternative 1A.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in the discussion of Alternative 1A.

Impact AQUA-182: Effects of Maintenance of Water Conveyance Facilities on River Lamprey

NEPA Effects: The potential effects of the maintenance of water conveyance facilities under Alternative 3 would be similar to those described for Alternative 1A (see Impact AQUA-182) except that only two intakes would need to be maintained under Alternative 3 rather than five as under Alternative 1A. As concluded in Alternative 1A, Impact AQUA-182, the impact would not be adverse for river lamprey.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-182, the impact of the maintenance of water conveyance facilities on river lamprey would be less than significant and no mitigation would be required.

Water Operations of CM1

Impact AQUA-183: Effects of Water Operations on Entrainment of River Lamprey

The potential entrainment impacts of Alternative 3 on river lamprey would be proportionally similar to those described for Alternative 1A for operating new SWP/CVP north Delta intakes (Impact AQUA-183), non-physical barriers at the entrances to Clifton Court Forebay and the Delta Mendota Canal (Impact AQUA-183), and decommissioning agricultural diversions in ROAs (Impact AQUA-183). These actions would minimize or reduce potential entrainment.

NEPA Effects: Under Alternative 3, average annual entrainment of lamprey at the south Delta export facilities, as estimated by salvage density, would be reduced by 25% (834 fish) (Table 11-3-55) across all water year types compared to NAA. Therefore, Alternative 3 would not have adverse effects on lamprey.

Table 11-3-55. Lamprey Annual Entrainment Index[a] at the SWP and CVP Salvage Facilities - for Alternative 3

	Absolute Difference (Percent Difference)	
Water Year Types	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
All Years	-939 (-28%)	-834 (-25%)
	Shading indicates entrainment increased 10% or more.	

a Estimated annual number of fish lost, based on non-normalized data.

CEQA Conclusion: As described above, annual entrainment losses of lamprey would be decreased under Alternative 3 (A3_LLT) relative to Existing Conditions by 28% (939 fish). Impacts of water operations on entrainment of river lamprey are considered less than significant, and no mitigation would be required.

Impact AQUA-184: Effects of Water Operations on Spawning and Egg Incubation Habitat for River Lamprey

In general, effects of Alternative 3 on river lamprey spawning conditions would be negligible relative to the NAA based.

Flow-related impacts on river lamprey spawning habitat were evaluated by estimating effects of flow alterations on redd dewatering risk as described for Pacific lamprey with appropriate time-frames for river lamprey incorporated into the analysis. Rapid reductions in flow can dewater redds leading to mortality. The same locations were analyzed as for Pacific lamprey: the Sacramento River at Keswick and Red Bluff, Trinity River downstream of Lewiston, Feather River at Thermalito Afterbay, and American River at Nimbus Dam and at the confluence with the Sacramento River. River lamprey spawn in these rivers between February and June so flow reductions during those months have the potential to dewater redds, which could result in incomplete development of the eggs to ammocoetes (the larval stage).

Dewatering risk to redd cohorts was characterized by the number of cohorts experiencing a month-over-month reduction in flows (using CALSIM II outputs) of greater than 50%. Small-scale spawning location suitability characteristics (e.g., depth, velocity, and substrate) of river lamprey are not adequately described to employ a more formal analysis such as a weighted usable area analysis. Therefore, as described for Pacific lamprey, there is uncertainty that these values represent actual redd dewatering events, and results should be treated as rough estimates of flow fluctuations under each model scenario. Results were expressed as the number of cohorts exposed to dewatering risk and as a percentage of the total number of cohorts anticipated in the river based on the applicable time-frame, February to June.

Results for the Sacramento River indicate that there would be no biologically meaningful effects in any location evaluated (Table 11-3-56). In the Feather River, the effect is of small magnitude (9%) and would not have biologically meaningful effects on dewatering risk.

Table 11-3-56. Differences between Model Scenarios in Dewatering Risk of River Lamprey Redd Cohorts[a]

Location	Comparison[b]	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
Sacramento River at Keswick	Difference	4	1
	Percent Difference	13%	3%
Sacramento River at Red Bluff	Difference	2	0
	Percent Difference	5 %	0%
Trinity River downstream of Lewiston	Difference	-4	-2
	Percent Difference	-6%	-3%
Feather River Below Thermalito Afterbay	Difference	-5	5
	Percent Difference	-7%	9%
American River at Nimbus	Difference	10	1
	Percent Difference	18%	2%
American River at Sacramento River confluence	Difference	16	-1
	Percent Difference	27%	-1%

[a] Difference and percent difference between model scenarios in the number of Pacific lamprey redd cohorts experiencing a month-over-month reduction in flows of greater than 50%.

[b] Positive values indicate a higher value in Alternative 3 than under the baseline (EXISTING CONDITIONS or NAA).

Because water temperatures under Alternative 3 would be similar to those under Alternative 1A, results of the analysis on river lamprey egg exposure to elevated temperatures for Alternative 3 would be similar to that for Alternative 1A. Results from Alternative 1A, Impact AQUA-184 indicate that egg exposure would be similar to NAA at most locations, although egg exposure would moderately increase in the Feather River below Thermalito Afterbay. Because this is isolated to a single location in the Feather River, it is not expected to cause a population level effect on river lamprey.

NEPA Effects: These results indicate that the effect is not adverse because it would not substantially reduce suitable spawning habitat or substantially reduce the number of fish as a result of egg mortality. Effects of Alternative 3 on flow would have negligible effects (<5%) in all locations on redd dewatering risk and exposure to elevated temperatures, with the exception of a single increase in elevated water temperature exposure in one location, that would not have biologically meaningful effects on spawning success.

CEQA Conclusion: In general, effects of Alternative 3 on river lamprey spawning conditions would be negligible relative to the Existing Conditions.

Rapid reductions in flow can dewater redds leading to mortality. Flow-related impacts on river lamprey spawning habitat were evaluated by estimating effects of flow alterations on redd dewatering risk as described for Pacific lamprey with appropriate time-frames for river lamprey incorporated into the analysis, and evaluation of effects of Alternative 3 on water temperatures.

Conclusions for Alternative 1A are that effects of Alternative 3 on flow reductions during the river lamprey spawning period from February to June in the Sacramento River and American River consist of negligible effects (<5%) in the Sacramento River at Red Bluff, Trinity River, and Feather

River (Table 11-3-56). There would be increases in river lamprey redd cohort dewatering risk relative to Existing Conditions for the Sacramento River at Keswick (13%), and for the American River at Nimbus Dam (15%) and at the confluence (27%).

Because water temperatures under Alternative 3 would be similar to those under Alternative 1A, results of the analysis on egg exposure to elevated temperatures for Alternative 3 would be similar to that for Alternative 1A. Results from Alternative 1A, Impact AQUA-184 indicate that egg exposure would be greater than under Existing Conditions at the Sacramento, Feather, American, and Stanislaus Rivers.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-184 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 3 could be significant because, under the CEQA baseline, the alternative could substantially, reduce suitable spawning habitat and substantially reduce the number of fish as a result of egg mortality, contrary to the NEPA conclusion set forth above. River lamprey egg exposure to elevated water temperatures would be greater than under Existing Conditions at the Sacramento, Feather, American, and Stanislaus Rivers. However, there would be negligible effects (<5%) on redd dewatering in the Sacramento River at Red Bluff, the Trinity River, and the Feather River; the increased exposure of river lamprey redd cohorts to dewatering from the project predicted for the Sacramento River at Keswick and the American River consist of small (13%, 15%) to moderate (27%) increased risks of dewatering that would not have biologically meaningful negative effects.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 3 indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 3. This indicates that the differences between Existing Conditions and Alternative 3 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 3, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on spawning and egg incubation habitat for river lamprey. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-185: Effects of Water Operations on Rearing Habitat for River Lamprey

In general, effects of Alternative 3 on river lamprey rearing conditions would be negligible relative to the NAA,.

Lower flows can reduce the instream area available for rearing and rapid reductions in flow can strand ammocoetes leading to mortality. Flow-related effects on river lamprey rearing habitat were evaluated by estimating effects of flow alterations on ammocoete exposure, or stranding risk, as described for Pacific lamprey. Effects of Alternative 3 on flow were evaluated in the Sacramento River at Keswick and Red Bluff, the Trinity River, Feather River, and the American River at Nimbus Dam and at the confluence with the Sacramento River. As for Pacific lamprey, the analysis of river lamprey ammocoete stranding was conducted by analyzing a range of month-over-month flow reductions from CALSIM II outputs, using the range of 50%–90% in 5% increments. A cohort of ammocoetes was assumed to be born every month during their spawning period (February through June) and spend 5 years rearing upstream. Therefore, a cohort was considered stranded if at least one month-over-month flow reduction was greater than the flow reduction at any time during the period.

For evaluation of ammocoete stranding risk, comparisons of Alternative 3 to NAA for the Sacramento River at Keswick (Table 11-3-57) indicated either no effect (0%), negligible effects (<5% difference), or a small increase (11%) or decrease (-7%) in cohort exposure due to flow reductions attributable to the project. These results indicate that the project-related effects of Alternative 3 on flow reductions consist of negligible or small effects on ammocoete exposure to flow reductions and would not cause biologically meaningful effects in the Sacramento River at Keswick.

Table 11-3-57. Percent Difference between Model Scenarios in the Number of River Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Sacramento River at Keswick

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
-50%	0	0
-55%	2	0
-60%	6	3
-65%	12	11
-70%	0	0
-75%	-2	4
-80%	4	-7
-85%	44	0
-90%	NA	NA

Note: Negative values indicate reduced cohort exposure, a benefit of Alternative 3.
NA = could not be calculated because the denominator was 0.

Results of comparisons for the Sacramento River at Red Bluff (Table 11-3-58) indicate no change (0%) or negligible effects (<5%) attributable to the project with the exception of a small increase (5%) in exposure to 60% flow reductions, which would not have biologically meaningful negative effects, and a decrease (-14%) in exposure to 75% flow reductions, which would have a small beneficial effect. These results indicate that the effects of Alternative 3 on flow reductions would not have biologically meaningful effects on river lamprey ammocoete stranding in the Sacramento River at Red Bluff, relative to NAA.

Table 11-3-58. Percent Difference between Model Scenarios in the Number of River Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Sacramento River at Red Bluff

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
-50%	0	0
-55%	5	1
-60%	12	5
-65%	-3	-4
-70%	10	1
-75%	5	-14
-80%	6	-4
-85%	100	0
-90%	NA	NA

NA = could not be calculated because the denominator was 0.
[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 3.

Comparisons for the Trinity River negligible effects (<5%) or reductions in exposures (-5%) in all flow categories attributable to the project, under Alternative 3 relative to NAA (Table 11-3-59). These results indicate that project-related effects of Alternative 3 on flow would not have biologically meaningful effects on river lamprey ammocoete stranding in the Trinity River.

Table 11-3-59. Percent Difference between Model Scenarios in the Number of River Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Trinity River at Lewiston

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
-50%	0	0
-55%	0	0
-60%	0	0
-65%	0	0
-70%	0	0
-75%	29	-2
-80%	32	-5
-85%	24	-5
-90%	47	-4

[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 3.

Comparisons for the Feather River (A3_LLT compared to NAA) indicate negligible effects (<5%) or reductions in exposures (to -32%) in all flow categories attributable to the project, which would have beneficial effects on ammocoete rearing success (Table 11-3-60). These results indicate that project-related effects of Alternative 3 on flow would not have biologically meaningful negative effects on river lamprey ammocoete stranding in the Feather River, relative to NAA.

Table 11-3-60. Percent Difference between Model Scenarios in the Number of River Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Feather River at Thermalito Afterbay

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
-50%	0	0
-55%	0	0
-60%	0	0
-65%	0	0
-70%	0	0
-75%	0	0
-80%	-8	-2
-85%	5	-20
-90%	-62	-32

[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 3.

Comparisons for the American River at Nimbus Dam(A3_LLT compared to NAA) (Table 11-3-61) and at the confluence with the Sacramento River (Table 11-3-62) indicate no effect (0%), negligible effects (<5%), or small increases or decreases (to 12%) that would not have biologically meaningful effects on spawning success. These results indicate that project-related effects of Alternative 3 on flow would not have biologically meaningful negative effects on river lamprey ammocoete stranding in the American River, relative to NAA.

Table 11-3-61. Percent Difference between Model Scenarios in the Number of River Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, American River at Nimbus Dam

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
-50%	0	0
-55%	0	0
-60%	4	0
-65%	7	-1
-70%	41	-11
-75%	117	-4
-80%	354	-4
-85%	420	-7
-90%	236	12

NA = could not be calculated because the denominator was 0.
[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 3.

Table 11-3-62. Relative Difference between Model Scenarios in the Number of River Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, American River at the Confluence with the Sacramento River

Percent Flow Reduction	Percent Difference[a]	
	EXISTING CONDITIONS vs. A3_LLT	NAA vs. A3_LLT
-50%	0	0
-55%	0	0
-60%	4	0
-65%	4	-1
-70%	15	-7
-75%	62	5
-80%	241	0
-85%	330	0
-90%	396	7

[a] Negative values indicate reduced cohort exposure, a benefit of Alternative 3.

Because water temperatures under Alternative 3 would be similar to those under Alternative 1A, results of the analysis on ammocoete exposure to elevated temperatures for Alternative 3 would be similar to that for Alternative 1A. Results from Alternative 1A, Impact AQUA-185 indicate that there would be small to moderate increases and decreases in exposure relative to NAA that will balance out within rivers such that there would be no overall effect on river lamprey ammocoetes.

NEPA Effects: Collectively, these results indicate that the effect is not adverse because it would not substantially reduce rearing habitat or substantially reduce the number of fish as a result of ammocoete mortality. Effects of Alternative 3 on ammocoete rearing in all locations analyzed would consist of negligible effects on flow reductions (<5% difference), small increases in occurrence of one or more flow reduction categories (to 12%) that would not have biologically meaningful effects, and small to substantial reductions (7% to 32% lower) in occurrence of flow reductions that would have beneficial effects on rearing success. Decreased occurrence of flow reduction events (i.e., a beneficial effect) would be most consistent and of the greatest magnitude in the Feather River, with reductions up to 32% for all flow reduction categories. In addition, there would be small to moderate increases and decreases in ammocoete exposure to elevated water temperatures that will balance out within rivers such that there would be no overall effect on river lamprey ammocoetes.

CEQA Conclusion: In general, under Alternative 3 water operations, the quantity and quality of spawning and egg incubation habitat for river lamprey rearing habitat would not be affected relative to the CEQA baseline.

Lower flows can reduce the instream area available for rearing and rapid reductions in flow can strand ammocoetes leading to mortality. Flow-related effects on river lamprey rearing habitat were evaluated by estimating effects of flow alterations on ammocoete exposure, or stranding risk, as described for Pacific lamprey, and effects of Alternative 3 on water temperature.

For evaluation of ammocoete stranding risk, comparisons of Alternative 3 to Existing Conditions for the Sacramento River at Keswick indicate negligible effects (<5%) on the number of ammocoete cohorts exposed to flow reductions for all flow reduction categories (Table 11-3-57) with the exception of a small increase (12%) in month-over-month flow reductions of 65% and a 44%

increase in reductions of 85%. Comparisons for the Sacramento River at Red Bluff indicate slightly more variable results with negligible effects (<5%) for all flow reduction categories except for small increases (5% to 12%) in the 55%, 60%, and 70% flow reduction categories, and a more substantial increase (100%, or from 25 to 50 cohorts) in the 85% flow reduction category (Table 11-3-58). While there would be a fairly substantial increase in the number of cohorts exposed to the 85% reduction category, effects would be negligible or small in all other flow reduction categories and therefore conclusions are that effects of Alternative 3 on flow reductions would not have biologically meaningful effects on river lamprey ammocoete stranding in the Sacramento River.

Comparisons for the Trinity River indicated no effect (0%) for flow reduction categories from 50% to 70%, and increases ranging from 24% to 47% for the higher flow reduction categories (Table 11-3-59). These consistent and more substantial increases in ammocoete cohort exposures to larger flow reductions would have negative effects on ammocoete rearing success through meaningful increases in risk of stranding.

Comparisons for the Feather River indicated no effect or reductions in frequency of occurrence for all flow reduction categories with the exception of a small increase in cohort exposure (5%) to 85% flow reductions (Table 11-3-60). These results indicate that the effects of Alternative 3 on flow would not have biologically meaningful effects on river lamprey ammocoete stranding in the Feather River.

Comparisons for the American River at Nimbus Dam (Table 11-3-61) and at the confluence with the Sacramento River (Table 11-3-62) indicate increased ammocoete cohort exposures to flow reductions between 70 and 90% for Alternative 3 compared to Existing Conditions; meaningful (>5%) predicted increases are from 117 to 420% (increase in cohorts exposed from 25 to 130) for Nimbus Dam and from 15 to 396% (increase in cohorts exposed from 25 to 124) for the confluence. These consistent and substantial increases in ammocoete cohorts exposed to flow reductions would have negative effects on ammocoete rearing success through increased risk of stranding in the American River.

Because water temperatures under Alternative 3 would be similar to those under Alternative 1A, results of the analysis on ammocoete exposure to elevated temperatures for Alternative 3 would be similar to that for Alternative 1A. Results from Alternative 1A, Impact AQUA-185 indicate that there would be moderate to large increases in ammocoete exposure under Alternative 1A relative to Existing Conditions in all rivers evaluated that would substantially reduce rearing habitat conditions.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-185 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 3 could be significant because, under the CEQA baseline, the alternative could substantially reduce rearing habitat and substantially reduce the number of fish as a result of ammocoete mortality, contrary to the NEPA conclusion set forth above. Alternative 3 would have substantial effects on ammocoete cohort stranding in the Trinity River (increases to 47% for the larger flow reduction categories) and American River (increases to 420% for the larger flow reduction categories), but would not have effects in the Sacramento River and the Feather River (based on negligible effects, <5%, small increases, to 12%, in some flow reduction categories, or larger, isolated increases, to 100%, in a single flow reduction category). In addition, there would be moderate to large increases in ammocoete exposure in all rivers evaluated that would substantially reduce rearing habitat conditions for river lamprey.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 3 indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 3. This indicates that the differences between Existing Conditions and Alternative 3 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 3, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on rearing habitat for river lamprey. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-186: Effects of Water Operations on Migration Conditions for River Lamprey

In general, effects of Alternative 3 on river lamprey migration conditions would be negligible relative to the NAA.

Macropthalmia

After 3 to 5 years river lamprey ammocoetes migrate downstream and become macropthalmia once they reach the Delta. River lamprey migration generally occurs September through November (U.S. Fish and Wildlife Service unpublished data). The effects of water operations on seasonal migration flows for river lamprey macropthalmia were assessed using CALSIM II flow output. Flow rates along the likely migration pathways of river lamprey during the likely migration period (September through November) were examined to predict how Alternative 3 may affect migration flows for outmigrating macropthalmia.

Analyses were conducted for the Sacramento River at Red Bluff, Feather River at the confluence with the Sacramento River, and the American River at the confluence with the Sacramento River.

Sacramento River

Comparisons for the Sacramento River at Red Bluff (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for September through November (A3_LLT compared to NAA) indicates negligible effects (<5%) or project-related decreases (to -43%) in wetter water years during September and a moderate increase (17%) in critical years, more substantial increases to 33% during October in all water years, and decreases to -29% during November in all water years. The more substantial decreases in flow during September would occur in wetter water years when effects on migration would be less critical. Increases in mean monthly flow during October would have a beneficial effect on migration, and decreases during drier years (when effects would be more critical for migration) during November are relatively small (-23% in below normal years, -13% in dry years, and -8% in critical years). These results indicate that while flow reductions would occur, flow reductions would not be consistent or substantial enough throughout the migration period to have biologically meaningful effects on outmigrating macropthalmia.

Feather River

Comparisons for the Feather River at the confluence with the Sacramento River for September through November indicate decreases in mean monthly flows (to -68%) during September in all but critical years (increase of 9%), primarily increased flows during October (to 23%), and small decreases during November in wetter water years (to -11%) and a small increase (6%) or negligible effect (<5%) in drier years. Isolating the effects of the project from the effects of climate change (A3_LLT compared to NAA) indicates project-related effects would cause decreases in mean monthly flow during September in wetter years (to -53%) when effects on migration would be less critical, and increases (to 19%) in drier years which would have a beneficial effect on migration; primarily increases during October (to 56%) which would have beneficial effects on migration conditions, and negligible effects (<5%) or small increases or decreases during November (to 13%) which would not have biologically meaningful effects on migration conditions. These results indicate that effects of Alternative 3 on flow would not have biologically meaningful effects on river lamprey macropthalmia migration in the Feather River.

American River

Comparisons for the American River at the confluence with the Sacramento River for September through November indicate substantial reductions in flows during September in all water years (-31 to -58%), and during November in all water years (-13% to -39%). Flow during October would increase in all water years (18% to 40%). Isolating the effects of the project from the effects of climate change (A3_LLT compared to NAA) indicates a slightly smaller project-related contribution to decreased flows during September in wetter water years (to -50%) and a negligible effect (<5%) and small increase (6%) in drier water years when flow effects would be more critical for migration, increases in mean monthly flows during October in all water years (to 33%) which would have beneficial effects on migration, and negligible project-related changes during November except for relatively small decrease in mean monthly flow (-15%) in above normal water years. These results indicate that project-related effects of Alternative 3 on flows would not have biologically meaningful effects on river lamprey macropthalmia migration in the American River.

Overall, despite some variation in results by location, month, and water year type, these results indicate that Alternative 3 would not have biologically meaningful effects on river lamprey macropthalmia migration.

Adults

Effects of Alternative 3 on flow during the adult migration period, September through November, would be the same as described for the macropthalmia migration period, September through November, above.

NEPA Effects: Collectively, these results indicate that the effect is not adverse because it would not substantially reduce the amount of suitable habitat or substantially interfere with the movement of fish. Effects of Alternative 3 on flow would generally consist of negligible effects (<5% difference), increases in mean monthly flow, to 56%, that would have beneficial effects on migration conditions, small to moderate decreases, to -29%, in drier years that would not occur with sufficient frequency to have biologically meaningful effects, and more substantial decreases in flow, to -53%, that would occur in wetter years when flow reductions would not have negative effects on migration conditions due to higher flow conditions.

CEQA Conclusion: In general, under Alternative 3 water operations, the quantity and quality of river lamprey migration habitat would not be affected relative to the CEQA baseline.

Macropthalmia

Sacramento River

Comparisons for the Sacramento River at Red Bluff for September through November indicate variable effects of Alternative 3 during September, with negligible effects (<5%) or a small increase in flow (9%, above normal years), with the exception of moderate flow reductions in wet years (-24%) and dry years (-20%). Effects during October would consist of increases in mean monthly flow for all water year types (14 to 30%) that would have a beneficial effect on migration conditions. Effects during November would consist of relatively small to moderate reductions in mean monthly flow (-5% to -21%) in all water years, with the maximum flow reduction in a drier water year type of -15% (dry years). Flow reductions during September (-20%) and November (-15%) in dry years, and smaller reductions during November in below normal (-13%) and critical years (-10%), would have incremental effects on migration conditions. However, these effects would be offset by more substantial increases in October. Overall effects of Alternative 3 on flows would not have biologically meaningful effects on river lamprey macropthalmia migration conditions in the Sacramento River.

Feather River

Comparisons for the Feather River at the confluence with the Sacramento River for September through November indicate variable results by month and water year type, with primarily decreases (to -24%) during September with the exception of an increase (14%) in critical years, primarily increases in mean monthly flow during October (to 40%), and negligible effects (<5%) or small-scale increases (6%) or decreases (to -13%) in flow that would not be of a magnitude to cause biologically meaningful effects. While decreases for some of the drier water years during September and below normal years during November would contribute incrementally to migration conditions, overall effects of Alternative 3 on flows would not have biologically meaningful negative effects on river lamprey macropthalmia migration conditions in the Feather River.

American River

Comparisons for the American River at the confluence with the Sacramento River for September through November indicate reductions in flow during September and November in all water year types, ranging from -15 to -55%, and increases in mean monthly flow during October for all water years ranging from 9% to 30%. The increases in mean monthly flow during October would have a beneficial effect on migration conditions, but the predominance of moderate to substantial decreased flows under Alternative 3 during September and November in all water years (with decreases during drier water years ranging from -15% to -55%) would have negative effects on river lamprey macropthalmia migration conditions in the American River.

Overall, these results indicate that effects of Alternative 3 on flow from September through November would not have biologically meaningful effects on river lamprey macropthalmia migration in the Sacramento River and the Feather River, but would have negative effects in the American River.

Adults

Effects of Alternative 3 on flow during the adult migration period, September through November, would be the same as described for the macropthalmia migration period, September through November, above.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-186 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 3 could be significant because, under the CEQA baseline, the alternative could substantially reduce the amount of suitable habitat and substantially interfere with the movement of fish, contrary to the NEPA conclusion set forth above. Effects of Alternative 3 on flow would be substantial for river lamprey macropthalmia and adult migration conditions in the American River based on substantial flow reductions for all water year types, including in drier years (to -55%), during two out of three months of the migration period. There would be no negative effects of Alternative 3 on flow in the Sacramento River or Feather River based on negligible effects (<5% difference), increases in mean monthly flow (to 40%) that would have beneficial effects on migration, moderate decreases (to -24%) in wetter years when effects on migration would not be as critical, and infrequent, small to moderate decreases in drier years (to -20%) that would not have biologically meaningful effects.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 3 indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 3. This indicates that the differences between Existing Conditions and Alternative 3 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 3, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on migration conditions for river lamprey. This impact is found to be less than significant and no mitigation is required.

Restoration Measures (CM2, CM4–CM7, and CM10)

Alternative 3 has the same restoration measures as Alternative 1A. Because no substantial differences in restoration-related fish effects are anticipated anywhere in the affected environment under Alternative 3 compared to those described in detail for Alternative 1A, the fish effects of restoration measures described for river lamprey under Alternative 1A (Impact AQUA-187 through AQUA-189) also appropriately characterize effects under Alternative 3.

The following impacts are those presented under Alternative 1A that are identical for Alternative 3.

Impact AQUA-187: Effects of Construction of Restoration Measures on River Lamprey

Impact AQUA-188: Effects of Contaminants Associated with Restoration Measures on River Lamprey

Impact AQUA-189: Effects of Restored Habitat Conditions on River Lamprey

NEPA Effects: All three of these effects have been determined to result in no adverse effects on river lamprey for the reasons identified for Alternative 1A.

CEQA Conclusion: All three of these impacts would be considered less than significant for the reasons identified for Alternative 1A.

Other Conservation Measures (CM12–CM19 and CM21)

Alternative 3 has the same other conservation measures as Alternative 1A. Because no substantial differences in other conservation-related fish effects are anticipated anywhere in the affected environment under Alternative 3 compared to those described in detail for Alternative 1A, the fish effects of other conservation measures described for river lamprey under Alternative 1A (Impact AQUA-190 through AQUA-198) also appropriately characterize effects under Alternative 3.

The following impacts are those presented under Alternative 1A that are identical for Alternative 3.

Impact AQUA-190: Effects of Methylmercury Management on River Lamprey (CM12)

Impact AQUA-191: Effects of Invasive Aquatic Vegetation Management on River Lamprey (CM13)

Impact AQUA-192: Effects of Dissolved Oxygen Level Management on River Lamprey (CM14)

Impact AQUA-193: Effects of Localized Reduction of Predatory Fish on River Lamprey (CM15)

Impact AQUA-194: Effects of Nonphysical Fish Barriers on River Lamprey (CM16)

Impact AQUA-195: Effects of Illegal Harvest Reduction on River Lamprey (CM17)

Impact AQUA-196: Effects of Conservation Hatcheries on River Lamprey (CM18)

Impact AQUA-197: Effects of Urban Stormwater Treatment on River Lamprey (CM19)

Impact AQUA-198: Effects of Removal/Relocation of Nonproject Diversions on River Lamprey (CM21)

NEPA Effects: The nine impact mechanisms have been determined to range from no effect, to no adverse effect, or beneficial effects on river lamprey for NEPA purposes, for the reasons identified for Alternative 1A.

CEQA Conclusions: The nine impact mechanisms would be considered to range from no impact, to less than significant, or beneficial on river lamprey, for the reasons identified for Alternative 1A, and no mitigation is required.

Non-Covered Aquatic Species of Primary Management Concern

Construction and Maintenance of CM1

The effects of construction and maintenance of CM1 under Alternative 3 would be similar for all non-covered species; therefore, the analysis below is combined for all non-covered species instead of analyzed by individual species.

Impact AQUA-199: Effects of Construction of Water Conveyance Facilities on Non-Covered Aquatic Species of Primary Management Concern

Refer to Impact AQUA-1 under delta smelt for a discussion of the effects of construction of water conveyance facilities on non-covered species of primary management concern. The potential effects of the construction of water conveyance facilities under Alternative 3 would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-1) except that Alternative 3 would include two intakes compared to five intakes under Alternative 1A, so the effects would be proportionally less under this alternative. This would convert about 4,450 lineal feet of existing shoreline habitat into intake facility structures and would require about 10.2 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. The effects related to temporary increases in turbidity, accidental spills, underwater noise, in-water work activities, and disturbance of contaminated sediments would be similar to Alternative 1A and the same environmental commitments and mitigation measures (described under Impact AQUA-1 for delta smelt and in Appendix 3B, *Environmental Commitments*) would be available to avoid and minimize potential effects. Additionally, California bay shrimp would not be affected because they do not occur in the vicinity and Sacramento-San Joaquin roach and hardhead are unlikely to be affected because their primary distributions are upstream.

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-199, environmental commitments and mitigation measures would be available to avoid and minimize potential effects, and the effect would not be adverse for non-covered aquatic species of primary management concern.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-1, the impact of the construction of the water conveyance facilities on non-covered aquatic species of primary management concern would not be significant except for construction noise associated with pile driving. Potential pile driving impacts would be less than Alternative 1A because only two intakes would be constructed rather than five. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Alternative 1A, Impact AQUA-1.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Alternative 1A, Impact AQUA-1.

Impact AQUA-200: Effects of Maintenance of Water Conveyance Facilities on Non-Covered Aquatic Species of Primary Management Concern

Refer to Impact AQUA-2 under delta smelt for a discussion of the effects of maintenance of water conveyance facilities on non-covered species of primary management concern. That discussion under delta smelt addresses the type, magnitude, and range of impact mechanisms that are relevant to the aquatic environment and aquatic species.

NEPA Effects: The potential effects of the construction of water conveyance facilities under Alternative 3 would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-200). For a detailed discussion, please see Alternative 1A, Impact AQUA-200. California bay shrimp would not be affected because they do not occur in the vicinity and Sacramento-San Joaquin roach and hardhead are unlikely to be affected because their primary distributions are upstream. Consequently, the effects would not be adverse.

CEQA Conclusion: As described above, these impacts would be less than significant.

Water Operations of CM1

The effects of water operations of CM1 under Alternative 3 include a detailed analysis of the following species:

- Striped Bass
- American Shad
- Threadfin Shad
- Largemouth Bass
- Sacramento tule perch
- Sacramento-San Joaquin roach—California species of special concern
- Hardhead—California species of special concern
- California bay shrimp

Impact AQUA-201: Effects of Water Operations on Entrainment of Non-Covered Aquatic Species of Primary Management Concern

Also, see Alternative 1A, Impact AQUA-201 for additional background information relevant to non-covered species of primary management concern.

Striped Bass

Striped bass eggs and larvae would be vulnerable to entrainment at the proposed north SWP/CVP Delta diversions and the alternate NBA intake as these life stages are passively transported downstream to the north Delta. State of the art fish screens on these north Delta intakes though would exclude juvenile and adult striped bass.

Entrainment losses under Alternative 3 to the SWP/CVP south Delta intakes would be expected to decrease compared to NAA since exports from the south Delta facilities would be substantially reduced in the summer. This result is based on the assumption that striped bass entrainment is proportional to south Delta exports.

Agricultural diversions are potential sources of entrainment for small fish such as larval and juvenile striped bass (Nobriga et al. 2004). Reduction or consolidation of diversions from the ROAs (approximately 4–12% of diversions) would not increase entrainment and may provide a minor benefit. Also, restoration activities as part of the conservation measures should increase the amount of habitat for young striped bass (e.g. inshore rearing habitat), and increase their food supply. The expectation is that these habitat changes would result in at least a minor improvement in production of juvenile striped bass.

NEPA Effects: Variations in striped bass survival rates during the first few months of life are moderated by a population bottleneck between YOY striped bass and three-year-old individuals (Kimmerer et al. 2000). Therefore it would be expected that reductions in entrainment of juveniles and adults at the south Delta intakes would have a greater population impact than increases in entrainment of striped bass larvae and eggs at the proposed SWP/CVP north Delta intakes and the NBA intake. Furthermore, decommissioning of agricultural diversions may also reduce entrainment of striped bass. Overall, the effect on striped bass entrainment would not be adverse.

CEQA Conclusion: The impact of water operations on entrainment of striped bass would be the same as described immediately above. The changes in entrainment under Alternative 3 would not substantially reduce the striped bass population when other conservation measures are taken into account. The impact would be less than significant and no mitigation would be required.

American Shad

American shad eggs and larvae would be vulnerable to entrainment at the proposed north SWP/CVP Delta diversions and the alternate NBA intake as these life stages are passively transported downstream to the north Delta. State of the art fish screens on these north Delta intakes though would exclude juvenile and adult American shad.

NEPA Effects: American shad entrainment losses under Alternative 3 would decrease compared to NAA due to reduced south Delta exports in the summer. Reduced south Delta entrainment would also be expected to reduce predation loss associated with these facilities, especially within Clifton Court Forebay. Reduction or consolidation of agricultural diversions in ROAs would not increase entrainment. Overall, the effect on American shad would not be adverse, and would be slightly beneficial.

CEQA Conclusion: The impact of water operations on entrainment of American shad would be the same as described immediately above. The changes in entrainment under Alternative 3 would not substantially reduce the American shad population. The impact would be less than significant and no mitigation would be required.

Threadfin Shad

The effect of water operations on entrainment of threadfin shad would be the same as discussed for Alternative 1A, Impact AQUA-201. Entrainment at the south Delta would be reduced due to overall lower exports from south Delta facilities; there would also be a concomitant reduction in predation loss especially within Clifton Court Forebay. There would be entrainment of threadfin shad eggs and larvae at the north Delta intakes. Decommissioning agricultural diversions in Delta ROAs would decrease or have no impact on threadfin shad entrainment.

NEPA Effects: Overall, threadfin shad entrainment would be reduced because they are most abundant in the southwestern portion of the Delta and would benefit from reduced south Delta exports. The effect would not be adverse.

CEQA Conclusion: The impact of water operations on entrainment of threadfin shad would be the same as described immediately above. The changes in entrainment under Alternative 3 would not substantially reduce the threadfin shad population. The impact would be less than significant and no mitigation would be required.

Largemouth Bass

NEPA Effects: Since largemouth bass are predominantly found in the south and central portions of the Delta, largemouth bass would be most vulnerable to entrainment at south Delta facilities. Entrainment to the south Delta would be reduced because of reductions in south Delta exports in the summer. As discussed for Alternative 1A, Impact AQUA-201, few larval largemouth bass would be vulnerable to entrainment to north Delta and alternative NBA intakes since they are not expected to readily occur there. Decommissioning agricultural diversions could reduce entrainment of largemouth bass since they hold in shallow water habitats where most agricultural diversions are sited. Overall entrainment would be reduced under Alternative 3 and there could be a small benefit to the species.

CEQA Conclusion: The impact of water operation on largemouth bass would be as described immediately above. The changes in entrainment under Alternative 3 could benefit the largemouth bass population. The impact would be less than significant and no mitigation would be required.

Sacramento Tule Perch

NEPA Effects: The effects and conclusion for this impact would be similar to Alternative 1A, Impact AQUA-201. Entrainment of Sacramento tule perch to the SWP/CVP south Delta facilities would decrease because south Delta exports would be less compared to NAA (NAA). Entrainment-related predation loss would also be reduced. Because Sacramento tule perch are viviparous, newly born Sacramento tule perch would be large enough to be effectively screened at the proposed north Delta facilities. Reduction or consolidation of the agricultural diversions would decrease entrainment of Sacramento tule perch into these agricultural intakes. Overall the reduction in entrainment of Sacramento tule perch under Alternative 3 would not be adverse, and may provide a benefit for the species.

CEQA Conclusion: The impact of water operations on entrainment of Sacramento tule perch would be the same as described immediately above. The changes in entrainment under Alternative 3 would not substantially reduce the Sacramento tule perch population. The impact would be less than significant and no mitigation would be required.

Sacramento-San Joaquin Roach

NEPA Effects: The effect of water operations on entrainment of Sacramento-San Joaquin roach under Alternative 3 would be similar to that described for Alternative 1A (see Alternative 1A, Impact AQUA-201). As described for Alternative 1A, Impact AQUA-201, the effects would not be adverse.

CEQA Conclusion: The impact of water operations on entrainment of Sacramento-San Joaquin roach would be the same as described immediately above. The impacts would be less than significant.

Hardhead

NEPA Effects: The effect of water operations on entrainment of hardhead under Alternative 3 would be similar to that described for Alternative 1A (see Alternative 1A, Impact AQUA-3). That discussion under delta smelt addresses the type, magnitude, and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. As described for Alternative 1A, Impact AQUA-3 the effects would not be adverse.

CEQA Conclusion: The impact of water operations on entrainment of hardhead would be the same as described immediately above. The impacts would be less than significant.

California Bay Shrimp

NEPA Effects: The effect of water operations on entrainment of California bay shrimp under Alternative 3 would be similar to that described for Alternative 1A (see Alternative 1A, Impact AQUA-3). That discussion under delta smelt addresses the type, magnitude, and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. California bay shrimp do not occur in the vicinity of the intakes and there would be no effect.

CEQA Conclusion: The impact of water operations on entrainment of California bay shrimp would be the same as described immediately above. There would be no impact.

Impact AQUA-202: Effects of Water Operations on Spawning and Egg Incubation Habitat for Non-Covered Aquatic Species of Primary Management Concern

Also, see Alternative 1A, Impact AQUA-202 for additional background information relevant to non-covered species of primary management concern.

Striped Bass

In general, Alternative 3 would slightly improve the quality and quantity of upstream habitat conditions for striped bass relative to NAA.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the April through June striped bass spawning, embryo incubation, and initial rearing period. Lower flows could reduce the quantity and quality of instream habitat available for spawning, egg incubation, and rearing.

In the Sacramento River upstream of Red Bluff, flows under A3_LLT would generally be similar to or greater than flows under NAA during April through June except in wet years during May compared to NAA (14% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A3_LLT would generally be similar to or greater than flows under NAA during April through June except in above normal years during April (11% lower)(Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A3_LLT would generally be similar to flows under NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A3_LLT would generally be substantially greater by up to 162% than flows under NAA during April through June, regardless of water year (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A3_LLT would be similar to or greater than flows under NAA, regardless of water year type.

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 3 would be about the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months outside of the 59°F to 68°F suitable water temperature range for striped bass spawning, embryo incubation, and initial rearing during April through June was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced spawning success and increased egg and larval stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, Feather, American, and Stanislaus rivers under Alternative 3 would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature related effects in these rivers during the April through June period. Further, water temperatures were not modeled in Clear Creek or the San Joaquin River.

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because Alternative 3 would not cause a substantial reduction in striped bass spawning, incubation, or initial rearing habitat. Flows in all rivers examined during the April through June spawning, incubation, and initial rearing period under Alternative 3 would generally be similar to flows under NAA. In the Feather River, flows under Alternative 3 would be greater than flows under NAA, indicating that the alternative would provide flow-related improvements to upstream habitat for striped bass. There would be no temperature-related effects of Alternative 3 on upstream striped bass habitat.

CEQA Conclusion: In general, Alternative 3 would slightly improve the quality and quantity of upstream habitat conditions for striped bass relative to the Existing Conditions.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the April through June striped bass spawning, embryo incubation, and initial rearing period. Lower flows could reduce the quantity and quality of instream habitat available for spawning, egg incubation, and rearing.

In the Sacramento River upstream of Red Bluff, flows under A3_LLT would generally be similar to flows under Existing Conditions during April and generally greater than flows under Existing

Conditions during May and June, except in wet years during May (14% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A3_LLT would generally be similar to or greater than flows under Existing Conditions during April through June, except in critical years during May (6% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A3_LLT would generally be similar to flows under Existing Conditions during April through June, except in critical water years, in which flows would be 6% to 14% greater under A3_LLT depending on month (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A3_LLT would generally be substantially greater by up to 149% than flows under Existing Conditions during April through June, except in wet years during May (30% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A3_LLT would generally be similar to or greater than flows under Existing Conditions during April and June, except in above normal years during April (6% lower) and wet and critical years during June (26% and 39% lower, respectively) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows during May would generally up to 25% than under Existing Conditions.

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 3 would be about the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months outside of the 59°F to 68°F suitable water temperature range for striped bass spawning, embryo incubation, and initial rearing during April through June was examined in the Sacramento, Trinity, Feather, American. Water temperatures outside this range could lead to reduced spawning success and increased egg and larval stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, Feather, American, and Stanislaus rivers under Alternative 3 would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature related effects in these rivers during the April through June period.

Collectively, these results indicate that the impact would be less than significant because Alternative 3 would result in a cumulative improvement of spawning, incubation, and initial rearing habitat. Therefore, no mitigation is necessary. Flows in all rivers examined during the April through June spawning, incubation, and initial rearing habitat of striped bass. Flows in all rivers except the San Joaquin and Stanislaus rivers during the April through June spawning, incubation, or initial rearing period under Alternative 3 would generally be similar to or greater than flows under the Existing Conditions. Flows in the San Joaquin and Stanislaus rivers would be lower under Alternative 3 relative to the Existing Conditions, although this effect would not be biologically meaningful to striped bass. There would be no temperature-related effects of Alternative 3 on upstream striped bass habitat.

American Shad

In general, Alternative 3 would slightly improve the quality and quantity of upstream habitat conditions for American shad relative to the NAA.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the April through June American shad adult migration and spawning period. Lower flows could reduce migration ability and instream habitat quantity and quality for spawning.

In the Sacramento River upstream of Red Bluff, flows under A3_LLT would generally be similar to or greater than flows under NAA during April through June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A3_LLT would generally be similar to or greater than flows under NAA during April through June except in above normal years during April (11% lower)(Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A3_LLT would generally be similar to flows under NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A3_LLT would generally be substantially greater by up to 162% than flows under NAA during April through June, regardless of water year (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A3_LLT would be similar to or greater than flows under NAA, regardless of water year type.

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 3 would be about the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months outside of the 60°F to 70°F water temperature range for American shad adult migration and spawning during April through June was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced spawning success and increased adult migrant stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, Feather American, and Stanislaus rivers under Alternative 3 would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature related effects in these rivers during the April through June period. Further, water temperatures were not modeled in Clear Creek or the San Joaquin River.

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because Alternative 3 would not cause a substantial reduction in American shad spawning or adult migration. Flows in all rivers examined during the April through June adult migration and spawning period under Alternative 3 would nearly always be similar to flows would generally be similar to flows under the NAA. In the Feather River, flows under Alternative 3 would be greater than flows under the NAA, indicating that the alternative would provide flow-related improvements to upstream habitat for American shad. There would be no temperature-related effects of Alternative 3 on upstream American shad habitat.

CEQA Conclusion: In general, Alternative 3 would slightly improve the quality and quantity of upstream habitat conditions for American shad relative to the Existing Conditions.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the April through June American shad adult migration and spawning period. Lower flows could reduce migration ability and instream habitat quantity and quality for spawning.

In the Sacramento River upstream of Red Bluff, flows under A3_LLT would generally be similar to flows under Existing Conditions during April and generally greater than flows under Existing Conditions during May and June, except in wet years during May (14% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A3_LLT would generally be similar to or greater than flows under Existing Conditions during April through June, except in critical years during May (6% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A3_LLT would generally be similar to flows under Existing Conditions during April through June, except in critical water years, in which flows would be 6% to 14% greater under A3_LLT depending on month (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A3_LLT would generally be substantially greater by up to 149% than flows under Existing Conditions during April through June, except in wet years during May (30% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A3_LLT would generally be similar to or greater than flows under Existing Conditions during April and June, except in above normal years during April (6% lower) and wet and critical years during June (26% and 39% lower, respectively) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows during May would generally up to 25% than under Existing Conditions.

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 3 would be about the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months outside of the 60°F to 70°F water temperature range for American shad adult migration and spawning during April through June was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced spawning success and increased adult migrant stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, Feather, American, and Stanislaus rivers under Alternative 3 would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature related effects in these rivers during the April through June period.

Collectively, these results indicate that the impact would be less than significant because Alternative 3 would not cause a substantial reduction in American shad adult migration and spawning habitat, and no mitigation would be required. Flows in all rivers examined during the April through June adult migration and spawning period under Alternative 3 would nearly always be similar to or greater than flows under the Existing Conditions. Flows in the San Joaquin and Stanislaus rivers would be lower under Alternative 3 relative to the Existing Conditions, although this effect would not be biologically meaningful to American shad. There would be no temperature-related effects of Alternative 3 on upstream American shad habitat.

Threadfin Shad

In general, Alternative 3 would not affect the quality and quantity of upstream habitat conditions for threadfin shad relative to NAA.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during April through August threadfin shad spawning period. Lower flows could reduce the quantity and quality of instream habitat available for spawning.

In the Sacramento River upstream of Red Bluff, flows under A3_LLT would generally be similar to flows under NAA during April, June, and July, greater by up to 15% during May, and lower by up to 18% during August (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A3_LLT would be similar to flows under NAA, except in above normal years during April (11% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A3_LLT would nearly always be similar to or greater than flows under NAA throughout the period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A3_LLT would generally be greater during April through June (up to 72% greater) and lower (by up to 44%) than flows under NAA during July and August (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A3_LLT would generally be similar to flows under NAA during April, greater by up to 31% during May and June, and lower by up to 30% during July and August (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 3 would be about the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months below 68°F water temperature threshold for the April through August adult threadfin shad spawning period was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures below this threshold could delay or prevent successful spawning in these areas. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, Feather, American, and Stanislaus rivers under Alternative 3 would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers throughout the year.

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because Alternative 3 would not cause a substantial reduction in spawning habitat. Flows in all rivers examined during the April through August spawning period under Alternative 3 would generally be similar to or greater than flows under the NAA, except during summer months in the Sacramento, Feather, and American rivers. Lower flows during these months these rivers are not of sufficient magnitude or frequency to have a biologically meaningful effect on threadfin shad. The percentage of months below the spawning temperature threshold would be similar in all rivers between Alternative 3 and the NAA.

CEQA Conclusion: In general, Alternative 3 would not affect the quality and quantity of upstream habitat conditions for threadfin shad relative to the Existing Conditions.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during April through August spawning period. Lower flows could reduce the quantity and quality of instream habitat available for spawning.

In the Sacramento River upstream of Red Bluff, flows under A3_LLT would generally be similar to flows under Existing Conditions during April and July, greater by up to 20% during May and June, and lower by up to 24% during August (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A3_LLT would generally be similar to flows under Existing Conditions throughout the period, except during June, when flows would be up to 28% greater than flows under Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A3_LLT would nearly always be similar to or greater than flows under Existing Conditions throughout the period, except in critical years during August (17% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A3_LLT would generally greater during April through June (up to 149% greater), and lower during July and August (up to 51% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A3_LLT would generally be similar to flows under Existing Conditions during April and June and lower by up to 52% during May, July, and August (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 3 would be about the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A.

Water Temperature

The percentage of months below 68°F water temperature threshold for the April through August adult threadfin shad spawning period was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures below this threshold could delay or prevent successful spawning in these areas. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, Feather, American, and Stanislaus rivers under Alternative 3 would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the April through November period.

Collectively, these results indicate that the impact would be less than significant because Alternative 3 would not cause a substantial reduction in habitat, and no mitigation is necessary. Flows in all rivers examined during the April through August spawning period under Alternative 3 would generally be similar to or greater than flows under the Existing Conditions, except during summer months in the Sacramento, Feather, and American rivers. Lower flows during these months in these rivers would not be of sufficient magnitude or frequency to cause a biologically meaningful effect on threadfin shad. The percentage of months outside all temperature thresholds are generally lower under Alternative 3 than under the Existing Conditions, indicating that there would be a net temperature benefit of Alternative 3 to threadfin shad.

Largemouth Bass

In general, Alternative 3 would not affect the quality and quantity of upstream habitat conditions for largemouth bass relative to NAA.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the March through June largemouth bass spawning period. Lower flows could reduce the quantity and quality of instream spawning habitat.

In the Sacramento River upstream of Red Bluff, flows under A3_LLT would generally be similar to or greater than flows under NAA during March through June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A3_LLT would generally be similar to or greater than flows under NAA during March through June except in above normal water years during April (11% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A3_LLT would generally be similar to or greater than flows under NAA during March through June except in below normal years during March (6% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A3_LLT would be substantially greater (up to 162% greater) than flows under NAA during March through June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A3_LLT would be similar to flows under NAA except in March dry and critical years (7% and 8%, respectively). Flows during May and June under A3_LLT would generally be up to 31% greater than flows under NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 3 would be about the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months outside of the 59°F to 75°F suitable water temperature range for largemouth bass spawning during March through June was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced spawning success. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, Feather, American, and Stanislaus rivers under Alternative 3 would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the March through June period.

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because Alternative 3 would not cause a substantial reduction spawning habitat. Flows in all rivers examined during the year under Alternative 3 are generally similar to or greater than flows under NAA in most months. Flows from July through September are generally lower in the Feather River high flow channel and in the American River below Nimbus Dam, although these reductions would not be biologically meaningful to the largemouth bass population. The percentage of months outside all temperature thresholds examined in the Feather River under Alternative 3 are generally similar to or lower than under NAA.

CEQA Conclusion: In general, Alternative 3 would reduce the quality and quantity of upstream habitat conditions for largemouth bass relative to the Existing Conditions.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the March through June largemouth bass spawning period. Lower flows could reduce the quantity and quality of instream spawning habitat.

In the Sacramento River upstream of Red Bluff, flows under A3_LLT would generally be similar to or greater than flows under Existing Conditions during March through June, except in wet years during May (14% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A3_LLT would generally be similar to or greater than flows under Existing Conditions during March through June, except in below normal years during March and critical years during May (6% lower in both) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A3_LLT would be similar to or greater than flows under Existing Conditions during March through June regardless of water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A3_LLT would generally be substantially greater (up to 149% greater) than flows under Existing Conditions during March through June, except in below normal years during March (33% lower) and in wet years during May (30% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A3_LLT would generally be similar to or greater than flows under Existing Conditions during March, April, and June with some exceptions (up to 39% lower). Flows under A3_LLT in May would generally be up to 25% lower than those under Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 3 would be about the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months outside of the 59°F to 75°F suitable water temperature range for largemouth bass spawning during March through June was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced spawning success. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, Feather, American, and Stanislaus rivers under Alternative 3 would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the March through June period.

Collectively, these results indicate that the impact would be less than significant because Alternative 3 would not cause a substantial reduction in largemouth bass habitat. No mitigation is necessary.

Sacramento Tule Perch

In general, Alternative 3 would not affect the quality and quantity of upstream habitat conditions for Sacramento tule perch relative to NAA.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during year-round Sacramento tule perch presence. Lower flows could reduce the quantity and quality of instream habitat available for rearing.

In the Sacramento River upstream of Red Bluff, flows under A3_LLT generally be similar to flows under NAA during January through April, June, July, and December, greater by up to 33% during May and October, and lower by up to 43% during August, September, and November (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A3_LLT would generally be similar to or greater than flows under NAA throughout the period with some exceptions (up to 11% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A3_LLT would generally be similar to or greater than flows under NAA throughout the year, with some exceptions (up to 37% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A3_LLT would generally be greater during April through June and October through November (up to 72% greater) and lower (up to 84%) than flows under NAA during July through September (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A3_LLT would generally be similar to flows under NAA during January through April and November through December, greater by up to 31% during May, June and October, and lower by up to 47% during July through November (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 3 would be about the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months exceeding water temperature thresholds of 72°F and 75°F for the year-round occurrence of all life stages of Sacramento tule perch was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures exceeding these thresholds could lead to reduced rearing habitat quantity and quality and increased stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, Feather, American, and Stanislaus rivers under Alternative 3 would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers throughout the year.

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because Alternative 3 would not cause a substantial reduction in upstream habitat for Sacramento tule perch. Flows under Alternative 3 in all rivers examined throughout the year are generally similar to or greater than flows under NAA, except during summer months in the Feather and American rivers. These reductions in flows, however, would not cause an overall biologically meaningful effect on Sacramento tule perch. The percentages of months outside all temperature thresholds are generally lower under Alternative 3 than under NAA.

CEQA Conclusion: In general, Alternative 3 would not affect the quality and quantity of upstream habitat conditions for Sacramento tule perch relative to the Existing Conditions.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during year-round Sacramento tule perch presence. Lower flows could reduce the quantity and quality of instream habitat available for rearing.

In the Sacramento River upstream of Red Bluff, flows under A3_LLT would generally be similar to flows under Existing Conditions during January, March, April, July, September, and December, greater by up to 30% during February, May, June, and October, and lower by up to 24% during August and November (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A3_LLT would generally be similar to flows under Existing Conditions during March through May and July through September, greater by up to 61% during January, February, and June, and lower by up to 25% during October and December (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A3_LLT would generally be similar to or greater than flows under Existing Conditions throughout the year, except in critical years during August and September (17% and 38%, respectively) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A3_LLT would generally be similar to flows under Existing Conditions during February and November, greater during January, March through June, October, and December (up to 149% greater), and lower during July through September (up to 51% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A3_LLT would generally be similar to flows under Existing Conditions during January, April, and June, greater by up to 29% during February, March, and October, and lower by up to 52% during May, July through September, November, and December (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 3 would be about the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be small to moderate reductions in flows during the year relative to Existing Conditions.

Water Temperature

The percentage of months exceeding water temperatures of 72°F and 75°F for the year-round occurrence of all life stages of Sacramento tule perch was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures exceeding these thresholds could lead to reduced rearing habitat quality and increased stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, Feather, American, and Stanislaus rivers under Alternative 3 would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A.

Collectively, these results indicate that the impact would not be significant because Alternative 3 would not cause a substantial reduction in upstream habitat for Sacramento tule perch. No mitigation is necessary. Flows would be lower during half of the year in the American River. However, given that flow reductions in other rivers, including the San Joaquin and Stanislaus rivers, would be minimal, flow reductions in the American River would not cause biologically meaningful effects to Sacramento tule perch habitat. The percentages of months outside all temperature thresholds are generally lower under Alternative 3 than under the Existing Conditions.

Sacramento-San Joaquin Roach – California Species of Special Concern

In general, Alternative 3 would not affect the quality and quantity of upstream habitat conditions for Sacramento-San Joaquin Roach relative to NAA.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the March through June Sacramento-San Joaquin roach spawning period. Lower flows could reduce the quantity and quality of instream habitat available for spawning.

In the Sacramento River upstream of Red Bluff, flows under A3_LLT would generally be similar to or greater than flows under NAA during March through June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A3_LLT would generally be similar to or greater than flows under NAA during March through June except in above normal water years during April (11% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A3_LLT would generally be similar to or greater than flows under NAA during March through June except in below normal years during March (6% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A3_LLT would generally be similar to or greater than flows under NAA during March through June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A3_LLT would be similar to flows under NAA except in March dry and critical years (7% and 8%, respectively). Flows during May and June under A3_LLT would generally be up to 31% greater than flows under NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 3 would be about the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months below the 60.8°F water temperature threshold for Sacramento-San Joaquin roach spawning initiation during March through June was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures below this threshold could delay or prevent spawning initiation. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, Feather, American, and Stanislaus rivers under Alternative 3 would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A.

NEPA Effects: As described for Alternative 1A, Alternative 3 would not adversely effect on the quality and quantity of upstream habitat conditions for Sacramento-San Joaquin roach relative to the NAA

CEQA Conclusion: In general, Alternative 3 would not affect the quality and quantity of upstream habitat conditions for Sacramento-San Joaquin roach relative to the Existing Conditions.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the March through June Sacramento-San Joaquin roach spawning period. Lower flows could reduce the quantity and quality of instream habitat available for spawning.

In the Sacramento River upstream of Red Bluff, flows under A3_LLT would generally be similar to or greater than flows under Existing Conditions during March through June, except in wet years during May (14% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A3_LLT would generally be similar to or greater than flows under Existing Conditions during March through June, except in below normal years during March and critical years during May (6% lower in both) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A3_LLT would be similar to or greater than flows under Existing Conditions during March through June regardless of water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A3_LLT would generally be substantially greater (up to 149% greater) than flows under Existing Conditions during March through June, except in below normal years during March (33% lower) and in wet years during May (30% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A3_LLT would generally be similar to or greater than flows under Existing Conditions during March, April, and June with some exceptions (up to 39% lower). Flows under A3_LLT in May would generally be up to 25% lower than those under Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 3 would be about the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months below the 60.8°F water temperature threshold for Sacramento-San Joaquin roach spawning initiation during March through June was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures below this threshold could delay or prevent spawning initiation. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, Feather, American, and Stanislaus rivers under Alternative 3 would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the March through June period.

Hardhead – California Species of Special Concern

In general, Alternative 3 would not affect the quality and quantity of upstream habitat conditions for hardhead relative to NAA.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the April through May hardhead spawning period. Lower flows could reduce the quantity and quality of instream habitat available for spawning.

In the Sacramento River upstream of Red Bluff, flows under A3_LLT would generally be similar to or greater than flows under NAA throughout the period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A3_LLT would generally be similar to or greater than flows under NAA throughout the period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A3_LLT would always to be similar to flows under NAA throughout the period regardless of water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A3_LLT would generally be substantially greater (up to 162% greater) than flows under NAA throughout the period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A3_LLT would be similar to or greater than flows under NAA in April and May (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 3 would be about the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months outside of the 59°F to 64°F suitable water temperature range for hardhead spawning during April through May was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced spawning success and increased egg and larval stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, Feather, American, and Stanislaus rivers under Alternative 3 would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers throughout the year.

NEPA Effects: In general, Alternative 3 would not adversely affect the quality and quantity of upstream habitat conditions for hardhead relative to the NAA.

CEQA Conclusion: In general, Alternative 3 would not affect the quality and quantity of upstream habitat conditions for hardhead relative to the Existing Conditions.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the April through May hardhead spawning period. Lower flows could reduce the quantity and quality of instream habitat available for spawning.

In the Sacramento River upstream of Red Bluff, flows under A3_LLT would generally be similar to or greater than flows under Existing Conditions throughout the period, except in wet years during May (14% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A3_LLT would generally be similar to or greater than flows under Existing Conditions throughout the period, except in critical years during May (6% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A3_LLT would be similar to or greater than flows under Existing Conditions throughout the period regardless of water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A3_LLT would generally be substantially greater by up to 149% than flows under Existing Conditions throughout the period, except in wet years during May (30% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A3_LLT would be similar to or greater than flows under Existing Conditions during April, except in above normal years (6% lower). Flows under A3_LLT would generally be lower than flows under Existing Conditions, by up to 25%, during May (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 3 would be about the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months outside of the 59°F to 64°F suitable water temperature range for hardhead spawning during April through May was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced spawning success and increased egg and larval stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, Feather, American, and Stanislaus rivers under Alternative 3 would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A.

California Bay Shrimp

NEPA Effects: The effect of water operations on spawning habitat of California bay shrimp under Alternative 3 would be similar to that described for Alternative 1A (see Alternative 1A, Impact AQUA-4). That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. As described for Alternative 1A, Impact AQUA-4, the effects would not be adverse.

CEQA Conclusion: The impact of water operations on spawning habitat of California bay shrimp would be the same as described immediately above. The impacts would be less than significant.

Impact AQUA-203: Effects of Water Operations on Rearing Habitat for Non-Covered Aquatic Species of Primary Management Concern

Also, see Alternative 1A, Impact AQUA-203 for additional background information relevant to non-covered species of primary management concern.

Striped Bass

NEPA Effects: The discussion under Alternative 3, Impact AQUA-202 for striped bass also addresses the embryo and initial rearing period. That analysis indicates that there are no adverse effects on striped bass rearing during that period. Other effects of water operations on rearing habitat for striped bass under Alternative 3 would be similar to that described for Alternative 1A (see Alternative 1A, Impact AQUA-203). As described for Alternative 1A, Impact AQUA-203, the effects would not be adverse.

CEQA Conclusion: As described above the impacts on striped bass rearing habitat would be less than significant.

American Shad

NEPA Effects: The effects of water operations on rearing habitat for striped bass under Alternative 3 would be similar to that described for Alternative 1A (see Alternative 1A, Impact AQUA-203). As described for Alternative 1A, Impact AQUA-203, the effects would not be adverse.

CEQA Conclusion: As described above the impacts on American shad rearing habitat would be less than significant.

Threadfin Shad

NEPA Effects: The effects of water operations on rearing habitat for threadfin shad under Alternative 3 would be similar to that described for Alternative 1A (see Alternative 1A, Impact AQUA-203). As described for Alternative 1A, Impact AQUA-203, the effects would not be adverse.

CEQA Conclusion: As described above the impacts on threadfin shad rearing habitat would be less than significant.

Largemouth Bass

Juveniles

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the April through November juvenile largemouth bass rearing period. Lower flows could reduce the quantity and quality of instream habitat available for juvenile rearing.

In the Sacramento River upstream of Red Bluff, flows under A3_LLT would generally be similar to flows under NAA during April, June, and July, greater by up to 33% during May and October, and lower by up to 43% during August, September, and November (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A3_LLT would generally be similar to flows under NAA throughout the period, except in critical years during October (6% lower) and wet years during November (7% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, April through November flows under A3_LLT would generally be similar to or greater than flows under NAA, with some exceptions (up to 37% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A3_LLT would generally be lower (up to 84%) than flows under NAA during July through September and greater during April through June and October through November (up to 72% greater) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A3_LLT would generally be similar to flows under NAA during April and November, greater by up to 31% during May, June, and October, and lower by up to 47% during July through November (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 3 would be about the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months above the 88°F water temperature threshold for juvenile largemouth bass rearing during April through November was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Elevated water temperatures could lead to reduced quantity and quality of instream habitat available for juvenile rearing and increased stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, Feather, American, and Stanislaus rivers under Alternative 3 would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the April through November period.

Adults

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during year-round adult largemouth bass rearing period. Lower flows could reduce the quantity and quality of instream habitat available for adult rearing.

In the Sacramento River upstream of Red Bluff, flows under A3_LLT would generally be similar to flows under NAA during January through April, June, July, and December, greater by up to 33% during May and October, and lower by up to 43% during August, September, and November (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A3_LLT would generally be similar to or greater than flows under NAA throughout the period with some exceptions (up to 11% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A3_LLT would generally be similar to or greater than flows under NAA throughout the year, with some exceptions (up to 37% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A3_LLT would generally be greater during April through June and October through November (up to 72% greater) and lower (up to 84%) than flows under NAA during July through September (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A3_LLT would generally be similar to flows under NAA during January through April and November through December, greater by up to 31% during May, June and October, and lower by up to 47% during July through November (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 3 would be about the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months above the 86°F water temperature threshold for year-round adult largemouth bass rearing period was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Elevated water temperatures could lead to reduced quantity and quality of adult rearing habitat and increased stress and mortality of rearing adults. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, Feather, American, and Stanislaus rivers under Alternative 3 would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the year-round period.

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because Alternative 3 would not cause a substantial reduction in juvenile or adult rearing habitat. Flows in all rivers examined during the year under Alternative 3 are generally similar to or greater than flows under NAA in most months. Flows from July through September are generally lower in the Feather River high flow channel and in the American River below Nimbus Dam, although these reductions would not be biologically meaningful to the largemouth bass population. The percentage of months outside all temperature thresholds examined in the Feather River under Alternative 3 are generally similar to or lower than under NAA.

CEQA Conclusion: In general, Alternative 3 would reduce the quality and quantity of upstream habitat conditions for largemouth bass relative to the Existing Conditions.

Juveniles

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the April through November juvenile largemouth bass rearing period. Lower flows could reduce the quantity and quality of instream habitat available for juvenile rearing.

In the Sacramento River upstream of Red Bluff, flows under A3_LLT would generally be similar to flows under Existing Conditions during April and July, greater by up to 30% during May, June, and October, and lower by up to 24% during August, September, and November (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A3_LLT would generally be similar to flows under Existing Conditions during April, May, and July through September, greater by up to 28% during June, and lower by up to 25% during October and November (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A3_LLT would generally be similar to or greater than flows under Existing Conditions throughout the April through November period, except in critical years during August and September (17% to 38% lower, respectively) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A3_LLT would generally be similar to flows under Existing Conditions during November, lower during July through September (up to 51% lower), and greater during April through June and October (up to 149% greater) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A3_LLT would generally be similar to flows under Existing Conditions during April and June, greater by up to 29% during October, and lower by up to 52% during May, July through September, and November (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 3 would be about the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months above the 88°F water temperature threshold for juvenile largemouth bass rearing during April through November was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Elevated water temperatures could lead to reduced quantity and quality of instream habitat available for juvenile rearing and increased stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, Feather, American, and Stanislaus rivers under Alternative 3 would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the April through November period.

Adults

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the year-round adult largemouth bass rearing period. Lower flows could reduce the quantity and quality of instream habitat available for adult rearing.

In the Sacramento River upstream of Red Bluff, flows under A3_LLT would generally be similar to flows under Existing Conditions during January, March, April, July, September, and December, greater by up to 30% during February, May, June, and October, and lower by up to 24% during August and November (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A3_LLT would generally be similar to flows under Existing Conditions during March through May and July through September, greater by up to 61% during January, February, and June, and lower by up to 25% during October and December (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A3_LLT would generally be similar to or greater than flows under Existing Conditions throughout the year, except in critical years during August and September (17% and 38%, respectively) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A3_LLT would generally be similar to flows under Existing Conditions during February and November, greater during January, March through June, October, and December (up to 149% greater), and lower during July through September (up to 51% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A3_LLT would generally be similar to flows under Existing Conditions during January, April, and June, greater by up to 29% during February, March, and October, and lower by up to 52% during May, July through September, November, and December (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 3 would be about the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months above the 86°F water temperature threshold for year-round adult largemouth bass rearing period was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Elevated water temperatures could lead to reduced quantity and quality of adult rearing habitat and increased stress and mortality of rearing adults. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, Feather, American, and Stanislaus rivers under Alternative 3 would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the April through November period.

Collectively, these results indicate that the impact would not be significant because Alternative 3 would not cause a substantial reduction in largemouth bass habitat. No mitigation is necessary. Flows would be lower during half of the year-round adult rearing period in the American River. However, given that flow reductions in other rivers, including the San Joaquin and Stanislaus rivers, would be minimal, flow reductions in the American River would not cause biologically meaningful effects to largemouth bass habitat. The percentages of months outside all temperature thresholds are generally lower under Alternative 3 than under the Existing Conditions.

Sacramento Tule Perch

NEPA Effects: The effects of water operations on rearing habitat for Sacramento tule perch under Alternative 3 would be similar to that described for Alternative 1A (see Alternative 1A, Impact AQUA-5). That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. As described for Alternative 1A, Impact AQUA-5, the effects would not be adverse.

CEQA Conclusion: As described above the impacts on Sacramento tule perch rearing habitat would be less than significant.

Sacramento-San Joaquin Roach

In general, Alternative 3 would not affect the quality and quantity of upstream habitat conditions for Sacramento-San Joaquin Roach relative to NAA.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the year-round juvenile and adult Sacramento-San Joaquin roach rearing period. Lower flows could reduce the quantity and quality of instream habitat available for rearing.

In the Sacramento River upstream of Red Bluff, flows under A3_LLT would generally be similar to flows under NAA during January through April, June, July, and December, greater by up to 33% during May and October, and lower by up to 43% during August, September, and November (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A3_LLT would generally be similar to or greater than flows under NAA throughout the period with some exceptions (up to 11% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A3_LLT would generally be similar to or greater than flows under NAA throughout the year, with some exceptions (up to 37% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A3_LLT would generally be greater during April through June and October through November (up to 72% greater) and lower (by up to 84%) than flows under NAA during July through September (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A3_LLT would generally be similar to flows under NAA during January through April and November through December, greater by up to 31% during May, June and October, and lower by up to 47% during July through November (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 3 would be about the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months above the 86°F water temperature threshold for year-round juvenile and adult Sacramento-San Joaquin roach rearing period was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Elevated water temperatures could lead to reduced rearing habitat quality and increased stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, Feather, American, and Stanislaus rivers under Alternative 3 would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers throughout the year.

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because Alternative 3 would not cause a substantial reduction in rearing habitat. Flows under Alternative 3 in all rivers examined throughout the year are generally similar to or greater than flows under NAA, except during summer months in the Feather and American rivers, although these reductions would not be biologically meaningful to the roach population. The percentage of months outside temperature thresholds is generally similar to or lower under Alternative 3 than under NAA.

CEQA Conclusion: In general, Alternative 3 would not affect the quality and quantity of upstream habitat conditions for Sacramento-San Joaquin roach relative to the Existing Conditions.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the year-round juvenile and adult Sacramento-San Joaquin roach rearing period. Lower flows could reduce the quantity and quality of instream habitat available for rearing.

In the Sacramento River upstream of Red Bluff, flows under A3_LLT would generally be similar to flows under Existing Conditions during January, March, April, July, September, and December, greater by up to 30% during February, May, June, and October, and lower by up to 24% during August and November (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A3_LLT would generally be similar to flows under Existing Conditions during March through May and July through September, greater by up to 61% during January, February, and June, and lower by up to 25% during October and December (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A3_LLT would generally be similar to or greater than flows under Existing Conditions throughout the year, except in critical years during August and September (17% and 38%, respectively) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A3_LLT would generally be similar to flows under Existing Conditions during February and November, greater during January, March through June, October, and December (up to 149% greater), and lower during July through September (up to 51% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A3_LLT would generally be similar to flows under Existing Conditions during January, April, and June, greater by up to 29% during February, March, and October, and lower by up to 52% during May, July through September, November, and December (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 3 would be about the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months above the 86°F water temperature threshold for year-round juvenile and adult Sacramento-San Joaquin roach rearing period was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Elevated water temperatures could lead to reduced quantity and quality of adult rearing habitat and increased stress and mortality of rearing adults. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, Feather, American, and Stanislaus rivers under Alternative 3 would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the April through November period.

Collectively, these results indicate that the impact would not be significant because Alternative 3 would not cause a substantial reduction in Sacramento-San Joaquin roach habitat. No mitigation is necessary. Flows would be lower during half of the year-round adult rearing period in the American River. However, given that flow reductions in other rivers, including the San Joaquin and Stanislaus rivers, would be minimal, flow reductions in the American River would not cause biologically meaningful effects to roach habitat. The percentages of months outside all temperature thresholds are generally lower under Alternative 3 than under the Existing Conditions.

Hardhead

In general, Alternative 3 would not affect the quality and quantity of upstream habitat conditions for hardhead relative to NAA.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the year-round juvenile and adult hardhead rearing period. Lower flows could reduce the quantity and quality of instream habitat available for juvenile and adult rearing.

In the Sacramento River upstream of Red Bluff, flows under A3_LLT would generally be similar to flows under NAA during January through April, June, July, and December, greater by up to 33% during May and October, and lower by up to 43% during August, September, and November (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under A3_LLT would generally be similar to or greater than flows under NAA throughout the period with some exceptions (up to 11% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A3_LLT would generally be similar to or greater than flows under NAA throughout the year, with some exceptions (up to 37% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A3_LLT would generally be greater during April through June and October through November (up to 72% greater) and lower (up to 84%) than flows under NAA during July through September (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A3_LLT would generally be similar to flows under NAA during January through April and November through December, greater by up to 31% during May, June and October, and lower by up to 47% during July through November (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 3 would be about the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months outside of the 65°F to 82.4°F suitable water temperature range for year-round juvenile and adult hardhead rearing was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced rearing habitat quality and increased stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, Feather, American, and Stanislaus rivers under Alternative 3 would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers throughout the year.

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because Alternative 3 would not cause a substantial reduction in rearing habitat. Flows under Alternative 3 in all rivers examined throughout the year are generally similar to or greater than flows under NAA, except during summer months in the Feather and American rivers. These reductions in flows, however, would not cause an overall biologically meaningful effect on hardhead. The percentages of months outside all temperature thresholds are generally lower under Alternative 3 than under NAA.

CEQA Conclusion: In general, Alternative 3 would not affect the quality and quantity of upstream habitat conditions for hardhead relative to the Existing Conditions.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the year-round juvenile and adult hardhead rearing period. Lower flows could reduce the quantity and quality of instream habitat available for juvenile and adult rearing. In the Sacramento River upstream of Red Bluff, flows under A3_LLT would generally be similar to flows under Existing Conditions during January, March, April, July, September, and December, greater by up to 30% during February, May, June, and October, and lower by up to 24% during August and November (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis).*

In the Trinity River below Lewiston Reservoir, flows under A3_LLT would generally be similar to flows under Existing Conditions during March through May and July through September, greater by up to 61% during January, February, and June, and lower by up to 25% during October and December (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under A3_LLT would generally be similar to or greater than flows under Existing Conditions throughout the year, except in critical years during August and September (17% and 38%, respectively) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under A3_LLT would generally be similar to flows under Existing Conditions during February and November, greater during January, March through June, October, and December (up to 149% greater), and lower during July through September (up to 51% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under A3_LLT would generally be similar to flows under Existing Conditions during January, April, and June, greater by up to 29% during February, March, and October, and lower by up to 52% during May, July through September, November, and December (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under Alternative 3 would be about the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months in which year-round in-stream temperatures would be outside of the 65°F to 82.4°F suitable water temperature range for juvenile and adult hardhead rearing was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced rearing habitat quality and increased stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, Feather, American, and Stanislaus rivers under Alternative 3 would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the April through November period.

Collectively, these results indicate that the impact would be significant because Alternative 3 would cause a substantial reduction in hardhead habitat. No mitigation is necessary. Flows would be lower during half of the year-round juvenile and adult rearing period in the American River. However, given that flow reductions in other rivers, including the San Joaquin and Stanislaus rivers, would be minimal, flow reductions in the American River would not cause biologically meaningful effects to hardhead habitat. The percentages of months outside both temperature thresholds are generally lower under Alternative 3 than under the Existing Conditions.

California Bay Shrimp

NEPA Effects: The effect of water operations on rearing habitat of California bay shrimp under Alternative 3 would be similar to that described for Alternative 1A (see Alternative 1A, Impact AQUA-5). That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. As described for Alternative 1A, Impact AQUA-5, the effects would not be adverse.

CEQA Conclusion: As described above the impacts on California bay shrimp rearing habitat would be less than significant.

Impact AQUA-204: Effects of Water Operations on Migration Conditions for Non-Covered Aquatic Species of Primary Management Concern

Also, see Alternative 1A, Impact AQUA-204 for additional background information relevant to non-covered species of primary management concern.

Striped Bass

NEPA Effects: Monthly flows in the Sacramento River downstream of the north Delta intakes would decrease (7–13% for NAA) under Alternative 3 during the adult striped bass migration. Sacramento River flows are highly variable interannually, and striped bass are still able to migrate upstream the Sacramento River during lower flow years. Overall, the effect of reduced Sacramento flows under Alternative 3 would not be adverse for striped bass.

CEQA Conclusion: Impacts would be as described immediately above and would be less than significant because the changes in flow (15–21% lower compared to Existing Conditions) would not interfere substantially with movement of pre-spawning adult striped bass through the Delta. No mitigation would be required.

American Shad

NEPA Effects: Flows in the Sacramento River below the north Delta diversion facilities would be lower than NAA during March-May. Monthly flows on average would be 7–16% less than NAA when climate change effects are accounted for. Flows from the San Joaquin River at Vernalis would be unchanged. Sacramento River flows are highly variable interannually, and American shad are still able to migrate upstream the Sacramento River during lower flow years. Overall, the impact to American shad migration habitat conditions would not be adverse under Alternative 3.

CEQA Conclusion: Impacts would be as described immediately above and would be less than significant because the changes in flow (15–21% lower compared to Existing Conditions) would not interfere substantially with movement of American shad from the Delta to upstream spawning habitat. No mitigation would be required.

Threadfin Shad

NEPA Effects: Threadfin shad are semi-anadromous, moving between freshwater and brackish water habitats. Threadfin shad found in the Delta to not actively migrate upstream to spawn. Therefore there is no effect on migration habitat conditions.

CEQA Conclusion: Impacts would be as described immediately above and would be less than significant because flow changes in the Delta under Alternative 3 would not alter movement patterns for threadfin shad and no mitigation would be required.

Largemouth Bass

NEPA Effects: Largemouth bass are non-migratory fish within the Delta. Therefore they do not use the Delta as migration habitat corridor. There would be no effect.

CEQA Conclusion: As described immediately above, flow changes under Alternative 3 would not affect largemouth movements within the Delta. No mitigation would be required.

Sacramento Tule Perch

NEPA Effects: Similar with largemouth bass, Sacramento tule perch are a non-migratory species and do not use the Delta as a migration corridor as they are a resident Delta species. There would be no effect.

CEQA Conclusion: As described immediately above, flow movements would not affect Sacramento tule perch movements within the Delta. No mitigation would be required.

Sacramento-San Joaquin Roach

NEPA Effects: For Sacramento-San Joaquin roach the overall flows and temperature in upstream rivers during migration to their spawning grounds would be similar to those described under Alternative 3, Impact AQUA-202 for spawning. As described for Alternative 3, Impact AQUA-202, the overall change in flows under Alternative 3 would slightly improve the upstream conditions relative to NAA. These conditions would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of water operations on migration conditions for Sacramento-San Joaquin roach would not be significant and no mitigation is required.

Hardhead

NEPA Effects: For hardhead the overall flows and temperature in upstream rivers during migration to their spawning grounds would be similar to those described under Alternative 3, Impact AQUA-202 for spawning. As described for Alternative 3, Impact AQUA-202, the overall change in flows under Alternative 3 would slightly improve the upstream conditions relative to NAA. These conditions would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of water operations on migration conditions for hardhead would not be significant and no mitigation is required.

California Bay Shrimp

NEPA Effects: The effect of water operations on migration conditions of California bay shrimp under Alternative 3 would be similar to that described for Alternative 1A (see Alternative 1A, Impact AQUA-6). That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. As described for Alternative 1A, Impact AQUA-6, the effects of Alternative 3 would not be adverse.

CEQA Conclusion: As described above the impacts on California bay shrimp migration conditions would be less than significant.

Restoration Measures (CM2, CM4–CM7, and CM10)

The effects of restoration measures under Alternative 3 would be similar for all non-covered species; therefore, the analysis below is combined for all non-covered species instead of analyzed by individual species.

Impact AQUA-205: Effects of Construction of Restoration Measures on Non-Covered Aquatic Species of Primary Management Concern

Refer to Impact AQUA-7 under delta smelt for a discussion of the effects of construction of restoration measures on non-covered species of primary management concern. That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species.

NEPA Effects: The potential effects of the construction of restoration measures under Alternative 3 would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-7). As described for Alternative 1A, Impact AQUA-7, the effects of Alternative 3 would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of the construction of restoration measures would be less than significant.

Impact AQUA-206: Effects of Contaminants Associated with Restoration Measures on Non-Covered Aquatic Species of Primary Management Concern

NEPA Effects: Refer to Impact AQUA-8 under delta smelt a discussion of the effects of contaminants associated with restoration measures on non-covered species of primary management concern. That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. The potential effects of the construction of contaminants associated with restoration measures under Alternative 3 would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-8). As described for Alternative 1A, Impact AQUA-8, the effects of Alternative 3 would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of contaminants associated with restoration measures would be less than significant.

Impact AQUA-207: Effects of Restored Habitat Conditions on Non-Covered Aquatic Species of Primary Management Concern

Refer to Impact AQUA-9 under delta smelt a discussion of the effects of restored habitat conditions on non-covered species of primary management concern. That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. Although there are minor differences the effects are similar.

NEPA Effects: The potential effects of restored habitat conditions under Alternative 3 would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-8). For a detailed discussion, please see Alternative 1A, Impact AQUA-8. In addition, see Alternative 1A, Impact AQUA-207 for a discussion of the different effects on non-covered species of primary management concern. As described for Alternative 1A, the effects of Alternative 3 would range from slightly beneficial to beneficial.

CEQA Conclusion: As described immediately above, the impacts of restored habitat conditions would range from slightly beneficial to beneficial.

Impact AQUA-208: Effects of Methylmercury Management on Non-Covered Aquatic Species of Primary Management Concern (CM12)

NEPA Effects: Refer to Impact AQUA-10 under delta smelt for a discussion of the effects of methylmercury management on non-covered species of primary management concern. That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. The potential effects of methylmercury management under Alternative 3 would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-10). As described for Alternative 1A, Impact AQUA-10, the effects of Alternative 3 would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of methylmercury management would be less than significant.

Impact AQUA-209: Effects of Invasive Aquatic Vegetation Management on Non-Covered Aquatic Species of Primary Management Concern (CM13)

Refer to Impact AQUA-11 under delta smelt a discussion of the effects of invasive aquatic vegetation management on non-covered species of primary management concern. That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. The potential effects of invasive aquatic vegetation management under Alternative 3 would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-11) except for predatory species (striped bass and largemouth bass) and Sacramento tule perch. Invasive aquatic vegetation provides hiding habitat for predatory fish which improves their hunting success. Sacramento tule perch also use the cover of aquatic plants in the Sacramento and San Joaquin rivers and in Suisun marsh. Consequently, reducing the amount of invasive aquatic habitat will negatively affect these predatory species and Sacramento tule perch. However, this control will not substantially reduce the ability of the predatory species to hunt and there will still be many other habitats in which the predatory species can successfully hunt and in which Sacramento tule perch will thrive.

NEPA Effects: As described above, the effect on non-covered aquatic species will not be adverse. Control of invasive aquatic vegetation would not occur within California bay shrimp habitat and there would be no effect on them.

CEQA Conclusion: Refer to Impact AQUA-11 under delta smelt a discussion of the effects of invasive aquatic vegetation management on non-covered species of primary management concern. There are minor differences and the effects are similar except for predatory species (striped bass and largemouth bass) and Sacramento tule perch. Invasive aquatic vegetation provides hiding habitat for predatory fish which improves their hunting success. Control of invasive aquatic vegetation would not occur within California bay shrimp habitat and there would be no effect on them. Sacramento tule perch use the cover of aquatic plants in the Sacramento and San Joaquin rivers and in Suisun marsh. Consequently, reducing the amount of invasive aquatic habitat will negatively affect the predatory species and Sacramento tule perch. However, this control will not substantially reduce the ability of the predatory species to hunt and there will still be many other habitats in which the predatory species can successfully hunt and in which Sacramento tule perch will thrive. Therefore the impact on them will not be significant and no mitigation is required.

Other Conservation Measures (CM12–CM19 and CM21)

The effects of restoration measures under Alternative 3 would be similar for all non-covered species; therefore, the analysis below is combined for all non-covered species instead of analyzed by individual species.

Impact AQUA-210: Effects of Dissolved Oxygen Level Management on Non-Covered Aquatic Species of Primary Management Concern (CM14)

NEPA Effects: Refer to Impact AQUA-12 under delta smelt for a discussion of the effects of dissolved oxygen management on non-covered species of primary management concern. The potential effects of dissolved oxygen management under Alternative 3 would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-12). For a detailed discussion, please see Alternative 1A, Impact AQUA-12. California bay shrimp do not occur in this habitat and there would be no effect on them. As described immediately above, the impacts of oxygen level management would be beneficial.

CEQA Conclusion: As described immediately above, the impacts of oxygen level management would be beneficial.

Impact AQUA-211: Effects of Localized Reduction of Predatory Fish on Non-Covered Aquatic Species of Primary Management Concern (CM15)

NEPA Effects: Refer to Alternative 1A, Impact AQUA-13 under delta smelt a discussion of the effects of predatory fish (striped bass and largemouth bass) and predator management on non-predatory fish. That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. The purpose of predatory fish management is to reduce the numbers of predatory fish and to reduce their hunting success. This management will have negative effects on predatory fish. However, the numbers of predatory fish are high and the extent of the habitats in which they hunt is extensive. As described for Alternative 1A, the effects of this management will not be adverse. California bay shrimp do not occur in these habitats and there would be no effect on them.

Therefore the effects of this management will not be adverse. California bay shrimp do not occur in these habitats and there would be no effect on them.

CEQA Conclusion: Refer to Alternative 1A, Impact AQUA-13 under delta smelt a discussion of the effects of predatory fish and predator management on non-predatory fish. The purpose of predatory fish management is to reduce the numbers of predatory fish and to reduce their hunting success. This management will have negative effects on predatory fish. However, the numbers of predatory fish are high and the extent of the habitats in which they hunt is extensive. Therefore the effects of this management will not be significant. No mitigation is required. California bay shrimp do not occur in these habitats and there would be no effect on them.

Impact AQUA-212: Effects of Nonphysical Fish Barriers on Non-Covered Aquatic Species of Primary Management Concern (CM16)

Refer to Impact AQUA-14 under delta smelt for a discussion of the effects of nonphysical fish barriers on non-covered species of primary management concern. That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species.

NEPA Effects: The potential effects of nonphysical fish barriers under Alternative 3 would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-14). For a detailed discussion, please see Alternative 1A, Impact AQUA-14. The effects would be similar except for Sacramento-San Joaquin roach and hardhead which are unlikely to be present in their vicinity. California bay shrimp do not occur in these habitats and there would be no effect on them. As described for Alternative 1A, the effects would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of nonphysical fish barriers would be less than significant.

Impact AQUA-213: Effects of Illegal Harvest Reduction on Non-Covered Aquatic Species of Primary Management Concern (CM17)

Refer to Impact AQUA-15 under delta smelt for a discussion of the effects of illegal harvest reduction on non-covered species of primary management concern. That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species.

NEPA Effects: The potential effects of illegal harvest reduction under Alternative 3 would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-15). California bay shrimp do not occur in these habitats and there would be no effect on them. As described for Alternative 1A, the effects would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of illegal harvest reduction would be less than significant.

Impact AQUA-214: Effects of Conservation Hatcheries on Non-Covered Aquatic Species of Primary Management Concern (CM18)

NEPA Effects: Refer to Impact AQUA-16 under delta smelt for a discussion of the effects of conservation hatcheries on non-covered species of primary management concern. The potential effects of conservation hatcheries under Alternative 3 would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-16). As described for Alternative 1A, there would be no effect.

CEQA Conclusion: As described immediately above, conservation hatcheries would have not impact.

Impact AQUA-215: Effects of Urban Stormwater Treatment on Non-Covered Aquatic Species of Primary Management Concern (CM19)

NEPA Effects: Refer to Impact AQUA-17 under delta smelt for a discussion of the effects of stormwater treatment on non-covered species of primary management concern. That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. The potential effects of stormwater treatment under Alternative 3 would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-17). As described for Alternative 1A, these effects would be beneficial.

CEQA Conclusion: As described immediately above, the impacts of stormwater management would be beneficial.

Impact AQUA-216: Effects of Removal/Relocation of Nonproject Diversions on Non-Covered Aquatic Species of Primary Management Concern (CM21)

Refer to Impact AQUA-18 under delta smelt for a discussion of the effects of removal/relocation of nonproject diversions on non-covered species of primary management concern. That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species.

NEPA Effects: The potential effects of removal/relocation of nonproject diversions under Alternative 3 would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-18). For a detailed discussion, please see Alternative 1A, Impact AQUA-18. The effects would be similar except for Sacramento-San Joaquin roach, hardhead and Sacramento perch which are unlikely to be present near these diversions. California bay shrimp do not occur in these habitats and there would be no effect on them. As described for Alternative 1A, the effects would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of removal/relocation of nonproject diversions would be less than significant.

Upstream Reservoirs

Impact AQUA-217: Effects of Water Operations on Reservoir Coldwater Fish Habitat

NEPA Effects: Similar to the description for Alternative 1A, this effect would not be adverse because coldwater fish habitat in the CVP and SWP upstream reservoirs under Alternative 3 would not be substantially reduced when compared to NAA.

CEQA Conclusion: Similar to the description for Alternative 1A, Alternative 3 would reduce the quantity of coldwater fish habitat in the CVP and SWP as shown in Table 11-1A-102. There would be a greater than 5% increase (5 years) for several of the reservoirs, which could result in a significant impact. These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. As a result, the CEQA conclusion regarding Alternative 3, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on coldwater habitat in upstream reservoirs. This impact is found to be less than significant and no mitigation is required.

11.3.4.9 Alternative 4—Dual Conveyance with Modified Pipeline/Tunnel and Intakes 2, 3, and 5 (9,000 cfs; Operational Scenario H)

Alternative 4 would result in the same potential construction impact mechanisms as Alternative 1A; however, there would be two fewer intakes under Alternative 4. Consequently, the intensity and extent of impacts related to the construction of the intakes would be less under Alternative 4 than under Alternative 1A. As a result of having fewer intakes, however, Alternative 4 will also include an expanded Clifton Court Forebay with a new embankment dividing the forebay into a north cell and a south cell along with additional connections and control structures to the Banks and Jones pumping plants. These actions will result in additional construction impacts for Alternative 4 compared to Alternative 1A.

Alternative 4 has a lower maximum diversion capacity (up to 9,000 cfs) from the north Delta area than Alternative 1A (up to 15,000 cfs).

The temporary construction footprint of the three intakes would occupy about 16.21 acres of in-water habitat, while the total permanent in-water footprint would be approximately 12.3 acres (9.5 acres smaller under Alternative 4 than under Alternative 1A). The total length of permanent intakes and the associated bank protection would be approximately 6,360 feet (5,540 feet less than Alternative 1A) (see Table 11-5). Under Alternative 4 there would be five barge locations rather than six under Alternative 1A. One of the five barge landings under Alternative 4 would be in the same location as Alternative 1A while the four would be in different locations. The analysis assumes all of these would operate the same as the landings under Alternative 1A. The effects of the landing construction and operation, including the cargo handling system, are assumed to be the same under Alternative 4 as under Alternative 1A although some barge activities would take place on levees using a barge ramp in conjunction with a crane/excavator barge or a crane or excavator placed on or near the levee. Therefore, all impacts related to construction of the conveyance tunnel and pipelines, and the barge unloading facilities, are considered to be the same. The Sacramento River channel and bank would be affected by construction of the three north Delta intake facilities (Intakes 2, 3, and 5) between RM 44 (south of Freeport) and approximately RM 39 (at the town of Courtland). The locations, dimensions, and construction footprints of the intakes considered in Alternative 4 are provided in Table 11-5.

The number of barge trips required under Alternative 4 would be similar to the estimated 3,000 barge trips under Alternative 1A; although only three intake facilities would be constructed under Alternative 4 compared to five intakes under Alternative 1A additional trips would be required for Clifton Court Forebay construction. Other aspects of in-water construction would be similar under Alternative 4 as described for Alternative 1A, except as they relate to the reduced number of intakes constructed and construction at Clifton Court Forebay under Alternative 4.

New water conveyance facilities of Alternative 4 that would affect the aquatic environment include creating a north and south cell in Clifton Court Forebay by constructing an embankment to separate them, increasing the forebay by 690 acres (to 2,950 acres total) by expanding the south cell to the southeast, and excavating the existing Clifton Court Forebay to expand the storage (Table 3-11). Additionally, three culvert siphons would be constructed under Alternative 4. One would serve as a transition between Tunnel 2 and the expanded Clifton Court Forebay under Italian Slough, one would connect the north cell of the expanded Clifton Court Forebay to a new approach canal to the Banks and Jones Pumping Plants under the south cell of the Forebay, and one would connect the new approach canal to the existing approach canal to Banks Pumping Plant under Byron Highway. Construction and excavation at Clifton Court Forebay would be done in the dry via installation of cofferdams for isolation and dewatering of work areas.

Alternative 4 also includes different water conveyance operational criteria (Operational Scenario H) than Alternative 1A (Operational Scenario A), resulting in different patterns of water withdrawals from the north Delta, and potentially different effects on water quality and aquatic habitat conditions in the Plan Area. As fully described in Chapter 3, *Description of Alternatives,* Alternative 4 operations incorporate a decision tree process that results in four potential operational sub-scenarios, depending on the outcome of the decision tree process for spring outflow and Fall X2 operations. The decision tree process will specifically test the need for Fall X2 for delta smelt and spring outflow for longfin smelt as described in Chapter 3, *Description of Alternatives*. The four potential operational outcomes of the decision tree are as follows:

- Scenario H1 – Does not include enhanced spring outflow or Fall X2 requirements.
- Scenario H2 – includes enhanced spring outflow, but not Fall X2 requirements. This scenario lies within the range of the other scenarios.
- Scenario H3 – Does not include enhanced spring outflow, but includes Fall X2 requirements (similar to Alternative 2A). This scenario lies within the range of the H1 and H4 scenarios.
- Scenario H4 – Includes both enhanced spring outflow requirements, and Fall X2 requirements.

Based on a comparison of the flow effects of H1 and H4, it is concluded that they represent the bookends for operational effects of Alternative 4 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis, Section11C.4.3*. As such, H1 and H4, along with Scenario H3, which includes Fall X2 but not enhanced spring outflow, are used as the primary point of comparison for purposes of evaluating the effects of Alternative 4 because together they represent the end and middle points of potential effects. The decision tree will be used to determine the actual operational scenario for Alternative 4 prior to CM1 operations in order to achieve results that are not adverse and are less than significant. The operations impact analysis compares late long-term (LLT) Alternative 4 results for Existing Conditions (CEQA) or no action (NEPA) with the range of outcomes from the operational sub-scenarios (H1–H4), and concludes with a single impact statement for each issue.

Delta Smelt

Construction and Maintenance of CM1

The construction and maintenance activities would occur entirely within designated critical habitat. Small numbers of delta smelt eggs, larvae, and adults could be present in the north Delta in June during a portion of the in-water construction period for the intake facilities. Small numbers could also be present in June or July during construction of the barge landings in the east Delta and south Delta and during construction at Clifton Court Forebay (see Table 11-4).

Impact AQUA-1: Effects of Construction of Water Conveyance Facilities on Delta Smelt

NEPA Effects: The potential effects of construction of the water conveyance facilities on delta smelt or critical habitat would be similar to those described for Alternative 1A (Impact AQUA-1) except that Alternative 4 would include three intakes compared to five intakes under Alternative 1A, so the effects would be proportionally less under this alternative. This would convert about 6,360 lineal feet of existing shoreline habitat into intake facility structures and would require about 17.1 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. Alternative 4 would use five barge locations rather than six as under Alternative 1A so those effects would also be proportionally less.

Additionally, construction and excavation at Clifton Court Forebay would be done in the dry via installation of cofferdams for isolation and dewatering of work areas. Implementation of Appendix 3B, *Environmental Commitments*, including construction BMPs and 3B.8–*Fish Rescue and Salvage Plan,* would minimize adverse effects as described for Alternative 1A. Mitigation measures would also be available to avoid and minimize potential effects. As concluded for Alternative 1A, Impact AQUA-1, the effect would not be adverse for delta smelt.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-1, the impact of the construction of the water conveyance facilities on delta smelt or critical habitat would not be significant except for construction noise associated with pile driving. Potential pile driving impacts would be less than Alternative 1A because only three intakes would be constructed rather than five. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in the discussion of Alternative 1A.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in the discussion of Alternative 1A.

Impact AQUA-2: Effects of Maintenance of Water Conveyance Facilities on Delta Smelt

NEPA Effects: The potential effects of the maintenance of water conveyance facilities under Alternative 4 would be the same as those described for Alternative 1A (see Impact AQUA-2) except that only three intakes would need to be maintained under Alternative 4 rather than five under Alternative 1A. As concluded in Alternative 1A, Impact AQUA-2, the impact would not be adverse for delta smelt or their designated critical habitat.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-2 for delta smelt, the impact of the maintenance of water conveyance facilities on delta smelt or critical habitat would not be significant and no mitigation is required.

Water Operations of CM1

Impact AQUA-3: Effects of Water Operations on Entrainment of Delta Smelt

Water Exports from SWP/CVP South Delta Facilities

Alternative 4 would result in lower overall entrainment of delta smelt than the NAA. The predicted entrainment of larval/juvenile delta smelt at the south Delta export facilities was generally lowest under Scenario H4 operations, and highest under the NAA and H3/H1 scenarios (Figure 11-4-1). Each of the Alternative 4 subscenarios would result in lower entrainment of delta smelt in wet and above-normal water years; however, only H4 provided for lower predicted entrainment in below-normal and dry water years, and all of the subscenarios had similar entrainment to the NAA in critical water years.

The predicted entrainment of adult delta smelt was generally lower than the NAA under Alternative 4 operations (Figure 11-4-2). This pattern was most pronounced and most similar among subscenarios in wet and above-normal water years in which predicted entrainment was lowered by about one-third and one-quarter respectively. The predictions of adult delta smelt entrainment were lower than, but increasingly similar to, the NAA as modeled hydrology got drier (below-normal, dry, critical). Estimated entrainment under Scenario H3 would be 0.015 less (20% lower in relative terms) for adults and 0.019 less (9% lower in relative terms) for the combined juvenile and adult population compared to NAA (Table 11-4-1). These differences represent 2% or less of the population.

Entrainment losses of delta smelt at the SWP/CVP south Delta facilities are related to OMR flows. All of the Alternative 4 subscenarios include the same south Delta operational criteria, but the differences in spring and fall outflow result in minor differences in actual operations, and resultant minor differences in entrainment effects on delta smelt (Figures 11-4-1 and 11-4-2). Scenario H3 does not include enhanced spring outflow, although it includes stricter south Delta operational criteria relative to OMR flows as compared to the NAA. Because delta smelt entrainment occurs primarily in the winter and spring, Scenario H3 represents greatest potential effects of delta smelt entrainment based on methods that correlate spring OMR flows and delta smelt entrainment.

Table 11-4-1. Proportional Entrainment Index of Delta Smelt at SWP/CVP South Delta Facilities for Alternative 4 (Scenario H3)

Water Year	Proportional Entrainment[a] Difference in Proportions (Relative Change in Proportions)	
	EXISTING CONDITIONS vs. A4	NAA vs. A4
Total Population		
Wet	-0.017 (-16%)	-0.043 (-32%)
Above Normal	-0.010 (-6%)	-0.038 (-20%)
Below Normal	0.024 (11%)	-0.006 (-2%)
Dry	0.015 (6%)	-0.004 (-1%)
Critical	0.009 (3%)	0.010 (3%)
All Years	0.002 (1%)	-0.019 (-9%)
Juvenile Delta Smelt (March–June)		
Wet	0.011 (28%)	-0.016 (-24%)
Above Normal	0.011 (14%)	-0.018 (-16%)
Below Normal	0.034 (25%)	0.003 (1%)
Dry	0.024 (13%)	0.004 (2%)
Critical	0.015 (6%)	0.011 (4%)
All Years	0.018 (15%)	-0.005 (-3%)
Adult Delta Smelt[b] (December–March)		
Wet	-0.028 (-40%)	-0.027 (-39%)
Above Normal	-0.021 (-26%)	-0.020 (-25%)
Below Normal	-0.010 (-13%)	-0.008 (-10%)
Dry	-0.009 (-11%)	-0.008 (-10%)
Critical	-0.006 (-9%)	-0.001 (-2%)
All Years	-0.017 (-22%)	-0.015 (-20%)

Shading indicates >5% or more increased entrainment.

Note: Negative values indicate lower entrainment loss under Alternative 4 than under existing biological conditions.

[a] Proportional entrainment index calculated in accordance with USFWS BiOp (U.S. Fish and Wildlife Service 2008a).

[b] Adult proportional entrainment adjusted according to Kimmerer (2011).

Water Exports from SWP/CVP North Delta Intake Facilities

The impact would be similar in manner to Impact AQUA-3 in Alternative 1A for north Delta intakes, but possibly lower because Alternative 4 has fewer intakes. Potential entrainment and impingement risks at the proposed north Delta facilities would be limited since delta smelt rarely occur in the vicinity of the proposed intake sites (Swanson et al. 2005, 2010; White et al. 2007). The intakes would be screened to exclude fish larger than approximately 15 mm.

Water Exports with a Dual Conveyance for the SWP North Bay Aqueduct

Particle tracking modeling simulated delta smelt larval entrainment at the North Bay Aqueduct. A total of 38 runs were analyzed under Scenario H3, with each hydroperiod matched to a 20-mm larval delta smelt starting distribution on the basis of Delta outflow. Particle entrainment at the NBA was low, averaging 1.4% under Scenario H3 compared to 1.9% under NAA, or 25% lower in relative terms (Table 11-4-2).

Table 11-4-2. Average Percentage (and Difference) of Particles Representing Larval Delta Smelt Entrained by the North Bay Aqueduct under Alternative 4 (Scenario H3) and Baseline Scenarios

Average Percent Particles Entrained at NBA			Difference (and Relative Difference)	
EXISTING CONDITIONS	NAA	A4_LLT	A4_LLT vs. EXISTING CONDITIONS	A4_LLT vs. NAA
1.9	1.9	1.4	-0.52 (-27%)	-0.46 (-25%)

Note: 60-day DSM2-PTM simulation. Negative difference indicates lower entrainment under the alternative compared to the baseline scenario

Predation Associated with Entrainment

Under Alternative 4, pre-screen predation losses at the south Delta facilities would be reduced commensurate with the reductions in entrainment described above. Predation loss at the north Delta intakes may occur but would be limited because few delta smelt are anticipated to occur that far upstream.

NEPA Effects: Delta smelt entrainment under Alternative 4 would not be adverse relative to the NAA; model predictions indicate that notable reductions in entrainment would occur. Thus, Alternative 4 is likely to benefit delta smelt due to lower average entrainment and associated predation losses at the south Delta export facilities coupled with expectations of minimal entrainment risk at the north Delta facilities and NBA intakes.

CEQA Conclusion: As described above (Table 11-4-1), under Scenario H3 entrainment at the south Delta SWP/CVP water export facilities averaged across all years would be 0.017 less (a 22% relative decrease) for adult delta smelt, and 0.018 more (a 15% relative increase) for juvenile delta smelt compared to Existing Conditions. However, the percentage of the larval/juvenile population affected would be small (<2%). It is worth considering how this result differs from the NEPA conclusion set forth above. Under the CEQA analysis, Alternative 4 could substantially increase larval/juvenile proportional entrainment when compared to Existing Conditions. However, as described under Alternative 1A (Impact AQUA-3), this interpretation of the biological modeling results is likely attributable to different modeling assumptions for four factors: sea level rise, climate change, future water demands, and implementation of the alternative. Note that the analysis for larvae and juveniles includes both OMR flows and X2 as predictors of proportional entrainment; primarily because of sea level rise assumptions, X2 would be further upstream in the ELT and LLT even with similar water operations, so that the comparison of Alternative 4 in the ELT and LLT to Existing Conditions is confounded. Because the action alternative modeling does not partition the effects of implementation of the alternative from the effects of sea level rise, climate change and future water demands, the comparison to Existing Conditions may not offer a clear understanding of the impact of the alternative on the environment.

Therefore, the analysis of larval/juvenile delta smelt entrainment at the south Delta SWP/CVP water export facilities is better informed by the results from the NEPA analysis presented above, which accounts for sea level rise by considering the NAA in the LLT. When compared to NAA and informed by the NEPA analysis, above, larval-juvenile delta smelt entrainment is generally similar to conditions without BDCP (entrainment is reduced by 3%). Proportional entrainment under Scenario H1 would be similar to H3, and would be lower under Scenario H4. Entrainment under Scenario H1 would be similar to Scenario H3 and lower than Existing Conditions while conditions under Scenario H4 would further reduce entrainment relative to Scenario H3. Scenarios H1 and H4 represent the full range of conditions expected under the four potential outcomes for Alternative 4, and therefore entrainment is expected to be reduced under Alternative 4. Pre-screen delta smelt predation losses at the south Delta facilities would be no greater and may be lower compared to Existing Conditions due to lower overall entrainment. Predation losses at the north Delta intakes would be minimal because delta smelt rarely occur in that vicinity. Overall, the impact would be less than significant because overall entrainment of delta smelt would be reduced compared to Existing Conditions and only a small proportion of the delta smelt population would be affected. No mitigation would be required.

Impact AQUA-4: Effects of Water Operations on Spawning and Egg Incubation Habitat for Delta Smelt

NEPA Effects: The effects of operations under Alternative 4 on abiotic spawning habitat would be similar as those described for Alternative 1A (Impact AQUA-4). Flows affect the amount of spawning habitat available to delta smelt (Hobbs et al. 2005; 2007), although spawning habitat is not known to be limited. Alternative 4 would reduce the flows downstream of the north Delta intakes, with the reduction being greatest for H1 and H3 (which do not include enhanced spring outflow) and lowest for H2 and H4 (which include enhanced spring outflow). However, flow reductions below the north Delta intakes are not expected to substantially reduce available spawning habitat under any of the operating scenarios for Alternative 4 because implementation of *CM4 Tidal Natural Communities Restoration* is expected to more than offset any loss of spawning habitat caused by reduced flows below the north Delta intakes. This is indicated by the results presented in Appendix 5E of the BDCP Effects Analysis (section 5E.4.2.4.4), wherein the habitat suitability index for delta smelt eggs/larvae in each subregion of the Plan Area is appreciably greater under the BDCP than under Existing Conditions. Therefore, there will be no adverse effect on delta smelt spawning.

CEQA Conclusion: As described above, operations under Alternative 4 would not reduce abiotic spawning habitat availability or change water temperatures for spawning delta smelt under any of the proposed flow scenarios. Consequently, the impact would be less than significant, and no mitigation is required.

Impact AQUA-5: Effects of Water Operations on Rearing Habitat for Delta Smelt

Larval and juvenile delta smelt generally rear throughout the west Delta, Suisun Bay, Suisun Marsh, and in Cache Slough. Other areas in the Delta may also be used for rearing. The extent of abiotic habitat for delta smelt in the fall (September–December, the older juvenile rearing and maturation period) as a function of changes in flows was assessed using a technique based on the method of Feyrer and coauthors (2011) (as detailed in *BDCP Effects Analysis –Appendix 5.C, Flow, Section 5C.5.4.5.1 Delta Smelt Fall Abiotic Habitat Index hereby incorporated by reference*. *BDCP Effects Analysis –Appendix 5.E Habitat Restoration* presents additional analyses of effects on delta smelt related to juvenile habitat).

Feyrer and coauthors (2011) demonstrated that X2 in the fall correlates nonlinearly with an index of delta smelt abiotic habitat in the West Delta, Suisun Bay, and Suisun Marsh subregions, as well as smaller portions of the Cache Slough, South Delta, and North Delta subregions (see Figure 3 of Feyrer et al. 2011). Investigations in recent years have indicated that delta smelt occur year-round in the Cache Slough subregion, including Cache Slough, Liberty Island, and the Sacramento Deep Water Ship Channel (Baxter et al. 2010; Sommer et al. 2011). Whether the same individuals are residing in these areas for their full life cycles or different individuals are moving between upstream and downstream habitats is not known (Sommer et al. 2011). The delta smelt fall abiotic habitat index is the surface area of water in the west Delta, Suisun Bay, and Suisun Marsh (as well as smaller portions of the Cache Slough, South Delta, and North Delta subregions) weighted by the probability of presence of delta smelt based on water clarity (Secchi depth) and salinity (specific conductance) in the water. Feyrer and coauthors' (2011) method found these two variables to be significant predictors of delta smelt presence in the fall. They also concluded that water temperature was not a predictor of delta smelt presence in the fall, although it has been shown to be important during summer months (Nobriga et al. 2008).

Investigations in recent years have indicated that delta smelt occur year-round in the Cache Slough subregion, including Cache Slough, Liberty Island, and the Sacramento Deep Water Ship Channel (Baxter et al. 2010; Sommer et al. 2011). The degree of individual movement between upstream and downstream habitats has not been confirmed (Sommer et al. 2011), although emerging evidence suggests that a substantial fraction of the fish occurring in the upstream areas are residing there throughout the year (Hobbs in prep.).

Disagreements regarding the relationship between Fall X2 and delta smelt abundance prompted the development of the Fall X2 decision tree, which will use information generated by adaptive management processes under BDCP to inform operational rules for CM1 in the fall months.

The intent of the Fall X2 decision tree is to benefit delta smelt rearing habitat through some combination of outflow and physical habitat restoration. The decision tree branches represent several modeled possibilities for how operations and habitat restoration could combine to provide habitat benefits for this species. Scenarios H1 and H4 bracket a range of fall outflow operations that, based on current understanding, might be required. Scenarios H3 and H4 include Fall X2 per the 2008 Delta Smelt BiOp while Scenarios H1 and H2 do not. These differences drive the results presented below. Habitat restoration (CM4), particularly in the Suisun Marsh, West Delta, and Cache Slough ROAs is intended to improve rearing habitat suitability per unit of flow (see Results below), particularly by supplementing food production.

Analysis of larval and juvenile delta smelt habitat suitability in the restoration opportunity areas (ROAs) demonstrated that *CM4 Tidal Natural Communities Restoration* has the potential to result in considerably more suitable delta smelt habitat than currently exists.

Under Scenarios H3 and H4 operations (which include Fall X2), if it is assumed that habitat restoration will provide similar environmental conditions and occupancy to adjacent existing tidal areas, the abiotic habitat index would be 28-30% greater compared to NAA (Table 11-4-3). The greatest increase (34–38% higher compared to NAA) could occur in below normal and dry years. These estimates are based on an assumption that 100% of the newly restored habitat in Suisun Marsh, West Delta, and Cache Slough ROAs would be utilized by rearing delta smelt, and that food production benefits of the new habitat would be high. With fully effective BDCP habitat restoration actions, the abiotic habitat index under Scenario H1 would be similar (3% lower) than under the NAA, and with ineffective restoration, H1 would result in a 21% reduction in fall abiotic habitat compared to NAA.

NEPA Effects: The BDCP includes both water operations and habitat restoration components that are expected to provide habitat benefits to delta smelt. As described above, the contribution of operations to delta smelt habitat can be estimated on the basis of Delta outflow. The benefits of restored habitat for this species will depend on the success of restoration in creating physical habitat for smelt and in fostering ecological conditions that favor good feeding conditions and production of food upon which smelt can feed. The magnitude of restored habitat benefits is uncertain. As such, restoration success will have to be assessed empirically during the term of the BDCP permit. In the absence of restored habitat, or in the event BDCP habitat restoration does not produce the desired benefits, the average fall abiotic habitat index across all years would be similar to NAA in the Scenarios that include augmented fall outflow (2% greater under Scenario H3 and 3% greater under Scenario H4) (Figure 11-4-4, Table 11-4-3). Under Scenarios H1 and H2, which do not include Fall X2, the abiotic habitat index would be 21% (H1) and XX% (H2) lower than NAA. If BDCP habitat restoration produces large benefits for delta smelt, then the extent of suitable abiotic habitat and other habitat measures would be correspondingly higher in all scenarios, and the net benefits might exceed the NAA in the low outflow scenario.

Through the term of the permit, BDCP water operations will be subject to adjustment via adaptive management, beginning with the decision tree process in the years prior to CM1 operations. Recognizing the uncertainties of habitat restoration and disagreement regarding the importance of fall outflow augmentation to delta smelt, the Decision Tree phase of adaptive management is designed to allow for further evaluation of the need for fall outflow, concurrent with early evaluation of the level of benefits of BDCP habitat restoration for delta smelt. The decision tree process will inform a decision made at the time CM1 operations begin regarding the parameters of water operations. That decision will, on the basis of what has been learned about the effects of outflow and habitat restoration, identify CM1 operations that are expected to meet the delta smelt population growth and abundance objectives. Those operations will ensure the impacts of water operations on rearing habitat for delta smelt are not adverse and support a contribution to recovery of this species. Following this decision, the Adaptive Management Program will continue to evaluate the effects of water operations and habitat restoration on the delta smelt population, including making adjustments as appropriate to improve water supply reliability.

CEQA Conclusion: Without habitat restoration, the average fall abiotic habitat index for Alternative 4 would be greater than Existing Conditions for Scenario H3 (25% greater) and Scenario H4 (26% greater), and reduced 4% for Scenario H1 (Table 11-4-3). However, with habitat restoration under Alternative 4 (Scenarios H1–H4) the average fall abiotic habitat index would increase 21% under Scenario H1 and increase 57-59% under Scenarios H3 and H4 (Table 11-4-3, Figure 11-4-3).

Note that the CEQA analysis predicts a greater increase in the abiotic habitat index relative to baseline than the NEPA analysis. It is unclear whether this increase compared to Existing Conditions is a function of project operations under the alternative, or attributable to differences in modeling assumptions (Existing Conditions does not include Fall X2). The NEPA analysis is a better approach for isolating the effect of the alternative from the effects of sea level rise, climate change, future water demands, and implementation of required actions such as the Fall X2 requirement.

When compared to the NAA and informed by the NEPA analysis, the average delta smelt abiotic habitat index under Alternative 4 without restoration would be 21% lower under Scenario H1 and similar to baseline with Fall X2 under Scenarios H3 and H4. With restoration, the average abiotic index would be 3% lower under Scenario H1 and 28-30% greater under Scenarios H3 and H4 compared to NAA.

Overall, there would be a beneficial impact on the species compared to existing conditions without Fall X2, primarily from implementation of the restoration. The benefits of restored habitat for this species will depend on the success of restoration in creating physical habitat for smelt and in fostering ecological conditions that favor good feeding conditions and production of food upon which smelt can feed. The magnitude of restored habitat benefits is uncertain. As described above in the NEPA analysis, BDCP water operations will be subject to adjustment via adaptive management, in order to ensure the impacts of water operations on rearing habitat for delta smelt are not significant and to support a contribution to recovery of this species. The Adaptive Management Program with the decision tree process will evaluate the effects of water operations and habitat restoration on the delta smelt population, including adjustments as appropriate to improve water supply reliability.

Therefore, since Alternative 4 would benefit rearing delta smelt because the abiotic habitat index under all the flow scenarios would be greater than Existing Conditions, the impact is less than significant. No mitigation would be required.

Table 11-4-3. Differences in Delta Smelt Fall Abiotic Index (hectares) between Alternative 4 (Scenarios H3, H1, and H4) and Existing Biological Conditions Scenarios, with and without Habitat Restoration, Averaged by Prior Water Year Type

	EXISTING CONDITIONS vs. A4			NAA vs. A4		
Water Years	H3	H1	H4	H3	H1	H4
Without Restoration						
All	1,002 (25%)	-140 (-3.5%)	1,034 (26.0%)	116 (2%)	-1,022 (-21%)	153 (3%)
Wet	2,183 (46%)	-657 (-14.0%)	2,192 (46.6%)	-13 (0%)	-2,853 (-41%)	-4 (0%)
Above Normal	1,718 (45%)	13 (0.3%)	1,739 (45.5%)	50 (1%)	-1,655 (-30%)	72 (1%)
Below Normal	-5 (0%)	32 (0.8%)	156 (3.8%)	233 (6%)	180 (5%)	303 (8%)
Dry	222 (6%)	267 (7.5%)	282 (7.9%)	313 (9%)	358 (10%)	373 (11%)
Critical	24 (1%)	27 (0.9%)	33 (1.1%)	23 (1%)	26 (1%)	33 (1%)
With Restoration						
All	2,335 (59%)	821 (20.6%)	2,289 (57.5%)	1,449 (30%)	-155 (-3%)	1,453 (28%)
Wet	4,073 (87%)	339 (7.2%)	3,909 (83.1%)	1,876 (27%)	-1,857 (-27%)	1,712 (25%)
Above Normal	3,228 (84%)	1,057 (27.6%)	3,250 (85.0%)	1,560 (28%)	-610 (-11%)	1,583 (29%)
Below Normal	1,222 (30%)	1,152 (27.8%)	1,305 (31.5%)	1,370 (34%)	1,300 (33%)	1,453 (36%)
Dry	1,216 (34%)	1,243 (34.9%)	1,268 (35.6%)	1,308 (38%)	1,334 (38%)	1,359 (39%)
Critical	729 (24%)	630 (21.1%)	575 (19.3%)	728 (24%)	630 (21%)	575 (19%)

Note: Negative values indicate lower habitat indices under alternative scenarios. Water year 1922 was omitted because water year classification for prior year was not available.

Impact AQUA-6: Effects of Water Operations on Migration Conditions for Delta Smelt

From December to March, many mature delta smelt migrate upstream from brackish rearing areas in and around Suisun Bay and the confluence of the Sacramento and San Joaquin Rivers (U.S. Fish and Wildlife Service 2008a; Sommer et al. 2011). The initiation of migration is associated with pulses of freshwater inflow, which are turbid, cool, and less saline (Grimaldo et al. 2009). Changes in flow under Alternative 4 could change turbidity, but is not expected to result in changes in water temperatures or pulses of local rainwater into the Delta. As described above in Impact AQUA-4, in-Delta water temperatures would not change in response to Alternative 4 flows. The modeling results indicate no biologically meaningful changes in water temperature within the Delta under Alternative 4 and no substantial changes in the number of stressful or lethal condition days for juveniles.

Turbid water is an important habitat characteristic for delta smelt (Nobriga et al. 2008; Feyrer et al. 2011), and has been correlated to long-term changes in delta smelt abundance or survival either by itself or in combination with other factors (Thomson et al. 2010; Miller et al. 2012). Therefore, it is assumed that turbidity is an attribute of critical importance to delta smelt larvae, juveniles, and adults. Operation of the north Delta intakes (*CM1 Water Facilities and Operation*) is estimated to result in around 8 to 9% less sediment entering the Plan Area from the Sacramento River, the main source of sediment for the Delta and downstream subregions. In addition, sediment could be accreted (captured) in the ROAs (*CM4 Tidal Natural Communities Restoration*). Notching the Fremont Weir (*CM2 Yolo Bypass Fisheries Enhancements)* will also direct more Sacramento River water and sediment into the Bypass. These actions could limit sediment supply to areas currently important to delta smelt, such as Suisun Bay, which would result in less seasonal deposition of sediment that could be resuspended by wind-wave action to make/keep the overlying water column turbid. Therefore, there is a potential for a slight increase in water clarity, and a corresponding reduction in habitat quality for delta smelt. However, Alternative 4 is not expected to affect suspended sediment concentration during the first flush of precipitation that cues delta smelt migration. As such, turbidity cues associated with adult delta smelt migration should not change. With regard to suspended sediment concentrations at other times of the year, any effect will be minimized through the reintroduction of sediment collected at the north Delta intakes into tidal natural communities restoration projects (CM4), consistent with the Environmental Commitment addressing Disposal and Reuse of Spoils, Reusable Tunnel Material (RTM), and Dredged Material.

NEPA Effects: Alternative 4 may decrease sediment supply to the estuary by 8 to 9 percent, with the potential for decreased habitat suitability for delta smelt in some locations.

CEQA Conclusion: As described above, operations for all flow operating scenarios under Alternative 4 would not substantially alter the turbidity cues associated with winter flush events that may initiate migration, nor would there be appreciable changes in water temperatures. Consequently, the impact on adult delta smelt migration conditions would be less than significant, and no mitigation is required.

Restoration Measures (CM2, CM4–CM7, and CM10)

Alternative 4 has the same restoration measures as Alternative 1A. Because no substantial differences in impacts of tidal habitat restoration on delta smelt are anticipated anywhere in the affected environment under Alternative 4 compared to those described in detail for Alternative 1A, the effects of restoration measures described for delta smelt under Alternative 1A (Impacts AQUA-7 through AQUA-9) also appropriately disclose the anticipated effects of habitat restoration in Alternative 4.

The following impacts are those presented under Alternative 1A that are anticipated to be identical for Alternative 4.

Impact AQUA-7: Effects of Construction of Restoration Measures on Delta Smelt

Impact AQUA-8: Effects of Contaminants Associated with Restoration Measures on Delta Smelt

Impact AQUA-9: Effects of Restored Habitat Conditions on Delta Smelt

NEPA Effects: Detailed discussions regarding the potential effects of these three impact mechanisms on delta smelt are the same for Alternative 4, as those described under Alternative 1A (Impacts AQUA 7-through AQUA-9). Despite the anticipated improvements in habitat and habitat functions in the Delta from tidal habitat restoration activities, habitat quality for delta smelt is expected to decline by the LLT primarily because of climate change (Cloern et al. 2011; Brown et al. 2013). However, it is concluded that overall, the effect of landscape restoration activities in Alternative 4 relative to NAA is expected to provide a net benefit for delta smelt, which spend their entire lives in the Plan Area. The ultimate performance of habitat restoration is expected to interact with river and Delta outflows such that the benefits of habitat restoration would be greatest in H4 and lowest in H1. Specifically for AQUA-8, the effects of contaminants on delta smelt with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on delta smelt are uncertain.

CEQA Conclusion: All three of the impact mechanisms listed above would be beneficial or less than significant, and no mitigation is required.

Other Conservation Measures (CM12–CM19 and CM21)

Alternative 4 has the same other conservation measures as Alternative 1A. Because no substantial differences in other conservation-related fish effects are anticipated in the affected environment under Alternative 4 compared to those described in detail for Alternative 1A, the fish effects of other conservation measures described for delta smelt under Alternative 1A (Impacts AQUA-10 through AQUA-18) also appropriately characterize effects under Alternative 4.

The following impacts are those presented under Alternative 1A that are identical for Alternative 4.

Impact AQUA-10: Effects of Methylmercury Management on Delta Smelt (CM12)

Impact AQUA-11: Effects of Invasive Aquatic Vegetation Management on Delta Smelt (CM13)

Impact AQUA-12: Effects of Dissolved Oxygen Level Management on Delta Smelt (CM14)

Impact AQUA-13: Effects of Localized Reduction of Predatory Fish on Delta Smelt (CM15)

Impact AQUA-14: Effects of Nonphysical Fish Barriers on Delta Smelt (CM16)

Impact AQUA-15: Effects of Illegal Harvest Reduction on Delta Smelt (CM17)

Impact AQUA-16: Effects of Conservation Hatcheries on Delta Smelt (CM18)

Impact AQUA-17: Effects of Urban Stormwater Treatment on Delta Smelt (CM19)

Impact AQUA-18: Effects of Removal/Relocation of Nonproject Diversions on Delta Smelt (CM21)

NEPA Effects: Detailed discussions regarding the potential effects of these nine impact mechanisms on delta smelt are the same as those described under Alternative 1A (Impacts AQUA-10 through AQUA-18). The effects range from no effect, to not adverse, to beneficial.

CEQA Conclusion: The effects of the nine impact mechanisms listed above range from no impact, to less than significant, to beneficial, and no mitigation is required.

Longfin Smelt

Construction and Maintenance of CM1

Impact AQUA-19: Effects of Construction of Water Conveyance Facilities on Longfin Smelt

The potential effects of construction of the water conveyance facilities on longfin smelt would be similar to those described for Alternative 1A (Impact AQUA-19) except that Alternative 4 would include three intakes compared to five intakes under Alternative 1A, so the effects would be proportionally less under this alternative. This would convert about 6,360 lineal feet of existing shoreline habitat into intake facility structures and would require 17.1 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging). Alternative 4 would use five barge locations rather than six as under Alternative 1A so those effects would also be proportionally less.

Additionally, construction and excavation at Clifton Court Forebay would be done in the dry via installation of cofferdams for isolation and dewatering of work areas. Implementation of Appendix 3B, *Environmental Commitments*, including construction BMPs and 3B.8–*Fish Rescue and Salvage Plan*, would minimize adverse effects as described for Alternative 1A. Mitigation measures would also be available to avoid and minimize potential effects.

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-19, the effect would not be adverse for longfin smelt.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-19, the impact of the construction of water conveyance facilities on longfin smelt would not be significant except for construction noise associated with pile driving. Potential pile driving impacts under Alternative 4 would be less than Alternative 1A because only three intakes would be constructed rather than five. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in the discussion of Alternative 1A.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in the discussion of Alternative 1A.

Impact AQUA-20: Effects of Maintenance of Water Conveyance Facilities on Longfin Smelt

NEPA Effects: The potential effects of water conveyance facilities maintenance under Alternative 4 would be the similar to those described for Alternative 1A, Impact AQUA-20, except that only three intakes would need to be maintained under Alternative 4 instead of the five under Alternative 1A. As concluded in Alternative 1A, Impact AQUA-20, the impact would not be adverse for longfin smelt.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-20, the impact of the maintenance of water conveyance facilities on longfin smelt would not be significant and no mitigation is required.

Water Operations of CM1

Impact AQUA-21: Effects of Water Operations on Entrainment of Longfin Smelt

Water Exports from SWP/CVP South Delta Facilities

For larval longfin smelt, entrainment risk was simulated using particle tracking modeling for wetter and drier starting distributions. Average particle entrainment by the south Delta facilities was 1.0–1.3% under Scenario H3, which does not include enhanced spring outflow, compared to 1.4–1.8% under NAA. Larval entrainment under Scenario H1 would be similar to Scenario H3 because of similar spring outflow and south Delta operations. Under Scenarios H2 and H4 for Alternative 4, which include enhanced spring outflow, larval longfin smelt entrainment would be lower than NAA because of the enhanced spring outflow criteria that results in a further reduction in south Delta exports.

Table 11-4-4. Percentage of Particles (and Difference) Representing Longfin Smelt Larvae Entrained by the South Delta Facilities under Alternative 4 (Scenario H3) and Baseline Scenarios

	Percent Particles Entrained			Difference (and Relative Difference)	
Starting Distribution	EXISTING CONDITIONS	NAA	A4_LLT	A4_LLT vs. EXISTING CONDITIONS	A4_LLT vs. NAA
Wetter	1.7	1.4	1.0	-0.69 (-41%)	-0.45 (-31%)
Drier	2.1	1.8	1.3	-0.83 (-39%)	-0.50 (-28%)

Note: 60-day DSM2-PTM simulation of wetter and drier starting distributions. Negative values indicate lower entrainment under the alternative compared to the baseline scenario.

For juveniles and adults, entrainment at the south Delta facilities (entrainment index based on the salvage-density method, averaged across all water year types) under the Scenario H3 would be 42% lower for juveniles and 52% lower for adults compared to baseline conditions (Table 11-4-5). Scenarios H2 and H4 would result in even greater reductions in entrainment, due to higher spring outflows and the associated reduction in south Delta exports. Under all Alternative 4 scenarios, the predicted adult and juvenile entrainment decreases in all five water year types. Estimated entrainment under Scenario H1 would be similar to Scenario H3.

Table 11-4-5. Longfin Smelt Entrainment Index at the SWP and CVP Salvage Facilities—Differences (Absolute and Percentage) between Model Scenarios for Alternative 4 (Scenario H3)

		Absolute Difference (Percent Difference)	
Life Stage	Water Year Types	EXISTING CONDITIONS vs. A4 (H3)	NAA vs. A4 (H3)
Juvenile (March–June)	Wet	-34,213 (-54%)	-39,655 (-57%)
	Above Normal	-1,054 (-23%)	-1,343 (-28%)
	Below Normal	-571 (-19%)	-779 (-24%)
	Dry	-65,111 (-12%)	-123,418 (-21%)
	Critical	-199,486 (-35%)	-125,616 (-25%)
	All Years	-97,872 (-37%)	-122,883 (-42%)
Adult (December–March)	Wet	-67 (-52%)	-71 (-53%)
	Above Normal	-302 (-46%)	-342 (-50%)
	Below Normal	-728 (-38%)	-650 (-35%)
	Dry	-364 (-30%)	-299 (-26%)
	Critical	-7,981 (-33%)	-5,847 (-26%)
	All Years	-1,885 (-52%)	-1,849 (-52%)

Water Exports from SWP/CVP North Delta Intake Facilities

As described under Alternative 1A for Impact AQUA-22, longfin smelt are not known to spawn in the reach of the Sacramento River where the north Delta diversions will be built. Therefore, entrainment of longfin smelt at the proposed north Delta intakes would be extremely low because this species is only expected to occur occasionally in very low numbers this far upstream on the Sacramento River.

Water Export with a Dual Conveyance for the SWP North Bay Aqueduct

Particle tracking modeling was used to simulate larval longfin smelt entrainment to the NBA under Scenario H3. In general, average percent particle entrainment at the NBA under both NAA and Scenario H3 was about 0.1% for the wetter starting distribution, and was just under 0.2% for Alternative 4 and 0.14% for NAA under the drier starting distribution (Table 11-4-6). Entrainment of larval longfin smelt under Alternative 4 for all scenarios is expected to be low and similar to NAA. Note that the PTM modeling results do not account for the provision of an alternative NBA intake on the Sacramento River upstream of longfin smelt likely areas of occurrence, which potentially would reduce the number of longfin smelt larvae that otherwise would be entrained at the Barker Slough intake to the NBA.

Table 11-4-6. Percentage of Particles (and Difference) Representing Longfin Smelt Larvae Entrained by the North Bay Aqueduct under Alternative 4 (Scenario H3) and Baseline Scenarios

Starting Distribution	Percent Particles Entrained: EXISTING CONDITIONS	NAA	A4_LLT	Difference (and Relative Difference): A4_LLT vs. EXISTING CONDITIONS	A4_LLT vs. NAA
Wetter	0.10	0.09	0.10	0.00 (-3%)	0.01 (10%)
Drier	0.18	0.14	0.19	0.01 (7%)	0.04 (31%)

Note: Values reported are averages of 60-day DSM2-PTM simulation of wetter and drier starting distributions, based on 27 simulated months. Negative values indicate lower entrainment under the alternative compared to the baseline scenario.

Predation Associated with Entrainment

Pre-screen predation losses of longfin smelt at the SWP/CVP south Delta water export facilities are believed to be high and proportional to entrainment. It is assumed that pre-screen predation losses of longfin smelt would be similar to delta smelt based on their similar size, shape, and pelagic nature. Predation losses of both juvenile and adult longfin smelt under Alternative 4 would be no greater than baseline and may be lower, given the much lower entrainment losses at the south Delta facilities (37–42% lower for juveniles and 52–53% lower for adults) compared to NAA (Table 11-4-5). Predation loss at the proposed north Delta intakes would be unlikely because longfin smelt do not generally occur that far upstream on the Sacramento River. Under the range of flow operating scenarios under Alternative 4, entrainment-related predation loss would be reduced relative to NAA, with the greatest decreases in entrainment occurring under Scenario H4.

NEPA Effects: To summarize, predation of juvenile and adult longfin smelt, as a function of entrainment at the SWP/CVP south Delta facilities, would be reduced substantially under all flow operating scenario for Alternative 4 compared to NAA across all water years (Table 11-4-5). Predation loss of longfin smelt at the proposed north Delta intakes would be unlikely since longfin smelt are not expected to occur in that area of the Sacramento River. Longfin smelt entrainment to the NBA, and associated predation, would be unchanged compared to NAA. The predation risk associated with the NPB structures would be low, the same as described for Alternative 1A. In conclusion, Alternative 4 would not have an adverse effect on entrainment-related predation and would likely provide a benefit to the species because of substantial reductions in juvenile and adult entrainment at the south Delta facilities.

CEQA Conclusion: Entrainment of all life stages of longfin smelt at the south Delta facilities would be reduced under Alternative 4 compared to Existing Conditions. Particle entrainment, representing larval longfin smelt, was lower under Alternative 4 for both drier and wetter starting distributions (refer to *BDCP Appendix 5.B* for further details). Entrainment loss would be substantially lower for both juvenile (37% less) and adult longfin smelt (52% less) (Table 11-4-5). Entrainment to the north Delta intakes would be unlikely because longfin smelt are not expected to occur in the vicinity of the intakes. Larval entrainment to the NBA, as indicated by particle tracking, would be minimal under both wetter (0.1%) and drier (0.2%) starting distributions, and at levels similar to the Existing Conditions. In conclusion, Alternative 4 would provide a benefit to the species because of the substantial reductions in south Delta entrainment, and therefore no mitigation would be required.

Impact AQUA-22: Effects of Water Operations on Spawning, Egg Incubation, and Rearing Habitat for Longfin Smelt

Adult longfin smelt inhabit primarily brackish water and marine areas in San Pablo and San Francisco Bays and nearshore coastal marine waters. Prespawning adult longfin smelt use the Delta for staging and spawning. The planktonic larvae are transported downstream after hatching; within the Plan Area, the early juvenile life stages rear in the low-salinity areas of the West Delta and Suisun Bay subregions. Juvenile and adult longfin smelt occupying the Plan Area during fall through spring migrate westward into San Francisco Bay during the summer.

Longfin smelt spawn in the late winter and early spring months when water temperatures in the lower rivers and Delta are seasonally cool. Longfin smelt spawn adhesive eggs that are thought to be deposited on sand and gravel and possibly other hard substrates. Spawning occurs in the lower reaches of the Sacramento River in the vicinity of Cache Slough and Rio Vista, although some spawning occurs in the lower San Joaquin River based on presence of early larval and adult longfin smelt in CDFW larval trawl samples (California Department of Fish and Game 2009b). Spawning also occurs in Suisun Marsh and the Napa River.

Immediately after hatching from the incubating eggs, longfin smelt larvae are planktonic and drift passively with water flows; older larvae use a variety of behaviors to help retain themselves in favorable habitats (Bennett et al. 2002). Larvae are typically present in the Delta during the late winter and early spring months. Juvenile longfin smelt rear in the spring (approximately March to June) in the Suisun Bay and the West Delta subregions before migrating downstream of the Plan Area into San Pablo and San Francisco Bays and nearshore coastal marine waters, where they continue to rear for a year or more. Larval and early juvenile longfin smelt could be affected by covered activities when they are present in the Plan Area during the winter and spring months.

Longfin smelt rear in the Plan Area principally during spring and the abundance of longfin smelt in the Fall Midwater Trawl (FMWT) has been correlated to outflow (expressed as the location of X2) in the preceding winter and spring months (January–June), when spawning and rearing are occurring (Kimmerer 2002a; Kimmerer et al. 2009; Rosenfield and Baxter 2007; Mac Nally et al. 2010; Thomson et al. 2010). Based on Kimmerer et al. (2009), reduced outflow in January through June, compared to the NAA, has the potential to reduce longfin smelt abundance. The X2–longfin smelt abundance relationship provided by Kimmerer et al. (2009) was used to evaluate the effects of the alternatives on longfin smelt, following the historical observation that lower X2 (farther downstream) would contribute to increased recruitment. Relationships between December through May X2 position and log longfin smelt abundance developed by Kimmerer et al. (2009) were used to determine how the changes in winter-spring X2 position described above might influence longfin smelt abundance the following fall.

Table 11-4-7. Differences in Mean Monthly Delta Outflow (cfs) between NAA and Alternative 4 Scenarios H1, H2, H3, and H4, by Water Year Type, for Winter-Spring (December–June)

Month	Water-Year Type	NAA vs. H1	NAA vs. H2	NAA vs. H3	NAA vs. H4
January	Wet	-423 (-0.4%)	-833 (-0.9%)	-3,978 (-4.2%)	-2,778 (-2.9%)
	Above Normal	-468 (-0.9%)	-533 (-1%)	-2,949 (-5.8%)	-3,029 (-5.9%)
	Below Normal	-68 (-0.3%)	610 (2.7%)	-676 (-3%)	-177 (-0.8%)
	Dry	901 (6.1%)	1,674 (11.4%)	649 (4.4%)	332 (2.3%)
	Critical	852 (6.7%)	892 (7.1%)	824 (6.5%)	-388 (-3.1%)
	All	108 (0.2%)	260 (0.6%)	-1,545 (-3.3%)	-1,338 (-2.9%)
February	Wet	97 (0.1%)	90 (0.1%)	-809 (-0.8%)	-1,222 (-1.1%)
	Above Normal	66 (0.1%)	919 (1.4%)	-1,817 (-2.8%)	-1,193 (-1.8%)
	Below Normal	-911 (-2.5%)	156 (0.4%)	-2,017 (-5.6%)	-1,026 (-2.8%)
	Dry	-1,313 (-6.1%)	-1,297 (-6%)	-1,218 (-5.7%)	-1,111 (-5.2%)
	Critical	-205 (-1.6%)	-212 (-1.7%)	-270 (-2.1%)	20 (0.2%)
	All	-433 (-0.8%)	-126 (-0.2%)	-1,174 (-2.1%)	-978 (-1.7%)
March	Wet	-512 (-0.6%)	1,826 (2.2%)	-1,504 (-1.8%)	944 (1.1%)
	Above Normal	-213 (-0.4%)	472 (0.8%)	-1,507 (-2.7%)	-613 (-1.1%)
	Below Normal	-2,167 (-9.6%)	2,283 (10.2%)	-2,846 (-12.7%)	1,447 (6.4%)
	Dry	-2,440 (-12.2%)	-693 (-3.5%)	-2,523 (-12.6%)	-737 (-3.7%)
	Critical	-332 (-2.7%)	-111 (-0.9%)	-353 (-2.9%)	-258 (-2.1%)
	All	-1,148 (-2.5%)	870 (1.9%)	-1,789 (-4%)	257 (0.6%)
April	Wet	-5,353 (-9.81%)	-138 (-0.3%)	-5,586 (-10.2%)	-438 (-0.8%)
	Above Normal	-5,242 (-17.1%)	1,976 (6.5%)	-5,173 (-16.9%)	2,154 (7%)
	Below Normal	-2,098 (-10.2%)	4,079 (19.8%)	-2,229 (-10.8%)	3,743 (18.1%)
	Dry	-707 (-5.3%)	404 (3%)	-798 (-6%)	409 (3%)
	Critical	-344 (-3.7%)	-344 (-3.7%)	-406 (-4.4%)	-264 (-2.8%)
	All	-3,028 (-10.2%)	980 (3.3%)	-3,143 (-10.6%)	867 (2.9%)
May	Wet	-3,574 (-10.9%)	220 (0.7%)	-3,608 (-11%)	274 (0.8%)
	Above Normal	-2,417 (-11.1%)	731 (3.4%)	-2,343 (-10.8%)	728 (3.4%)
	Below Normal	110 (0.8%)	1,908 (14%)	257 (1.9%)	1,625 (12%)
	Dry	628 (6.1%)	663 (6.4%)	660 (6.4%)	580 (5.6%)
	Critical	38 (0.6%)	142 (2.3%)	-15 (-0.2%)	128 (2%)
	All	-1,325 (-6.9%)	669 (3.5%)	-1,300 (-6.8%)	617 (3.2%)
June	Wet	139 (0.9%)	-87 (-0.6%)	101 (0.6%)	-240 (-1.5%)
	Above Normal	320 (3%)	-233 (-2.2%)	378 (3.5%)	-168 (-1.6%)
	Below Normal	942 (10.5%)	982 (11%)	710 (7.9%)	984 (11%)
	Dry	207 (2.7%)	67 (0.9%)	127 (1.7%)	83 (1.1%)
	Critical	-276 (-4.9%)	-297 (-5.3%)	-312 (-5.5%)	-298 (-5.3%)
	All	257 (2.4%)	77 (0.7%)	191 (1.8%)	42 (0.4%)
December	Wet	1,737 (3.8%)	3,380 (7.5%)	-1,178 (-2.6%)	-261 (-0.6%)
	Above Normal	817 (4.3%)	-622 (-3.3%)	10 (0.1%)	-693 (-3.6%)
	Below Normal	923 (7.5%)	612 (5%)	-26 (-0.2%)	-241 (-2%)
	Dry	972 (11%)	692 (7.8%)	682 (7.7%)	678 (7.7%)
	Critical	288 (4.4%)	124 (1.9%)	-130 (-2%)	-572 (-8.7%)
	All	1,083 (4.9%)	1,255 (5.7%)	-246 (-1.1%)	-160 (-0.7%)

Ultimately, initial Alternative 4 water operations will be determined through the BDCP decision tree process to determine the necessary spring Delta outflow. Under Scenarios H1 and H3, which do not include enhanced spring outflow, modeled average Delta spring outflow is often lower than the NAA. The spring outflows in H2 and H4, which include the enhanced spring outflow, were greater than NAA in a number of years, as illustrated by differences in water-year-type average Delta outflow (See Table 11-4-7 above). As such, based on Kimmerer et al. 2009, the longfin smelt abundance for H1 and H3 ranged from a reduction of 32 to 37% compared to Existing Conditions, to a reduction of 3% to an increase of 3% compared to the NAA. For H2 and H4, which include enhanced spring outflow and climate change effects, the predicted longfin smelt abundance ranged from a reduction of 26% to 30% compared to Existing Conditions to an increase of 12% to 16% when compared to the NAA, based on the X2-abundance equation in Kimmerer et al. (2009).

NEPA Effects: Through the term of the permit, BDCP water operations will be subject to adjustment via adaptive management, beginning with the decision tree process in the years prior to CM1 operations. Recognizing the uncertainties of habitat restoration and disagreement regarding the magnitudes of spring outflow augmentation necessary to support the conservation of longfin smelt, the Decision Tree phase of adaptive management is designed to allow for further evaluation of this, and other species' spring outflow needs, concurrent with early evaluation of the level of benefits of BDCP habitat restoration for longfin smelt. The decision tree process will inform a decision made at the time CM1 operations begin regarding the parameters of water operations. That decision will, on the basis of what has been learned about the effects of outflow and habitat restoration, identify CM1 operations that are expected to meet the longfin smelt population growth objective. Those operations will ensure the impacts of water operations on rearing habitat for longfin smelt are not adverse and support a contribution to recovery of this species. Following this decision, the Adaptive Management Program will continue to evaluate the effects of water operations and habitat restoration on the longfin smelt population, including making adjustments as appropriate to improve water supply reliability.

Table 11-4-8. Estimated Differences Between Alternative 4 (Scenario H3) and Baseline for Longfin Smelt Relative Abundance in the Fall Midwater Trawl or Bay Otter Trawl Based on the X2-Relative Abundance Regression of Kimmerer et al. (2009)

	Fall Midwater Trawl Relative Abundance		Bay Otter Trawl Relative Abundance	
Water Year Type	EXISTING CONDITIONS vs. A4 (H3)	NAA vs. A4 (H3)	EXISTING CONDITIONS vs. A4 (H3)	NAA vs. A4 (H3)
Scenario H3				
All	-2,959 (-33%)	77 (1%)	-11,658 (-38%)	544 (3%)
Wet	-6,423 (-34%)	614 (5%)	-27,026 (-39%)	2,856 (7%)
Above Normal	-3,264 (-32%)	-267 (-4%)	-12,018 (-37%)	-881 (-4%)
Below Normal	-1,629 (-36%)	-291 (-9%)	-5,107 (-42%)	-903 (-11%)
Dry	-619 (-27%)	-106 (-6%)	-1,747 (-31%)	-295 (-7%)
Critical	-208 (-20%)	-38 (-4%)	-511 (-24%)	-93 (-5%)
Scenario H1 (Low Outflow)				
All	-2,879 (-32%)	157 (3%)	-11,367 (-37%)	836 (5%)
Wet	-6,298 (-33%)	739 (6%)	-26,515 (-38%)	3,367 (8%)
Above Normal	-3,069 (-31%)	-72 (-1%)	-11,361 (-35%)	-224 (-1%)
Below Normal	-1,558 (-35%)	-220 (-7%)	-4,907 (-40%)	-702 (-9%)
Dry	-626 (-27%)	-113 (-6%)	-1,764 (-32%)	-313 (-8%)
Critical	-199 (-19%)	-29 (-3%)	-490 (-23%)	-71 (-4%)
Scenario H4 (High Outflow)				
All	-2,308 (-26%)	727 (12%)	-9,338 (-31%)	2,864 (16%)
Wet	-5,359 (-28%)	1,678 (14%)	-23,092 (-33%)	6,790 (17%)
Above Normal	-2,060 (-20%)	936 (13%)	-7,606 (-24%)	3,531 (17%)
Below Normal	-946 (-21%)	391 (12%)	-2,958 (-24%)	1,246 (16%)
Dry	-519 (-22%)	-6 (0%)	-1,453 (-26%)	-2 (0%)
Critical	-221 (-21%)	-51 (-6%)	-539 (-25%)	-120 (-7%)
	Shading indicates relative abundance under Alt4 decrease of 10% or greater.			

CEQA Conclusion: Under Alternative 4, average Delta outflow would be slightly greater than under Existing Conditions during January and February (Table 11-4-9). Under Scenarios H1 and H3, monthly Delta outflow is reduced in March to June compared to Existing Conditions, with variation among water year types. Under Scenarios H2 and H4, average Delta outflows would be similar to Existing Conditions from January to April, but on average 12% lower in May and 17% lower in June.

Table 11-4-9. Differences in Mean Monthly Delta Outflow (cfs) between Existing Conditions and Alternative 4 Scenarios H1, H2, H3, and H4, by Water Year Type, for Winter-Spring (December–June)

Month	Water-Year Type	EXISTING CONDITIONS vs. H1	EXISTING CONDITIONS vs. H2	EXISTING CONDITIONS vs. H3	EXISTING CONDITIONS vs. H4
January	Wet	8,297 (9.7%)	7,887 (9.2%)	4,741 (5.5%)	5,942 (6.9%)
	Above Normal	1,185 (2.4%)	1,119 (2.3%)	-1,297 (-2.6%)	-1,377 (-2.8%)
	Below Normal	-736 (-3.2%)	-57 (-0.2%)	-1,343 (-5.8%)	-844 (-3.7%)
	Dry	898 (6.1%)	1,671 (11.3%)	646 (4.4%)	329 (2.2%)
	Critical	2,160 (19%)	2,200 (19.4%)	2,132 (18.8%)	920 (8.1%)
	All	3,192 (7.4%)	3,343 (7.7%)	1,538 (3.6%)	1,745 (4%)
February	Wet	10,347 (10.7%)	10,340 (10.7%)	9,441 (9.8%)	9,028 (9.3%)
	Above Normal	3,618 (5.8%)	4,471 (7.2%)	1,735 (2.8%)	2,358 (3.8%)
	Below Normal	-1,593 (-4.3%)	-526 (-1.4%)	-2,699 (-7.3%)	-1,708 (-4.6%)
	Dry	-767 (-3.7%)	-751 (-3.6%)	-673 (-3.2%)	-565 (-2.7%)
	Critical	-398 (-3.1%)	-405 (-3.1%)	-463 (-3.6%)	-173 (-1.3%)
	All	3,312 (6.3%)	3,619 (6.9%)	2,571 (4.9%)	2,767 (5.3%)
March	Wet	5,003 (6.3%)	7,342 (9.3%)	4,012 (5.1%)	6,459 (8.2%)
	Above Normal	2,353 (4.3%)	3,039 (5.6%)	1,060 (2%)	1,953 (3.6%)
	Below Normal	-3,728 (-15.5%)	722 (3%)	-4,408 (-18.3%)	-114 (-0.5%)
	Dry	-2,334 (-11.7%)	-588 (-3%)	-2,418 (-12.2%)	-632 (-3.2%)
	Critical	-28 (-0.2%)	193 (1.6%)	-49 (-0.4%)	45 (0.4%)
	All	778 (1.8%)	2,795 (6.5%)	137 (0.3%)	2,182 (5.1%)
April	Wet	-5,185 (-9.5%)	30 (0.1%)	-5,418 (-10%)	-270 (-0.5%)
	Above Normal	-6,641 (-20.8%)	577 (1.8%)	-6,572 (-20.6%)	754 (2.4%)
	Below Normal	-3,385 (-15.4%)	2,793 (12.7%)	-3,516 (-16%)	2,457 (11.2%)
	Dry	-1,435 (-10.2%)	-325 (-2.3%)	-1,527 (-10.8%)	-319 (-2.3%)
	Critical	-104 (-1.1%)	-104 (-1.1%)	-166 (-1.8%)	-24 (-0.3%)
	All	-3,524 (-11.7%)	484 (1.6%)	-3,639 (-12.1%)	371 (1.2%)
May	Wet	-11,733 (-28.6%)	-7,940 (-19.3%)	-11,767 (-28.7%)	-7,885 (-19.2%)
	Above Normal	-4,908 (-20.3%)	-1,760 (-7.3%)	-4,833 (-20%)	-1,762 (-7.3%)
	Below Normal	-2,593 (-15.9%)	-795 (-4.9%)	-2,446 (-15%)	-1,078 (-6.6%)
	Dry	515 (4.9%)	550 (5.2%)	547 (5.2%)	468 (4.5%)
	Critical	324 (5.4%)	428 (7.1%)	271 (4.5%)	415 (6.9%)
	All	-4,721 (-21%)	-2,727 (-12.1%)	-4,696 (-20.9%)	-2,779 (-12.3%)
June	Wet	-7,672 (-32.7%)	-7,898 (-33.7%)	-7,710 (-32.9%)	-8,051 (-34.3%)
	Above Normal	-805 (-6.8%)	-1,358 (-11.5%)	-747 (-6.3%)	-1,293 (-11%)
	Below Normal	1,881 (23.5%)	1,921 (24%)	1,649 (20.6%)	1,923 (24%)
	Dry	1,261 (19%)	1,121 (16.9%)	1,181 (17.8%)	1,136 (17.1%)
	Critical	34 (0.6%)	13 (0.2%)	-2 (0%)	11 (0.2%)
	All	-1,948 (-15.3%)	-2,127 (-16.7%)	-2,014 (-15.8%)	-2,162 (-16.9%)
December	Wet	-1,258 (-2.6%)	386 (0.8%)	-4,172 (-8.7%)	-3,255 (-6.8%)
	Above Normal	1,921 (10.7%)	482 (2.7%)	1,115 (6.2%)	412 (2.3%)
	Below Normal	1,204 (10.1%)	893 (7.5%)	255 (2.1%)	40 (0.3%)
	Dry	916 (10.3%)	636 (7.2%)	626 (7%)	622 (7%)
	Critical	1,317 (23.8%)	1,154 (20.9%)	899 (16.3%)	458 (8.3%)
	All	482 (2.1%)	654 (2.9%)	-847 (-3.7%)	-762 (-3.4%)

Average relative abundance of longfin smelt, as estimated by the Kimmerer et al. 2009 method, is 32% to 38% lower under Scenarios H1 and H3 compared to Existing Conditions (Table 11-4-8). For H2 and H4, which include enhanced spring outflow, the longfin smelt abundance is 26% to 31% lower compared to Existing Conditions, based on Kimmerer et al. 2009.

Contrary to the NEPA conclusion set forth above, these results indicate that the difference between Existing Conditions and Alternative 4 could be significant because the alternative could substantially reduce relative abundance based on Kimmerer 2009. However, this interpretation of the biological modeling results is likely attributable to different modeling assumptions for four factors: sea level rise, climate change, future water demands, and implementation of the alternative. As discussed above (Section 11.3.3), because of differences between the CEQA and NEPA baselines, it is sometimes possible for CEQA and NEPA significance conclusions to vary between one another under the same impact discussion. The baseline for the CEQA analysis is Existing Conditions at the time the NOP was prepared. Both the action alternative and the NEPA baseline (NAA) models anticipated future conditions that would occur in 2060 (LLT implementation period), including the projected effects of climate change (precipitation patterns), sea level rise and future water demands, as well as implementation of required actions under the 2008 USFWS BiOp and the 2009 NMFS BiOp. Because the action alternative modeling does not partition the effects of implementation of the alternative from the effects of sea level rise, climate change and future water demands, the comparison to Existing Conditions may not offer a clear understanding of the impact of the alternative on the environment. This suggests that the NEPA analysis, which compares results between the alternative and NAA, is a better approach because it isolates the effect of the alternative from those of sea level rise, climate change, and future water demands.

When compared to NAA and informed by the NEPA analysis, above, the average longfin smelt abundance, based on Kimmerer et al. (2009), increased 1% to 5% for H1 and H3, and increased 12% to 16% for H2 and H4, which include enhanced spring outflow (Table 11-4-8). These results represent the increment of change attributable to the alternative, demonstrating the similarities in modeled longfin smelt recruitment under Alternative 4 and the NAA, and addressing the limitations of the comparison the CEQA baseline (Existing Conditions). Furthermore, the decision tree process, which is part of the Adaptive Management and Monitoring Program, is designed to allow for an evaluation of the needed volume of spring outflow and to inform a decision regarding starting operations. This will help the BDCP to meet the longfin smelt population growth and abundance objectives, and will ensure the impacts of water operations on spawning, egg incubation and rearing habitat for longfin smelt are less than significant. After initial starting operations, the Adaptive Management Program will continue to evaluate water operations and make adjustments as necessary to protect longfin smelt abundances and ensure the impacts of water operations on spawning, egg incubation and rearing habitat for longfin smelt are less than significant. Therefore, this impact is found to be less than significant and no mitigation is required. In addition, CM4 could also improve the quality of spawning and rearing habitat for longfin smelt, by increasing suitable habitat area and food production in the Delta, although there is some uncertainty of the outcome related to habitat restoration.

Impact AQUA-23: Effects of Water Operations on Rearing Habitat for Longfin Smelt

The analysis, NEPA Effects and CEQA Conclusion for effects of water operations on rearing habitat for longfin smelt is included in Impact AQUA-22: Effects of Water Operations on Spawning, Egg Incubation, and Rearing Habitat for Longfin Smelt.

Impact AQUA-24: Effects of Water Operations on Migration Conditions for Longfin Smelt

The analysis, NEPA Effects and CEQA Conclusion for effects of water operations on migration conditions for longfin smelt is included in Impact AQUA-22: Effects of Water Operations on Spawning, Egg Incubation, and Rearing Habitat for Longfin Smelt.

Restoration Measures (CM2, CM4–CM7, and CM10)

Alternative 4 has the same restoration measures as Alternative 1A. Because no substantial differences in restoration-related effects on fish are anticipated anywhere in the affected environment under Alternative 4 compared to those described in detail for Alternative 1A, the effects of restoration measures on longfin smelt described under Alternative 1A (Impacts AQUA-25 through AQUA-27) also appropriately characterize effects under Alternative 4.

The following impacts are those presented under Alternative 1A that are identical for Alternative 4.

Impact AQUA-25: Effects of Construction of Restoration Measures on Longfin Smelt

Impact AQUA-26: Effects of Contaminants Associated with Restoration Measures on Longfin Smelt

Impact AQUA-27: Effects of Restored Habitat Conditions on Longfin Smelt

NEPA Effects: Detailed discussions regarding the potential effects of these three impact mechanisms on longfin smelt are the same, as those described under Alternative 1A (Impacts AQUA-25 through AQUA-27). The effects would not be adverse, and would generally be beneficial. Specifically for AQUA-26, the effects of contaminants on longfin smelt with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on longfin smelt are uncertain.

CEQA Conclusion: All three of the impact mechanisms listed above would be at least slightly beneficial, or less than significant, and no mitigation is required for the reasons identified for Alternative 1A.

Other Conservation Measures (CM12–CM19 and CM21)

Alternative 4 has the same other conservation measures as Alternative 1A. Because no substantial differences in other conservation-related effects on fish are anticipated anywhere in the affected environment under Alternative 4 compared to those described in detail for Alternative 1A, the effects of other conservation measures on longfin smelt described under Alternative 1A (Impacts AQUA-28 through AQUA-36) also appropriately characterize effects under Alternative 4.

The following impacts are those presented under Alternative 1A that are identical for Alternative 4.

Impact AQUA-28: Effects of Methylmercury Management on Longfin Smelt (CM12)

Impact AQUA-29: Effects of Invasive Aquatic Vegetation Management on Longfin Smelt (CM13)

Impact AQUA-30: Effects of Dissolved Oxygen Level Management on Longfin Smelt (CM14)

Impact AQUA-31: Effects of Localized Reduction of Predatory Fish on Longfin Smelt (CM15)

Impact AQUA-32: Effects of Nonphysical Fish Barriers on Longfin Smelt (CM16)

Impact AQUA-33: Effects of Illegal Harvest Reduction on Longfin Smelt (CM17)

Impact AQUA-34: Effects of Conservation Hatcheries on Longfin Smelt (CM18)

Impact AQUA-35: Effects of Urban Stormwater Treatment on Longfin Smelt (CM19)

Impact AQUA-36: Effects of Removal/Relocation of Nonproject Diversions on Longfin Smelt (CM21)

NEPA Effects: Detailed discussions regarding the potential effects of these nine impact mechanisms on longfin smelt are the same as those described under Alternative 1A (Impacts AQUA-28 through AQUA-36). The effects range from no effect, to not adverse, to beneficial.

CEQA Conclusion: The effects of the nine impact mechanisms listed above range from no impact, to less than significant, to beneficial, and no mitigation is required.

Winter-Run Chinook Salmon

Construction and Maintenance of CM1

Impact AQUA-37: Effects of Construction of Water Conveyance Facilities on Chinook Salmon (Winter-Run ESU)

The potential effects of construction of the water conveyance facilities on winter-run Chinook salmon would be the same as those described for Alternative 1A (Impact AQUA-37) except that Alternative 4 would include three intakes instead of five, so the effects would be proportionally less under this alternative. This would convert about 6,360 lineal feet of existing shoreline habitat into intake facility structures and would require about 17.1 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. Alternative 4 would use five barge locations rather than six as under Alternative 1A so those effects would also be proportionally less. Additionally, construction and excavation at Clifton Court Forebay would be done in the dry via installation of cofferdams for isolation and dewatering of work areas. Implementation of Appendix 3B, *Environmental Commitments*, including construction BMPs and 3B.8–*Fish Rescue and Salvage Plan*, would minimize adverse effects as described for Alternative 1A. Mitigation measures would also be available to avoid and minimize potential effects.

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-37, the effect would not be adverse for Chinook salmon.

CEQA Conclusion: As described in Alternative 1A (Impact AQUA-37) the impact of construction of the water conveyance facilities on Chinook salmon would not be significant except for construction noise associated with pile driving. Potential pile driving impacts would be less than Alternative 1A because only three intakes would be constructed rather than five. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in the discussion of Alternative 1A.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in the discussion of Alternative 1A.

Impact AQUA-38: Effects of Maintenance of Water Conveyance Facilities on Chinook Salmon (Winter-Run ESU)

NEPA Effects: The potential effects of the maintenance of water conveyance facilities under Alternative 4 would be the same as those described for Alternative 1A (Impact AQUA-38) except that only three intakes would need to be maintained under Alternative 4 rather than five under Alternative 1A. As concluded in Alternative 1A, Impact AQUA-38, the impact would not be adverse for winter-run Chinook salmon.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-38, the impact of the maintenance of water conveyance facilities on Chinook salmon would be less than significant and no mitigation is required.

Water Operations of CM1

Impact AQUA-39: Effects of Water Operations on Entrainment of Chinook Salmon (Winter-Run ESU)

Water Exports from SWP/CVP South Delta Facilities

The proportion of juvenile winter-run Chinook salmon subject to entrainment is low under Existing Conditions and NAA (annual index of abundance average 1.4%) and Alternative 4 would further reduce entrainment of juvenile winter-run Chinook salmon at the south Delta facilities. For example, Scenario H3 would reduce the proportion of juvenile winter-run Chinook entrained in the south Delta (average of 0.6%). As such, average entrainment under Scenario H3 would be reduced by 52% (~3,500 fish: Table 11-4-10) across all water years compared to NAA. Entrainment would be substantially reduced in wet and above normal water year types (60–70% less than NAA) and would be moderately reduced in below normal, dry, and critical water year types (18–33% less than NAA).

Scenarios H2 and H4 is expected to further reduce entrainment of winter-run salmon because south Delta exports during the spring would be less relative to the Scenario H3. Entrainment losses under Scenario H1 are expected to be similar to Scenario H3.

Table 11-4-10. Juvenile Winter-Run Chinook Salmon Annual Entrainment Index at the SWP and CVP Salvage Facilities—Differences between Model Scenarios for Alternative 4 (Scenario H3)

	Absolute Difference (Percent Difference)	
Water Year	EXISTING CONDITIONS vs. H3	NAA vs. H3
Wet	-7,816 (-69%)	-8,237 (-70%)
Above Normal	-3,919 (-59%)	-4,043 (-60%)
Below Normal	-2,666 (-37%)	-2,241 (-33%)
Dry	-1,116 (-29%)	-809 (-23%)
Critical	-343 (-27%)	-205 (-18%)
All Years	-3,584 (-53%)	-3,524 (-52%)

Note: Estimated annual number of fish lost, based on normalized data.

Water Exports from SWP/CVP North Delta Intake Facilities

The effect of Alternative 4 on entrainment and impingement at the north Delta intakes would be the same as described for Alternative 1A (Impact AQUA-39), but the degree would be less because Alternative 4 would have fewer intakes. State-of-the-art fish screens operated with an adaptive management plan would be expected to eliminate entrainment risk for juvenile winter-run Chinook salmon.

Water Export with a Dual Conveyance for the SWP North Bay Aqueduct

The effect would be the same as described for Alternative 1A (Impact AQUA-39). Entrainment and impingement effects would be minimal because intakes on the Sacramento River would have state-of-the-art screens installed.

Predation Associated with Entrainment

Entrainment-related predation loss of winter-run Chinook salmon at the south Delta facilities under this alternative would be no greater than loss under NAA and may be lower than loss under NAA due to a decrease in entrainment loss. Entrainment-related predation losses at the south Delta under Scenario H1 are expected to be similar to Scenario H3, and decreased further under Scenarios H2 and H4 as spring outflow is increased and south Delta exports are decreased.

Predation at the north Delta would be increased due to the installation of the proposed SWP/CVP North Delta intake facilities on the Sacramento River. Bioenergetics modeling with a median predator density predicts increased predation loss of about 4,300 juveniles, or 0.16% of the winter-run Chinook salmon juvenile index of abundance under Alternative 4 (Table 11-4-11).

Table 11-4-11. Winter-Run Chinook Salmon Predation Loss at the Proposed North Delta Diversion (NDD) Intakes (Three Intakes for Alternative 4)

Striped Bass at NDD (Three Intakes)			Winter-Run Chinook Consumed	
Density Assumption	Bass per 1,000 Feet of Intake	Total Number of Bass	Number	Percentage of Annual Juvenile Production
Low	18	86	648	0.02%
Median	119	571	4,283	0.16%
High	219	1,051	7,881	0.30%

Note: Based on bioenergetics modeling of Chinook salmon consumption by striped bass (Appendix 5F Biological Stressors).

NEPA Effects: In conclusion, Alternative 4 would reduce overall entrainment losses of juvenile winter-run Chinook salmon relative to NAA. This effect would not be adverse and would provide a benefit to the species because of the reductions in entrainment loss and mortality.

CEQA Conclusion: As described above, entrainment losses of juvenile winter-run Chinook salmon at the south Delta facilities would decrease under Alternative 4 compared to Existing Conditions (Table 11-4-10). Overall, impacts of water operations on entrainment of juvenile Chinook salmon (winter-run ESU) would be less than significant and may be beneficial. No mitigation would be required.

Impact AQUA-40: Effects of Water Operations on Spawning and Egg Incubation Habitat for Chinook Salmon (Winter-Run ESU)

In general, the effects of Alternative 4 on spawning and egg incubation habitat for winter-run Chinook salmon relative to the NAA are uncertain.

H3/ESO

Flows in the Sacramento River between Keswick and upstream of Red Bluff Diversion Dam were examined during the May through September winter-run spawning period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Lower flows can reduce the instream area available for spawning and egg incubation. Flows under H3 would generally be greater (by up to 20%) than flows under NAA during May and June and similar during July through September. Based on these flow results, it is expected that H3 would generally provide flow-related benefits to winter-run Chinook salmon spawning and egg incubation habitat in earlier months and no effects in later months.

Shasta Reservoir storage volume at the end of May influences flow rates below the dam during the May through September winter-run spawning and egg incubation period. May Shasta storage under H3 would be similar (<5% difference) to storage under NAA for all water year types (Table 11-4-12).

Table 11-4-12. Difference and Percent Difference in May Water Storage Volume (thousand acre-feet) in Shasta Reservoir for Alternative 4 (Scenario H3)

Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
Wet	-59 (-1%)	-25 (-1%)
Above Normal	-156 (-3%)	-70 (-2%)
Below Normal	-330 (-8%)	-132 (-3%)
Dry	-550 (-15%)	-106 (-3%)
Critical	-622 (-25%)	-38 (-2%)

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the May through September winter-run spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period at either location.

The number of days on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month (May through September) and year of the 82-year modeling period (Table 11-4-13). The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern", as defined in Table 11-4-14. Differences between baselines and H3in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4-15. There would be no difference in levels of concern between NAA and H3.

Table 11-4-13. Maximum Water Temperature Criteria for Covered Salmonids and Sturgeon Provided by NMFS and Used in the BDCP Effects Analysis

Location	Period	Maximum Water Temperature (°F)	Purpose
Upper Sacramento River			
Bend Bridge	May–Sep	56	Winter- and spring-run spawning and egg incubation
		63	Green sturgeon spawning and egg incubation
Red Bluff	Oct–Apr	56	Spring-, fall-, and late fall–run spawning and egg incubation
Hamilton City	Mar–Jun	61 (optimal), 68 (lethal)	White sturgeon spawning and egg incubation
Feather River			
Robinson Riffle (RM 61.6)	Sep–Apr	56	Spring-run and steelhead spawning and incubation
	May–Aug	63	Spring-run and steelhead rearing
Gridley Bridge	Oct–Apr	56	Fall- and late fall–run spawning and steelhead rearing
	May–Sep	64	Green sturgeon spawning, incubation, and rearing
American River			
Watt Avenue Bridge	May–Oct	65	Juvenile steelhead rearing

Table 11-4-14. Number of Days per Month Required to Trigger Each Level of Concern for Water Temperature Exceedances in the Sacramento River for Covered Salmonids and Sturgeon Provided by NMFS and Used in the BDCP Effects Analysis

Exceedance above Water Temperature Threshold (°F)	Level of Concern			
	None	Yellow	Orange	Red
1	0–9 days	10–14 days	15–19 days	≥20 days
2	0–4 days	5–9 days	10–14 days	≥15 days
3	0 days	1–4 days	5–9 days	≥10 days

Table 11-4-15. Differences between Baseline and H3 Scenarios in the Number of Years in Which Water Temperature Exceedances above 56°F Are within Each Level of Concern, Sacramento River at Bend Bridge, May through September

Level of Concern	EXISTING CONDITIONS vs. H3	NAA vs. H3
Red	31 (61%)	0 (0%)
Orange	-17 (-100%)	0 (NA)
Yellow	-11 (-100%)	0 (NA)
None	-3 (-100%)	0 (NA)

Note: For definitions of levels of concern, see Table 11-4-14.
NA = could not be calculated because the denominator was 0.

Total degree-days exceeding 56°F at Bend Bridge were summed by month and water year type during May through September (Table 11-4-16). Total degree-days under H3 would be up to 11% lower than under NAA during May and June and up to 11% higher during July through September.

Table 11-4-16. Differences between Baseline and H3 Scenarios in Total Degree-Days (°F-Days) by Month and Water Year Type for Water Temperature Exceedances above 56°F in the Sacramento River at Bend Bridge, May through September

Month	Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
May	Wet	1,065 (282%)	-137 (-9%)
	Above Normal	228 (107%)	-127 (-22%)
	Below Normal	434 (198%)	-29 (-4%)
	Dry	246 (132%)	-168 (-28%)
	Critical	454 (205%)	44 (7%)
	All	2,427 (200%)	-417 (-10%)
June	Wet	500 (130%)	-211 (-19%)
	Above Normal	66 (45%)	-163 (-43%)
	Below Normal	276 (199%)	-76 (-15%)
	Dry	514 (273%)	-20 (-3%)
	Critical	623 (155%)	73 (8%)
	All	1,979 (157%)	-397 (-11%)
July	Wet	653 (126%)	47 (4%)
	Above Normal	347 (428%)	77 (22%)
	Below Normal	591 (402%)	135 (22%)
	Dry	1,313 (466%)	385 (32%)
	Critical	1,776 (216%)	-10 (-0.4%)
	All	4,680 (253%)	634 (11%)
August	Wet	2,091 (300%)	128 (5%)
	Above Normal	830 (203%)	171 (16%)
	Below Normal	1,246 (470%)	211 (16%)
	Dry	2,063 (308%)	453 (20%)
	Critical	2,732 (184%)	113 (3%)
	All	8,962 (254%)	1,076 (9%)
September	Wet	806 (109%)	97 (7%)
	Above Normal	586 (82%)	186 (17%)
	Below Normal	1,570 (210%)	424 (22%)
	Dry	2,425 (190%)	-171 (-4%)
	Critical	1,938 (93%)	47 (1%)
	All	7,325 (132%)	583 (5%)

The Reclamation egg mortality model predicts that winter-run Chinook salmon egg mortality in the Sacramento River under H3 would be lower or similar to mortality under NAA except in below normal and dry water years (76% and 11% greater, respectively), although the absolute increase in these water years would be only 1% (Table 11-4-17). Therefore, the increase in mortality from NAA to H3, although relatively large, would be negligible at an absolute scale to the winter-run population.

Table 11-4-17. Difference and Percent Difference in Percent Mortality of Winter-Run Chinook Salmon Eggs in the Sacramento River (Egg Mortality Model)

Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
Wet	1 (262%)	-0.1 (-4%)
Above Normal	2 (340%)	-0.1 (-3%)
Below Normal	2 (228%)	1 (76%)
Dry	7 (436%)	1 (11%)
Critical	42 (156%)	-2 (-3%)
All	9 (185%)	0.1 (1%)

SacEFT predicts that there would be a 28% decrease in the percentage of years with good spawning availability, measured as weighted usable area, under H3 relative to NAA (Table 11-4-18). On an absolute scale, this reduction would be small (9% lower). SacEFT predicts that the percentage of years with good (lower) redd scour risk, good (lower) redd dewatering risk, and good egg incubation conditions under H3 would be similar to the percentage of years under NAA. These results indicate that there would be a small negative effect of H3 on spawning habitat, but no effects on other modeled parameters.

The biological significance of a reduction in available suitable spawning habitat varies at the population level in response to a number of factors, including adult escapement. For those years when adult escapement is less than the carrying capacity of the spawning habitat, a reduction in area would have little or no population level effect. In years when escapement exceeds carrying capacity of the reduced habitat, competition among spawners for space (e.g., increased redd superimposition) would increase, resulting in reduced reproductive success. The reduction in the frequency of years in which spawning habitat availability is considered to be good by SacEFT could result in reduced reproductive success and abundance of winter-run Chinook salmon if the number of spawners is limited by spawning habitat quantity.

Table 11-4-18. Difference and Percent Difference in Percentage of Years with "Good" Conditions for Winter-Run Chinook Salmon Habitat Metrics in the Upper Sacramento River (from SacEFT)

Metric	EXISTING CONDITIONS vs. H3	NAA vs. H3
Spawning WUA	-35 (-60%)	-9 (-28%)
Redd Scour Risk	0 (0%)	0 (0%)
Egg Incubation	-25 (-26%)	-2 (-3%)
Redd Dewatering Risk	3 (12%)	-1 (-3%)
Juvenile Rearing WUA	-24 (-48%)	1 (4%)
Juvenile Stranding Risk	0 (0%)	-11 (-35%)
WUA = Weighted Usable Area.		

H1/LOS

Flows in the Sacramento River between Keswick and Red Bluff Diversion Dam under H1 between May and September would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis).* Further, May storage in Shasta Reservoir under H1 would be similar to storage under H3 (Table 11-4-19).

Table 11-4-19. Difference and Percent Difference in May Water Storage Volume (thousand acre-feet) in Shasta Reservoir for H1, H3, and H4 Scenarios

Water Year	H3 vs. H1	H3 vs. H4
Wet	-1 (-0.02%)	15 (0.4%)
Above Normal	7 (0.2%)	17 (0.4%)
Below Normal	34 (0.9%)	149 (3.9%)
Dry	115 (3.6%)	117 (3.6%)
Critical	32 (1.8%)	148 (8.1%)

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the May through September winter-run spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period at either location.

The number of days on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month (May through September) and year of the 82-year modeling period (Table 11-4-13). The combination of number of days and degrees above the 56°F threshold were further assigned a “level of concern”, as defined in Table 11-4-14. Differences between baselines and H1 in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4-20. There would be no difference in levels of concern between NAA and H1.

Table 11-4-20. Differences between Baseline Scenarios and H1 and H4 Scenarios in the Number of Years in Which Water Temperature Exceedances above 56°F Are within Each Level of Concern, Sacramento River at Bend Bridge, May through September

Level of Concern	EXISTING CONDITIONS vs. H1	NAA vs. H1	EXISTING CONDITIONS vs. H4	NAA vs. H4
Red	31 (61%)	0 (0%)	30 (59%)	-1 (-1%)
Orange	-17 (-100%)	0 (NA)	-16 (-94%)	1 (NA)
Yellow	-11 (-100%)	0 (NA)	-11 (-100%)	0 (NA)
None	-3 (-100%)	0 (NA)	-3 (-100%)	0 (NA)

Note: For definitions of levels of concern, see Table 11-4-14.
NA = could not be calculated because the denominator was 0.

Total degree-days exceeding 56°F at Bend Bridge were summed by month and water year type during May through September (Table 11-4-21). Total degree-days under H1 would be up to 11% to 12% lower than under NAA during May and June and 8% to 16% higher during July through September.

Table 11-4-21. Differences between Baseline Scenarios and H1 and H4 Scenarios in Total Degree-Days (°F-Days) by Month and Water Year Type for Water Temperature Exceedances above 56°F in the Sacramento River at Bend Bridge, May through September

Month	Water Year Type	EXISTING CONDITIONS vs. H1	NAA vs. H1	EXISTING CONDITIONS vs. H4	NAA vs. H4
May	Wet	1,050 (279%)	-152 (-10%)	1,109 (294%)	-93 (-6%)
	Above Normal	273 (128%)	-82 (-14%)	290 (136%)	-65 (-11%)
	Below Normal	429 (196%)	-34 (-5%)	493 (225%)	30 (4%)
	Dry	216 (116%)	-198 (-33%)	392 (211%)	-22 (-4%)
	Critical	428 (194%)	18 (3%)	392 (177%)	-18 (-3%)
	All	2,396 (197%)	-448 (-11%)	2,676 (220%)	-168 (-4%)
June	Wet	468 (122%)	-243 (-22%)	645 (168%)	-66 (-6%)
	Above Normal	91 (61%)	-138 (-37%)	247 (167%)	18 (5%)
	Below Normal	245 (176%)	-107 (-22%)	374 (269%)	22 (4%)
	Dry	458 (244%)	-76 (-11%)	576 (306%)	42 (6%)
	Critical	671 (167%)	121 (13%)	607 (151%)	57 (6%)
	All	1,933 (153%)	-443 (-12%)	2,449 (194%)	73 (2%)
July	Wet	658 (127%)	52 (5%)	633 (122%)	27 (2%)
	Above Normal	352 (435%)	82 (23%)	299 (369%)	29 (8%)
	Below Normal	621 (422%)	165 (27%)	506 (344%)	50 (8%)
	Dry	1,162 (412%)	234 (19%)	1,033 (366%)	105 (9%)
	Critical	1,731 (210%)	-55 (-2%)	1,438 (175%)	-348 (-13%)
	All	4,524 (244%)	478 (8%)	3,909 (211%)	-137 (-2%)
August	Wet	2,153 (309%)	190 (7%)	1,861 (267%)	-102 (-4%)
	Above Normal	816 (200%)	157 (15%)	593 (145%)	-66 (-6%)
	Below Normal	1,302 (491%)	267 (21%)	1,010 (381%)	-25 (-2%)
	Dry	2,003 (299%)	393 (17%)	1,577 (235%)	-33 (-1%)
	Critical	2,605 (175%)	-14 (-0.3%)	2,284 (154%)	-335 (-8%)
	All	8,879 (252%)	993 (9%)	7,325 (208%)	-561 (-5%)
September	Wet	2,321 (314%)	1,612 (111%)	681 (92%)	-28 (-2%)
	Above Normal	1,025 (144%)	625 (56%)	406 (57%)	6 (1%)
	Below Normal	1,278 (171%)	132 (7%)	1,289 (173%)	143 (8%)
	Dry	2,206 (173%)	-390 (-10%)	2,178 (171%)	-418 (-11%)
	Critical	1,843 (89%)	-48 (-1%)	1,691 (81%)	-200 (-5%)
	All	8,673 (156%)	1,931 (16%)	6,245 (112%)	-497 (-4%)

H4/HOS

Flows in the Sacramento River between Keswick and Red Bluff Diversion Dam under H4 between May and September would generally be similar to flows under H3, except during May and June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis).* During May and June, flows would be up to 13% lower under H4 than under H3, although these reductions are too low of magnitude to have a biologically meaningful effect on winter-run Chinook salmon spawning and egg incubation habitat. Further, May storage in Shasta Reservoir under H4 would be similar to storage under H3 (Table 11-4-19).

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the May through September winter-run spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period at either location.

The number of days on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month (May through September) and year of the 82-year modeling period (Table 11-4-13). The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern", as defined in Table 11-4-14. Differences between baselines and H4 in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4-20. There would be no difference in levels of concern between NAA and H4.

Total degree-days exceeding 56°F at Bend Bridge were summed by month and water year type during May through September (Table 11-4-21). Total degree-days under H4 would be up to 5% lower than under NAA during August and similar during other months.

NEPA Effects: Alternative 4 does not propose any changes in Shasta Reservoir operating criteria, and CALSIM results show that Reclamation could operate Shasta in such a manner that it does not affect upstream storage or flows substantially as compared to the NAA. Available analytical tools show conflicting results regarding the temperature effects of relatively small changes in predicted summer and fall flows. Several models (CALSIM, SRWQM, and Reclamation Egg Mortality Model) generally show no change in upstream conditions as a result of Alternative 4. However, one model, SacEFT, shows adverse effects under some conditions. After extensive investigation of these results, they appear to be a function of high model sensitivity to relatively small changes in estimated upstream conditions, which may or may not accurately predict adverse effects. Temperature and end of September storage criteria from the NMFS (2009a) BiOp for Shasta reservoir are maintained, in order to minimize adverse effects to spawning and incubating salmonids including winter-run-run Chinook salmon. However, the new NDD structures allow for spring time deliveries of water south of the Delta that are currently constrained under the NAA. For this reason, additional spring storage criteria may be necessary to ensure Shasta operations similar to what was modeled. These discussions will occur in the Section 7 consultation with Reclamation on Shasta and system-wide operations, which is outside the scope of BDCP. In conclusion, Alternative 4 modeling results support a finding that effects are uncertain. Alternative 4 does not propose any changes to Shasta operating criteria, but modeled results are mixed and operations that match the CALSIM modeling are not assured. Model results will be submitted to independent peer review to confirm that adverse effects are not reasonably anticipated to occur.

CEQA Conclusion: In general, under all the Alternative 4 water operations scenarios, the quantity and quality of spawning and egg incubation habitat for winter-run Chinook salmon would not change relative to Existing Conditions.

H3/ESO

CALSIM flows in the Sacramento River between Keswick and upstream of Red Bluff were examined during the May through September winter-run spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows at Keswick under H3 combined with climate change, during May and June would generally be up to 22% greater than flows under Existing Conditions, lower by up to 29% during August and September, and similar during July with some exceptions. Flows upstream of Red Bluff under H3 during May and June would generally be up to 20% greater than flows under Existing Conditions, up to 26% lower during August, and similar during July and September, with some exceptions.

Shasta Reservoir storage volume at the end of May under H3 combined with climate change, would be similar to storage under Existing Conditions in wet and above normal water years and 8% to 25% lower in below normal, dry, and critical water years (Table 11-4-12). This indicates that there would be a small to moderate effect of H3 on flows during the spawning and egg incubation period in drier water years.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the May through September winter-run spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H3 during May and June. Mean monthly water temperature would be up to 14% higher under H3 in July through September depending on month, water year type, and location.

The number of days on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month (May through September) and year of the 82-year modeling period (Table 11-4-13). The combination of number of days and degrees above the 56°F threshold were further assigned a “level of concern”, as defined in Table 11-4-14. The number of years classified as “red” would increase by 61% under H3 relative to Existing Conditions (Table 11-4-15).

Total degree-days exceeding 56°F at Bend Bridge were summed by month and water year type during May through September (Table 11-4-16). Total degree-days under H3 would be 132% to 273% higher than that under Existing Conditions depending on month throughout the period.

The Reclamation egg mortality model predicts that winter-run Chinook salmon egg mortality in the Sacramento River under H3 would be 156% to 436% greater (relative scale) than mortality under Existing Conditions depending on water year type (Table 11-4-17). However, only in dry (7% higher) and critical (42% higher) years would the increase be >5% of the winter-run population on an absolute scale and, therefore, be biologically meaningful. Overall, these results indicate that H3, in combination with climate change effects, would cause increased winter-run Chinook salmon mortality in the Sacramento River in drier years.

SacEFT predicts that there would be a 60% decrease in the percentage of years with good spawning availability, measured as weighted usable area, under H3 relative to Existing Conditions (Table 11-4-18) as a result of the combined effects of climate change and Alternative 4. SacEFT predicts that the percentage of years with good (lower) redd scour risk under H3 and climate change would be similar to the percentage of years under Existing Conditions. SacEFT predicts that the percentage of years with good egg incubation conditions under H3 and climate change would be 26% lower than under Existing Conditions. SacEFT predicts that the percentage of years with good (lower) redd dewatering risk under H3 and climate change would be 12% greater than the percentage of years under Existing Conditions. These results indicate that Alternative 4, in combination with climate change effects which are the primary driver for these changes, would cause a large reduction in spawning WUA and egg incubation conditions.

H1/LOS

Flows in the Sacramento River between Keswick and Red Bluff Diversion Dam under H1 between May and September would generally be similar to flows under H3 (Appendix 11C, CALSIM II Model

Results utilized in the Fish Analysis). Also, May storage in Shasta Reservoir under H1 would be similar to storage under H3 (Table 11-4-19).

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the May through September winter-run spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperature would be up to 13% higher under H1 in July through September depending on month, water year type, and location.

The number of days on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month (May through September) and year of the 82-year modeling period (Table 11-4-13). The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern", as defined in Table 11-4-14. Differences between baselines and H1 in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4-20. There would be a 61% increase in the number of years with a red level of concern under H1 relative to Existing Conditions.

Total degree-days exceeding 56°F at Bend Bridge were summed by month and water year type during May through September (Table 11-4-21). Total degree-days under H1 would be 153% to 252% higher than under Existing Conditions depending on month.

H4/HOS

Flows in the Sacramento River between Keswick and Red Bluff Diversion Dam under H4 between May and September would generally be similar to flows under H3, except during May and June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis).* During these months, flows would be up to 13% lower under H4 than under H3, although these reductions are too low of magnitude to have a biologically meaningful effect on winter-run Chinook salmon spawning and egg incubation habitat. Additionally, May storage in Shasta Reservoir under H4 would be similar to storage under H3 in all water years except critical, in which storage under H4 would be 8% greater than storage under H3 (Table 11-4-19). Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the May through September winter-run spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperature would be up to 12% higher under H4 in July through September depending on month, water year type, and location.

The number of days on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month (May through September) and year of the 82-year modeling period (Table 11-4-13). The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern", as defined in Table 11-4-14. Differences between baselines and H4 in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4-20. There would be a 59% increase in the number of years with a red level of concern under H4 relative to Existing Conditions.

Total degree-days exceeding 56°F at Bend Bridge were summed by month and water year type during May through September (Table 11-4-21). Total degree-days under H4 would be 112% to 220% higher than under Existing Conditions depending on month.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-40 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 4 could be significant because, when compared to the CEQA baseline, the alternative could substantially reduce suitable spawning habitat and substantially reduce the number of fish as a result of egg mortality, contrary to the NEPA conclusion set forth above, which is directly related to the inclusion of climate change effects in Alternative 4.

Egg mortality (according to the Reclamation egg mortality model) in drier water years, during which winter-run Chinook salmon would already be stressed due to reduced flows and increased temperatures, would be up to 42% greater under Alternative 4, including climate change, compared to the CEQA baseline (Table 11-4-17). Egg incubation conditions according to the SacEFT model are predicted to be 26% lower under H3, including climate change, than under the CEQA baseline. Further, the extent of spawning habitat predicted by SacEFT would be 60% lower underH3, including climate change, compared to the CEQA baseline (Table 11-4-18), which represents a substantial reduction in spawning habitat and, therefore, in adult spawner and redd carrying capacity. Exceedances above NMFS temperature thresholds would be substantially greater under Alternative 4 relative to the CEQA baseline. Conditions under H4 would generally be similar under H1 and H4 to those under H3, although May storage and flows would be slightly higher under H4 and temperatures would be lower under H1 during spring but higher during fall.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to H3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow and reservoir storage outputs between Existing Conditions in the late long-term implementation period and H3 indicates that flows and reservoir storage in the locations and during the months analyzed above would generally be similar between future conditions without the alternative (NAA) and H3. This indicates that the differences between Existing Conditions and Alternative 4 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 4, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on spawning habitat for winter-run Chinook salmon. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-41: Effects of Water Operations on Rearing Habitat for Chinook Salmon (Winter-Run ESU)

In general, Alternative 4 would not adversely affect rearing habitat for fry and juvenile winter-run Chinook salmon relative to the NAA.

H3/ESO

Sacramento River flows upstream of Red Bluff were examined for the juvenile winter-run Chinook salmon rearing period (August through December) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Lower flows can lead to reduced extent and quality of fry and juvenile rearing habitat. Flows under H3 during August through October and December would generally be similar to flows under NAA with few exceptions. Flows during November under H3 would generally be5% to 18% lower than flows under NAA. This reduction in flow during 1 of 5 months of the rearing period is not expected to have a biologically meaningful effect on rearing juvenile winter-run Chinook salmon due to limited duration and magnitude.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the August through December winter-run juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period at either location.

SacEFT predicts that the percentage of years with good juvenile rearing habitat availability, measured as weighted usable area, under H3 would not different from the percentage of years under NAA (Table 11-4-18). In addition, the percentage of years with good (low) juvenile stranding risk under H3 is predicted to be 35% lower than under NAA. On an absolute scale, the reduction in juvenile stranding risk would be small (11%) and would not have a biologically meaningful effect on winter-run Chinook salmon. These results indicate that neither the quantity nor quality of juvenile rearing habitat in the Sacramento River would differ between NAA and H3.

SALMOD predicts that winter-run smolt equivalent habitat-related mortality under H3 would be 5% higher than under NAA. These results are somewhat inconsistent with SacEFT results, which indicate that juvenile stranding risk would increase under H3 (Table 11-4-18). However, the increase in juvenile stranding risk predicted by SacEFT is small on an absolute scale (11% lower) and would not affect winter-run Chinook salmon at a population scale, which is more consistent with SALMOD results. Both SacEFT and SALMOD are considered to be reliable models for winter-run Chinook salmon in the Sacramento River. SALMOD has been used for decades for assessing changes in flows associated with SWP and CVP. Therefore, results of both models were used to draw conclusions about winter-run Chinook salmon rearing conditions.

H1/LOS

Flows in the Sacramento River between Keswick and Red Bluff Diversion Dam under H1 between August and December would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*), with exceptions during some months and water year types. However, these reductions would be too infrequent or of too low of magnitude to have biologically meaningful effects on winter-run Chinook salmon.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the August through December winter-run juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period at either location.

H4/HOS

Flows in the Sacramento River between Keswick and Red Bluff Diversion Dam under H4 between August and December would generally be similar to or greater than flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the August through December winter-run juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period at either location.

NEPA Effects: Collectively, these results indicate that the effect of Alternative 4 is not adverse because it does not have the potential to substantially reduce the amount of suitable habitat or substantially interfere with winter-run Chinook salmon rearing. Differences in flows and temperatures are generally small and inconsistent among months and water year types. SALMOD and SacEFT predicted contradicting results regarding habitat-related mortality although the magnitude of effect predicted by both models would not be biologically meaningful. There would be no differences between scenarios.

CEQA Conclusion: In general, Alternative 4 would not reduce the quantity and quality of fry and juvenile rearing habitat for winter-run Chinook salmon relative to Existing Conditions.

H3/ESO

Sacramento River flows upstream of Red Bluff were examined for the juvenile winter-run Chinook salmon rearing period (August through December) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*)*.* Lower flows can lead to reduced extent and quality of fry and juvenile rearing habitat. Flows under H3 during August and November would generally be lower by up to 26% than flows under Existing Conditions and similar to flows under Existing Conditions during September, October, and December.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the August through December winter-run rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperature would be higher (by up to 14%, but generally less than 8%) under H3 in August through October depending on month, water year type, and location. There would be no differences (<5%) between Existing Conditions and H3 in mean monthly water temperature during July, November, and December at either location.

SacEFT predicts that the percentage of years with good juvenile rearing habitat availability, measured as weighted usable area, under H3, combined with climate change, would be 48% lower than under Existing Conditions (Table 11-4-18). The percentage of years with good (low) juvenile stranding risk under H3 is predicted to be identical to the percentage under Existing Conditions. This indicates that the amount of juvenile rearing habitat in the Sacramento River would be lower under H3 relative to Existing Conditions, but juvenile stranding risk would be similar between scenarios

SALMOD predicts that winter-run smolt equivalent habitat-related mortality under H3 would be 6% higher than under Existing Conditions. These results are inconsistent with SacEFT results, which indicate that juvenile rearing WUA would be substantially reduced by H3 (Table 11-4-18). Both

SacEFT and SALMOD are considered to be reliable models for winter-run Chinook salmon in the Sacramento River. SALMOD has been used for decades for assessing changes in flows associated with SWP and CVP. Therefore, results of both models were used to draw conclusions about winter-run Chinook salmon rearing conditions.

H1/LOS

Flows in the Sacramento River between Keswick and Red Bluff Diversion Dam under H1 between August and December would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis),* with exceptions during some months and water year types. However, these reductions would be too infrequent or of too low of magnitude to have biologically meaningful effects on winter-run Chinook salmon.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the August through December winter-run rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperature would be higher (by up to 13%, but generally less than 8%) under H1 in August through October depending on month, water year type, and location. There would be no differences (<5%) between Existing Conditions and H1 in mean monthly water temperature during July, November, and December at either location.

H4/HOS

Flows in the Sacramento River between Keswick and Red Bluff Diversion Dam under H4 between August and December would generally be similar to or greater than flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the August through December winter-run rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperature would be higher (by up to 12%, but generally less than 8%) under H4 in August through October depending on month, water year type, and location. There would be no differences (<5%) between Existing Conditions and H4 in mean monthly water temperature during July, November, and December at either location.

Summary of CEQA Conclusion

These results indicate that the impact would be less than significant because it does not have the potential to substantially reduce the amount of suitable habitat and substantially interfere with the movement of fish, and no mitigation is necessary. Flows are generally comparable between Alternative 4 and Existing Conditions and there would be small increases under the alternative in water temperatures during some of the period of presence. SALMOD and SacEFT predicted contradicting results regarding habitat-related mortality. Overall, the impact would be less than significant. There would be no differences between scenarios.

Impact AQUA-42: Effects of Water Operations on Migration Conditions for Chinook Salmon (Winter-Run ESU)

In general, the effects of Alternative 4 on winter-run Chinook salmon migration conditions relative to the NAA are uncertain.

Upstream of the Delta

H3/ESO

Flows in the Sacramento River upstream of Red Bluff were examined for the July through November juvenile emigration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). A reduction in flow may reduce the ability of juvenile winter-run to migrate effectively through the Sacramento River. Flows under H3 would be 5% to 18% lower than under NAA during November and generally similar to NAA during the rest of the juvenile winter-run Chinook salmon migration period (July through October).

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the July through November winter-run juvenile emigration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period at either location.

Flows in the Sacramento River upstream of Red Bluff during the adult winter-run Chinook salmon upstream migration period (December through August) under H3 would generally be similar to those under NAA, except during May and June in which flows would be up to 12% greater than flows under NAA.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the December through August winter-run upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period at either location.

H1/LOS

Flows in the Sacramento River upstream of Red Bluff during the July through November juvenile emigration period under H1 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) except in wetter water year types during September and November. Reductions during November would be too low of magnitude (3% to 12% lower) to have biologically meaningful effects on emigrating juveniles. Flow reductions during both months would occur only during wetter water years when flow reductions are less critical to emigrating juveniles and, therefore, would not cause biologically meaningful effects.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the July through November winter-run juvenile emigration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period at either location.

Flows in the Sacramento River upstream of Red Bluff during the adult winter-run Chinook salmon upstream migration period (December through August) would generally be similar to or greater than flows under H3.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the December through August winter-run upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in* *the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period at either location.

H4/HOS

Flows in the Sacramento River upstream of Red Bluff during the July through November juvenile emigration period under H4 would generally be similar to or greater than flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the July through November winter-run juvenile emigration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period at either location.

Flows in the Sacramento River upstream of Red Bluff during the adult winter-run Chinook salmon upstream migration period (December through August) would generally be similar to flows under H3, except during June in which flows would be up to 12% lower under H4 and during August, in which flows would be up to 13% greater under H4. These flow reductions and increases would not be of sufficient frequency or magnitude to cause biologically meaningful effects on migrating adults.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the December through August winter-run upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period at either location.

Through-Delta

H3/ESO

Juveniles

Plan Area flows have considerable importance for downstream migrating juvenile salmonids and would be affected by the north Delta diversions, as discussed above for winter-run Chinook above (Impact AQUA-42 for Alternative 1A). Average monthly flows Sacramento River flows below the NDD under H3 for juvenile winter-run migrants (November through May) would be reduced 11% to 23% compared to NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Note that *CM1 Water Facilities and Operation* includes bypass flow criteria that will be managed in real time to minimize adverse effects of diversions at the north Delta intakes on downstream-migrating salmonids.

Potential predation effects at the north Delta intakes could occur if predatory fish aggregated along the screens as has been observed at other long screens in the Central Valley (Vogel 2008). Baseline levels of predation are uncertain, however. Analysis by a bioenergetics model (Appendix 5.F, *Biological Stressors on Covered Fish,* Section 5.F.3.2.1) suggests that considerably less than 0.3% of winter-run juveniles could be preyed upon (Table 11-4-22). Using another scenario of predation that assumes a 5% loss per intake (based on GCID losses, Vogel 2008) would yield a cumulative loss of about 12% of the annual production that reaches the north Delta. The three intake structures would also permanently displace approximately 13.7 acres of in-water habitat and 7,450 linear feet of shoreline along the migration route. However, there are appreciable uncertainties in these analyses, including unknown baseline levels of predation, uncertainty in the bioenergetics model parameters, and the comparability of the GCID intakes for estimating loss rates. This is discussed in detail in Alternative 1A.

Table 11-4-22. Winter-Run Chinook Salmon Predation Loss at the Proposed North Delta Diversion Intakes (Three Intakes for Alternative 4)

Striped Bass at NDD (Three Intakes)			Winter-Run Chinook Consumed	
Density Assumption	Bass per 1,000 Feet of Intake	Total Number of Bass	Number	Percentage of Annual Juvenile Production
Low	18	86	648	0.02%
Median	119	571	4,283	0.16%
High	219	1,051	7,881	0.30%

Note: Based on bioenergetics modeling of Chinook salmon consumption by striped bass (Appendix 5F Biological Stressors).

Through-Delta survival by juvenile winter-run Chinook salmon, as estimated by the Delta Passage Model under Scenario H3, averaged 33.2% across all years, 26% in drier years up to 45.3% in wetter years (for further details, refer to *BDCP Appendix 5.C, Section 5C.5.3.1.3.1*). Average juvenile survival under H3 was similar or slightly lower than NAA (1% less, a 3% relative decrease) (Table 11-4-23).

Table 11-4-23. Through-Delta Survival (%) of Emigrating Juvenile Winter-Run Chinook Salmon under Alternative 4 (Scenarios H3, H1, and H4)

Water Year Type	Average Percentage Survival					Difference in Percentage Survival (Relative Difference)					
	SCENARIO					EXISTING CONDITIONS vs. Alt 4 Scenario			NAA vs. Alt 4 Scenario		
	EXISTING CONDITIONS	NAA	H3	H1	H4	H3	H1	H4	H3	H1	H4
Wetter Years	46.3	46.1	45.3	45.2	46.0	-1.1 (-2%)	-1.1 (-2%)	-0.3 (-1%)	-0.8 (-2%)	-0.9 (-2%)	-0.1 (0%)
Drier Years	28.0	27.1	26.0	26.1	25.7	-2.0 (-7%)	-1.9 (-7%)	-2.3 (-8%)	-1.1 (-4%)	-1.0 (-4%)	-1.4 (-5%)
All Years	34.9	34.2	33.2	33.3	33.3	-1.6 (-5%)	-1.6 (-5%)	-1.6 (-5%)	-1.0 (-3%)	-0.9 (-3%)	-0.9 (-3%)

Note: Average Delta Passage Model results for survival to Chipps Island.
Wetter = Wet and Above Normal Water Years (6 years).
Drier = Below Normal, Dry and Critical Water Years (10 years).
H3 = ESO operations, H1 = Low Outflow, H4 = High Outflow.

Adults

Adult salmonids migrating through the delta use flow and olfactory cues for navigation to their natal streams (Marston et al. 2012), as discussed above for winter-run Chinook (Impact AQUA-42 for Alternative 1A). The importance of flow changes to currently affect these cues is rated as low but with low certainty. Attraction flows and olfactory cues in the west Delta would be altered because of shifts in exports from the south Delta to the north Delta. Flows in the Sacramento River downstream of the north Delta intake diversions would be reduced, with concomitant proportional increases in

San Joaquin River flow, with differences between water-year types because of differences in the relative proportion of water being exported from the north Delta and south Delta facilities (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*.

These changes would slightly decrease the Sacramento River olfactory cues used by migrating adults. Fingerprint analyses determined that attraction flow, as estimated by the percentage of Sacramento River water at Collinsville, declined from NAA to Scenario H3 operations by up to 4% during the peak migration period for winter-run adults (December through February) (Table 11-4-24). The flow changes under Scenario H3 would slightly decrease the olfactory cues for migrating adult salmon in the Sacramento River (by 9% or less compared to NAA). Nevertheless, the Sacramento River would still represent a substantial proportion of Delta outflows. Under Scenario H4, the difference would be less due to increased spring outflows in March, April, and May. Scenario H1 results would be similar to Scenario H3. Overall, the reductions in olfactory cues resulting from all scenarios would be less than the magnitude of change in dilution (20% or more) reported to cause a significant change in migration by Fretwell (1989) and, therefore, are not expected to affect adult Chinook salmon migration. However, uncertainty remains with regard to adult salmon behavioral response to anticipated changes in lower Sacramento River flow percentages. This topic is discussed further in Impact AQUA-42 for Alternative 1A.

Table 11-4-24. Percentage (%) of Water at Collinsville that Originated in the Sacramento River during the Adult Winter-Run Chinook Salmon Migration Period for Alternative 4 (Scenario H3)

Month	EXISTING CONDITIONS	NAA	H3	EXISTING CONDITIONS vs. H3	NAA vs. H3
December	67	66	66	-1	0
January	76	75	73	-3	-2
February	75	72	68	-7	-4
March	78	76	68	-10	-8
April	77	75	66	-11	-9
May	69	65	59	-10	-6
June	64	62	58	-6	-4
July	64	65	56	-8	-9
	Shading indicates 10% or greater difference.				

H1/LOS

Juveniles

Plan Area flows have considerable importance for downstream migrating juvenile salmonids and would be affected by the north Delta diversions, as discussed above for winter-run Chinook above (Impact AQUA-42 for Alternative 1A). Under H1, Sacramento River flows below the NDD during the juvenile winter-run migration period (November-May) would be reduced compared to NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Note that *CM1 Water Facilities and Operation* includes bypass flow criteria that will be managed in real time to minimize adverse effects of diversions at the north Delta intakes on downstream-migrating salmonids.

Through-Delta survival by juvenile winter-run Chinook salmon under Scenario H1 averaged 33.3% across all years, 26.1% in drier years up to 45.2% in wetter years (for further details, refer to *BDCP*

Appendix 5.C, Section 5C.5.3.1.3.1). Average survival under Scenario H1 was generally similar to NAA (Table 11-4-23).

Overall, the similarity in through-Delta survival these scenarios is explained by the relatively low overlap of the winter-run Delta entry distribution with the spring period that has differing outflows for the Alternative 4 operations scenarios. In addition, the DPM has less representation of intermediate-outflow years where the differences among the Alternative 4 operations scenarios are more pronounced than wetter or drier years.

Adults

Results for H1 regarding attraction flows and olfactory cues are presented as part of the corresponding discussion under H3.

H4/HOS

Juveniles

Plan Area flows have considerable importance for downstream migrating juvenile salmonids and would be affected by the north Delta diversions, as discussed above for winter-run Chinook above (Impact AQUA-42 for Alternative 1A). Under H4, Sacramento River flows below the NDD during the juvenile winter-run migration period (November–May) would be reduced 5% to 23% compared to NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Note that *CM1 Water Facilities and Operation* includes bypass flow criteria that will be managed in real time to minimize adverse effects of diversions at the north Delta intakes on downstream-migrating salmonids.

Through-Delta survival by juvenile winter-run Chinook salmon under Scenario H4 averaged 33.3% across all years, 25.7% in drier years up to 46% in wetter years (for further details, refer to *BDCP Appendix 5.C, Section 5C.5.3.1.3.1*). Average survival under Scenario H4 was generally similar to NAA, with slightly lower survival for H4 in wetter years (0.9% less, a 3% relative decrease) (Table 11-4-23).

Overall, the similarity in through-Delta survival these scenarios is explained by the relatively low overlap of the winter-run Delta entry distribution with the spring period that has differing outflows for the Alternative 4 operations scenarios. In addition, the DPM has less representation of intermediate-outflow years where the differences among the Alternative 4 operations scenarios are more pronounced than wetter or drier years.

Adults

Results for H4 regarding attraction flows and olfactory cues are presented as part of the corresponding discussion under H3.

NEPA Effects: Upstream of the Delta, the effects of Alternative 4 are uncertain, with the effects analysis showing conflicting lines of evidence regarding whether or not additional adverse effects would occur as a result of re-operation of Shasta reservoir. Modeling analyses indicate that some scenarios of Alternative 4 would potentially improve upstream conditions whereas some scenarios could degrade upstream conditions compared to NAA. Within the Delta, adult attraction flows under Alternative 4 would not be substantially different from those under NAA and, therefore, the effects of Alternative 4 on adult migration would be expected to be similar to NAA.

Near-field effects of Alternative 4 NDD on winter-run Chinook salmon related to impingement and predation associated with three new intake structures could result in negative effects on juvenile migrating winter-run Chinook salmon, although there is high uncertainty regarding the overall effects. It is expected that the level of near-field impacts would be directly correlated to the number of new intake structures in the river and thus the level of impacts associated with 3 new intakes would be considerably lower than those expected from having 5 new intakes in the river. Estimates within the effects analysis range from very low levels of effects (<1% mortality) to more significant effects (~ 12% mortality above current baseline levels). CM15 would be implemented with the intent of providing localized and temporary reductions in predation pressure at the NDD. Additionally, several pre-construction surveys to better understand how to minimize losses associated with the three new intake structures will be implemented as part of the final NDD screen design effort. Alternative 4 also includes an Adaptive Management Program and Real-Time Operational Decision-Making Process to evaluate and make limited adjustments intended to provide adequate migration conditions for winter-run Chinook. However, at this time, due to the absence of comparable facilities anywhere in the lower Sacramento River/Delta, the degree of mortality expected from near-field effects at the NDD remains highly uncertain.

Two recent studies (Newman 2003 and Perry 2010) indicate that far-field effects associated with the new intakes could cause a reduction in smolt survival in the Sacramento River downstream of the NDD intakes due to reduced flows in this area. The analyses of other elements of Alternative 4 predict improvements in smolt condition and survival associated with increased access to the Yolo Bypass, reduced interior Delta entry, and reduced south Delta entrainment. The overall magnitude of each of these factors and how they might interact and/or offset each other in affecting salmonid survival through the plan area is uncertain, and remains an area of active investigation for the BDCP.

The DPM is a flow-based model being developed for BDCP which attempts to combine the effects of all of these elements of BDCP operations and conservation measures to predict smolt migration survival throughout the entire Plan Area. The current draft of this model predicts that smolt migration survival under Alternative 4 would be similar to those estimated for NAA. Further refinement and testing of the DPM, along with several ongoing and planned studies related to salmonid survival at and downstream of, the NDD are expected to be completed in the foreseeable future. These efforts are expected to improve our understanding of the relationships and interactions among the various factors affecting salmonid survival, and reduce the uncertainty around the potential effects of BDCP implementation on migration conditions for Chinook salmon. However, until these efforts are completed and their results are fully analyzed, the overall cumulative effect of Alternative 4 on winter-run Chinook salmon migration remains uncertain.

CEQA Conclusion: In general, Alternative 4 would not reduce migration conditions for winter-run Chinook salmon relative to Existing Conditions.

Upstream of the Delta

H3/ESO

Flows in the Sacramento River upstream of Red Bluff were examined during the July through November juvenile emigration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). A reduction in flow may reduce the ability of juvenile winter-run to migrate effectively through the Sacramento River. Flows under H3, combined with climate change, for juvenile migrants would be up to 14% lower than under Existing Conditions during November depending on water year type. However, flows under H3, combined with climate change, would generally be similar to those under Existing Conditions during the rest of the juvenile winter-run Chinook salmon migration period (July through October) with few exceptions.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the July through November winter-run juvenile emigration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperature would be higher (by up to 14%, but mostly <8%) under H3 in August through October depending on month, water year type, and location. There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H3 during July and November.

Flows in the Sacramento River upstream of Red Bluff were examined during the adult winter-run Chinook salmon upstream migration period (December through August). Flows under H3 would generally be similar to flows under Existing Conditions throughout the adult migration period, except during May and June, in which flows would be up to 20% greater under H3, combined with climate change, and during August, in which flows would be up to 26% lower under H3, combined with climate change. These flow reductions would not be frequent enough to cause a biologically meaningful effect on adult migrants.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the December through August winter-run upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H3 during December through July. Mean monthly water temperature would be up to 14% higher under H3 in August depending on water year.

H1/LOS

Flows in the Sacramento River upstream of Red Bluff during the July through November juvenile emigration period under H1 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) except in wetter water year types during September and November, as a results of not implementing Fall X2 requirements for delta smelt. Reductions during November would be too low of magnitude (3% to 12% lower) to have biologically meaningful effects on emigrating juveniles. Flow reductions during both months would occur only during wetter water years when flow reductions are less critical to emigrating juveniles and, therefore, would not cause biologically meaningful effects.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the July through November winter-run juvenile emigration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperature would be higher (by up to 13%, but mostly <8%) under H1 in August through October depending on month, water year type, and location. There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H1 during July and November.

Flows in the Sacramento River upstream of Red Bluff during the adult winter-run Chinook salmon upstream migration period (December through August) would generally be similar to or greater than flows under H3.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the December through August winter-run upstream migration period (Appendix

11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H1 during December through July. Mean monthly water temperature would be up to 13% higher under H1 in August depending on water year.

H4/HOS

Flows in the Sacramento River upstream of Red Bluff during the July through November juvenile emigration period under H4 would generally be similar to or greater than flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the July through November winter-run juvenile emigration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperature would be higher (by up to 12%, but mostly <8%) under H4 in August through October depending on month, water year type, and location. There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H4 during July and November.

Flows in the Sacramento River upstream of Red Bluff during the adult winter-run Chinook salmon upstream migration period (December through August) under H4 would generally be similar to flows under H3, except during June in which flows would be up to 12% lower under H4 and during August, in which flows would be up to 13% greater under H4. These flow reductions and increases would not be of sufficient frequency or magnitude to cause biologically meaningful effects on migrating adults. Water temperatures in the Sacramento River under H4 would be similar to those under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the December through August winter-run upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H4 during December through July. Mean monthly water temperature would be up to 12% higher under H4 in August depending on water year.

Through-Delta

Juveniles

During the juvenile winter-run Chinook salmon emigration period (November through May), mean monthly flows in the Sacramento River below the NDD under H3 averaged across years would be lower (15% to 27% lower monthly mean) compared to Existing Conditions. Potential predation losses at the three north Delta intakes would range from considerably less than 1% (bioenergetics modeling) to 11.7% (conservative upper bound based on 5% loss per intake) of the annual production that reaches the north Delta. In addition, the three intake structures would permanently displace approximately 13.7 acres of in-water habitat.

Through-Delta survival by juvenile winter-run Chinook salmon, as estimated by the Delta Passage Model under Scenario H3, would be slightly lower than Existing Conditions for H3 (1.6% less, a 5% relative decrease), with the greatest reduction in drier years (2.0% lower, a 7% relative decrease) (Table 11-4-23).

Under Scenarios H1 and H4, average survival was 1.6% less (5% relative decrease) than Existing Conditions, with a 2.3% reduction under H4 in drier years (an 8% relative decrease).

Adults

Flows in the Sacramento River downstream of the north Delta intake diversions would be reduced. These changes would slightly decrease the olfactory cues for migrating adult salmon. Under Scenario H3, the proportion of Sacramento River water was reduced no more than 7% during peak migration (December through February) and reduced by 10–11% in March-May compared to Existing Conditions (Table 11-4-24). Scenario H1 results would be similar to Scenario H3. The reductions in percentage are small in comparison with the magnitude of change in dilution (20% or more) reported to cause a significant change in migration by Fretwell (1989) and, therefore, are not expected to affect adult Chinook salmon migration. The Sacramento River would still represent a substantial proportion of Delta outflows. However, uncertainty remains with regard to adult salmon behavioral response to anticipated changes in lower Sacramento River flow percentages. This topic is discussed further in Impact AQUA-42 for Alternative 1A.

Summary of CEQA Conclusion

Collectively, these results indicate that the effect would be less than significant because it does not have the potential to substantially reduce migration habitat or substantially interfere with the movement of fish. Upstream flows and water temperatures would not be difference between Alternative 4 and Existing Conditions for any scenario. Although upper Sacramento River flows under Alternative 4 would be lower than under Existing Conditions during August and November, flows during the remaining months of the juvenile emigration and adult immigration periods would be similar to or greater than flows under Existing Conditions. Further, winter-run Chinook salmon juvenile survival through the Delta would be similar between Alternative 4 and Existing Conditions during all water year types. Due to similarities in migration conditions between Alternative 4 and Existing Conditions, it is concluded that the impact would be less than significant and no mitigation would be required.

Restoration Measures (CM2, CM4–CM7, and CM10)

Alternative 4 has the same Restoration Measures as Alternative 1A. Because no substantial differences in restoration-related fish effects are anticipated anywhere in the affected environment under Alternative 4 compared to those described in detail for Alternative 1A, the fish effects of restoration measures described for winter-run Chinook salmon under Alternative 1A (Impacts AQUA-43 through AQUA-45) also appropriately characterize effects under Alternative 4.

The following impacts are those presented under Alternative 1A that are identical for Alternative 4.

Impact AQUA-43: Effects of Construction of Restoration Measures on Chinook Salmon (Winter-Run ESU)

Impact AQUA-44: Effects of Contaminants Associated with Restoration Measures on Chinook Salmon (Winter-Run ESU)

Impact AQUA-45: Effects of Restored Habitat Conditions on Chinook Salmon (Winter-Run ESU)

NEPA Effects: Detailed discussions regarding the potential effects of these three impact mechanisms on winter-run Chinook salmon are the same as those described under Alternative 1A (Impacts AQUA-43 through AQUA-45). The effects would not be adverse, and would generally be beneficial. Specifically for AQUA-44, the effects of contaminants on winter-run Chinook salmon with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on winter-run Chinook salmon are uncertain.

CEQA Conclusion: All three of the impact mechanisms listed above would be at least slightly beneficial, or less than significant, and no mitigation is required, for the reasons identified for Alternative 1A.

Other Conservation Measures (CM12–CM19 and CM21)

Alternative 4 has the same other conservation measures as Alternative 1A. Because no substantial differences in other conservation-related fish effects are anticipated anywhere in the affected environment under Alternative 4 compared to those described in detail for Alternative 1A, the fish effects of other conservation measures described for winter-run Chinook salmon under Alternative 1A (Impacts AQUA-46 through AQUA-54) also appropriately characterize effects under Alternative 4.

The following impacts are those presented under Alternative 1A that are identical for Alternative 4.

Impact AQUA-46: Effects of Methylmercury Management on Chinook Salmon (Winter-Run ESU) (CM12)

Impact AQUA-47: Effects of Invasive Aquatic Vegetation Management on Chinook Salmon (Winter-Run ESU) (CM13)

Impact AQUA-48: Effects of Dissolved Oxygen Level Management on Chinook Salmon (Winter-Run ESU) (CM14)

Impact AQUA-49: Effects of Localized Reduction of Predatory Fish on Chinook Salmon (Winter-Run ESU) (CM15)

Impact AQUA-50: Effects of Nonphysical Fish Barriers on Chinook Salmon (Winter-Run ESU) (CM16)

Impact AQUA-51: Effects of Illegal Harvest Reduction on Chinook Salmon (Winter-Run ESU) (CM17)

Impact AQUA-52: Effects of Conservation Hatcheries on Chinook Salmon (Winter-Run ESU) (CM18)

Impact AQUA-53: Effects of Urban Stormwater Treatment on Chinook Salmon (Winter-Run ESU) (CM19)

Impact AQUA-54: Effects of Removal/Relocation of Nonproject Diversions on Chinook Salmon (Winter-Run ESU) (CM21)

NEPA Effects: Detailed discussions regarding the potential effects of these nine impact mechanisms on winter-run Chinook salmon are the same as those described under Alternative 1A (Impacts AQUA-46 through AQUA-54). The effects range from no effect, to not adverse, to beneficial.

CEQA Conclusion: The effects of the nine impact mechanisms listed above range from no impact, to less than significant, to beneficial, and no mitigation is required.

Spring-Run Chinook Salmon

Construction and Maintenance of CM1

Impact AQUA-55: Effects of Construction of Water Conveyance Facilities on Chinook Salmon (Spring-Run ESU)

The potential effects of construction of the water conveyance facilities on spring-run Chinook salmon would be similar to those described for Alternative 1A (Impact AQUA-55) except Alternative 4 would include three intakes compared to five intakes under Alternative 1A, so the effects would be proportionally less under this alternative. This would convert about 6,360 lineal feet of existing shoreline habitat into intake facility structures and would require about 17.1 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. Alternative 4 would use five barge locations rather than six as under Alternative 1A so those effects would also be proportionally less. Additionally, construction and excavation at Clifton Court Forebay would be done in the dry via installation of cofferdams for isolation and dewatering of work areas. Implementation of Appendix 3B, *Environmental Commitments*, including construction BMPs and 3B.8–*Fish Rescue and Salvage Plan*, would minimize adverse effects as described for Alternative 1A. Mitigation measures would also be available to avoid and minimize potential effects.

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-55, the effect would not be adverse for spring-run Chinook salmon.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-55, the impact of the construction of water conveyance facilities on spring-run Chinook salmon would not be significant except for construction noise associated with pile driving. Potential pile driving impacts would be less than Alternative 1A because only three intakes would be constructed rather than five. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in the discussion of Alternative 1A.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in the discussion of Alternative 1A.

Impact AQUA-56: Effects of Maintenance of Water Conveyance Facilities on Chinook Salmon (Spring-Run ESU)

NEPA Effects: The potential effects of maintenance of the water conveyance facilities under Alternative 4 would be the same as those described for Alternative 1A (Impact AQUA-56) except that only three intakes would need to be maintained under Alternative 4 rather than five under Alternative 1A. As concluded in Alternative 1A, Impact AQUA-56, the impact would not be adverse for spring-run Chinook salmon.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-56, the impact of maintenance of the water conveyance facilities on spring-run Chinook salmon would not be significant and no mitigation is required.

Water Operations of CM1

Impact AQUA-57: Effects of Water Operations on Entrainment of Chinook Salmon (Spring-Run ESU)

Water Exports from SWP/CVP South Delta Facilities

Average entrainment of juvenile spring-run Chinook salmon at the south Delta export facilities would be reduced 40% under the Scenario H3 compared to NAA (Table 11-4-25). The greatest reduction would be in wet years, when entrainment would be reduced 63% (~58,000 fish) compared to NAA. Entrainment loss under Scenario H4 would further reduce south Delta entrainment relative to the Scenario H3.

Table 11-4-25. Juvenile Spring-Run Chinook Salmon Annual Entrainment Index[a] at the SWP and CVP Salvage Facilities—Differences between Model Scenarios for Alternative 4 (Scenario H3)

	Absolute Difference (Percent Difference)	
Water Year	EXISTING CONDITIONS vs. H3	NAA vs. H3
Wet	-54,712 (-62%)	-58,340 (-63%)
Above Normal	-7,576 (-28%)	-10,644 (-36%)
Below Normal	-784 (-12%)	-1,579 (-22%)
Dry	-766 (-5%)	-1,960 (-11%)
Critical	-2,937 (-25%)	-1,316 (-13%)
All Years	-14,145 (-37%)	-15,755 (-40%)

Note: Estimated annual number of fish lost, based on normalized data.

The proportion of the annual spring-run Chinook salmon index of abundance (assumed to be 750,000 juveniles approaching the Delta) lost at the south Delta facilities averaged 5.3% across all years under the NAA, and decreased to 3.2% under Alternative 4 Scenario H3. The greatest improvement was in wet years, when the proportion lost decreased by 7.8% under Alternative 4 Scenario H3 (4.5%) compared to NAA (12.3%). Entrainment under Scenario H1 would be similar to Scenario H3, while conditions under Scenario H4 are expected to further reduce entrainment losses relative to both Scenarios H3 and H1.

Water Exports from SWP/CVP North Delta Intake Facilities

The effect of Alternative 4 on entrainment and impingement at the north Delta facilities would be the same as described for Alternative 1A (Impact AQUA-57), but the degree would be less because Alternative 4 would have fewer intakes. State-of-the-art fish screens operated with an adaptive management plan would be expected to eliminate entrainment risk for juvenile spring-run Chinook salmon.

Water Export with a Dual Conveyance for the SWP North Bay Aqueduct

Entrainment to the NBA would be the same as described for Alternative 1A (Impact AQUA-57). Entrainment and impingement effects would be minimal because intakes on the Sacramento River would have state-of-the-art screens installed.

Predation Associated with Entrainment

Entrainment-related predation loss of spring-run Chinook salmon at the south Delta facilities would be no greater and may be lower than baseline due to a reduction in entrainment loss. Entrainment-related predation losses are expected to decrease under Scenario H4 compared to Scenario H3, while conditions under Scenario H1 would be similar to Scenario H3.

Predation at the north Delta would be increased at the proposed North Delta intake facilities on the Sacramento River. Bioenergetics modeling with a median predator density predicts a predation loss of about 8,200 juveniles, or 0.2% of the spring-run juvenile population under Alternative 4 (Table 11-4-26). This is well under the criteria of a 5% population loss, thus the impact from predation loss would not be adverse.

Table 11-4-26. Juvenile Spring-Run Chinook Salmon Predation Loss at the Proposed North Delta Diversion (NDD) Intakes for Alternative 4 (Three Intakes)

Striped Bass at NDD (Three Intakes)			Spring-Run Chinook Consumed	
Density Assumption	Bass per 1,000 feet of Intake	Total Number of Bass	Number	Percentage of Annual Juvenile Production
Low	18	86	1,243	0.03%
Median	119	571	8,217	0.20%
High	219	1,051	15,122	0.36%

Note: Based on bioenergetics modeling of Chinook salmon consumption by striped bass (Appendix 5F Biological Stressors).

NEPA Effects: In conclusion, Alternative 4 would reduce overall entrainment losses of juvenile spring-run Chinook salmon relative to NAA. The population benefit would be small because entrainment losses affect about 5% of annual juvenile spring-run Chinook salmon production. Conditions under Scenario H4 would further reduce entrainment losses compared to Scenario H3 and Scenario H1. The effect of Alternative 4 would not be adverse and may provide some benefit.

CEQA Conclusion: Entrainment losses of juvenile spring-run Chinook salmon at the south Delta facilities will be substantially reduced under the Scenario H3 operations for Alternative 4 for all water year types (37% average reduction in entrainment index) compared to existing biological conditions (Table 11-4-25). The proportion of the annual spring-run Chinook index of abundance entrained at the south Delta facilities averaged 5.0% across all years under Existing Conditions, and would decrease to 3.2% under Alternative 4. The greatest improvement would be in wet years, when the proportion lost would decrease by 7% under Scenario H3 (4.5%) compared to Existing Conditions (11.8%). Under Scenario H4, entrainment losses are expected to further decrease relative to Existing Conditions. Entrainment at the NBA would be minimal. Predation loss at the north Delta intakes would have minor population level effects on spring-run Chinook salmon (<0.4% of the annual index of abundance). Overall, impacts to spring-run Chinook salmon under Alternative 4 would be beneficial because of the reductions in entrainment losses at the south Delta facilities across all water-years compared to existing biological conditions. No mitigation would be required.

Impact AQUA-58: Effects of Water Operations on Spawning and Egg Incubation Habitat for Chinook Salmon (Spring-Run ESU)

In general, the effects of Alternative 4 on spawning and egg incubation habitat for spring-run Chinook salmon relative to the NAA are uncertain.

H3/ESO

Sacramento River

There has been a small, inconsistent spawning population (<400 individuals) in the mainstem Sacramento River primarily upstream of Red Bluff Diversion Dam over the past decade (Azat 2012).

Flows in the Sacramento River upstream of Red Bluff were examined during the spring-run Chinook salmon spawning and incubation period (September through January) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 during all months except November would generally be similar to those under NAA with few exceptions. Flows under H3 during November would be 5% to 18% lower than flows during NAA depending on water year type.

Shasta Reservoir storage volume at the end of September influences flows downstream of the dam during the spring-run spawning and egg incubation period (September through January). Storage under H3 would be similar to (<5% different from) storage under NAA in all water year types (Table 11-4-27) so there would be no biologically meaningful effects.

Table 11-4-27. Difference and Percent Difference in September Water Storage Volume (thousand acre-feet) in Shasta Reservoir for Alternative 4 (Scenario H3)

Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
Wet	-605 (-18%)	-93 (-3%)
Above Normal	-677 (-21%)	-62 (-2%)
Below Normal	-443 (-15%)	-89 (-4%)
Dry	-535 (-22%)	-24 (-1%)
Critical	-392 (-33%)	-10 (-1%)

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the September through January spring-run Chinook salmon spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period at either location.

The number of days on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month (May through September At Bend Bridge and October through April at Red Bluff) and year of the 82-year modeling period (Table 11-4-13). The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern", as defined in Table 11-4-14. Differences between baselines and H3 in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4-15 for Bend Bridge and in Table 11-4-28 for Red Bluff. There would be no difference in levels of concern between NAA and H3 at Bend Bridge. At Red Bluff, there would be 2 (4%) and 3 (23%) more years with a "red" and "orange" level of concern, respectively, under H3 that would not be biologically meaningful to spring-run Chinook salmon spawners and eggs, as this is a small proportion of the 82 year period.

Table 11-4-28. Differences between Baseline and H3 Scenarios in the Number of Years in Which Water Temperature Exceedances above 56°F Are within Each Level of Concern, Sacramento River at Red Bluff, October through April

Level of Concern[a]	EXISTING CONDITIONS vs. H3	NAA vs. H3
Red	38 (317%)	2 (4%)
Orange	10 (167%)	3 (23%)
Yellow	-3 (-23%)	-2 (-17%)
None	-45 (-88%)	-3 (-33%)

[a] For definitions of levels of concern, see Table 11-4-14.

Total degree-days exceeding 56°F were summed by month and water year type at Bend Bridge during May through September and at Red Bluff during October through April. At Bend Bridge, total degree-days under H3 would be up to 11% lower than under NAA during May and June and up to 11% higher during July through September (Table 11-4-16). At Red Bluff, total degree-days under H3 would be 5% higher than those under NAA during October, 7% lower during April, and similar during remaining months (Table 11-4-29).

Table 11-4-29. Differences between Baseline and H3 Scenarios in Total Degree-Days (°F-Days) by Month and Water Year Type for Water Temperature Exceedances above 56°F in the Sacramento River at Red Bluff, October through April

Month	Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
October	Wet	1,262 (491%)	93 (7%)
	Above Normal	514 (198%)	37 (5%)
	Below Normal	798 (382%)	92 (10%)
	Dry	1,164 (237%)	93 (6%)
	Critical	926 (154%)	3 (0%)
	All	4,664 (257%)	318 (5%)
November	Wet	96 (9,600%)	6 (7%)
	Above Normal	67 (NA)	6 (10%)
	Below Normal	52 (NA)	4 (8%)
	Dry	159 (1,988%)	8 (5%)
	Critical	102 (2,550%)	-8 (-7%)
	All	476 (3,662%)	16 (3%)
December	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
January	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
February	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
March	Wet	9 (NA)	0 (0%)
	Above Normal	5 (NA)	1 (25%)
	Below Normal	29 (322%)	8 (27%)
	Dry	64 (457%)	0 (0%)
	Critical	24 (2,400%)	-3 (-11%)
	All	131 (546%)	6 (4%)
April	Wet	260 (226%)	-1 (0%)
	Above Normal	204 (146%)	-25 (-7%)
	Below Normal	229 (290%)	-1 (0%)
	Dry	248 (133%)	-72 (-14%)
	Critical	137 (1,142%)	-14 (-9%)
	All	1,078 (203%)	-113 (-7%)

NA = could not be calculated because the denominator was 0.

The Reclamation egg mortality model predicts that spring-run Chinook salmon egg mortality in the Sacramento River under H3 would be similar to mortality under NAA in dry and critical years, less in dry years, but greater in wet, above normal, and below normal (11% to 29% greater) water years (Table 11-4-30). Relative increases of 11% mortality of the spring-run population under wet and above normal water years would be negligible to the overall population, particularly because this represents a 3% to 4% increase on an absolute scale. However, the 29% relative increase in mortality in below normal years would have an effect on the spring-run population. Combining all water years, there would be no effect of H3 on egg mortality (3% absolute change).

Table 11-4-30. Difference and Percent Difference in Percent Mortality of Spring-Run Chinook Salmon Eggs in the Sacramento River (Egg Mortality Model)

Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
Wet	18 (174%)	3 (11%)
Above Normal	26 (195%)	4 (11%)
Below Normal	41 (349%)	12 (29%)
Dry	54 (275%)	-3 (-3%)
Critical	22 (30%)	0 (0%)
All	32 (141%)	3 (6%)

SacEFT predicts that there would be a 6% relative decrease (3% on an absolute scale) in the percentage of years with good spawning availability, measured as weighted usable area, under H3 relative to NAA (Table 11-4-31). SacEFT predicts that there would be no difference in the percentage of years with good (lower) redd scour risk under H3 relative to NAA. SacEFT predicts that there would be a 12% decrease on an absolute scale (35% relative decrease) in the percentage of years with good (lower) egg incubation conditions under H3 relative to NAA. SacEFT predicts that there would be a 6% relative decrease (2% on an absolute scale) in the percentage of years with good (lower) redd dewatering risk under H3 relative to NAA.

Table 11-4-31. Difference and Percent Difference in Percentage of Years with "Good" Conditions for Spring-Run Chinook Salmon Habitat Metrics in the Upper Sacramento River (from SacEFT)

Metric	EXISTING CONDITIONS vs. H3	NAA vs. H3
Spawning WUA	-24 (-34%)	-3 (-6%)
Redd Scour Risk	0 (0%)	0 (0%)
Egg Incubation	-64 (-74%)	-12 (-35%)
Redd Dewatering Risk	-17 (-35%)	-2 (-6%)
Juvenile Rearing WUA	4 (18%)	4 (18%)
Juvenile Stranding Risk	-7 (-37%)	-2 (-14%)

WUA = Weighted Usable Area.

There is an apparent discrepancy in results of the SacEFT model and Reclamation egg mortality model with regard to conditions for spring-run salmon eggs. SacEFT predicts that egg incubation habitat would decrease (12% absolute scale decrease) and the Reclamation egg mortality model predicts that overall egg mortality would be unaffected by the H3, except in below normal water years. The SacEFT uses mid-August through early March as the egg incubation period, based on

Vogel and Marine (1991), and the reach between ACID Dam and Battle Creek for redd locations. The Reclamation egg mortality model uses the number of days after Julian week 33 (mid-August) that it takes to accumulate 750 temperature units to hatching and another 750 temperature units to emergence. Temperatures units are calculated by subtracting 32°F from daily river temperature and are computed on a daily basis. As a result, egg incubation duration is generally mid-August through January, but is dependent on river temperature. The Reclamation model uses the reach between ACID Dam and Jelly's Ferry (approximately 5 river miles downstream of Battle Creek), which includes 95% of Sacramento River spawning locations based on 2001–2004 redd survey data (Reclamation 2008). These differences in egg incubation period and location likely account for the difference between model results. Although the SacEFT model has been peer-reviewed, the Reclamation egg mortality model has been extensively reviewed and used in prior biological assessments and BiOps. Therefore, both results are considered valid and were considered in drawing conclusions about spring-run egg mortality in the Sacramento River.

Clear Creek

Flows in Clear Creek during the spring-run Chinook salmon spawning and egg incubation period (September through January) under H3 would generally be similar to flows under NAA throughout the spring-run spawning and egg incubation period for all water year types (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).The potential risk of spring-run Chinook salmon redd dewatering in Clear Creek was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in September when spawning is assumed to occur. The greatest reduction in flows under H3 would be the same as that under NAA in all water year types (Table 11-4-32).

Water temperatures were not modeled in Clear Creek.

Table 11-4-32. Difference and Percent Difference in Greatest Monthly Reduction (Percent Change) in Instream Flow in Clear Creek below Whiskeytown Reservoir during the September through January Spawning and Egg Incubation Period[a]

Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
Wet	0 (NA)	0 (NA)
Above Normal	-27 (NA)	0 (0%)
Below Normal	53 (100%)	0 (NA)
Dry	-67 (NA)	0 (0%)
Critical	-33 (-50%)	0 (0%)

NA = could not be calculated because the denominator was 0.

[a] Redd dewatering risk not applicable for months when flows during the egg incubation period were at or greater than flows in September, when spawning is assumed to occur. A negative value indicates that the greatest monthly reduction would be of greater magnitude (worse) under the alternative than under the baseline.

Feather River

Flows were examined in the Feather River low-flow channel (upstream of Thermalito Afterbay) where spring-run Chinook salmon primarily spawn during September through January. Flows under H3 would not differ from NAA because minimum Feather River flows are included in the FERC settlement agreement (California Department of Water Resources 2006) and would be met for all model scenarios (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Oroville Reservoir storage volume at the end of September influences flows downstream of the dam during the spring-run spawning and egg incubation period. Storage volume at the end of September under H3 would be similar to storage under NAA in wet, above normal, and below normal water years and 18% and 11% greater in dry and critical water years (Table 11-4-33).

Table 11-4-33. Difference and Percent Difference in September Water Storage Volume (thousand acre-feet) in Oroville Reservoir for Alternative 4 (Scenario H3)

Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
Wet	-978 (-34%)	36 (2%)
Above Normal	-823 (-35%)	-32 (-2%)
Below Normal	-571 (-28%)	38 (3%)
Dry	-170 (-12%)	183 (18%)
Critical	-100 (-10%)	88 (11%)

The potential risk of redd dewatering in the Feather River low-flow channel was evaluated by comparing the magnitude of flow reduction each month over the egg incubation period compared to the flow in September when spawning is assumed to occur. Minimum flows in the low-flow channel during October through January were identical between H3 and NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Therefore, there would be no effect of H3 on redd dewatering in the Feather River low-flow channel.

Mean monthly water temperatures in the low-flow channel would not differ between NAA and H3 (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

Effects of H3 on water temperature-related spawning and egg incubation conditions for spring-run Chinook salmon in the Feather River were analyzed by comparing the percent of months between September through January over the 82-year CALSIM modeling period that exceed a 56°F temperature threshold in the low-flow channel (above Thermalito Afterbay) (Table 11-4-34). In general, differences in the percent of months exceeding the threshold between NAA and H3 would be negligible (<5% on an absolute scale), although there would be a 6% reduction (absolute scale) in the percent of months exceeding the threshold by >3°F under H3 relative to NAA during October and in the percent of months exceeding the threshold by >5°F during October and November.

Table 11-4-34. Differences between Baseline and H3 Scenarios in Percent of Months during the 82-Year CALSIM Modeling Period during Which Water Temperatures in the Feather River above Thermalito Afterbay Exceed the 56°F Threshold, September through January

	Degrees Above Threshold				
Month	>1.0	>2.0	>3.0	>4.0	>5.0
EXISTING CONDITIONS vs. H3					
September	0 (0%)	1 (1%)	7 (8%)	25 (34%)	44 (109%)
October	63 (283%)	59 (800%)	48 (780%)	46 (1,850%)	31 (1,250%)
November	60 (2,450%)	56 (4,500%)	42 (3,400%)	35 (NA)	19 (NA)
December	4 (NA)	2 (NA)	1 (NA)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
NAA vs. H3					
September	0 (0%)	0 (0%)	0 (0%)	1 (1%)	2 (3%)
October	-1 (-1%)	1 (2%)	-1 (-2%)	-1 (-3%)	-6 (-16%)
November	-4 (-6%)	-2 (-4%)	-6 (-13%)	2 (8%)	-6 (-25%)
December	0 (0%)	1 (100%)	0 (0%)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.

The effects of H3 on water temperature-related spawning and egg incubation conditions for spring-run Chinook salmon in the Feather River were also analyzed by comparing the total degree-months for months that exceed the 56°F NMFS threshold during the September through January spring-run Chinook salmon spawning and egg incubation period for all 82 years (Table 11-4-35). Combining all water year types, there would be a small (5% to 7%) reduction in degree-months exceeded under H3 relative to NAA during October and November and no other differences between NAA and H3. Results are highly variable when separating out by water year type, ranging from a 9% more degree-months under H3 in below normal water years during September to a 17% fewer degree-months under H3 in dry water years during October. Overall, there would be many more water year types within months with reductions in exceedances under H3 than increases in exceedances.

Table 11-4-35. Differences between Baseline and H3 Scenarios in Total Degree-Months (°F-Months) by Month and Water Year Type for Water Temperature Exceedances above 56°F in the Feather River above Thermalito Afterbay, September through January

Month	Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
September	Wet	30 (28%)	5 (4%)
	Above Normal	14 (33%)	4 (8%)
	Below Normal	39 (65%)	8 (9%)
	Dry	71 (103%)	-17 (-11%)
	Critical	54 (83%)	-8 (-6%)
	All	208 (60%)	-8 (-1%)
October	Wet	79 (1,580%)	-17 (-17%)
	Above Normal	30 (300%)	-5 (-11%)
	Below Normal	50 (714%)	-4 (-7%)
	Dry	81 (1,157%)	1 (1%)
	Critical	41 (513%)	0 (0%)
	All	281 (759%)	-25 (-7%)
November	Wet	57 (NA)	1 (2%)
	Above Normal	23 (767%)	-2 (-7%)
	Below Normal	32 (3,200%)	-2 (-6%)
	Dry	46 (NA)	-5 (-10%)
	Critical	26 (NA)	-2 (-7%)
	All	184 (4,600%)	-10 (-5%)
December	Wet	1 (NA)	0 (0%)
	Above Normal	2 (NA)	1 (100%)
	Below Normal	3 (NA)	0 (0%)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	6 (NA)	1 (20%)
January	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.

H1/LOS

Sacramento River

Flows in the Sacramento River between Keswick and upstream of RBDD under H1 during the September through January spring-run Chinook salmon spawning and egg incubation period would generally be up to 23% greater than flows under H3 during January, similar to flows under H3 during September, October, and December, and up to 16% lower during November depending on water year type. However, these increases and reductions in flows would be too infrequent or of too low a magnitude to have a biologically meaningful effect on spring-run Chinook salmon spawning and egg incubation habitat. Shasta Reservoir storage at the end of September under H1 would be similar to storage under H3 (Table 11-4-36).

Table 11-4-36. Difference and Percent Difference in September Water Storage Volume (thousand acre-feet) in Shasta Reservoir for H1, H3, and H4 Scenarios

Water Year Type	H3 vs. H1	H3 vs. H4
Wet	331 (12.2%)	10 (0.4%)
Above Normal	170 (6.8%)	43 (1.7%)
Below Normal	-11 (-0.4%)	125 (5.2%)
Dry	74 (3.8%)	71 (3.7%)
Critical	10 (1.3%)	55 (6.9%)

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the September through January spring-run Chinook salmon spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period at either location.

The number of days on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month (May through September at Bend Bridge and October through April at Red Bluff) and year of the 82-year modeling period (Table 11-4-13). The combination of number of days and degrees above the 56°F threshold were further assigned a “level of concern”, as defined in Table 11-4-14. Differences between baselines and H1 in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4-20 for Bend Bridge and in Table 11-4-37 for Red Bluff. There would be no difference in levels of concern between NAA and H1 at Bend Bridge. At Red Bluff, there would be 6 (13%) fewer years with a “red” level of concern.

Table 11-4-37. Differences between Baseline and H3 Scenarios in the Number of Years in Which Water Temperature Exceedances above 56°F Are within Each Level of Concern, Sacramento River at Red Bluff, October through April

Level of Concern[a]	EXISTING CONDITIONS vs. H1	NAA vs. H1	EXISTING CONDITIONS vs. H4	NAA vs. H4
Red	30 (250%)	-6 (-13%)	38 (317%)	2 (4%)
Orange	15 (250%)	8 (62%)	9 (150%)	2 (15%)
Yellow	-2 (-15%)	-1 (-8%)	-5 (-38%)	-4 (-33%)
None	-43 (-84%)	-1 (-11%)	-42 (-82%)	0 (0%)

[a] For definitions of levels of concern, see Table 11-4-14.

Total degree-days exceeding 56°F were summed by month and water year type at Bend Bridge during May through September and at Red Bluff during October through April. At Bend Bridge, total degree-days under H1would be up to 11% to 12% lower than under NAA during May and June and 8% to 16% higher during July through September (Table 11-4-21). At Red Bluff, total degree-days under H1 would be 10% lower than those under H1 during November, 5% higher during March, and similar during remaining months (Table 11-4-38).

Table 11-4-38. Differences between Baseline and H3 Scenarios in Total Degree-Days (°F-Days) by Month and Water Year Type for Water Temperature Exceedances above 56°F in the Sacramento River at Red Bluff, October through April

Month	Water Year Type	EXISTING CONDITIONS vs. H1	NAA vs. H1	EXISTING CONDITIONS vs. H4	NAA vs. H4
October	Wet	1,084 (422%)	-85 (-6%)	1,261 (491%)	92 (6%)
	Above Normal	452 (174%)	-25 (-3%)	498 (192%)	21 (3%)
	Below Normal	685 (328%)	-21 (-2%)	697 (333%)	-9 (-1%)
	Dry	1,018 (207%)	-53 (-3%)	1,044 (213%)	-27 (-2%)
	Critical	859 (143%)	-64 (-4%)	827 (138%)	-96 (-6%)
	All	4,098 (226%)	-248 (-4%)	4,327 (238%)	-19 (-0.3%)
November	Wet	72 (7,200%)	-18 (-20%)	94 (9,400%)	4 (4%)
	Above Normal	64 (NA)	3 (5%)	71 (NA)	10 (16%)
	Below Normal	41 (NA)	-7 (-15%)	45 (NA)	-3 (-6%)
	Dry	139 (1,738%)	-12 (-8%)	145 (1,813%)	-6 (-4%)
	Critical	98 (2,450%)	-12 (-11%)	88 (2,200%)	-22 (-19%)
	All	414 (3,185%)	-46 (-10%)	443 (3,408%)	-17 (-4%)
December	Wet	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)	0 (NA)	0 (NA)
January	Wet	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	Wet	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)	0 (NA)	0 (NA)
March	Wet	9 (NA)	0 (0%)	9 (NA)	0 (0%)
	Above Normal	6 (NA)	2 (50%)	5 (NA)	1 (25%)
	Below Normal	29 (322%)	8 (27%)	35 (389%)	14 (47%)
	Dry	63 (450%)	-1 (-1%)	65 (464%)	1 (1%)
	Critical	25 (2,500%)	-2 (-7%)	26 (2,600%)	-1 (-4%)
	All	132 (550%)	7 (5%)	140 (583%)	15 (10%)
April	Wet	259 (225%)	-2 (-1%)	262 (228%)	1 (0%)
	Above Normal	202 (144%)	-27 (-7%)	205 (146%)	-24 (-7%)
	Below Normal	230 (291%)	0 (0%)	255 (323%)	25 (8%)
	Dry	294 (158%)	-26 (-5%)	322 (173%)	2 (0%)
	Critical	135 (1,125%)	-16 (-10%)	131 (1,092%)	-20 (-12%)
	All	1,120 (211%)	-71 (-4%)	1,175 (221%)	-16 (-1%)

NA = could not be calculated because the denominator was 0.

Clear Creek

Flows in Clear Creek during the spring-run Chinook salmon spawning and egg incubation period (September through January) under H1 would generally be similar to those under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Because flows would generally be similar between H1 and H3, results of the redd dewatering analysis would be similar between H1 and H3. Therefore, no analysis of redd dewatering risk was conducted for H1 in Clear Creek. Due to similar flows between H1 and H3, effects of H1 on spring-run Chinook salmon spawning and egg incubation habitat in Clear Creek would not be different from effects of H3.

Feather River

H1 flows in the Feather River low-flow channel during the spring-run Chinook salmon spawning and egg incubation period (September through January) would be similar between H1 and H3 (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Oroville Reservoir storage volume at the end of September under H1 would generally be similar to or greater than storage under H3 depending on water year type (Table 11-4-39). Higher storage during wetter water year types would generally benefit spring-run Chinook spawning and egg incubation habitat.

Table 11-4-39. Difference and Percent Difference in September Water Storage Volume (thousand acre-feet) in Oroville Reservoir for H1, H3, and H4 Scenarios

Water Year Type	H3 vs. H1	H3 vs. H4
Wet	388 (20.2%)	19 (1%)
Above Normal	178 (11.5%)	82 (5.3%)
Below Normal	81 (5.6%)	-48 (-3.3%)
Dry	62 (5.2%)	137 (11.5%)
Critical	50 (5.6%)	207 (23.4%)

Mean monthly water temperatures in the low-flow channel would not differ between NAA and H1 (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

Differences in the percent of months exceeding the 56°F threshold between NAA and H1 would generally be negligible (<5% on an absolute scale) except during October and November, during which the exceedances would be between 17% and 26% (absolute scale) lower under H1 (Table 11-4-40). This represents a moderate benefit of H1 on spring-run spawning habitat conditions in the Feather River.

Table 11-4-40. Differences between Baselines and H1 and H4 Scenarios in Percent of Months during the 82-Year CALSIM Modeling Period during Which Water Temperatures in the Feather River above Thermalito Afterbay Exceed the 56°F Threshold, September through January

	Degrees Above Threshold				
Month	>1.0	>2.0	>3.0	>4.0	>5.0
EXISTING CONDITIONS vs. H1					
September	0 (0%)	1 (1%)	9 (9%)	21 (29%)	46 (112%)
October	40 (178%)	37 (500%)	31 (500%)	28 (1,150%)	20 (800%)
November	41 (1,650%)	35 (2,800%)	22 (1,800%)	11 (NA)	7 (NA)
December	2 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
NAA vs. H1					
September	0 (0%)	0 (0%)	1 (1%)	-2 (-3%)	4 (4%)
October	-25 (-29%)	-21 (-32%)	-19 (-33%)	-19 (-38%)	-17 (-44%)
November	-23 (-35%)	-23 (-40%)	-26 (-53%)	-21 (-65%)	-17 (-70%)
December	-1 (-33%)	-1 (-100%)	-1 (-100%)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
EXISTING CONDITIONS vs. H4					
September	0 (0%)	0 (0%)	6 (7%)	19 (25%)	40 (97%)
October	46 (206%)	49 (667%)	41 (660%)	37 (1,500%)	36 (1,450%)
November	46 (1,850%)	41 (3,300%)	30 (2,400%)	22 (NA)	15 (NA)
December	2 (NA)	1 (NA)	1 (NA)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
NAA vs. H4					
September	0 (0%)	-1 (-1%)	-1 (-1%)	-5 (-5%)	-2 (-3%)
October	-19 (-21%)	-9 (-13%)	-9 (-16%)	-10 (-20%)	-1 (-3%)
November	-19 (-28%)	-17 (-29%)	-19 (-38%)	-10 (-31%)	-10 (-40%)
December	-1 (-33%)	0 (0%)	0 (0%)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.

During September, exceedances above the 56°F threshold under H1 would not differ from those under NAA across all water years (Table 11-4-41). Total degree-months above the 56°F threshold under H1 would be higher than those under NAA in wetter water years and lower in drier water year types. During October and November, exceedances above the threshold under H1 would be 76 to 112 (33% to 38%) fewer degree-months than exceedances under NAA. There would be no meaningful differences between NAA and H1 during December and January.

Table 11-4-41. Differences between Baseline Scenarios and H1 and H4 Scenarios in Total Degree-Months (°F-Months) by Month and Water Year Type for Water Temperature Exceedances above 56°F in the Feather River above Thermalito Afterbay, September through April

Month	Water Year Type	EXISTING CONDITIONS vs. H1	NAA vs. H1	EXISTING CONDITIONS vs. H4	NAA vs. H4
September	Wet	59 (55%)	34 (26%)	56 (52%)	31 (23%)
	Above Normal	23 (53%)	13 (25%)	32 (74%)	22 (42%)
	Below Normal	37 (62%)	6 (7%)	69 (115%)	38 (42%)
	Dry	53 (77%)	-35 (-22%)	50 (72%)	-38 (-24%)
	Critical	44 (68%)	-18 (-14%)	25 (38%)	-37 (-29%)
	All	216 (63%)	0 (0%)	232 (67%)	16 (3%)
October	Wet	46 (920%)	-50 (-50%)	98 (1,960%)	2 (2%)
	Above Normal	25 (250%)	-10 (-22%)	52 (520%)	17 (38%)
	Below Normal	41 (586%)	-13 (-21%)	62 (886%)	8 (13%)
	Dry	52 (743%)	-28 (-32%)	77 (1,100%)	-3 (-3%)
	Critical	31 (388%)	-10 (-20%)	14 (175%)	-27 (-55%)
	All	194 (524%)	-112 (-33%)	303 (819%)	-3 (-1%)
November	Wet	28 (NA)	-28 (-50%)	47 (NA)	-9 (-16%)
	Above Normal	18 (600%)	-7 (-25%)	30 (1,000%)	5 (18%)
	Below Normal	18 (1,800%)	-16 (-46%)	28 (2,800%)	-6 (-17%)
	Dry	32 (NA)	-19 (-37%)	41 (NA)	-10 (-20%)
	Critical	23 (NA)	-5 (-18%)	9 (NA)	-19 (-68%)
	All	118 (2,950%)	-76 (-38%)	155 (3,875%)	-39 (-20%)
December	Wet	0 (NA)	-1 (-100%)	0 (NA)	-1 (-100%)
	Above Normal	1 (NA)	0 (0%)	1 (NA)	0 (0%)
	Below Normal	1 (NA)	-2 (-67%)	3 (NA)	0 (0%)
	Dry	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Critical	1 (NA)	1 (NA)	1 (NA)	1 (NA)
	All	3 (NA)	-2 (-40%)	5 (NA)	0 (0%)
January	Wet	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.

Due to generally similar flows, reservoir storage, and water temperatures between H1 and H3, effects of H1 on spring-run Chinook salmon spawning and egg incubation habitat in the Feather River would generally not be different from effects of H3, except for beneficial effects of reservoir storage under H1 in wetter water year types and in the percent of months and total degree-months exceeding the 56°F threshold.

H4/HOS

Sacramento River

Flows in the Sacramento River between Keswick and upstream of RBDD under H4 during the September through January spring-run Chinook salmon spawning and egg incubation period would generally be similar to flows under H3. Shasta Reservoir storage at the end of September under H4 would be similar to storage under H3 (Table 11-4-27).

The number of days on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month (May through September at Bend Bridge and October through April at Red Bluff) and year of the 82-year modeling period (Table 11-4-13). The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern", as defined in Table 11-4-14. Differences between baselines and H4 in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4-20 for Bend Bridge and in Table 11-4-37 for Red Bluff. There would be no difference in levels of concern between NAA and H4 at Bend Bridge or at Red Bluff.

Total degree-days exceeding 56°F were summed by month and water year type at Bend Bridge during May through September and at Red Bluff during October through April. At Bend Bridge, total degree-days under H4 would be up to 5% lower than under NAA during August and similar during other months (Table 11-4-21). At Red Bluff, exceedances above the threshold under H4 would be 15 degree-days (10%) higher than those under Existing Conditions during March, and similar during remaining months (Table 11-4-38). On an absolute scale, the 15 degree-day increase during March, because it is the sum of the 82-year period, would not translate into a biologically meaningful effect on spring-run Chinook salmon.

Clear Creek

Flows in Clear Creek during the spring-run Chinook salmon spawning and egg incubation period (September through January) under H4 would generally be similar to those under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Because flows would generally be similar between H4 and H3, results of the redd dewatering analysis would be similar between H4 and H3. Therefore, no analysis of redd dewatering risk was conducted for H4 in Clear Creek. Due to similar flows between H4 and H3, effects of H4 on spring-run Chinook salmon spawning and egg incubation habitat in Clear Creek would not be different from effects of H3.

Feather River

Flows in the Feather River low-flow channel during the spring-run Chinook salmon spawning and egg incubation period (September through January) would be similar between H4 and H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis).* Oroville Reservoir storage volume at the end of September under H4 would generally be similar to or greater than storage under H3 depending on water year type (Table 11-4-39). Higher storage in drier water year types would generally benefit spring-run Chinook salmon spawning and rearing habitat. Mean monthly water temperatures in the low-flow channel would not differ between NAA and H4 (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

Differences in the percent of months exceeding the threshold between NAA and H4 would generally be negligible (<5% on an absolute scale) during all months except November, in which there would be up to 19% fewer months exceeding the threshold under H4 (Table 11-4-40).

Total degree-days of exceedance above the 56°F threshold under H4 would be similar to those under NAA in all months of the period except November, in which the total would be 20% lower. However, a reduction of 39 degree-days would not be biologically meaningful for the 82-year period.

Due to generally similar flows, reservoir storage, and water temperatures between H4 and H3, effects of H4 on spring-run Chinook salmon spawning and egg incubation habitat in the Feather River would generally not be different from effects of H3, except for beneficial effects of reservoir storage under H4 in drier water year types.

NEPA Effects: Alternative 4 does not propose any changes in Shasta Reservoir operating criteria, and CALSIM results show that Reclamation could operate Shasta in such a manner that it does not affect upstream storage or flows substantially as compared to the NAA. Available analytical tools show conflicting results regarding the temperature effects of relatively small changes in predicted summer and fall flows. Several models (CALSIM, SRWQM, and Reclamation Egg Mortality Model) generally show no change in upstream conditions as a result of Alternative 4. However, one model, SacEFT, shows adverse effects under some conditions. After extensive investigation of these results, they appear to be a function of high model sensitivity to relatively small changes in estimated upstream conditions, which may or may not accurately predict adverse effects. Temperature and end of September storage criteria from the NMFS (2009a) BiOp for Shasta reservoir are maintained, in order to minimize adverse effects to spawning and incubating salmonids including spring-run Chinook salmon. However, the new NDD structures allow for spring time deliveries of water south of the Delta that are currently constrained under the NAA. For this reason, additional spring storage criteria may be necessary to ensure Shasta operations similar to what was modeled. These discussions will occur in the Section 7 consultation with Reclamation on Shasta and system-wide operations, which is outside the scope of BDCP. In conclusion, Alternative 4 modeling results support a finding that effects are uncertain. Alternative 4 does not propose any changes to Shasta operating criteria, but modeled results are mixed and operations that match the CALSIM modeling are not assured. Model results will be submitted to independent peer review to confirm that adverse effects are not reasonably anticipated to occur.

Considering that Alternative 4 modeling results do not predict significant adverse changes in Feather River flows or temperatures (in the low-flow channel) during the spring-run spawning or incubation period, it is not expected that Alternative 4 will result in an adverse effect on spring-run Chinook salmon spawning and egg incubation habitat in the Feather River. Because the High Outflow Scenario of Alternative 4 (Scenario H3) results in changes to Oroville reservoir releases in some springs and summers, which, in turn, could affect the cold water pool and fall temperatures in the low-flow channel, temperature and biological modeling results will be submitted to independent peer review to confirm that adverse effects are not reasonably anticipated to occur.

CEQA Conclusion: In general, Alternative 4 would not affect the quantity and quality of spawning and egg incubation habitat for spring-run Chinook salmon relative to Existing Conditions.

H3/ESO

Sacramento River

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the September through January spring-run Chinook salmon spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). At Keswick, temperatures under H3 during September and October would both and 6% greater, respectively, than those under Existing Conditions, but not different in other months during the period. At Red Bluff, temperatures under H3 during September and October would be 5% and 6% greater, respectively, than those under Existing Conditions, but not different in other months during the period.

The number of days on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month (May through September At Bend Bridge and October through April at Red Bluff) and year of the 82-year modeling period (Table 11-4-13). The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern", as defined in Table 11-4-14. Differences between baselines and H3 in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4-15 for Bend Bridge and in Table 11-4-28 for Red Bluff. At Bend Bridge, there would be a 61% increase in the number of years with a "red" level of concern under H3 relative to Existing Conditions. At Red Bluff, there would be 317% and 167% increases in the number of years with "red" and "orange" levels of concern under H3 relative to Existing Conditions.

Total degree-days exceeding 56°F were summed by month and water year type at Bend Bridge during May through September and at Red Bluff during October through April. At Bend Bridge, total degree-days under H3 would be 132% to 273% higher than that under Existing Conditions depending on month throughout the period (Table 11-4-16). At Red Bluff, total degree-days under H3 would be 203% to 3,662% higher than those under Existing Conditions during October, November, March, and April, and similar during December through February (Table 11-4-29).

Flows in the Sacramento River upstream of Red Bluff were examined during the spring-run Chinook salmon spawning and incubation period (September through January). Flows under H3 during all months but November would generally be similar to flows under Existing Conditions with few exceptions. Flows under H3 during November would be 9% to 14% lower than flows under NAA depending on water year type.

Shasta Reservoir Storage volume at the end of September would be 15% to 33% lower under H3 relative to Existing Conditions (Table 11-4-27).

The Reclamation egg mortality model predicts that spring-run Chinook salmon egg mortality in the Sacramento River under H3 would be 30% to 349% greater than mortality under Existing Conditions depending on water year type (Table 11-4-30).

SacEFT predicts that there would be a 34% decrease in the percentage of years with good spawning availability, measured as weighted usable area, under H3 relative to Existing Conditions (Table 11-4-31). SacEFT predicts that there would be no difference in the percentage of years with good (lower) redd scour risk under H3 relative to Existing Conditions. SacEFT predicts that there would be a 74% decrease in the percentage of years with good (lower) egg incubation conditions under H3 relative to Existing Conditions. SacEFT predicts that there would be a 35% decrease in the percentage of years with good (lower) redd dewatering risk under H3 relative to Existing

Conditions. These results indicate that spawning and egg incubation conditions for spring-run Chinook salmon under H3 would be substantially lower relative to Existing Conditions.

Clear Creek

Flows in Clear Creek were examined during the spring-run Chinook salmon spawning and egg incubation period (September through January). Flows under H3 would generally be similar to flows under Existing Conditions with few exceptions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

The potential risk of spring-run Chinook salmon redd dewatering in Clear Creek was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in September when spawning is assumed to occur. The greatest reduction in flows under H3 would be similar to or lower magnitude than that under Existing Conditions in wet and below normal water years (Table 11-4-32). The greatest reduction in flows under H3 would be 27 cfs to 67cfs lower (worse) than Existing Conditions in above normal, dry, and critical years.

Water temperatures were not modeled in Clear Creek.

Feather River

Flows in the Feather River low-flow channel under H3 are not different from Existing Conditions during the September through January spring-run spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in October through January(800 cfs) would be equal to or greater than the spawning flows in September (773 cfs) for all model scenarios.

Oroville Reservoir storage volume at the end of September would be 10% to 35% lower under H3 relative to Existing Conditions depending on water year type (Table 11-4-33).

The potential risk of redd dewatering in the Feather River low-flow channel was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in September when spawning is assumed to occur. Minimum flows in the low-flow channel during October through January were identical between H3 and Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Therefore, there would be no effect of H3 on redd dewatering in the Feather River low-flow channel.

Mean monthly water temperatures in the low-flow channel under H3 would be up to 10% higher under H3 relative to Existing Conditions during the September through January spawning and egg incubation period(Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

Effects of H3 on water temperature in the Feather River were analyzed by determining the percent of months between September and October over the 82-year CALSIM modeling period that exceed a 56°F temperature threshold in the low-flow channel (above Thermalito Afterbay) (Table 11-4-34). In general, the percent of months exceeding the threshold under H3 would be similar to or greater by up to 63% (absolute scale) than the percent under Existing Conditions. This comparison includes the effects of climate change.

The effects of H3 on water temperature in the Feather River were also analyzed by comparing the total degree-months for months that exceed the 56°F NMFS threshold during the September and October spring-run Chinook salmon spawning period for all 82 years (Table 11-4-35). Total degree-months would be 60% to 4,600% higher under H3 relative to Existing Conditions regardless of month or water year type. This comparison includes the effects of climate change.

H1/LOS

Sacramento River

Flows in the Sacramento River between Keswick and upstream of RBDD under H1 during the September through January spring-run Chinook salmon spawning and egg incubation period would generally be up to 23% greater than flows under H3 during January, similar to flows under H3 during September, October, and December, and up to 16% lower during November depending on water year type. However, these increases and reductions in flows would be too infrequent or too low of magnitude to have a biologically meaningful effect on spring-run Chinook salmon spawning and egg incubation habitat. Shasta Reservoir storage at the end of September under H1 would be similar to storage under H3 (Table 11-4-27).

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the September through January spring-run Chinook salmon spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). At both Keswick and Red Bluff, temperatures under H1 during September and October would be 5% and 6% greater, respectively, than those under Existing Conditions, but not different in other months during the period.

The number of days on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month (May through September At Bend Bridge and October through April at Red Bluff) and year of the 82-year modeling period (Table 11-4-13). The combination of number of days and degrees above the 56°F threshold were further assigned a “level of concern”, as defined in Table 11-4-14. Differences between baselines and H1 and H4 scenarios in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4-20 for Bend Bridge and in Table 11-4-37 for Red Bluff. At Bend Bridge, there would be a 61% increase in the number of years with a “red” level of concern under H1 relative to Existing Conditions. At Red Bluff, there would be 250% increases in the number of years with “red” and “orange” levels of concern under H1 relative to Existing Conditions.

Total degree-days exceeding 56°F were summed by month and water year type at Bend Bridge during May through September and at Red Bluff during October through April. At Bend Bridge, total degree-days under H1 would be 153% to 255% higher than that under Existing Conditions depending on month throughout the period (Table 11-4-21). At Red Bluff, total degree-days under H1 would be 211% to 3,185% higher than those under Existing Conditions during October, November, March, and April, and similar during December through February (Table 11-4-38).

Due to similar flows, reservoir storage, and water temperatures between H1 and H3, results for additional analyses (e.g., egg mortality model, SacEFT) under H1 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H1. Overall, conclusions for H1 would be similar to those for H3.

Clear Creek

Flows in Clear Creek during the spring-run Chinook salmon spawning and egg incubation period (September through January) under H1 would generally be similar to those under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Because flows would generally be similar between H1 and H3, results of the redd dewatering analysis would be similar between H1 and H3. Therefore, no analysis of redd dewatering risk was conducted for H1 in Clear Creek. Due to similar flows between H1 and H3, effects of H1 on spring-run Chinook salmon spawning and egg incubation habitat in Clear Creek would not be different from effects of H3.

Feather River

Flows in the Feather River low-flow channel during the spring-run Chinook salmon spawning and egg incubation period (September through January) would be similar between H1 and H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Oroville Reservoir storage volume at the end of September under H1 would generally be similar to or greater than storage under H3 depending on water year type (Table 11-4-39). Higher storage during wetter water year types would generally benefit spring-run Chinook spawning and egg incubation habitat. Mean monthly water temperatures in the low-flow channel would be up to 9% higher under H1 relative to Existing Conditions during the September through January spawning and egg incubation period(Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

The percent of months exceeding the 56°F NMFS temperature threshold under H1 would be similar to or greater by up to 46% (absolute scale) than the percent under Existing Conditions during September through November, but similar during December and January (Table 11-4-40). This comparison includes the effects of climate change.

Total degree-months exceeding the 56°F NMFS threshold under H1 would be 63% to 2,950% higher relative to Existing Conditions regardless of month or water year type during September through November, but similar during December and January (Table 11-4-41). This comparison includes the effects of climate change.

Due to generally similar flows, reservoir storage, and water temperatures between H1 and H3, effects of H1 on spring-run Chinook salmon spawning and egg incubation habitat in the Feather River would generally not be different from effects of H3, except for beneficial effects of reservoir storage under H1 in wetter water year types.

H4/HOS

Sacramento River

Water temperatures in the Sacramento River under H4 would not differ from those under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in the Sacramento River between Keswick and upstream of RBDD under H4 during the September through January spring-run Chinook salmon spawning and egg incubation period would generally be similar to flows under H3. Shasta Reservoir storage at the end of September under H4 would be similar to storage under H3 (Table 11-4-27).

Due to similar flows, reservoir storage, and water temperatures between H4 and H3, results for additional analyses (e.g., egg mortality model, SacEFT) under H4 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H4. Overall, effects of H4 on spring-run Chinook salmon spawning and egg incubation habitat in the Sacramento River would not be different from effects of H3.

Clear Creek

Flows in Clear Creek during the spring-run Chinook salmon spawning and egg incubation period (September through January) under H4 would generally be similar to those under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Because flows would generally be similar between H4 and H3, results of the redd dewatering analysis would be similar between H4 and H3. Therefore, no analysis of redd dewatering risk was conducted for H4 in Clear Creek. Due to similar flows between H4 and H3, effects of H4 on spring-run Chinook salmon spawning and egg incubation habitat in Clear Creek would not be different from effects of H3.

Feather River

Flows in the Feather River low-flow channel during the spring-run Chinook salmon spawning and egg incubation period (September through October) would be similar between H4 and H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis).* Oroville Reservoir storage volume at the end of September under H4 would generally be similar to or greater than storage under H3 depending on water year type (Table 11-4-33). Higher storage in drier water year types would generally benefit spring-run Chinook salmon spawning and rearing habitat. Mean monthly water temperatures in the low-flow channel would be up to 9% higher under H4 relative to Existing Conditions during the September through January spawning and egg incubation period(Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

There would be an increased percent of months (up to 49% on an absolute scale) under H4 above the 56°F threshold compared to Existing Conditions during September through November and no change in December and January (Table 11-4-40).

The number of degree-months exceeding the threshold under H4 would be 67% to 3,875% higher than the number under Existing Conditions during September through November, but no there would be no differences during December and January (Table 11-4-41).

Due to generally similar flows, reservoir storage, and water temperatures between H4 and H3, effects of H4 on spring-run Chinook salmon spawning and egg incubation habitat in the Feather River would generally not be different from effects of H3, except for beneficial effects of reservoir storage under H4 in drier water year types.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-58 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 4 could be significant because, when compared to the CEQA baseline, the alternative could substantially reduce suitable spawning habitat and substantially reduce the number of fish as a result of egg mortality, contrary to the NEPA conclusion set forth above, which is directly related to the inclusion of climate change effects in Alternative 4.

There are biologically meaningful flow reductions and temperature increases in the Sacramento River that would lead to increased egg mortality and overall reduced habitat conditions in spring-run spawning and egg incubation habitat conditions. Flows in the Feather River low-flow channel do not differ between Alternative 4 and Existing Conditions. However, water temperature analyses in the Feather River low-flow channel using the NMFS thresholds indicate that there would be moderate to large negative effects on temperature conditions during spring-run Chinook salmon spawning and egg incubation.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to H3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow and reservoir storage outputs between Existing Conditions in the late long-term implementation period and H3 indicates that flows and reservoir storage in the locations and during the months analyzed above would generally be similar between future conditions without the BDCP (NAA) and H3. This indicates that the differences between Existing Conditions and Alternative 4 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 4, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on spawning and egg incubation habitat for spring-run Chinook salmon. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-59: Effects of Water Operations on Rearing Habitat for Chinook Salmon (Spring-Run ESU)

In general, Alternative 4 would not affect the quantity and quality of rearing habitat for fry and juvenile spring-run Chinook salmon relative to the NAA.

H3/ESO

Sacramento River

Flows were evaluated during the November through March larval and juvenile spring-run Chinook salmon rearing period in the Sacramento River between Keswick Dam and just upstream of Red Bluff (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). At Keswick, flows under H3 would generally be up to 23% lower during November than under NAA and similar in the remaining months. Upstream of Red Bluff, flows under H3 would generally be up to 18% lower during November than under NAA and similar in the remaining months. These results indicate that there would very few reductions in flows due to H3 in the Sacramento River.

As reported in Impact AQUA-40, May Shasta storage volume under H3 would be similar to or greater than storage under NAA for all water year types (Table 11-4-12) so there would be no biologically meaningful effects on downstream flows.

As reported in Impact AQUA-58, September Shasta storage volume under H3 would be similar to (<5% difference from) storage under NAA in all water year types (Table 11-4-27).

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the year-round spring-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period at either location.

SacEFT predicts that the percentage of years with good juvenile rearing WUA conditions under H3 would be 18% greater than that under NAA (Table 11-4-31). However, the percentage of years with good (lower) juvenile stranding risk conditions under H3 would be 14% lower than under NAA. On an absolute scale, juvenile stranding risk would decrease in only 2% of years. This reduction would not have a biologically meaningful effect on spring-run Chinook salmon.

SALMOD predicts that spring-run smolt equivalent habitat-related mortality would be similar to (<5% different from) NAA.

Clear Creek

Flows in Clear Creek during the November through March rearing period under H3 would generally be similar to flows under NAA with few exceptions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Water temperatures were not modeled in Clear Creek.

Feather River

Flows in the Feather River both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) during November through June were reviewed to determine flow-related effects on larval and juvenile spring-run rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Relatively constant flows in the low-flow channel throughout this period under H3 would not differ from those under NAA. In the high-flow channel, flows under H3 would generally be lower by up to 50% (monthly mean of up to 19% lower) than flows under NAA during July through September, generally greater by up to 79% (monthly mean of up to 48% higher) during February through June, and similar during January and October through December.

May Oroville storage volume under H3 would be similar to storage under NAA in all water year types (Table 11-4-42).

As reported in Impact AQUA-58, September Oroville storage volume under H3 would be similar to volume under NAA in wet, above normal, and below normal water years and 11% to 18% greater than volume under NAA during dry and critical water years (Table 11-4-33). Consequently, there would be minimal effects on downstream flows.

Table 11-4-42. Difference and Percent Difference in May Water Storage Volume (thousand acre-feet) in Oroville Reservoir for Alternative 4 (Model Scenario H3)

Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
Wet	-67 (-2%)	-21 (-1%)
Above Normal	-192 (-5%)	-36 (-1%)
Below Normal	-362 (-11%)	-9 (0%)
Dry	-532 (-19%)	-12 (-1%)
Critical	-372 (-20%)	-56 (-4%)

Mean monthly water temperatures in the Feather River both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were evaluated during November through June (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period at either location.

The percent of months exceeding the 63°F temperature threshold in the Feather River above Thermalito Afterbay (low-flow channel) was evaluated during May through August (Table 11-4-43). In general, differences in the percent of months exceeding the threshold between NAA and H3 would be negligible (<5% on an absolute scale), although there are some small (up to 9% on an absolute scale) increases and decreases in percent of months exceeding the threshold during June and August depending on the degrees above the threshold.

Table 11-4-43. Differences between Baseline and H3 Scenarios in Percent of Months during the 82-Year CALSIM Modeling Period during Which Water Temperatures in the Feather River above Thermalito Afterbay Exceed the 63°F Threshold, May through August

	Degrees Above Threshold				
Month	>1.0	>2.0	>3.0	>4.0	>5.0
EXISTING CONDITIONS vs. H3					
May	6 (NA)	2 (NA)	1 (NA)	0 (NA)	0 (NA)
June	31 (56%)	46 (168%)	38 (775%)	17 (NA)	5 (NA)
July	0 (0%)	0 (0%)	1 (1%)	27 (37%)	53 (134%)
August	0 (0%)	12 (14%)	41 (70%)	59 (209%)	56 (563%)
NAA vs. H3					
May	0 (0%)	0 (0%)	0 (0%)	0 (NA)	0 (NA)
June	-2 (-3%)	-5 (-6%)	-4 (-8%)	-4 (-18%)	0 (0%)
July	0 (0%)	0 (0%)	0 (0%)	1 (1%)	-1 (-1%)
August	0 (0%)	0 (0%)	0 (0%)	6 (8%)	9 (15%)

NA = could not be calculated because the denominator was 0.

The effects of H3 on water temperature-related juvenile rearing conditions for spring-run Chinook salmon in the Feather River were also analyzed by comparing the total degree-months for months that exceed the 56°F NMFS threshold during May through August for all 82 years (Table 11-4-44). Combining all water year types, there would be no difference in total degree-months exceeded between NAA and H3 except during June (6% lower). There would be no differences in exceedances during May and July, but small increases and decreases (up to 13%) in degree-months within June and August depending on water year type.

Table 11-4-44. Differences between Baseline and H3 Scenarios in Total Degree-Months (°F-Months) by Month and Water Year Type for Water Temperature Exceedances above 63°F in the Feather River above Thermalito Afterbay, May through August

Month	Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
May	Wet	1 (NA)	0 (0%)
	Above Normal	1 (NA)	0 (0%)
	Below Normal	0 (NA)	0 (NA)
	Dry	2 (NA)	0 (0%)
	Critical	4 (NA)	0 (0%)
	All	8 (NA)	0 (0%)
June	Wet	24 (160%)	-5 (-11%)
	Above Normal	13 (93%)	-4 (-13%)
	Below Normal	20 (154%)	-2 (-6%)
	Dry	31 (135%)	-2 (-4%)
	Critical	26 (433%)	1 (3%)
	All	114 (161%)	-12 (-6%)
July	Wet	43 (36%)	2 (1%)
	Above Normal	20 (45%)	0 (0%)
	Below Normal	27 (46%)	-1 (-1%)
	Dry	38 (54%)	2 (2%)
	Critical	38 (73%)	6 (7%)
	All	166 (48%)	9 (2%)
August	Wet	43 (48%)	10 (8%)
	Above Normal	20 (80%)	2 (5%)
	Below Normal	33 (87%)	4 (6%)
	Dry	48 (120%)	-5 (-5%)
	Critical	31 (74%)	-9 (-11%)
	All	175 (75%)	2 (1%)

NA = could not be calculated because the denominator was 0.

H1/LOS

Sacramento River

Flows during this period would generally be similar between H1 and H3, except during November, in which flows would be 3% to 17% lower, depending on water year type. Due to their low magnitude and frequency, these flow reductions would not have biologically meaningful effects on spring-run Chinook salmon rearing. September Shasta storage volume under H1 would generally be similar to September storage volume under H3 (Table 11-4-36).

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the year-round spring-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period at either location.

Clear Creek

Flows in Clear Creek during the November through March rearing period under H1 would generally be similar to flows under H3. Therefore, results for H1 regarding larval and juvenile spring-run Chinook salmon rearing habitat in Clear Creek would be similar to those under H3.

Feather River

Flows in the Feather River low-flow channel during November through June would not differ between H1 and H3 (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows in the high-flow channel under H1 during November through June juvenile rearing period would generally be similar to or greater than flows under H3. May and September Oroville storage under H1 would generally be similar to or greater than storage under H3 (Table 11-4-39, Table 11-4-45).

Table 11-4-45. Difference and Percent Difference in May Water Storage Volume (thousand acre-feet) in Oroville Reservoir for H1, H3, and H4 Scenarios

Water Year Type	H3 vs. H1	H3 vs. H4
Wet	2 (0.1%)	-374 (-10.9%)
Above Normal	-5 (-0.2%)	-487 (-14.7%)
Below Normal	77 (2.6%)	-391 (-13.5%)
Dry	167 (7.5%)	69 (3.1%)
Critical	83 (5.7%)	372 (25.6%)

Mean monthly water temperatures in the Feather River both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were evaluated during November through June (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period at either location.

Differences in the percent of months exceeding the 63°F threshold between NAA and H1 would generally be negligible (<5% on an absolute scale) during May and between 0% and 23% (absolute scale) lower under H1 during June through August (Table 11-4-46). This represents a small to moderate benefit of H1 on spring-run Chinook salmon juvenile rearing habitat conditions in the Feather River.

Table 11-4-46. Differences between Baselines and H1 and H4 Scenarios in Percent of Months during the 82-Year CALSIM Modeling Period during Which Water Temperatures in the Feather River above Thermalito Afterbay Exceed the 63°F Threshold, May through August

	Degrees Above Threshold				
Month	>1.0	>2.0	>3.0	>4.0	>5.0
EXISTING CONDITIONS vs. H1					
May	2 (NA)	2 (NA)	0 (NA)	0 (NA)	0 (NA)
June	26 (47%)	27 (100%)	23 (475%)	7 (NA)	2 (NA)
July	0 (0%)	0 (0%)	1 (1%)	25 (34%)	47 (119%)
August	0 (0%)	12 (14%)	36 (62%)	48 (170%)	41 (413%)
NAA vs. H1					
May	-4 (-60%)	0 (0%)	-1 (-100%)	0 (NA)	0 (NA)
June	-7 (-8%)	-23 (-30%)	-19 (-39%)	-14 (-65%)	-2 (-50%)
July	0 (0%)	0 (0%)	0 (0%)	-1 (-1%)	-7 (-8%)
August	0 (0%)	0 (0%)	-5 (-5%)	-5 (-6%)	-6 (-11%)
EXISTING CONDITIONS vs. H4					
May	2 (NA)	1 (NA)	0 (NA)	0 (NA)	0 (NA)
June	26 (47%)	31 (114%)	33 (675%)	15 (NA)	4 (NA)
July	0 (0%)	0 (0%)	1 (1%)	25 (34%)	51 (128%)
August	0 (0%)	12 (14%)	41 (70%)	53 (187%)	48 (488%)
NAA vs. H4					
May	-4 (-60%)	-1 (-50%)	-1 (-100%)	0 (NA)	0 (NA)
June	-7 (-8%)	-20 (-25%)	-9 (-18%)	-6 (-29%)	-1 (-25%)
July	0 (0%)	0 (0%)	0 (0%)	-1 (-1%)	-4 (-4%)
August	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (2%)

NA = could not be calculated because the denominator was 0.

Combining all water year types, total degree-months above the 63°F threshold under H1 would generally be similar (<5% difference) to those under NAA during May, July, and August but 9% lower during June (Table 11-4-47). Results by water year type are generally similar to those by combining all water year types, except during August, in which total degree-months under H1 would generally be higher under NAA in wetter water years and lower in drier water year types.

Table 11-4-47. Differences between Baseline and H1 and H4 Scenarios in Total Degree-Months (°F-Months) by Month and Water Year Type for Water Temperature Exceedances above 63°F in the Feather River above Thermalito Afterbay, May through August

Month	Water Year Type	EXISTING CONDITIONS vs. H1	NAA vs. H1	EXISTING CONDITIONS vs. H4	NAA vs. H4
May	Wet	1 (NA)	0 (0%)	1 (NA)	0 (0%)
	Above Normal	1 (NA)	0 (0%)	1 (NA)	0 (0%)
	Below Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Dry	2 (NA)	0 (0%)	2 (NA)	0 (0%)
	Critical	4 (NA)	0 (0%)	4 (NA)	0 (0%)
	All	8 (NA)	0 (0%)	8 (NA)	0 (0%)
June	Wet	25 (167%)	-4 (-9%)	24 (160%)	-5 (-11%)
	Above Normal	13 (93%)	-4 (-13%)	13 (93%)	-4 (-13%)
	Below Normal	18 (138%)	-4 (-11%)	18 (138%)	-4 (-11%)
	Dry	30 (130%)	-3 (-5%)	30 (130%)	-3 (-5%)
	Critical	23 (383%)	-2 (-6%)	23 (383%)	-2 (-6%)
	All	109 (154%)	-17 (-9%)	108 (152%)	-18 (-9%)
July	Wet	43 (36%)	2 (1%)	43 (36%)	2 (1%)
	Above Normal	20 (45%)	0 (0%)	20 (45%)	0 (0%)
	Below Normal	27 (46%)	-1 (-1%)	27 (46%)	-1 (-1%)
	Dry	39 (55%)	3 (3%)	40 (56%)	4 (4%)
	Critical	38 (73%)	6 (7%)	39 (75%)	7 (8%)
	All	167 (48%)	10 (2%)	169 (49%)	12 (2%)
August	Wet	42 (47%)	9 (7%)	42 (47%)	9 (7%)
	Above Normal	21 (84%)	3 (7%)	21 (84%)	3 (7%)
	Below Normal	30 (79%)	1 (1%)	32 (84%)	3 (4%)
	Dry	43 (108%)	-10 (-11%)	47 (118%)	-6 (-6%)
	Critical	33 (79%)	-7 (-9%)	32 (76%)	-8 (-10%)
	All	169 (72%)	-4 (-1%)	174 (74%)	1 (0.2%)

NA = could not be calculated because the denominator was 0.

Overall, due to similarities in flows, water temperatures, and storage volume between H1 and H3, results for H1 regarding larval and juvenile spring-run Chinook salmon rearing habitat in the Feather River would be similar to those for H3, although temperature conditions in the Feather River would be slightly better under H1.

H4/HOS

Sacramento River

Flows during this period would generally be similar between H4 and H3. September Shasta storage volume under H4 would generally be similar to September storage volume under H3 (Table 11-4-36). Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the year-round spring-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period at either location.

Clear Creek

Flows in Clear Creek during the November through March rearing period under H4 would generally be similar to flows under H3. Therefore, results for H4 regarding larval and juvenile spring-run Chinook salmon rearing habitat in Clear Creek would be similar to those under H3.

Feather River

Flows in the Feather River low-flow channel during November through June would not differ between H4 and H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in the high-flow channel under H4 during November through June juvenile rearing period would generally be similar to or greater than flows under H3, except during June, in which flows would be up to 39% lower than under H3. Because these reductions occur in only one month at the end of the rearing period, they are not expected to have biologically meaningful effects on spring-run rearing habitat. May storage would be 11% to 15% lower under H4 relative to H3 in wet, above normal, and below normal water years (Table 11-4-45). September Oroville storage under H4 would generally be similar to or greater than storage under H3 (Table 11-4-39).

Mean monthly water temperatures in the Feather River both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were evaluated during November through June (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period at either location.

Differences in the percent of months exceeding the 63°F threshold between NAA and H4 would be negligible (<5% on an absolute scale) during May, July, and August and between 1% and 20% (absolute scale) lower under H4 during June (Table 11-4-46). This represents a small to moderate benefit of H4 on spring-run spawning habitat conditions in the Feather River.

Combining all water year types, total degree-months above the 63°F threshold under H4 would be similar (<5% difference) to those under NAA during May, July, and August, but 9% lower during June (Table 11-4-47). Results by water year type are generally similar to those by combining all water year types, except during August, in which total degree-months are generally higher under NAA in wetter water years and lower in drier water year types.

Overall, due to similarities in flows and water temperatures between H4 and H3, results for H4 regarding larval and juvenile spring-run Chinook salmon rearing habitat in the Feather River would be similar to those for H3, although temperature conditions in the Feather River would be better under H4.

NEPA Effects: Collectively, these results indicate that the effect is not adverse because habitat would not be substantially reduced. Although SacEFT predicts that rearing habitat conditions in the Sacramento River would be reduced by Alternative 4, SALMOD predicts no substantial effects on spring-run rearing habitat. In the Feather River, habitat conditions would improve under Alternative 4 relative to the NAA, particularly in H1 and H4 scenarios. There would be no effects in Clear Creek.

CEQA Conclusion: In general, under all the Alternative 4 water operations scenarios, the quantity and quality of rearing habitat for spring-run Chinook salmon would be not be affected relative to the CEQA baseline.

H3/ESO

Sacramento River

Flows were evaluated during the November through March larval and juvenile spring-run Chinook salmon rearing period in the Sacramento River between Keswick Dam and just upstream of Red Bluff (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). At Keswick, flows under H3 would be up to 22% greater during February and similar in the remaining months. Upstream of Red Bluff, flows under H3 would generally be up to 26% lower during November than under Existing Conditions and similar in the remaining months. These results indicate that there would very few reductions in flows due to H3 in the Sacramento River.

As reported in Impact AQUA-40, Shasta Reservoir storage volume at the end of May under H3 would be similar to volume under Existing Conditions in wet and above normal water years and 8% to 25% lower than volume under Existing Conditions in below normal, dry, and critical water years (Table 11-4-19). As reported in AQUA-58, Shasta Reservoir storage volume at the end of September under H3 would be 15% to 33% lower relative to Existing Conditions (Table 11-4-27).

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the year-round spring-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). At both sites, mean monthly water temperature under H3 would be similar to those under Existing Conditions in all months except August through October, in which temperatures would be 5% to 6% higher under H3.

SacEFT predicts that the percentage of years with good juvenile rearing habitat availability, measured as weighted usable area, under H3 would be 18% lower than under Existing Conditions (Table 11-4-31). In addition, the percentage of years with good (low) juvenile stranding risk under H3 is predicted to be 37% lower than under Existing Conditions. This indicates that the quantity and quality of juvenile rearing habitat in the Sacramento River would be lower under H3 relative to Existing Conditions.

SALMOD predicts that spring-run smolt equivalent habitat-related mortality under H3 would be 32% lower than under Existing Conditions.

Clear Creek

Flows in Clear Creek during the November through March rearing period under H3 would generally be similar to flows under Existing Conditions, except during March, in which flows would be up to 29% greater (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Water temperatures were not model in Clear Creek.

Feather River

Relatively constant flows in the low-flow channel throughout the November through June rearing period under H3 would not differ from those under Existing Conditions. In the high-flow channel, flows under H3 would generally be up to 61% lower than flows under Existing Conditions during January, February, and December, up to 209% greater than flows under Existing Conditions during April through June, and similar during March and November.

May Oroville storage volume under H3 would be similar to volume under Existing Conditions in wet years and 5% to 20% lower than volume under Existing Conditions in other water year types (Table 11-4-42).

As reported in Impact AQUA-58, September Oroville storage volume would be 10% to 35% lower under H3 relative to Existing Conditions depending on water year type (Table 11-4-33).

Mean monthly water temperatures in the Feather River both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were evaluated during November through June (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). In the low-flow channel, mean monthly water temperatures under H3 would be 6% to 10% higher during November through March and not different during April through June. In the high-flow channel, mean monthly water temperatures under H3 would be 6% to 8% higher during November through February and not different during March through June.

Effects of H3 on water temperature-related effects on spring-run Chinook salmon juvenile rearing conditions in the Feather River were analyzed by comparing the percent of months between May and August over the 82-year CALSIM modeling period that exceed a 63°F temperature threshold in the low-flow channel (above Thermalito Afterbay) (Table 11-4-43). In general, the percent of months exceeding the threshold under H3 would be similar or up to 59% greater (absolute scale) than those under Existing Conditions. This comparison includes the effects of climate change.

The effects of H3 on water temperature-related juvenile rearing conditions for spring-run Chinook salmon in the Feather River were also analyzed by comparing the total degree-months for months that exceed the 56°F NMFS threshold during May through August for all 82 years (Table 11-4-44). Combining all water year types, there would be a very small difference (8 degree-months) between Existing Conditions and H3 during May, but up to 161% increase in degree-months during June, July, and August. This comparison includes the effects of climate change.

H1/LOS

Sacramento River

Flows during this period would generally be similar between H1 and H3, except during November, in which flows would be 3% to 17% lower, depending on water year type. Due to their low magnitude and frequency, these flow reductions would not have biologically meaningful effects on spring-run Chinook salmon rearing. September Shasta storage volume under H1 would generally be similar to May and September storage volume under H3 (Table 11-4-36).

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the year-round spring-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). At both locations, there would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H1 in any month except August through October, which would be 5% to 6% higher.

Clear Creek

Flows in Clear Creek during the November through March rearing period under H1 would generally be similar to flows under H3. Therefore, results for H1 regarding larval and juvenile spring-run Chinook salmon rearing habitat in Clear Creek would be similar to those under H3.

Feather River

Flows in the Feather River low-flow channel during November through June would not differ between H1 and H3 (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows in the high-flow channel under H1 during November through June juvenile rearing period would generally be similar to or greater than flows under H3. May and September Oroville storage under H1 would generally be similar to or greater than storage under H1 (Table 11-4-39, Table 11-4-45).

Mean monthly water temperatures in the Feather River both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were evaluated during November through June (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). In the low-flow channel, mean monthly water temperatures under H1 would be 6% to 9% higher during November through March and not different during April through June. In the high-flow channel, mean monthly water temperatures under H1 would be 6% to 8% higher during November through February and not different during March through June.

Differences in the percent of months exceeding the 63°F threshold between Existing Conditions and H1 would generally be negligible (<5% on an absolute scale) during May and between 0% and 48% (absolute scale) higher under H1 during June through August (Table 11-4-46). This comparison includes the effects of climate change.

Combining all water year types, there would be a very small difference (8 degree-months) between Existing Conditions and H1 during May, but up to 154% increase in degree-months during June, July, and August. (Table 11-4-47). This comparison includes the effects of climate change. Results by water year type are similar to those by combining all water year types but differ in magnitude of differences between Existing Conditions and H1.

Overall, due to similarities in flows, water temperatures, and storage volume between H1 and H3, results for H1 regarding larval and juvenile spring-run Chinook salmon rearing habitat in the Feather River would be similar to those for H3.

H4/HOS

Sacramento River

Flows during this period would generally be similar between H4 and H3. September Shasta storage volume under H4 would generally be similar to September storage volume under H3 (Table 11-4-36).

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the year-round spring-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). At both locations, there would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H4 in any month except August through October, which would be 5% to 6% higher.

Clear Creek

Flows in Clear Creek during the November through March rearing period under H4 would generally be similar to flows under H3. Therefore, results for H4 regarding larval and juvenile spring-run Chinook salmon rearing habitat in Clear Creek would be similar to those under H3.

Feather River

Flows in the Feather River low-flow channel during November through June would not differ between H4 and H3 (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows in the high-flow channel under H4 during November through June juvenile rearing period would generally be similar to or greater than flows under H3, except during June, in which flows would be up to 39% lower than under H3. Because these reductions occur in only one month at the end of the rearing period, they are not expected to have biologically meaningful effects on spring-run rearing habitat. May storage would be 11% to 15% lower under H4 relative to H3 in wet, above normal, and below normal water years (Table 11-4-39). September Oroville storage under H4 would generally be similar to or greater than storage under H3 (Table 11-4-45).

Mean monthly water temperatures in the Feather River both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were evaluated during November through June (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). In the low-flow channel, mean monthly water temperatures under H4 would be 5% to 9% higher during November through March and not different during April through June. In the high-flow channel, mean monthly water temperatures under H4 would be 6% to 8% higher during November through February and not different during March through June.

Differences in the percent of months exceeding the 63°F threshold between Existing Conditions and H4 would be negligible (<5% on an absolute scale) during May and between 0% and 53% (absolute scale) lower under H4 during June, July, and August (Table 11-4-46). This comparison includes the effects of climate change.

Combining all water year types, total degree-months above the 63°F threshold under H4 would be similar to those under Existing Conditions during May, but 49% to 152% greater than those under Existing Conditions during June through August (Table 11-4-47). Results by water year type are generally similar to those by combining all water year types, although magnitudes of differences vary by water year type within months. This comparison includes the effects of climate change.

Overall, due to similarities in flows and water temperatures between H4 and H3, results for H4 regarding larval and juvenile spring-run Chinook salmon rearing habitat in the Feather River would be similar to those for H3.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-59 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 4 could be significant because, under the CEQA baseline, the alternative could substantially reduce the amount of suitable habitat, contrary to the NEPA conclusion set forth above. There would be small to moderate flow-related effects of Alternative 4 on spring-run Chinook salmon in the Sacramento and Feather rivers and temperature-related effects in the Feather River. Both SacEFT and SALMOD predict reduced habitat conditions for spring-run Chinook salmon in the Sacramento River. Exceedances above NMFS temperature thresholds would be higher under Alternative 4 relative to Existing Conditions. Results would be similar among model scenarios.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to H3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and H3 indicates that flows in the locations and during the months analyzed above would generally be similar between future conditions without BDCP and H3. This indicates that the differences between Existing Conditions and Alternative 4 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 4, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on rearing habitat for spring-run Chinook salmon. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-60: Effects of Water Operations on Migration Conditions for Chinook Salmon (Spring-Run ESU)

In general, the effects of Alternative 4 on spring-run Chinook salmon migration conditions relative to the NAA are uncertain.

Upstream of the Delta

H3/ESO

Sacramento River

Flows in the Sacramento River upstream of Red Bluff were evaluated during the December through May juvenile Chinook salmon spring-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would generally be up to 12% greater than flows under NAA during May and similar to flows under NAA during December through April.

Flows in the Sacramento River upstream of Red Bluff were evaluated during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 during May and June would generally be up to 12% greater than flows under NAA and similar to flows under NAA during April, July, and August.

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

Clear Creek

Flows in Clear Creek during the November through May juvenile Chinook salmon spring-run migration period under H3 would generally be similar to or greater than flows under NAA throughout the period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flows in Clear Creek during the April through August adult spring-run Chinook salmon upstream migration period under H3 would be similar to flows under NAA, except in critical water years during June (8% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Water temperatures were not modeled in Clear Creek.

Feather River

Flows in the Feather River at the confluence with the Sacramento River were examined during the November through May juvenile spring-run Chinook salmon migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 during April and May would be up to 23% greater than flows under NAA and similar to flows under NAA in the remaining months.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the November through May juvenile spring-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

Flows in the Feather River at the confluence with the Sacramento River were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 during July and August would generally be up to 53% lower than flows under NAA, up to 65% greater than flows under NAA during May and June, and similar to flows under NAA during April. Although these reductions would be of moderate to large magnitude, flows under H3 during these months would generally exceed flows suggested by NMFS during the BDCP planning process at similar frequencies as those under NAA (Table 11-4-48). Therefore, these reduced flows would not affect spring-run Chinook salmon in a biologically meaningful way.

Table 11-4-48. Differences (Percentage Differences) in the Percentage of Years Exceeding NMFS Suggested Minimum Flows in the Feather River High-Flow Channel (at Thermalito)

	EXISTING CONDITIONS vs. H3	NAA vs. H3
Above Normal Water Year Type		
October	0 (0%)	0 (0%)
November	0 (0%)	0 (0%)
December	9.1 (50%)	-18.2 (-40%)
January	-27.3 (-60%)	0 (0%)
February	0 (0%)	0 (0%)
March	9.1 (25%)	9.1 (25%)
April	0 (NA)	0 (NA)
May	9.1 (100%)	9.1 (100%)
June	18.2 (25%)	0 (0%)
July	0 (0%)	0 (0%)
August	9.1 (10%)	0 (0%)
September	36.4 (57.2%)	0 (0%)
Below Normal Water Year Type		
October	-7.7 (-9.1%)	0 (0%)
November	-7.7 (-10%)	0 (0%)
December	0 (0%)	0 (0%)
January	-35.8 (-83.4%)	-7.2 (-50.3%)
February	-14.3 (-33.3%)	0 (0%)
March	-21.4 (-100%)	-7.1 (-100%)
April	7.1 (NA)	7.1 (NA)
May	7.1 (NA)	7.1 (NA)
June	28.6 (44.5%)	0 (0%)
July	0 (0%)	0 (0%)
August	0 (0%)	0 (0%)
September	-35.7 (-45.4%)	-50 (-53.8%)

NA = could not be calculated because the denominator was 0.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

H1/LOS

Sacramento River

Flows under H1 in the Sacramento River upstream of Red Bluff during the December through May juvenile spring-run Chinook salmon migration period and the April through August adult upstream migration period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model*

Results utilized in the Fish Analysis). Because flows would be similar between H1 and H3, results for H1 regarding migration conditions for spring-run Chinook salmon in the Sacramento River would be similar to those for H3.

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period.

Clear Creek

Flows under H1 in Clear Creek during the November through May juvenile spring-run Chinook salmon migration period and the April through August adult upstream migration period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Because flows would be similar between H1 and H3, results for H1 regarding migration conditions for spring-run Chinook salmon in Clear Creek would be similar to those for H3.

Feather River

Flows under H1 in the Feather River at the confluence with the Sacramento River during the November through May juvenile spring-run Chinook salmon migration period and the April through August adult upstream migration period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). This lack of reduction in flows is further confirmed by evaluating the exceedance of flows suggested by NMFS during the BDCP planning process for the Feather River (Table 11-4-49). Flows under H1 in both above and below normal water years during both periods would generally be similar to exceedances under H3. Because flows would be similar between H1 and H3, results for H1 regarding migration conditions for spring-run Chinook salmon in the Feather River would be similar to those for H3.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period.

Table 11-4-49. Differences (Percentage Differences) in the Percentage of Years Exceeding NMFS Suggested Minimum Flows in the Feather River High-Flow Channel (at Thermalito) between the H3 Model Scenario and H1 and H4 Model Scenarios

	H3 vs. H1	H3 vs. H4
Above Normal Water Year Type		
October	9.1 (12.5%)	9.1 (12.5%)
November	0 (0%)	0 (0%)
December	9.1 (33.3%)	-18.2 (-66.7%)
January	18.2 (100%)	9.1 (50%)
February	0 (0%)	9.1 (14.3%)
March	0 (0%)	0 (0%)
April	0 (NA)	36.4 (NA)
May	0 (0%)	9.1 (50%)
June	0 (0%)	-18.2 (-20%)
July	0 (0%)	-9.1 (-9.1%)
August	0 (0%)	-27.3 (-27.3%)
September	-81.8 (-81.8%)	-72.7 (-72.7%)
Below Normal Water Year Type		
October	0 (0%)	0 (0%)
November	0 (0%)	7.7 (11.1%)
December	0 (NA)	0 (NA)
January	0 (0%)	0 (0%)
February	-7.1 (-100%)	7.2 (101.4%)
March	7.1 (24.8%)	7.1 (24.8%)
April	7.1 (NA)	7.1 (NA)
May	-7.1 (-100%)	28.6 (402.8%)
June	0 (0%)	7.2 (101.4%)
July	0 (0%)	7.1 (7.6%)
August	0 (0%)	-7.1 (-7.1%)
September	0 (0%)	-7.1 (-7.1%)

NA = could not be calculated because the denominator was 0.

H4/HOS

Sacramento River

Flows under H4 in the Sacramento River upstream of Red Bluff during the December through May juvenile spring-run Chinook salmon migration period would generally be similar to flows under H3. Flows under H4 during the April through August adult upstream migration period would generally be similar to flows under H3, except during June, in which flows would be up to 12% lower under H4, and during August, in which flows would be up to 13% greater under H4. These differences in flows between H4 and H3 scenarios would not be large or frequent enough to have biologically meaningful effects on spring-run Chinook salmon adult migration conditions. Therefore, because flows and water temperatures would be similar between H4 and H3, results for H4 regarding migration conditions for spring-run Chinook salmon in the Sacramento River would be similar to those for H3.

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

Clear Creek

Flows under H4 in Clear Creek during the November through May juvenile spring-run Chinook salmon migration period and the April through August adult upstream migration period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Because flows would be similar between H4 and H3, results for H4 regarding migration conditions for spring-run Chinook salmon in Clear Creek would be similar to those for H3.

Feather River

Flows under H4 in the Feather River at the confluence with the Sacramento River during the November through May juvenile spring-run Chinook salmon migration period and the April through August adult upstream migration period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*), except during April and May in which flows would be up to 100% greater under H4*.* The exceedance of monthly flows in the Feather River suggested by NMFS during the BDCP planning process would differ between H4 and H3 (Table 11-4-49). Flows during the April through August adult upstream migration period would vary by month. flows would be lower under H4 relative to H3 during June through August and higher during January, February and May of above normal water years, but there would be no difference between H4 and H3 in below normal years.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

Through-Delta

Juveniles

Scenario H3 operations would reduce OMR reverse flows (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*), with a corresponding increase in net positive downstream flows, during the outmigration period of Chinook salmon through the interior Delta channels. Conditions under Scenario H1 and Scenario H3 would result in slightly decreased OMR flows in April and May relative to NAA, however flows during these months would still be net positive (flowing towards the sea). OMR flows under Scenario H4 would generally be improved compared to NAA conditions during all water year types throughout the migration period. These improved net positive downstream flows would be substantial benefits of the proposed operations.

Flows downstream of the north Delta intakes would be reduced, which may increase predation potential. During the juvenile spring-run Chinook salmon emigration period (December through May), mean monthly flows under Scenario H3 in the Sacramento River below the NDD would be lower (14% to 23% reduced in monthly mean across years) compared to NAA. Flows would be up to 27% to 28% lower in April and November of above normal years. Flows below the NDD would be similar for Scenarios H3 and H1. Under the high spring outflow Scenario, H4, flows during April and May would not decrease as much (5% to 9% lower) compared to NAA.

The three North Delta intake facilities proposed on the Sacramento River under Alternative 4 would displace aquatic habitat and attract predatory fish to the structure. Potential predation at the three North Delta intakes was estimated in two ways. Bioenergetics modeling with a median predator density predicts a predation loss of about 8,200 juveniles, or 0.2% of the spring-run juvenile population under Alternative 4 (Table 11-4-50). A conservative assumption of 5% loss per intake would yield a cumulative loss of 12% of juvenile spring-run Chinook that reach the north Delta. This assumption is uncertain and represents an upper bound estimate. In addition, the three intake structures would result in a permanent loss of 13.7 acres aquatic habitat and 7,450 linear feet of shoreline. This topic is discussed further in Impact AQUA-42 for Alternative 1A.

Table 11-4-50. Juvenile Spring-Run Chinook Salmon Predation Loss at the proposed North Delta Diversion intakes for Alternative 4 (Three Intakes)

Striped Bass at NDD (Three Intakes)			Spring-Run Chinook Consumed	
Density Assumption	Bass per 1,000 feet of Intake	Total Number of Bass	Number	Percentage of Annual Juvenile Production
Low	18	86	1,243	0.03%
Median	119	571	8,217	0.20%
High	219	1,051	15,122	0.36%

Note: Based on bioenergetics modeling of Chinook salmon consumption by striped bass (Appendix 5F Biological Stressors).

As estimated by the Delta Passage Model, through-Delta survival under Scenario H3 by juvenile spring-run Chinook salmon Alternative 4 averaged 29% across all years, ranging from about 24% in drier years to 38% in wetter years (Table 11-4-51). Scenario H3 survival was similar to NAA in both drier years (0.5% less survival, or 2% less in relative difference) and wetter years (2.5% reduced survival, or 6% less in relative difference) (Table 11-4-51).

Survival under Scenario H1 (low outflow) was similar to Scenario H3 and NAA (averages around 21%) (Table 11-4-51). Average survival under Scenario H4 (high outflow) was 30.7%, compared to 29.1% for Scenarios H1 and H3 and 30.3% for NAA. In wetter years, Scenario H4 had 2% greater survival, a 5% relative difference compared to NAA. This difference was driven by appreciably higher survival in wetter years (the above-normal year of 1980 and the wet year of 1984) as a result of greater outflow under Scenario H4.

Table 11-4-51. Through-Delta Survival (%) of Emigrating Juvenile Spring-Run Chinook Salmon under Alternative 4 (Scenarios H3, H1 and H4)

Water Year Type	Average Percentage Survival					Difference in Percentage Survival (Relative Difference)					
	Scenario					EXISTING CONDITIONS vs. Alt 4 Scenario			NAA vs. Alt 4 Scenario		
	EXISTING CONDITIONS	NAA	H3	H1	H4	H3	H1	H4	H3	H1	H4
Wetter Years	42.1	40.4	37.9	37.9	42.4	-4.2 (-10%)	-4.2 (-10%)	0.3 (1%)	-2.5 (-6%)	-2.5 (-6%)	2.0 (5%)
Drier Years	24.8	24.3	23.7	23.8	23.7	-1.0 (-4%)	-1.0 (-4%)	-1.1 (-5%)	-0.5 (-2%)	-0.5 (-2%)	-0.6 (-3%)
All Years	31.3	30.3	29.1	29.1	30.7	-2.2 (-7%)	-2.2 (-7%)	-0.6 (-2%)	-1.3 (-4%)	-1.2 (-4%)	0.4 (1%)

Note: Average Delta Passage Model results for survival to Chipps Island.
Wetter = Wet and Above Normal Water Years (6 years).
Drier = Below Normal, Dry and Critical Water Years (10 years).
H3 = ESO operations, H1 = Low Outflow, H4 = High Outflow.

Adults

As described for winter-run Chinook, attraction flows and olfactory cues in the west Delta would be altered because of shifts in exports from the south Delta to the north Delta. Flows in the Sacramento River downstream of the north Delta intake diversions would be reduced, with concomitant proportional increases in San Joaquin River flows. The flow changes under Scenario H3 would slightly decrease the olfactory cues for migrating adult salmon in the Sacramento River (by 9% or less compared to NAA) and slightly increase the olfactory cues for the San Joaquin River (Table 11-4-52). Conditions under Scenario H4 are expected to reduce the magnitude of this effect because it would involve fewer exports from the north Delta compared to Scenario H3 and Scenario 1.

Table 11-4-52. Percentage (%) of Water at Collinsville that Originated in the Sacramento during the Adult Spring-Run Chinook Salmon Migration Period for Alternative 4 (Scenario H3)

Month	EXISTING CONDITIONS	NAA	A4 (H3)	EXISTING CONDITIONS vs. A4 (H3)	NAA vs. A4 (H3)
March	78	76	68	-10	-8
April	77	75	66	-11	-9
May	69	65	59	-10	-6
June	64	62	58	-6	-4

Shading indicates 10% or greater absolute difference.

NEPA Effects: Upstream of the Delta, these results indicate that the effect would not be adverse because it does not have the potential to substantially interfere with the movement of fish. Flows in the Sacramento River and Clear Creek and water temperatures in the Sacramento and Feather Rivers would generally not be affected by Alternative 4. Flows under H3 and H4 scenarios in the Feather River would be lower during summer months due to the Fall X2 standard, although flows would otherwise not differ among scenarios.

Near-field effects of Alternative 4 NDD on spring-run Chinook salmon related to impingement and predation associated with three new intake structures could result in negative effects on juvenile migrating spring-run Chinook salmon, although there is high uncertainty regarding the overall effects. It is expected that the level of near-field impacts would be directly correlated to the number of new intake structures in the river and thus the level of impacts associated with 3 new intakes would be considerably lower than those expected from having 5 new intakes in the river. Estimates within the effects analysis range from very low levels of effects (<1% mortality) to more significant effects (~ 12% mortality above current baseline levels). CM15 would be implemented with the intent of providing localized and temporary reductions in predation pressure at the NDD. Additionally, several pre-construction surveys to better understand how to minimize losses associated with the three new intake structures will be implemented as part of the final NDD screen design effort. Alternative 4 also includes an Adaptive Management Program and Real-Time Operational Decision-Making Process to evaluate and make limited adjustments intended to provide adequate migration conditions for spring-run Chinook. However, at this time, due to the absence of comparable facilities anywhere in the lower Sacramento River/Delta, the degree of mortality expected from near-field effects at the NDD remains highly uncertain.

Two recent studies (Newman 2003 and Perry 2010) indicate that far-field effects associated with the new intakes could cause a reduction in smolt survival in the Sacramento River downstream of the NDD intakes due to reduced flows in this area. The analyses of other elements of Alternative 4 predict improvements in smolt condition and survival associated with increased access to the Yolo Bypass, reduced interior Delta entry, and reduced south Delta entrainment. The overall magnitude of each of these factors and how they might interact and/or offset each other in affecting salmonid survival through the plan area is uncertain, and remains an area of active investigation for the BDCP.

The DPM is a flow-based model being developed for BDCP which attempts to combine the effects of all of these elements of BDCP operations and conservation measures to predict smolt migration survival throughout the entire Plan Area. The current draft of this model predicts that smolt migration survival under Alternative 4 would be similar to those estimated for NAA. Further refinement and testing of the DPM, along with several ongoing and planned studies related to salmonid survival at and downstream of, the NDD are expected to be completed in the foreseeable future. These efforts are expected to improve our understanding of the relationships and interactions among the various factors affecting salmonid survival, and reduce the uncertainty around the potential effects of BDCP implementation on migration conditions for Chinook salmon. However, until these efforts are completed and their results are fully analyzed, the overall cumulative effect of Alternative 4 on spring-run Chinook salmon migration remains uncertain.

CEQA Conclusion: In general, Alternative 4 would not affect migration conditions for spring-run Chinook salmon relative to the CEQA baseline.

Upstream of the Delta

Sacramento River

Flows in the Sacramento River upstream of Red Bluff were examined during December through May juvenile spring-run Chinook salmon migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 during May would generally be up to 14% greater than flows under Existing Conditions, and similar to flows under Existing Conditions during December through April.

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the December through May juvenile Chinook salmon spring-run emigration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H3 in any month or water year type, except in critical years during January and wet years during May (5% lower in both).

Flows in the Sacramento River upstream of Red Bluff were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 during May and June would generally be up to 20% greater than flows under Existing Conditions, up to 26% lower during August, and similar to flows under Existing Conditions during April and July.

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H3 in any month except August, in which temperatures would be 6% greater under H3.

Clear Creek

Flows in Clear Creek were examined during the November through May juvenile Chinook salmon spring-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would generally be greater than flows under Existing Conditions during March, but similar during the remaining months.

Flows in Clear Creek were examined during the April through August adult spring-run Chinook salmon upstream migration period. Flows under H3 would generally be similar to flows under Existing Conditions, with few exceptions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Water temperatures were not modeled in Clear Creek.

Feather River

Flows in the Feather River at the confluence with the Sacramento River were examined during the November through May juvenile Chinook salmon spring-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would generally be up to 16% lower than flows under Existing Conditions during November, and similar during December through May.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the November through May juvenile spring-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H3 in any month except November and December, in which temperatures under H3 would be 5% greater.

Flows were examined for the Feather River at the confluence with the Sacramento River during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would generally be up to 64% lower than flows under Existing Conditions during July and August, and similar during April through June. However, the frequencies of exceedance above flow thresholds suggested by NMFS during the BDCP planning process under H3 would be similar to those under Existing Conditions during the two periods in above normal water years (Table 11-4-48). The frequencies of exceedance during the two periods in below normal water years would be lower during January through March.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H3 in any month except July and August, in which temperatures under H3 would be 6% greater.

H1/LOS

Sacramento River

Flows under H1 in the Sacramento River upstream of Red Bluff during the December through May juvenile spring-run Chinook salmon migration period and the April through August adult upstream migration period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Because flows would be similar between H1 and H3, results for H1 regarding migration conditions for spring-run Chinook salmon in the Sacramento River would be similar to those for H3.

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the December through May juvenile spring-run Chinook salmon migration period and the April through August adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H1 in any month except August, in which temperatures would be 6% greater under H1.

Clear Creek

Flows under H1 in Clear Creek during the November through May juvenile spring-run Chinook salmon migration period and the April through August adult upstream migration period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Because flows would be similar between H1 and H3, results for H1 regarding migration conditions for spring-run Chinook salmon in Clear Creek would be similar to those for H3.

Feather River

Flows under H1 in the Feather River at the confluence with the Sacramento River during the November through May juvenile spring-run Chinook salmon migration period and the April through August adult upstream migration period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). This lack of reduction in flows is further confirmed by evaluating the exceedance of flows suggested by NMFS during the BDCP planning process for the Feather River (Table 11-4-49). Flows under H1 in both above and below normal water years during both periods would generally be similar to exceedances under H3. Because flows would be similar between H1 and H3, results for H1 regarding migration conditions for spring-run Chinook salmon in the Feather River would be similar to those for H3.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the November through May juvenile spring-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H1 in any month except November and December, in which temperatures under H1 would be 5% greater.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H1 in any month except July and August, in which temperatures under H1 would be 6% greater.

H4/HOS

Sacramento River

Flows under H4 in the Sacramento River upstream of Red Bluff during the December through May juvenile spring-run Chinook salmon migration period would generally be similar to flows under H3. Flows under H4 during the April through August adult upstream migration period would generally be similar to flows under H3, except during June, in which flows would be up to 12% lower under H4, and during August, in which flows would be up to 13% greater under H4. These differences in flows between H4 and H3 scenarios would not be large or frequent enough to have biologically meaningful effects on spring-run Chinook salmon adult migration conditions. Therefore, because flows and water temperatures would be similar between H4 and H3, results for H4 regarding migration conditions for spring-run Chinook salmon in the Sacramento River would be similar to those for H3.

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H4 in any month except August, in which temperatures would be 6% greater under H4.

Clear Creek

Flows under H4 in Clear Creek during the November through May juvenile spring-run Chinook salmon migration period and the April through August adult upstream migration period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Because flows would be similar between H4 and H3, results for H4 regarding migration conditions for spring-run Chinook salmon in Clear Creek would be similar to those for H3.

Feather River

Therefore, no further temperature analyses were conducted in the Feather River to assess spring-run Chinook salmon migration conditions. Flows under H4 in the Feather River at the confluence with the Sacramento River during the November through May juvenile spring-run Chinook salmon migration period and the April through August adult upstream migration period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*), except during April and May in which flows would be up to 100% greater under H4. The exceedance of monthly flows in the Feather River suggested by NMFS during the BDCP planning process would be similar between H4 and H3 (Table 11-4-49). Flows during the April through August adult upstream migration period would vary by month. Flows during April and May would be up to 100% greater under H4, whereas flows during July through August would be up to 39% lower under H4. The exceedance of monthly flows in the Feather River suggested by NMFS during the BDCP planning process would be lower under H4 relative to H3 during June through August of above normal water years, but there would be no difference between H3 and H4 in below normal years. These results indicate that flows would be reduced in the Feather River by H4 relative to H3.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the November through May juvenile spring-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H4 in any month except November and December, in which temperatures under H4 would be 5% greater.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H4 in any month except July and August, in which temperatures under H4 would be 6% to 7% greater.

Through-Delta

Juveniles

As described above, Scenarios H3 and H1 operations have similar through-Delta survival averaged across all years compared to Existing Conditions (2.2% reduced survival, or 7% less in relative difference) (Table 11-4-51). Survival under the high outflow Scenario H4 would be similar to Existing Conditions (0.6% less averaged for all years, a 2% relative difference), particularly in wetter years. Overall reductions in OMR reverse flows under all flow scenarios for Alternative 4 would be beneficial (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Conditions under Scenario H4 would further improve OMR flow conditions (i.e., less reverse) relative to the Scenario H3 and H1. Flows below the north Delta intakes would be reduced, which may increase predation potential. The impact is considered less than significant due to similar or slightly greater survival between Alternative 4 and Existing Conditions during all water year types. No mitigation would be required.

Adults

As described above, attraction flows will be altered because of shifts in exports from the south Delta to the north Delta These changes would slightly decrease the olfactory cues for migrating adult salmon in the Sacramento River (reduced by 10–11% in March-May under the Scenario H3 compared to Existing Conditions) and slightly increase olfactory cues for the San Joaquin River (Table 11-4-52). Conditions between all flow scenarios under Alternative 4 would be similar; there would only be small changes in olfactory cues for migrating adult salmon. Overall, impacts related to migration conditions for spring-run Chinook salmon are considered less than significant. No mitigation is required.

Summary of CEQA Conclusion

Collectively, the results indicate that the effects would be less than significant because it would not substantially reduce the suitability of migration habitat or interfere with the movement of fish. Flows in the Sacramento River and Clear Creek and water temperatures in the Sacramento and Feather Rivers would generally not be affected by Alternative 4. Flows would be lower in 2 months of the 5-month adult migration period, although there would be no other flow reductions in the Feather River. Further, Alternative 4 would not reduce spring-run Chinook salmon juvenile survival through the Delta due to similar survival between Alternative 4 scenarios and Existing Conditions during all water year types and adult migration cues would not differ between Alternative 4 scenarios and Existing Conditions. No mitigation is necessary.

Restoration Measures (CM2, CM4–CM7, and CM10)

Alternative 4 has the same Restoration Measures as Alternative 1A. Because no substantial differences in restoration-related fish effects are anticipated anywhere in the affected environment under Alternative 4 compared to those described in detail for Alternative 1A, the fish effects of restoration measures described for spring-run Chinook salmon under Alternative 1A (Impacts AQUA-61 through AQUA-63) also appropriately characterize effects under Alternative 4.

The following impacts are those presented under Alternative 1A that are identical for Alternative 4.

Impact AQUA-61: Effects of Construction of Restoration Measures on Chinook Salmon (Spring-Run ESU)

Impact AQUA-62: Effects of Contaminants Associated with Restoration Measures on Chinook Salmon (Spring-Run ESU)

Impact AQUA-63: Effects of Restored Habitat Conditions on Chinook Salmon (Spring-Run ESU)

NEPA Effects: Detailed discussions regarding the potential effects of these three impact mechanisms on spring-run Chinook salmon are the same as those described under Alternative 1A (Impacts AQUA-61 through AQUA-63). The effects would not be adverse, and would generally be beneficial. Specifically for AQUA-62, the effects of contaminants on spring-run Chinook salmon with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on spring-run Chinook salmon are uncertain.

CEQA Conclusion: All three of the impact mechanisms listed above would be at least slightly beneficial, or less than significant, for the reasons identified for Alternative 1A, and no mitigation is required.

Other Conservation Measures (CM12–CM19 and CM21)

Alternative 4 has the same other conservation measures as Alternative 1A. Because no substantial differences in other conservation-related fish effects are anticipated anywhere in the affected environment under Alternative 4 compared to those described in detail for Alternative 1A, the fish effects of other conservation measures described for spring-run Chinook salmon under Alternative

1A (Impacts AQUA-64 through AQUA-72) also appropriately characterize effects under Alternative 4.

The following impacts are those presented under Alternative 1A that are identical for Alternative 4.

Impact AQUA-64: Effects of Methylmercury Management on Chinook Salmon (Spring-Run ESU) (CM12)

Impact AQUA-65: Effects of Invasive Aquatic Vegetation Management on Chinook Salmon (Spring-Run ESU) (CM13)

Impact AQUA-66: Effects of Dissolved Oxygen Level Management on Chinook Salmon (Spring-Run ESU) (CM14)

Impact AQUA-67: Effects of Localized Reduction of Predatory Fish on Chinook Salmon (Spring-Run ESU) (CM15)

Impact AQUA-68: Effects of Nonphysical Fish Barriers on Chinook Salmon (Spring-Run ESU) (CM16)

Impact AQUA-69: Effects of Illegal Harvest Reduction on Chinook Salmon (Spring-Run ESU) (CM17)

Impact AQUA-70: Effects of Conservation Hatcheries on Chinook Salmon (Spring-Run ESU) (CM18)

Impact AQUA-71: Effects of Urban Stormwater Treatment on Chinook Salmon (Spring-Run ESU) (CM19)

Impact AQUA-72: Effects of Removal/Relocation of Nonproject Diversions on Chinook Salmon (Spring-Run ESU) (CM21)

NEPA Effects: Detailed discussions regarding the potential effects of these nine impact mechanisms on spring-run Chinook salmon are the same as those described under Alternative 1A(Impacts AQUA-64 through AQUA-72). The effects range from no effect, to not adverse, to beneficial.

CEQA Conclusion: The effects of the nine impact mechanisms listed above range from no impact, to less than significant, to beneficial, and no mitigation is required.

Fall-/Late Fall–Run Chinook Salmon

Construction and Maintenance of CM1

Impact AQUA-73: Effects of Construction of Water Conveyance Facilities on Chinook Salmon (Fall-/Late Fall–Run ESU)

The potential effects of construction of the water conveyance facilities on fall-run/late fall-run Chinook salmon would be similar to those described for Alternative 1A, Impact AQUA-73, except that Alternative 4 would include three intakes instead of five intakes under Alternative 1A, so the effects would be proportionally less under this alternative. This would convert about 6,360 lineal feet of existing shoreline habitat into intake facility structures and would require about 17.1 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. Alternative 4 would use five barge locations rather than six as under Alternative 1A so those effects would also be proportionally less. Additionally, construction and excavation at Clifton Court Forebay would be done in the dry via installation of cofferdams for isolation and dewatering of work areas. Implementation of Appendix 3B, *Environmental Commitments*, including construction BMPs and 3B.8–*Fish Rescue and Salvage Plan*, would minimize adverse effects as described for Alternative 1A. Mitigation measures would also be available to avoid and minimize potential effects.

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-73, the effect would not be adverse for fall-run/late fall-run Chinook salmon.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-73, the impact of construction of the water conveyance facilities on fall-run/late fall-run Chinook salmon would not be significant except for construction noise associated with pile driving. Potential pile driving impacts would be less than Alternative 1A because only three intakes would be constructed rather than five. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in the discussion of Alternative 1A.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in the discussion of Alternative 1A.

Impact AQUA-74: Effects of Maintenance of Water Conveyance Facilities on Chinook Salmon (Fall-/Late Fall–Run ESU)

NEPA Effects: The potential effects of the maintenance of the water conveyance facilities under Alternative 4 would be the same as those described for Alternative 1A, Impact AQUA-74, except that only three intakes would need to be maintained under Alternative 4 rather than five under Alternative 1A. As concluded in Alternative 1A, Impact AQUA-74, the impact would not be adverse for fall-run/late fall-run Chinook salmon.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-74, the impact of maintenance of the water conveyance facilities on fall-run/late fall-run Chinook salmon would be less than significant and no mitigation is required.

Water Operations of CM1

Impact AQUA-75: Effects of Water Operations on Entrainment of Chinook Salmon (Fall-/Late Fall–Run ESU)

Overall entrainment under Alternative 4 at the south Delta export facilities would be reduced for all water year types (Table 11-4-53). Under Scenario H3, average entrainment across all years would be reduced 44% (~24,000 fish) for fall-run Chinook salmon and reduced 34% (627 fish) for late fall-run Chinook salmon compared to NAA.

Table 11-4-53. Juvenile Fall-Run and Late Fall-Run Chinook Salmon Annual Entrainment Index[a] at the SWP and CVP Salvage Facilities—Differences between Model Scenarios for Alternative 4 (Scenario H3)

	Absolute Difference (Percent Difference)	
Water Year	EXISTING CONDITIONS vs. A4 (H3)	NAA vs. A4 (H3)
Fall-run Chinook Salmon		
Wet	-80,609 (-63%)	-80,786 (-63%)
Above Normal	-13,488 (-41%)	-13,962 (-42%)
Below Normal	-3,504 (-26%)	-3,864 (-28%)
Dry	-1,890 (-10%)	-3,538 (-17%)
Critical	-12,803 (-31%)	-7,626 (-21%)
All Years	-23,960 (-44%)	-24,016 (-44%)
Late fall-run Chinook Salmon		
Wet	-2,801 (-47%)	-2,714 (-46%)
Above Normal	-259 (-45%)	-245 (-44%)
Below Normal	-21 (-38%)	-18 (-34%)
Dry	-45 (-33%)	-29 (-24%)
Critical	-51 (-31%)	-38 (-25%)
All Years	-708 (-37%)	-627 (-34%)

Shading indicates10% or greater increased entrainment.

Note: Estimated annual number of fish lost, based on normalized data.

The annual juvenile population that approaches the Delta is assumed to be 23 million fall-run Chinook salmon and 1 million late fall-run Chinook salmon (juvenile index of abundance). The proportion of juvenile index of abundance lost at the south Delta facilities is very low for both runs under NAA (fall-run 0.24%, late fall-run 0.19% averaged for all years), and under Scenario H3 decreases to negligible levels (fall-run 0.13%; late fall-run 0.12% A4_LLT).

In general, most covered fish species occur within the Plan Area during winter-spring and, therefore, there would be little difference in south Delta entrainment between Scenarios H3 and H1 based on the similarity of south Delta export pumping for these scenarios. Lower south Delta export pumping during the spring under Scenario H4 would result in lower entrainment during this period.

Entrainment under Scenario H1 would be similar to Scenario H3, while conditions under Scenario H4 are expected to further reduce entrainment losses.

Water Exports from SWP/CVP North Delta Intake Facilities

The impact would be similar in type to Alternative 1A, but the degree would be less because Alternative 4 would have fewer intakes. Thus under Alternative 4 there would be about a 40% reduction in impingement and predation risk relative to Alternative 1A (Impact AQUA-75).

Water Export with a Dual Conveyance for the SWP North Bay Aqueduct

The impact of entrainment to the NBA would be the same as described for Alternative 1A (Impact AQUA-75). Entrainment and impingement effects would be minimal because intakes on the Sacramento River would have state-of-the-art screens installed.

Predation Associated with Entrainment

Entrainment-related predation loss at the south Delta facilities would be no greater and may be lower than baseline (NAA), due to a reduction in entrainment loss. Scenario H3 Entrainment-related predation losses are expected to decrease under Scenario H4 compared to Scenario H3, while predation losses would be similar or slightly increased under Scenario H1 compared to Scenario H3.

Predation at the north Delta would be increased due to the installation of the proposed SWP/CVP North Delta intake facilities on the Sacramento River. Bioenergetics modeling with a median predator density predicts a predation loss under Alternative 4 of less than 0.6% of the annual juvenile production (155,000 fall-run juveniles, 0.25% annual production; 25,000 late fall-run juveniles, 0.58% annual production) (Table 11-4-54).

Table 11-4-54. Fall-Run and Late Fall-Run Chinook Salmon Juvenile Predation Loss at the Proposed North Delta Diversion (NDD) Intakes for Alternative 4 (Three Intakes)

Striped Bass at NDD (Three Intakes)			Fall-Run Chinook		Late Fall-Run Chinook	
Density	Bass per 1,000 Feet of Intake	Total Number of Bass	Number Consumed (LLT)	Percentage of Annual Production	Number Consumed (LLT)	Percentage of Annual Production
Low	18	86	23,395	0.04%	3,795	0.09%
Median	119	571	154,665	0.25%	25,089	0.58%
High	219	1,051	284,636	0.46%	46,172	1.07%

Note: Based on bioenergetics modeling of Chinook salmon consumption by striped bass (Appendix 5F Biological Stressors).

NEPA Effects: In conclusion, Alternative 4 would reduce overall entrainment losses of juvenile fall-run Chinook salmon and late fall-run Chinook salmon relative to NAA. The population benefit would be minor because entrainment losses affect less than 0.6% of annual juvenile index of abundance. Conditions under Scenario H4 would further reduce entrainment losses compared to Scenario H3 and Scenario H1. The effect of Alternative 4 would not be adverse.

CEQA Conclusion: Scenario H3 would substantially reduce entrainment at the south Delta facilities for fall-run (44% less) and late fall-run Chinook salmon (37% less) compared to Existing Conditions. Proportional losses of the juvenile population (juvenile index of abundance) would be slightly reduced from already-low levels (less that 0.25% average). Under Scenario H4, entrainment losses are expected to further decrease relative to Existing Conditions. Entrainment at the NBA would be minimal. Overall, impacts to fall-run and late fall-run Chinook salmon under Alternative 4 would be less than significant. No mitigation would be required.

Impact AQUA-76: Effects of Water Operations on Spawning and Egg Incubation Habitat for Chinook Salmon (Fall-/Late Fall–Run ESU)

In general, Alternative 4 would not affect the quantity and quality of spawning and egg incubation habitat for fall-/late fall-run Chinook salmon relative to the NAA.

H3/ESO

Sacramento River

Fall-Run

Sacramento River flows upstream of Red Bluff were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would generally be greater than or similar to NAA, except during October in below normal years (8% lower) and all water year types during November (5% to 18% lower, depending on water year type).

Shasta Reservoir storage at the end of September would affect flows during the fall-run spawning and egg incubation period. As reported in Impact AQUA-58, end of September Shasta Reservoir storage under H3 would be similar to storage under NAA in all water year types (Table 11-4-27).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

The number of days at Red Bluff on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month during October through April and year of the 82-year modeling period (Table 11-4-13). The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern", as defined in Table 11-4-14. Differences between baselines and H3 in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4-28. There would be 2 (4%) and 3 (23%) more years with a "red" and "orange" level of concern, respectively, under H3 that would not be biologically meaningful to fall-run Chinook salmon spawners and eggs, as this is a small proportion of the 82 year period.

Total degree-days exceeding 56°F were summed by month and water year type at Red Bluff during October through April. Total degree-days under H3 would be 5% higher than those under NAA during October, 7% lower during April, and similar during remaining months (Table 11-4-29).

The Reclamation egg mortality model predicts that fall-run Chinook salmon egg mortality in the Sacramento River under H3 would be lower than or similar to mortality under NAA in all water year types including wet, above normal, and below normal years (5% to 9% greater, respectively, but absolute increase of 1% and 2% of fall-run population) (Table 11-4-55). These results indicate that H3 would have negligible effects on fall-run Chinook salmon egg mortality.

Table 11-4-55. Difference and Percent Difference in Percent Mortality of Fall-Run Chinook Salmon Eggs in the Sacramento River (Egg Mortality Model)

Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
Wet	11 (110%)	1 (6%)
Above Normal	12 (111%)	1 (5%)
Below Normal	13 (124%)	2 (9%)
Dry	17 (116%)	0 (0%)
Critical	9 (31%)	-1 (-1%)
All	12 (89%)	1 (3%)

SacEFT predicts that there would be a 54% increase in the percentage of years with good spawning habitat availability for fall-run Chinook salmon, measured as weighted usable area, under H3 relative to NAA (Table 11-4-56). SacEFT predicts that there would be a 12% reduction in the percentage of years with good (lower) redd scour risk under H3 relative to NAA. SacEFT predicts that there would be no difference in the number of years with good egg incubation conditions between H3 and NAA. SacEFT predicts that there would be a 7% increase in redd dewatering risks under H3 relative to NAA.

Table 11-4-56. Difference and Percent Difference in Percentage of Years with "Good" Conditions for Fall-Run Chinook Salmon Habitat Metrics in the Upper Sacramento River (from SacEFT)

Metric	EXISTING CONDITIONS vs. H3	NAA vs. H3
Spawning WUA	6 (13%)	19 (54%)
Redd Scour Risk	-3 (-5%)	-8 (-12%)
Egg Incubation	-25 (-27%)	0 (0%)
Redd Dewatering Risk	2 (7%)	2 (7%)
Juvenile Rearing WUA	5 (15%)	-2 (-5%)
Juvenile Stranding Risk	-9 (-29%)	2 (10%)

WUA = Weighted Usable Area.

Late Fall-Run

Sacramento River flows upstream of Red Bluff were examined for the February through May late fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would be up to 12% greater than flows under NAA during May, and similar during February through April.

Shasta Reservoir storage at the end of September would affect flows during the fall-run spawning and egg incubation period. As reported in Impact AQUA-58, end of September Shasta Reservoir storage under H3 would be similar to storage under NAA in all water year types (Table 11-4-27).

The Reclamation egg mortality model predicts that late fall-run Chinook salmon egg mortality in the Sacramento River under H3 would be similar to or lower than mortality under NAA in all water years, including below normal water years in which, although there would be an 8% relative increase, the absolute increase would be <1% of the late fall-run population (Table 11-4-57).

Table 11-4-57. Difference and Percent Difference in Percent Mortality of Late Fall-Run Chinook Salmon Eggs in the Sacramento River (Egg Mortality Model)

Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
Wet	4 (193%)	-0.3 (-5%)
Above Normal	4 (150%)	-1 (-13%)
Below Normal	4 (301%)	0.4 (8%)
Dry	4 (161%)	-1 (-7%)
Critical	3 (141%)	-0.1 (-2%)
All	4 (183%)	-0.3 (-4%)

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the February through May late fall–run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

The number of days at Red Bluff on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month during October through April and year of the 82-year modeling period (Table 11-4-13). The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern", as defined in Table 11-4-14. Differences between baselines and H3 in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4-28. There would be 2 (4%) and 3 (23%) more years with a "red" and "orange" level of concern, respectively, under H3 that would not be biologically meaningful to late fall-run Chinook salmon spawners and eggs, as this is a small proportion of the 82 year period.

Total degree-days exceeding 56°F were summed by month and water year type at Red Bluff during October through April. Total degree-days under H3 would be 5% higher than those under NAA during October, 7% lower during April, and similar during remaining months (Table 11-4-29).

SacEFT predicts that there would be no difference in the percentage of years with good spawning availability for late fall-run Chinook salmon, measured as weighted usable area, between NAA and H3 (Table 11-4-58). SacEFT predicts that there would be no difference in redd scour risk between NAA and H3. SacEFT predicts that there would be a negligible difference in the percentage of years with good (lower) egg incubation conditions and redd dewatering risk between H3 and NAA.

Table 11-4-58. Difference and Percent Difference in Percentage of Years with "Good" Conditions for Late Fall-Run Chinook Salmon Habitat Metrics in the Upper Sacramento River (from SacEFT)

Metric	EXISTING CONDITIONS vs. H3	NAA vs. H3
Spawning WUA	-4 (-8%)	0 (0%)
Redd Scour Risk	-6 (-7%)	0 (0%)
Egg Incubation	0 (0%)	0 (0%)
Redd Dewatering Risk	-3 (-5%)	2 (4%)
Juvenile Rearing WUA	-3 (-7%)	-21 (-33%)
Juvenile Stranding Risk	-30 (-42%)	-4 (-9%)

WUA = Weighted Usable Area.

Clear Creek

No water temperature modeling was conducted in Clear Creek.

Fall-Run

Clear Creek flows below Whiskeytown Reservoir were examined for the September through February fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would generally be similar to flows under NAA with few exceptions.

The potential risk of redd dewatering in Clear Creek was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in September when spawning is assumed to occur. The greatest monthly reduction in Clear Creek flows during September through February under H3 would be similar to those under NAA in all water year types (Table 11-4-59).

Table 11-4-59. Difference and Percent Difference in Greatest Monthly Reduction (Percent Change) in Instream Flow in Clear Creek below Whiskeytown Reservoir during the September through February Spawning and Egg Incubation Period[a]

Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
Wet	0 (NA)	0 (NA)
Above Normal	-27 (NA)	0 (0%)
Below Normal	53 (100%)	0 (NA)
Dry	-67 (NA)	0 (0%)
Critical	-33 (-50%)	0 (0%)

NA = could not be calculated because the denominator was 0.

[a] Redd dewatering risk not applicable for months when flows during the egg incubation period were at or greater than flows in September, when spawning is assumed to occur. A negative value indicates that the greatest monthly reduction would be of greater magnitude (worse) under the alternative than under the baseline.

Feather River

Fall-Run

Flows in the Feather River in the low-flow and high-flow channels were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in the low-flow channel under H3 would be identical to those under NAA. Flows in the high-flow channel under H3 would generally be greater than those under NAA during October, and similar during November through January.

The potential risk of redd dewatering in the Feather River low-flow channel was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in October when spawning is assumed to occur. Minimum flows in the low-flow channel during November through January were identical between H3 and NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Therefore, there would be no effect of H3 on redd dewatering in the Feather River low-flow channel.

Mean monthly water temperatures in the Feather River above Thermalito Afterbay (low-flow channel) and below Thermalito Afterbay (high-flow channel) were examined during the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period at either location.

Effects of H3 on water temperature-related spawning and egg incubation conditions for fall-run Chinook salmon in the Feather River were analyzed by comparing the percent of months between October through April over the 82-year CALSIM modeling period that exceed a 56°F temperature threshold at Gridley (Table 11-4-60). In general, differences in the percent of months exceeding the threshold between NAA and H3 would be negligible (<5% on an absolute scale), although there would be a 6% reduction (absolute scale) in months exceeding the threshold by >3°F and >4°F during November.

Table 11-4-60. Differences between Baseline and H3 Scenarios in Percent of Months during the 82-Year CALSIM Modeling Period during Which Water Temperatures in the Feather River at Gridley Exceed the 56°F Threshold, October through April

	Degrees Above Threshold				
Month	>1.0	>2.0	>3.0	>4.0	>5.0
EXISTING CONDITIONS vs. H3					
October	2 (3%)	14 (16%)	27 (37%)	51 (124%)	63 (340%)
November	62 (1,667%)	41 (3,300%)	26 (NA)	12 (NA)	5 (NA)
December	1 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	4 (NA)	1 (NA)	0 (NA)	0 (NA)	0 (NA)
March	38 (517%)	27 (733%)	11 (900%)	7 (NA)	4 (NA)
April	20 (28%)	23 (41%)	40 (128%)	42 (243%)	27 (244%)
NAA vs. H3					
October	0 (0%)	0 (0%)	4 (4%)	2 (3%)	4 (5%)
November	4 (6%)	1 (3%)	-6 (-19%)	-6 (-33%)	-1 (-20%)
December	0 (0%)	-1 (-100%)	0 (NA)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	0 (0%)	1 (NA)	0 (NA)	0 (NA)	0 (NA)
March	1 (3%)	2 (9%)	1 (11%)	0 (0%)	0 (0%)
April	0 (0%)	0 (0%)	-2 (-3%)	0 (0%)	0 (0%)

NA = could not be calculated because the denominator was 0.

The effects of H3 on water temperature-related spawning and egg incubation conditions for fall-run Chinook salmon in the Feather River were also analyzed by comparing the total degree-months for months that exceed the 56°F NMFS threshold during the October through April fall-run Chinook salmon spawning and egg incubation period for all 82 years (Table 11-4-61). Combining all water year types, there would be no difference in total degree-months exceeded between NAA and H3. Large relative differences between NAA and H3 during December and February are mathematical artifacts due to small values of degree-months for NAA and would not translate into biologically meaningful effects on fall-run Chinook salmon. Results by water year type are generally similar to monthly results, except in dry water years during November (19% reduction). Overall, this method indicates that there would be no effect of H3 on temperature-related fall-run Chinook salmon spawning and egg incubation conditions in the Feather River.

Table 11-4-61. Differences between Baseline and H3 Scenarios in Total Degree-Months (°F-Months) by Month and Water Year Type for Water Temperature Exceedances above 56°F in the Feather River at Gridley, October through April

Month	Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
October	Wet	98 (134%)	-4 (-2%)
	Above Normal	35 (80%)	-1 (-1%)
	Below Normal	49 (89%)	0 (0%)
	Dry	74 (140%)	3 (2%)
	Critical	47 (115%)	3 (4%)
	All	303 (114%)	1 (0.2%)
November	Wet	37 (NA)	0 (0%)
	Above Normal	19 (950%)	0 (0%)
	Below Normal	20 (2,000%)	-1 (-5%)
	Dry	25 (NA)	-6 (-19%)
	Critical	20 (2,000%)	2 (11%)
	All	121 (3,025%)	-5 (-4%)
December	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	1 (NA)	-1 (-50%)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	1 (NA)	-1 (-50%)
January	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
February	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	2 (NA)	1 (100%)
	Dry	1 (NA)	1 (NA)
	Critical	1 (NA)	-1 (-50%)
	All	4 (NA)	1 (33%)
March	Wet	5 (NA)	0 (0%)
	Above Normal	3 (300%)	1 (33%)
	Below Normal	23 (2,300%)	2 (9%)
	Dry	24 (600%)	1 (4%)
	Critical	17 (425%)	0 (0%)
	All	72 (720%)	4 (5%)
April	Wet	37 (264%)	-1 (-2%)
	Above Normal	27 (117%)	0 (0%)
	Below Normal	21 (53%)	-4 (-6%)
	Dry	42 (86%)	1 (1%)
	Critical	33 (114%)	2 (3%)
	All	160 (103%)	-2 (-1%)

NA = could not be calculated because the denominator was 0.

The Reclamation egg mortality model predicts that fall-run Chinook salmon egg mortality in the Feather River under H3 would be similar to or lower than mortality under NAA in all water years, including above normal water years in which, although there would be a 15% relative increase, the absolute increase would be 2% of the fall-run population (Table 11-4-62).

Table 11-4-62. Difference and Percent Difference in Percent Mortality of Fall-Run Chinook Salmon Eggs in the Feather River (Egg Mortality Model)

Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
Wet	19 (1,391%)	0.2 (1%)
Above Normal	14 (1,269%)	2 (15%)
Below Normal	13 (759%)	0.4 (3%)
Dry	16 (718%)	-3 (-14%)
Critical	21 (427%)	-3 (-9%)
All	17 (806%)	-1 (-3%)

American River

Fall-Run

Flows in the American River at the confluence with the Sacramento River were examined during the October through January fall-run spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would generally be up to 8% lower than flows under NAA during November, and similar in the remaining three months.

The potential risk of redd dewatering in the American River at Nimbus Dam was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in October when spawning is assumed to occur. The greatest reduction in American River flows during November through January under H3 would be 9% to 49% greater in magnitude than under NAA in above normal below normal, dry, and critical water years and 9% lower in magnitude than NAA in wet water years (Table 11-4-63).

Table 11-4-63. Difference and Percent Difference in Greatest Monthly Reduction (Percent Change) in Instream Flow in the American River at Nimbus Dam during the October through January Spawning and Egg Incubation Period[a]

Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
Wet	-21 (-95%)	4 (9%)
Above Normal	-14 (-45%)	-4 (-9%)
Below Normal	-42 (-219%)	-15 (-32%)
Dry	-19 (-42%)	-22 (-49%)
Critical	8 (15%)	-4 (-10%)

NA = could not be calculated because the denominator was 0.

[a] Redd dewatering risk not applicable for months when flows during the egg incubation period were at or greater than flows in October, when spawning is assumed to occur. A negative value indicates that the greatest monthly reduction would be of greater magnitude (worse) under the alternative than under the baseline.

Mean monthly water temperatures in the American River at the Watt Avenue Bridge were examined during the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

The percent of months exceeding the 56°F temperature threshold in the American River at the Watt Avenue Bridge was evaluated during November through April (Table 11-4-64). The percent of months exceeding the threshold under H3 would generally be similar to the percent under NAA, except for the >5.0°F exceedance category during November, which would be 5% lower (absolute scale) under H3.

Table 11-4-64. Differences between Baseline and H3 Scenarios in Percent of Months during the 82-Year CALSIM Modeling Period during Which Water Temperatures in the American River at the Watt Avenue Bridge Exceed the 56°F Threshold, November through April

	Degrees Above Threshold				
Month	>1.0	>2.0	>3.0	>4.0	>5.0
EXISTING CONDITIONS vs. H3					
November	47 (103%)	54 (200%)	58 (427%)	54 (2,200%)	35 (2,800%)
December	2 (NA)	1 (NA)	0 (NA)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	4 (NA)	1 (NA)	0 (NA)	0 (NA)	0 (NA)
March	33 (270%)	25 (333%)	14 (550%)	11 (900%)	6 (NA)
April	25 (35%)	31 (50%)	35 (76%)	38 (119%)	32 (118%)
NAA vs. H3					
November	0 (0%)	-4 (-4%)	-2 (-3%)	0 (0%)	-5 (-12%)
December	1 (100%)	0 (0%)	0 (NA)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	0 (0%)	0 (0%)	0 (NA)	0 (NA)	0 (NA)
March	-4 (-8%)	0 (0%)	0 (0%)	0 (0%)	1 (25%)
April	-1 (-1%)	0 (0%)	0 (0%)	-1 (-2%)	2 (4%)

NA = could not be calculated because the denominator was 0.

Total degree-months exceeding 56°F were summed by month and water year type at the Watt Avenue Bridge during November through April (Table 11-4-65). Total degree-months would be similar between NAA and H3 for all months.

Table 11-4-65. Differences between Baseline and H3 Scenarios in Total Degree-Months (°F-Months) by Month and Water Year Type for Water Temperature Exceedances above 56°F in the American River at the Watt Avenue Bridge, November through April

Month	Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
November	Wet	78 (312%)	-4 (-4%)
	Above Normal	35 (318%)	-1 (-2%)
	Below Normal	42 (525%)	-1 (-2%)
	Dry	49 (377%)	-2 (-3%)
	Critical	36 (225%)	-2 (-4%)
	All	240 (329%)	-10 (-3%)
December	Wet	1 (NA)	1 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	2 (NA)	0 (0%)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	3 (NA)	1 (50%)
January	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
February	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	4 (NA)	0 (0%)
	All	4 (NA)	0 (0%)
March	Wet	12 (600%)	0 (0%)
	Above Normal	9 (NA)	0 (0%)
	Below Normal	11 (367%)	0 (0%)
	Dry	24 (600%)	-1 (-3%)
	Critical	19 (190%)	-1 (-3%)
	All	75 (395%)	-2 (-2%)
April	Wet	58 (207%)	0 (0%)
	Above Normal	34 (155%)	0 (0%)
	Below Normal	40 (111%)	-1 (-1%)
	Dry	45 (59%)	0 (0%)
	Critical	40 (68%)	5 (5%)
	All	217 (98%)	4 (1%)

NA = could not be calculated because the denominator was 0.

The Reclamation egg mortality model predicts that fall-run Chinook salmon egg mortality in the American River under H3 would be similar to mortality under NAA (Table 11-4-66).

Table 11-4-66. Difference and Percent Difference in Percent Mortality of Fall-Run Chinook Salmon Eggs in the American River (Egg Mortality Model)

Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
Wet	24 (160%)	1 (1%)
Above Normal	22 (207%)	-1 (-2%)
Below Normal	21 (171%)	-1 (-3%)
Dry	16 (99%)	-0.2 (-1%)
Critical	9 (44%)	-1 (-2%)
All	19 (128%)	-0.3 (-1%)

Stanislaus River

Fall-Run

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would be similar to flows under NAA throughout the period.

Water temperatures throughout the Stanislaus River would be similar under NAA and H3 throughout the October through January period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

San Joaquin River

Fall-Run

Flows in the San Joaquin River at Vernalis were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would be similar to flows under NAA throughout the period.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Fall-Run

Flows in the Mokelumne River at the Delta were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would be similar to flows under NAA throughout the period.

Water temperature modeling was not conducted in the Mokelumne River.

H1/LOS

Sacramento River

Fall-Run

Flows in the Sacramento River upstream of Red Bluff during October through January under H1 would generally be similar to flows under H3, except in November when flows would be up to 12% lower than under H3 depending on water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). This magnitude of flow reduction is not expected to have a biologically meaningful effect on fall-run Chinook salmon spawning and egg incubation habitat. September Shasta storage volume under H1 would generally be similar to September storage volume under H3 (Table 11-4-27).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period.

The number of days at Red Bluff on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month during October through April and year of the 82-year modeling period (Table 11-4-13). The combination of number of days and degrees above the 56°F threshold were further assigned a “level of concern”, as defined in Table 11-4-14. Differences between baselines and H1 in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4-67. There would be 6 (13%) fewer years with a “red” level of concern under H1 relative to NAA.

Table 11-4-67. Differences between Baseline Scenarios and H1 and H4 Scenarios in the Number of Years in Which Water Temperature Exceedances above 56°F Are within Each Level of Concern, Sacramento River at Red Bluff, October through April

Level of Concern[a]	EXISTING CONDITIONS vs. H1	NAA vs. H1	EXISTING CONDITIONS vs. H4	NAA vs. H4
Red	30 (250%)	-6 (-13%)	38 (317%)	2 (4%)
Orange	15 (250%)	8 (62%)	9 (150%)	2 (15%)
Yellow	-2 (-15%)	-1 (-8%)	-5 (-38%)	-4 (-33%)
None	-43 (-84%)	-1 (-11%)	-42 (-82%)	0 (0%)

[a] For definitions of levels of concern, see Table 11-4-14.

Total degree-days exceeding 56°F were summed by month and water year type at Red Bluff during October through April. Total degree-days under H1 would be 5% higher than those under NAA during March, 10% lower during November, and similar during remaining months (Table 11-4-68).

Table 11-4-68. Differences between Baseline Scenarios and H1 and H4 Scenarios in Total Degree-Days (°F-Days) by Month and Water Year Type for Water Temperature Exceedances above 56°F in the Sacramento River at Red Bluff, October through April

Month	Water Year Type	EXISTING CONDITIONS vs. H1	NAA vs. H1	EXISTING CONDITIONS vs. H4	NAA vs. H4
October	Wet	1,084 (422%)	-85 (-6%)	1,261 (491%)	92 (6%)
	Above Normal	452 (174%)	-25 (-3%)	498 (192%)	21 (3%)
	Below Normal	685 (328%)	-21 (-2%)	697 (333%)	-9 (-1%)
	Dry	1,018 (207%)	-53 (-3%)	1,044 (213%)	-27 (-2%)
	Critical	859 (143%)	-64 (-4%)	827 (138%)	-96 (-6%)
	All	4,098 (226%)	-248 (-4%)	4,327 (238%)	-19 (-0.3%)
November	Wet	72 (7,200%)	-18 (-20%)	94 (9,400%)	4 (4%)
	Above Normal	64 (NA)	3 (5%)	71 (NA)	10 (16%)
	Below Normal	41 (NA)	-7 (-15%)	45 (NA)	-3 (-6%)
	Dry	139 (1,738%)	-12 (-8%)	145 (1,813%)	-6 (-4%)
	Critical	98 (2,450%)	-12 (-11%)	88 (2,200%)	-22 (-19%)
	All	414 (3,185%)	-46 (-10%)	443 (3,408%)	-17 (-4%)
December	Wet	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)	0 (NA)	0 (NA)
January	Wet	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	Wet	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)	0 (NA)	0 (NA)
March	Wet	9 (NA)	0 (0%)	9 (NA)	0 (0%)
	Above Normal	6 (NA)	2 (50%)	5 (NA)	1 (25%)
	Below Normal	29 (322%)	8 (27%)	35 (389%)	14 (47%)
	Dry	63 (450%)	-1 (-1%)	65 (464%)	1 (1%)
	Critical	25 (2,500%)	-2 (-7%)	26 (2,600%)	-1 (-4%)
	All	132 (550%)	7 (5%)	140 (583%)	15 (10%)
April	Wet	259 (225%)	-2 (-1%)	262 (228%)	1 (0.3%)
	Above Normal	202 (144%)	-27 (-7%)	205 (146%)	-24 (-7%)
	Below Normal	230 (291%)	0 (0%)	255 (323%)	25 (8%)
	Dry	294 (158%)	-26 (-5%)	322 (173%)	2 (0.4%)
	Critical	135 (1,125%)	-16 (-10%)	131 (1,092%)	-20 (-12%)
	All	1,120 (211%)	-71 (-4%)	1,175 (221%)	-16 (-1%)

NA = could not be calculated because the denominator was 0.

Due to similar flows, reservoir storage, and water temperatures between H1 and H3, results for additional analyses (e.g., Reclamation egg mortality model, SacEFT) under H1 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H1. Overall, results for H1 would be similar to those for H3.

Late Fall-Run

Flows in the Sacramento River upstream of Red Bluff during February through May under H1 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). September Shasta storage volume under H1 would generally be similar to September storage volume under H3 (Table 11-4-27).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the February through May late fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period.

The number of days at Red Bluff on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month during October through April and year of the 82-year modeling period (Table 11-4-13). The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern", as defined in Table 11-4-14. Differences between baselines and H1 in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4-67. There would be 6 (13%) fewer years with a "red" level of concern under H1 relative to NAA.

Total degree-days exceeding 56°F were summed by month and water year type at Red Bluff during October through April. Total degree-days under H1 would be 5% higher than those under NAA during March, 10% lower during November, and similar during remaining months (Table 11-4-68).

Due to similar flows, reservoir storage, and water temperatures between H1 and H3, results for additional analyses (e.g., Reclamation egg mortality model, SacEFT) under H1 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H1. Overall, results for H1 would be similar to those for H3.

Clear Creek

No water temperature modeling was conducted in Clear Creek.

Fall-Run

Flows in Clear Creek flows below Whiskeytown Reservoir during October through January would generally be similar between H1 and H3 (*Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis*). As a result, no additional flow analyses were conducted for H1. Overall, results for H1 would be similar to those for H3.

Feather River

Fall-Run

Flows in the Feather River low-flow and high-flow channels during October through January would generally be similar between H1 and H3 (*Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis*).

Differences in the percent of months exceeding the 56°F NMFS threshold between NAA and H1 would be negligible (<5% on an absolute scale) during all months except October, November, March, and April, in which the percent of months under H1 would be similar to or up to 21% lower than those under NAA (Table 11-4-69).

Table 11-4-69. Differences between Baselines and H1 and H4 Scenarios in Percent of Months during the 82-Year CALSIM Modeling Period during Which Water Temperatures in the Feather River at Gridley Exceed the 56°F Threshold, October through April

	Degrees Above Threshold				
Month	>1.0	>2.0	>3.0	>4.0	>5.0
EXISTING CONDITIONS vs. H1					
October	2 (3%)	12 (14%)	21 (29%)	38 (94%)	53 (287%)
November	37 (1,000%)	25 (2,000%)	12 (NA)	6 (NA)	4 (NA)
December	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	1 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
March	26 (350%)	15 (400%)	6 (500%)	5 (NA)	2 (NA)
April	12 (18%)	19 (33%)	33 (108%)	36 (207%)	21 (189%)
NAA vs. H1					
October	0 (0%)	-1 (-1%)	-2 (-3%)	-10 (-11%)	-6 (-8%)
November	-21 (-34%)	-15 (-36%)	-20 (-62%)	-12 (-67%)	-2 (-40%)
December	-1 (-100%)	-1 (-100%)	0 (NA)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	-2 (-67%)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
March	-11 (-25%)	-10 (-35%)	-4 (-33%)	-2 (-33%)	-1 (-33%)
April	-7 (-8%)	-5 (-6%)	-9 (-12%)	-6 (-10%)	-6 (-16%)
EXISTING CONDITIONS vs. H4					
October	2 (3%)	12 (14%)	22 (31%)	42 (103%)	54 (293%)
November	43 (1,167%)	31 (2,500%)	21 (NA)	11 (NA)	7 (NA)
December	1 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	1 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
March	25 (333%)	14 (367%)	7 (600%)	5 (NA)	2 (NA)
April	-5 (-7%)	1 (2%)	21 (68%)	23 (136%)	15 (133%)
NAA vs. H4					
October	0 (0%)	-1 (-1%)	-1 (-1%)	-6 (-7%)	-5 (-6%)
November	-15 (-24%)	-9 (-21%)	-11 (-35%)	-7 (-40%)	1 (20%)
December	0 (0%)	-1 (-100%)	0 (NA)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	-2 (-67%)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
March	-12 (-28%)	-11 (-39%)	-2 (-22%)	-2 (-33%)	-1 (-33%)
April	-25 (-27%)	-22 (-28%)	-21 (-29%)	-19 (-31%)	-12 (-32%)

NA = could not be calculated because the denominator was 0.

Combining all water year types, there would be no difference between NAA and H1 in total degree-months exceeded in all months except October and November, during which degree-months would be lower by 9% and 28%, respectively (Table 11-4-70). Large relative differences between NAA and H1 during some months are due to small values of degree-months for NAA and would not translate into biologically meaningful effects on fall-run Chinook salmon. Results by water year type are generally similar to monthly results. Overall, this method indicates that there would be benefits of H1 on temperature-related fall-run Chinook salmon spawning and egg incubation conditions in the Feather River.

Table 11-4-70. Differences between Baselines and H1 and H4 Scenarios in Total Degree-Months (°F-Months) by Month and Water Year Type for Water Temperature Exceedances above 56°F in the Feather River at Gridley, October through April

Month	Water Year Type	EXISTING CONDITIONS vs. H1	NAA vs. H1	EXISTING CONDITIONS vs. H4	NAA vs. H4
October	Wet	78 (107%)	-24 (-14%)	106 (145%)	4 (2%)
	Above Normal	30 (68%)	-6 (-8%)	44 (100%)	8 (10%)
	Below Normal	44 (80%)	-5 (-5%)	55 (100%)	6 (6%)
	Dry	60 (113%)	-11 (-9%)	70 (132%)	-1 (-1%)
	Critical	42 (102%)	-2 (-2%)	33 (80%)	-11 (-13%)
	All	253 (95%)	-49 (-9%)	309 (116%)	7 (1%)
November	Wet	24 (NA)	-13 (-35%)	34 (NA)	-3 (-8%)
	Above Normal	16 (800%)	-3 (-14%)	23 (1,150%)	4 (19%)
	Below Normal	14 (1,400%)	-7 (-32%)	22 (2,200%)	1 (5%)
	Dry	19 (NA)	-12 (-39%)	24 (NA)	-7 (-23%)
	Critical	17 (1,700%)	-1 (-5%)	13 (1,300%)	-5 (-26%)
	All	90 (2,250%)	-36 (-28%)	116 (2,900%)	-10 (-8%)
December	Wet	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Below Normal	0 (NA)	-2 (-100%)	1 (NA)	-1 (-50%)
	Dry	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	All	0 (NA)	-2 (-100%)	1 (NA)	-1 (-50%)
January	Wet	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	Wet	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Below Normal	0 (NA)	-1 (-100%)	0 (NA)	-1 (-100%)
	Dry	1 (NA)	1 (NA)	0 (NA)	0 (NA)
	Critical	2 (NA)	0 (0%)	2 (NA)	0 (0%)
	All	2 (NA)	-1 (-33%)	2 (NA)	-1 (-33%)
March	Wet	5 (NA)	0 (0%)	6 (NA)	1 (20%)
	Above Normal	0 (0%)	-2 (-67%)	1 (100%)	-1 (-33%)
	Below Normal	19 (1,900%)	-2 (-9%)	17 (1,700%)	-4 (-18%)
	Dry	22 (550%)	-1 (-4%)	24 (600%)	1 (4%)
	Critical	16 (400%)	-1 (-5%)	17 (425%)	0 (0%)
	All	63 (630%)	-5 (-6%)	64 (640%)	-4 (-5%)
April	Wet	38 (271%)	0 (0%)	19 (136%)	-19 (-37%)
	Above Normal	26 (113%)	-1 (-2%)	7 (30%)	-20 (-40%)
	Below Normal	22 (55%)	-3 (-5%)	1 (3%)	-24 (-37%)
	Dry	41 (84%)	0 (0%)	42 (86%)	1 (1%)
	Critical	32 (110%)	1 (2%)	33 (114%)	2 (3%)
	All	159 (103%)	-3 (-1%)	102 (66%)	-60 (-19%)

NA = could not be calculated because the denominator was 0.

Due to similar flows and water temperatures between H1 and H3, results under H1 would be similar to results for analyses under H3.

American River

Fall-Run

Flows in the American River at the confluence with the Sacramento River during October through January would generally be similar between H1 and H3 with few exceptions that would not be biologically meaningful (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the American River at the Watt Avenue Bridge were examined during the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period.

The percent of months exceeding the 56°F temperature threshold in the American River at the Watt Avenue Bridge was evaluated during November through April (Table 11-4-71). The percent of months exceeding the threshold under H1 would similar to or up to 11% lower (absolute scale) than the percent under NAA.

Table 11-4-71. Differences between Baseline Scenarios and H1 and H4 Scenarios in Percent of Months during the 82-Year CALSIM Modeling Period during Which Water Temperatures in the American River at the Watt Avenue Bridge Exceed the 56°F Threshold, November through April

	Degrees Above Threshold				
Month	>1.0	>2.0	>3.0	>4.0	>5.0
EXISTING CONDITIONS vs. H1					
November	26 (57%)	23 (86%)	22 (164%)	19 (750%)	11 (900%)
December	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
March	2 (20%)	4 (50%)	6 (250%)	2 (200%)	1 (NA)
April	11 (16%)	7 (12%)	10 (22%)	10 (31%)	2 (9%)
NAA vs. H1					
November	-2 (-3%)	-10 (-12%)	-6 (-8%)	-11 (-20%)	-9 (-21%)
December	1 (100%)	0 (0%)	0 (NA)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	-2 (-67%)	-1 (-100%)	0 (NA)	0 (NA)	0 (NA)
March	-10 (-20%)	-10 (-31%)	-1 (-8%)	-2 (-20%)	0 (0%)
April	-1 (-1%)	-6 (-7%)	-7 (-9%)	-9 (-12%)	-5 (-9%)
EXISTING CONDITIONS vs. H4					
November	43 (95%)	51 (186%)	49 (364%)	46 (1,850%)	32 (2,600%)
December	1 (NA)	1 (NA)	0 (NA)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	1 (NA)	1 (NA)	0 (NA)	0 (NA)	0 (NA)
March	27 (220%)	17 (233%)	11 (450%)	10 (800%)	4 (NA)
April	26 (37%)	25 (40%)	27 (59%)	30 (92%)	25 (91%)
NAA vs. H4					
November	-4 (-4%)	-7 (-9%)	-11 (-15%)	-9 (-15%)	-7 (-18%)
December	0 (0%)	0 (0%)	0 (NA)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	-2 (-67%)	0 (0%)	0 (NA)	0 (NA)	0 (NA)
March	-10 (-20%)	-7 (-23%)	-2 (-15%)	-1 (-10%)	-1 (-25%)
April	0 (0%)	-6 (-7%)	-7 (-9%)	-10 (-14%)	-5 (-9%)

NA = could not be calculated because the denominator was 0.

Total degree-months exceeding 56°F were summed by month and water year type at the Watt Avenue Bridge during November through April (Table 11-4-72). Total degree-months would be similar between NAA and H1 for all months.

Table 11-4-72. Differences between Baseline Scenarios and H1 and H4 Scenarios in Total Degree-Months (°F-Months) by Month and Water Year Type for Water Temperature Exceedances above 56°F in the American River at the Watt Avenue Bridge, November through April

Month	Water Year Type	EXISTING CONDITIONS vs. H1	NAA vs. H1	EXISTING CONDITIONS vs. H4	NAA vs. H4
November	Wet	78 (312%)	-4 (-4%)	77 (308%)	-5 (-5%)
	Above Normal	33 (300%)	-3 (-6%)	32 (291%)	-4 (-9%)
	Below Normal	43 (538%)	0 (0%)	43 (538%)	0 (0%)
	Dry	46 (354%)	-5 (-8%)	50 (385%)	-1 (-2%)
	Critical	38 (238%)	0 (0%)	38 (238%)	0 (0%)
	All	238 (326%)	-12 (-4%)	240 (329%)	-10 (-3%)
December	Wet	1 (NA)	1 (NA)	1 (NA)	1 (NA)
	Above Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Below Normal	2 (NA)	0 (0%)	2 (NA)	0 (0%)
	Dry	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	All	3 (NA)	1 (50%)	3 (NA)	1 (50%)
January	Wet	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	Wet	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Critical	3 (NA)	-1 (-25%)	3 (NA)	-1 (-25%)
	All	3 (NA)	-1 (-25%)	3 (NA)	-1 (-25%)
March	Wet	10 (500%)	-2 (-14%)	10 (500%)	-2 (-14%)
	Above Normal	9 (NA)	0 (0%)	9 (NA)	0 (0%)
	Below Normal	10 (333%)	-1 (-7%)	11 (367%)	0 (0%)
	Dry	24 (600%)	-1 (-3%)	25 (625%)	0 (0%)
	Critical	20 (200%)	0 (0%)	20 (200%)	0 (0%)
	All	73 (384%)	-4 (-4%)	75 (395%)	-2 (-2%)
April	Wet	57 (204%)	-1 (-1%)	57 (204%)	-1 (-1%)
	Above Normal	33 (150%)	-1 (-2%)	33 (150%)	-1 (-2%)
	Below Normal	39 (108%)	-2 (-3%)	40 (111%)	-1 (-1%)
	Dry	45 (59%)	0 (0%)	45 (59%)	0 (0%)
	Critical	36 (61%)	1 (1%)	35 (59%)	0 (0%)
	All	210 (95%)	-3 (-1%)	210 (95%)	-3 (-1%)

NA = could not be calculated because the denominator was 0.

Due to similar flows and water temperatures between H1 and H3, results for additional analyses (e.g., risk of redd dewatering, Reclamation egg mortality model) under H1 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H1. Overall, results for H1 would be similar to those for H3.

Stanislaus River

Fall-Run

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H1 would be similar to flows under NAA throughout the period.

Water temperatures throughout the Stanislaus River would be similar under NAA and H1 throughout the October through January period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

San Joaquin River

Fall-Run

Flows in the San Joaquin River at Vernalis were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H1 would be similar to flows under NAA throughout the period.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Fall-Run

Flows in the Mokelumne River at the Delta were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H1 would be similar to flows under NAA throughout the period.

Water temperature modeling was not conducted in the Mokelumne River.

H4/HOS

Sacramento River

Fall-Run

Flows in the Sacramento River upstream of Red Bluff during October through January under H4 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). September Shasta storage volume under H4 would generally be similar to September storage volume under H3 (Table 11-4-27).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

The number of days at Red Bluff on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month during October through April and year of the 82-year modeling period (Table 11-4-13). The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern", as defined in Table 11-4-14. Differences between baselines and H4 in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4-67. There would be 2 (4%) and 2 (15%) more years with a "red" and orange level of concern, respectively, under H1 relative to NAA. It is not likely that these differences would be biologically meaningful.

Total degree-days exceeding 56°F were summed by month and water year type at Red Bluff during October through April. Total degree-days under H4 would be 10% higher than those under NAA during March and similar during remaining months (Table 11-4-68).

Due to similar flows, reservoir storage, and water temperatures between H4 and H3, results for additional analyses (e.g., Reclamation egg mortality model, SacEFT) under H4 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H4. Overall, results for H4 would be similar to those for H3.

Late Fall-Run

Flows in the Sacramento River upstream of Red Bluff during February through May under H4 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). September Shasta storage volume under H4 would generally be similar to September storage volume under H3 (Table 11-4-27).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the February through May late fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

The number of days at Red Bluff on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month during October through April and year of the 82-year modeling period (Table 11-4-13). The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern", as defined in Table 11-4-14. Differences between baselines and H4 in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4-67. There would be 2 (4%) and 2 (15%) more years with a "red" and orange level of concern, respectively, under H1 relative to NAA. It is not likely that these differences would be biologically meaningful.

Total degree-days exceeding 56°F were summed by month and water year type at Red Bluff during October through April. Total degree-days under H4 would be 10% higher than those under NAA during March and similar during remaining months (Table 11-4-68).

Due to similar flows, reservoir storage, and water temperatures between H4 and H3, results for additional analyses (e.g., Reclamation egg mortality model, SacEFT) under H4 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H4. Overall, results for H4 would be similar to those for H3.

Clear Creek

No water temperature modeling was conducted in Clear Creek.

Fall-Run

Flows in Clear Creek flows below Whiskeytown Reservoir during October through January would generally be similar between H4 and H3 (*Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis*). As a result, no additional flow analyses were conducted for H4. Overall, results for H4 would be similar to those for H3.

Feather River

Fall-Run

Flows in the Feather River low-flow channel during October through January would be similar between H4 and H3 (*Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 in the high-flow channel would generally be similar to those under H3, except during October, in which flows would be up to 27% lower depending on water year type. Because flow reductions would occur in only one month, they are not expected to have a biologically meaningful effect on fall-run Chinook salmon spawning and egg incubation.

Differences in the percent of months exceeding the 56°F NMFS threshold between NAA and H4 would be negligible (<5% on an absolute scale) during all months except October, November, March, and April, in which the percent of months under H4 would be similar to or up to 25% lower than those under NAA (Table 11-4-69). This method indicates that there would be benefits of H1 on temperature-related fall-run Chinook salmon spawning and egg incubation conditions in the Feather River.

Combining all water year types, there would be no difference between NAA and H1 in total degree-months exceeded in all months except November, March, and April, during which degree-months would be lower by 8%, 5%, and 19%, respectively (Table 11-4-70). Large relative differences between NAA and H1 during some months are mathematical artifacts due to small values of degree-months for NAA and would not translate into biologically meaningful effects on fall-run Chinook salmon. Splitting monthly results into water year types yields highly variable outcomes. There would be small increases and decreases in degree-months under H4 relative to NAA depending on month and water year type. Overall, this method indicates that there would be benefits of H1 on temperature-related fall-run Chinook salmon spawning and egg incubation conditions in the Feather River.

Due to generally similar flows and water temperatures between H4 and H3, results under H4 would be similar to results for analyses under H3.

American River

Fall-Run

Flows in the American River at the confluence with the Sacramento River during October through January would generally be similar between H4 and H3, except during October, in which flows would be 6% to 13% lower depending on water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*)*.* Because flow reductions would occur in only one month and would be low in magnitude, they are not expected to have a biologically meaningful effect on fall-run Chinook salmon spawning and egg incubation.

Mean monthly water temperatures in the American River at the Watt Avenue Bridge were examined during the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

The percent of months exceeding the 56°F temperature threshold in the American River at the Watt Avenue Bridge was evaluated during November through April (Table 11-4-71). The percent of months exceeding the threshold under H4 would similar to or up to 11% lower (absolute scale) than the percent under NAA.

Total degree-months exceeding 56°F were summed by month and water year type at the Watt Avenue Bridge during November through April (Table 11-4-72). Total degree-months would be similar between NAA and H4 for all months.

Due to generally similar flows and water temperatures between H4 and H3, results for additional analyses (e.g., risk of redd dewatering, Reclamation egg mortality model) under H4 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H4. Overall, results for H4 would be similar to those for H3.

Stanislaus River

Fall-Run

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 would be similar to flows under NAA throughout the period.

Water temperatures throughout the Stanislaus River would be similar under NAA and H4 throughout the October through January period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

San Joaquin River

Fall-Run

Flows in the San Joaquin River at Vernalis were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 would be similar to flows under NAA throughout the period.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Fall-Run

Flows in the Mokelumne River at the Delta were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results* *utilized in the Fish Analysis*). Flows under H4 would be similar to flows under NAA throughout the period.

Water temperature modeling was not conducted in the Mokelumne River.

NEPA Effects: Collectively, it is concluded that the effect is not adverse because habitat conditions are not substantially reduced. There are no reductions in flows under Alternative 4 or increases in temperatures that would translate into biologically meaningful effects on fall-/late fall-run Chinook salmon. In all rivers, there are no large or consistent differences relative to NAA. Biological modeling results also indicate that Alternative 4 would not substantially affect fall-/late fall-run Chinook salmon spawning and egg incubation habitat relative to the NEPA point of comparison. There would generally be no differences among scenarios.

CEQA Conclusion: In general, under all the Alternative 4 water operations scenarios, the quantity and quality of spawning and egg incubation habitat for fall-/late fall-run Chinook salmon would not be affected relative to the CEQA baseline.

H3/ESO

Sacramento River

Fall-Run

Flows in the Sacramento River upstream of Red Bluff were examined during the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*)*.* Flows under H3 would be up to 14% lower than flows under Existing Conditions during November, and similar during the remaining three months.

Shasta storage volume at the end of September would be 15% to 33% lower under H3 relative to Existing Conditions (Table 11-4-27).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H3 during the period, except during October, in which temperatures would be 6% higher under H3.

The number of days at Red Bluff on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month during October through April and year of the 82-year modeling period (Table 11-4-13). The combination of number of days and degrees above the 56°F threshold were further H3 in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4-28. There would be 38 (317%) and 10 (167%) more years with "red" and "orange" levels of concern under H3 than under Existing Conditions.

Total degree-days exceeding 56°F were summed by month and water year type at Red Bluff during October through April. Total degree-days under H3 would be 203% to 3,662% higher than those under Existing Conditions during October, November, March, and April, and similar during December through February (Table 11-4-29).

The Reclamation egg mortality model predicts that fall-run Chinook salmon egg mortality in the Sacramento River under H3 would be 31% to 124% greater than mortality under Existing Conditions (Table 11-4-55).

SacEFT predicts that there would be a 13% increase in the percentage of years with good spawning availability, measured as weighted usable area, under H3 relative to Existing Conditions (Table 11-4-56). SacEFT predicts that there would be a 5% reduction in the percentage of years with good (lower) redd scour risk under H3 relative to Existing Conditions. SacEFT predicts that there would be a 27% decrease in the percentage of years with good (lower) egg incubation conditions under H3 relative to Existing Conditions. SacEFT predicts that there would be a 7% increase in the percentage of years with good (lower) redd dewatering risk under H3 relative to Existing Conditions.

Late Fall-Run

Flows in the Sacramento River upstream of Red Bluff were examined during the February through May late fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would generally be up to 14% greater than flows under Existing Conditions during May, and similar during the other three months.

Storage volume at the end of September would be 15% to 33% lower under H3 relative to Existing Conditions (Table 11-4-27).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the February through May late fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H3 in any month or water year type throughout the period.

The number of days at Red Bluff on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month during October through April and year of the 82-year modeling period (Table 11-4-13). The combination of number of days and degrees above the 56°F threshold were further H3 in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4-28. There would be 38 (317%) and 10 (167%) more years with “red” and “orange” levels of concern under H3 than under Existing Conditions.

Total degree-days exceeding 56°F were summed by month and water year type at Red Bluff during October through April. Total degree-days under H3 would be 203% to 3,662% higher than those under Existing Conditions during October, November, March, and April, and similar during December through February (Table 11-4-29).

The Reclamation egg mortality model predicts that late fall-run Chinook salmon egg mortality in the Sacramento River under H3 would be 141% to 301% greater than mortality under Existing Conditions (Table 11-4-57). However, absolute differences in the percent of the late-fall population subject to mortality would be minimal in all water years.

SacEFT predicts that there would be a 8% decrease in the percentage of years with good spawning availability, measured as weighted usable area, under H3 relative to Existing Conditions (Table 11-4-58). SacEFT predicts that there would be a 7% decrease in the percentage of years with good (lower) redd scour risk under H3 relative to Existing Conditions. SacEFT predicts that there would be no difference in the percentage of years with good (lower) egg incubation conditions under H3 relative to Existing Conditions. SacEFT predicts that there would be a 5% decrease in the percentage of years with good (lower) redd dewatering risk under H3 relative to Existing Conditions.

Clear Creek

No water temperature modeling was conducted in Clear Creek.

Fall-Run

Flows in Clear Creek below Whiskeytown Reservoir under H3 during the September through February fall-run spawning and egg incubation period would generally be similar to flows under Existing Conditions with few exceptions.

The potential risk of redd dewatering in Clear Creek was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in September when spawning occurred. Clear Creek flows would be reduced during October through February under H3) in above normal, dry, and critical water years and increased in below normal water years (Table 11-4-59).

Feather River

Fall-Run

Flows in the Feather River low-flow channel during October through January under H3 would be identical to those under Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in the high-flow channel under H3 would generally be up to 46% lower than flows under Existing Conditions during December and January, up to 33% greater during October, and similar during November.

The potential risk of redd dewatering in the Feather River low-flow channel was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in October when spawning is assumed to occur. Minimum flows in the low-flow channel were identical between H3 and Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Therefore, there would be no effect of Alternative 4 on redd dewatering in the Feather River low-flow channel. Mean monthly water temperatures in the Feather River above Thermalito Afterbay (low-flow channel) and below Thermalito Afterbay (high-flow channel) were examined during the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures would be under H3 relative to Existing Conditions by 7% to 10% higher in the low-flow channel and 6% to 8% higher in the high-flow channel depending on month.

Effects of H3 on water temperature-related spawning and egg incubation conditions for fall-run Chinook salmon in the Feather River were analyzed by comparing the percent of months between October through April over the 82-year CALSIM modeling period that exceed a 56°F temperature threshold at Gridley (Table 11-4-60). In general, the percent of months exceeding the threshold under H3 would be up to 63% greater than the percent under Existing Conditions in all months except December, January, and February, during which the percent would not differ from Existing Conditions. This comparison includes the effects of climate change.

The effects of H3 on water temperature-related spawning and egg incubation conditions for fall-run Chinook salmon in the Feather River were also analyzed by comparing the total degree-months for months that exceed the 56°F NMFS threshold during the October through April fall-run Chinook salmon spawning and egg incubation period for all 82 years (Table 11-4-61). In general, total degree-months under H3 would be up to 303 degree-months (114%) greater than under Existing Conditions in all months except December, January, and February, during which degree-months would not differ from Existing Conditions. This comparison includes the effects of climate change. The Reclamation egg mortality model predicts that fall-run Chinook salmon egg mortality in the Feather River under H3 would be 427% to 1,391% greater than mortality under Existing Conditions (Table 11-4-62).

American River

Fall-Run

Flows in the American River at the confluence with the Sacramento River under H3 would generally be up to 33% lower than flows under Existing Conditions during November through January, but generally similar to flows under Existing Conditions during October.

The potential risk of redd dewatering in the American River at Nimbus Dam was evaluated by comparing the magnitude of flow reduction each month over the incubation period compared to the flow in October when spawning is assumed to occur. The greatest monthly reduction in American River flows during November through January under H3 would be 45% to 219% greater magnitude than those under Existing Conditions in all years except critical (15% lower magnitude)(Table 11-4-63).

Mean monthly water temperatures in the American River at the Watt Avenue Bridge were examined during the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly temperatures under H3 would be 5% to 12% greater than those under Existing Conditions depending on month.

The percent of months exceeding the 56°F temperature threshold in the American River at the Watt Avenue Bridge was evaluated during November through April (Table 11-4-64). The percent of months exceeding the threshold under H3 would be up to 58% greater (absolute scale) than the percent under Existing Conditions during November, March, and April and similar to the percent under Existing Conditions during December through February.

Total degree-months exceeding 56°F were summed by month and water year type at the Watt Avenue Bridge during November through April (Table 11-4-65). Total degree-months under H3 would be 98% to 395% greater than total degree-months under Existing Conditions during November, March and April and similar to total degree months under Existing Conditions during December through February.

The Reclamation egg mortality model predicts that fall-run Chinook salmon egg mortality in the American River under H3 would be 44% to 207% greater than mortality under Existing Conditions (Table 11-4-66).

Stanislaus River

Fall-Run

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the October through January fall-run spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H3 would be up 6% to 7% lower than those under Existing Conditions in all months except January, in which flows would be similar between Existing Conditions and H3.

Water temperatures in the Stanislaus River at the confluence with the San Joaquin River were examined during the October through January fall-run spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H3 would not be different from those under Existing Conditions during October, but 6% higher during November through January.

San Joaquin River

Fall-Run

Flows in the San Joaquin River at Vernalis were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would be similar in all months of the period except January, in which flows would be 5% greater under H3.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Fall-Run

Flows in the Mokelumne River at the Delta were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would be up to 14% lower than flows under Existing Conditions during October and November, up to 15% greater than flows under Existing Conditions during December, and similar to flows under Existing Conditions during January.

Water temperature modeling was not conducted in the Mokelumne River.

H1/LOS

Sacramento River

Fall-Run

Flows in the Sacramento River upstream of Red Bluff during October through January under H1 would generally be similar to flows under H3, except in November when flows would be up to 12% lower than under H3 depending on water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). This magnitude of flow reduction is not expected to have a biologically meaningful effect on fall-run Chinook salmon spawning and egg incubation habitat. September Shasta storage volume under H1 would generally be similar to September storage volume under H3 (Table 11-4-27).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H1 during the period, except during October, in which temperatures would be 5% higher under H1.

The number of days at Red Bluff on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month during October through April and year of the 82-year modeling period (Table 11-4-13). The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern", as defined in Table 11-4-14. Differences between baselines and H1 in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4-67. There would be 250% increases in the number of years with "red" and "orange" levels of concern under H1 relative to Existing Conditions.

Total degree-days exceeding 56°F were summed by month and water year type at Red Bluff during October through April. Total degree-days under H1would be 211% to 3,185% higher than those under Existing Conditions during October, November, March, and April, and similar during December through February (Table 11-4-68).

Due to similar flows, reservoir storage, and water temperatures between H1 and H3, results for additional analyses (e.g., Reclamation egg mortality model, SacEFT) under H1 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H1. Overall, results for H1 would be similar to those for H3.

Late Fall-Run

Flows in the Sacramento River upstream of Red Bluff during February through May under H1 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

September Shasta storage volume under H1 would generally be similar to September storage volume under H3 (Table 11-4-27).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the February through May late fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H1 in any month or water year type throughout the period.

The number of days at Red Bluff on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month during October through April and year of the 82-year modeling period (Table 11-4-13). The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern", as defined in Table 11-4-14. Differences between baselines and H1in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4-67. There would be 250% increases in the number of years with "red" and "orange" levels of concern under H1 relative to Existing Conditions.

Total degree-days exceeding 56°F were summed by month and water year type at Red Bluff during October through April. Total degree-days under H1would be 211% to 3,185% higher than those under Existing Conditions during October, November, March, and April, and similar during December through February (Table 11-4-68).

Due to similar flows, reservoir storage, and water temperatures between H1 and H3, results for additional analyses (e.g., Reclamation egg mortality model, SacEFT) under H1 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H1. Overall, results for H1 would be similar to those for H3.

Clear Creek

No water temperature modeling was conducted in Clear Creek.

Fall-Run

Flows in Clear Creek flows below Whiskeytown Reservoir during October through January would generally be similar between H1 and H3 (*Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis*). As a result, no additional flow analyses were conducted for H1. Overall, results for H1 would be similar to those for H3.

Feather River

Fall-Run

Flows in the Feather River low-flow and high-flow channels during October through January would generally be similar between H1 and H3 (*Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Feather River above Thermalito Afterbay (low-flow channel) and below Thermalito Afterbay (high-flow channel) were examined during the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures would be under H1 relative to Existing Conditions by 5% to 9% higher in the low-flow channel and 6% to 8% higher in the high-flow channel depending on month.

Differences in the percent of months exceeding the 56°F NMFS threshold between Existing Conditions and H1 would be negligible (<5% on an absolute scale) during all months except October, November, March, and April, in which the percent of months under H1 would be similar to or up to 53% lower (absolute scale) than those under Existing Conditions (Table 11-4-60). This comparison includes the effects of climate change.

Combining all water year types, there would be no difference between Existing Conditions and H1 in total degree-months exceeded in all months except October, November, March, and April during which degree-months under H1 would be greater by up to 253 degree-months (95%) (Table 11-4-61). This comparison includes the effects of climate change.

Due to generally similar flows and water temperatures between H1 and H3, results under H1 would be similar to results for analyses under H3.

American River

Fall-Run

Flows in the American River at the confluence with the Sacramento River during October through January would generally be similar between H1 and H3 with few exceptions that would not be biologically meaningful (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the American River at the Watt Avenue Bridge were examined during the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly temperatures under H1 would be 5% to 12% greater than those under Existing Conditions depending on month.

The percent of months exceeding the 56°F temperature threshold in the American River at the Watt Avenue Bridge was evaluated during November through April (Table 11-4-71). The percent of months exceeding the threshold under H1 would be up to 26% greater (absolute scale) than the percent under Existing Conditions during November, March, and April and similar to the percent under Existing Conditions during December through February.

Total degree-months exceeding 56°F were summed by month and water year type at the Watt Avenue Bridge during November through April (Table 11-4-72). Total degree-months under H1 would be 95% to 384% greater than total degree-months under Existing Conditions during November, March and April and similar to total degree months under Existing Conditions during December through February.

Due to similar flows and water temperatures between H1 and H3, results for additional analyses (e.g., risk of redd dewatering, Reclamation egg mortality model) under H1 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H1. Overall, results for H1 would be similar to those for H3.

Stanislaus River

Fall-Run

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the October through January fall-run spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H1 would be 6% to 7% lower than those under Existing Conditions in all months except January, in which flows would be similar between Existing Conditions and H1.

Water temperatures in the Stanislaus River at the confluence with the San Joaquin River were examined during the October through January fall-run spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H1 would not be different from those under Existing Conditions during October, but 6% higher during November through January.

San Joaquin River

Fall-Run

Flows in the San Joaquin River at Vernalis were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H1 would 5% lower than flows under Existing Conditions during October, similar during November and December, and 5% greater during January.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Fall-Run

Flows in the Mokelumne River at the Delta were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H1 would be up to 14% lower than flows under Existing Conditions during October and November and up to 18% greater than flows under Existing Conditions during December and January.

Water temperature modeling was not conducted in the Mokelumne River.

H4/HOS

Sacramento River

Fall-Run

Flows in the Sacramento River upstream of Red Bluff during October through January under H4 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). September Shasta storage volume under H4 would generally be similar to September storage volume under H3 (Table 11-4-27).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H4 during the period, except during October, in which temperatures would be 5% higher under H4.

The number of days at Red Bluff on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month during October through April and year of the 82-year modeling period (Table 11-4-13). The combination of number of days and degrees above the 56°F threshold were further assigned a “level of concern”, as defined in Table 11-4-14. Differences between baselines and H1in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4-67. There would be 317% and 150% increases in the number of years with “red” and “orange” levels of concern, respectively, under H1 relative to Existing Conditions.

Total degree-days exceeding 56°F were summed by month and water year type at Red Bluff during October through April. Total degree-days under H1would be 221% to 3,408% higher than those under Existing Conditions during October, November, March, and April, and similar during December through February (Table 11-4-68).

Due to similar flows, reservoir storage, and water temperatures between H4 and H3, results for additional analyses (e.g., Reclamation egg mortality model, SacEFT) under H4 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H4. Overall, results for H4 would be similar to those for H3.

Late Fall-Run

Flows in the Sacramento River upstream of Red Bluff during February through May under H4 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). September Shasta storage volume under H4 would generally be similar to September storage volume under H3 (Table 11-4-27).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the February through May late fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H4 during the period.

The number of days at Red Bluff on which temperature exceeded 56°F by >0.5°F to >5°F in 0.5°F increments was determined for each month during October through April and year of the 82-year modeling period (Table 11-4-13). The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern", as defined in Table 11-4-14. Differences between baselines and H1in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4-67. There would be 317% and 150% increases in the number of years with "red" and "orange" levels of concern, respectively, under H1 relative to Existing Conditions.

Total degree-days exceeding 56°F were summed by month and water year type at Red Bluff during October through April. Total degree-days under H1would be 221% to 3,408% higher than those under Existing Conditions during October, November, March, and April, and similar during December through February (Table 11-4-68).

Due to similar flows, reservoir storage, and water temperatures between H4 and H3, results for additional analyses (e.g., Reclamation egg mortality model, SacEFT) under H4 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H4. Overall, results for H4 would be similar to those for H3.

Clear Creek

No water temperature modeling was conducted in Clear Creek.

Fall-Run

Flows in Clear Creek flows below Whiskeytown Reservoir during October through January would generally be similar between H4 and H3 (*Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis*). As a result, no additional flow analyses were conducted for H4. Overall, results for H4 would be similar to those for H3.

Feather River

Fall-Run

Flows in the Feather River low-flow channel during October through January would be similar between H4 and H3 (*Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 in the high-flow channel would generally be similar to those under H3, except during October, in which flows would be up to 27% lower depending on water year type. Because flow reductions would occur in only one month, they are not expected to have a biologically meaningful effect on fall-run Chinook salmon spawning and egg incubation.

Mean monthly water temperatures in the Feather River above Thermalito Afterbay (low-flow channel) and below Thermalito Afterbay (high-flow channel) were examined during the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures would be under H4 relative to Existing Conditions by 7% to 9% higher in the low-flow channel and 6% to 8% higher in the high-flow channel depending on month.

Differences in the percent of months exceeding the 56°F NMFS threshold between Existing Conditions and H4 would be negligible (<5% on an absolute scale) during all months except October, November, March, and April, in which the percent of months under H4 would be similar to or up to 54% lower (absolute scale) than those under Existing Conditions.

Combining all water year types, there would be no difference between Existing Conditions and H4 in total degree-months exceeded in all months except October, November, March, and April, during which degree-months under H4 would be greater by up to 309 degree-months (116%).

Due to generally similar flows and water temperatures between H4 and H3, results under H4 would be similar to results for analyses under H3.

American River

Fall-Run

Flows in the American River at the confluence with the Sacramento River during October through January would generally be similar between H4 and H3, except during October, in which flows would be 6% to 13% lower depending on water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Because flow reductions would occur in only one month and would be low in magnitude, they are not expected to have a biologically meaningful effect on fall-run Chinook salmon spawning and egg incubation.

Mean monthly water temperatures in the American River at the Watt Avenue Bridge were examined during the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly temperatures under H4 would be 5% to 12% greater than those under Existing Conditions depending on month.

The percent of months exceeding the 56°F temperature threshold in the American River at the Watt Avenue Bridge was evaluated during November through April (Table 11-4-71). The percent of months exceeding the threshold under H4 would be up to 51% greater (absolute scale) than the percent under Existing Conditions during November, March, and April and similar to the percent under Existing Conditions during December through February.

Total degree-months exceeding 56°F were summed by month and water year type at the Watt Avenue Bridge during November through April (Table 11-4-72). Total degree-months under H4 would be 95% to 395% greater than total degree-months under Existing Conditions during November, March and April and similar to total degree months under Existing Conditions during December through February.

Due to generally similar flows and water temperatures between H4 and H3, results for additional analyses (e.g., risk of redd dewatering, Reclamation egg mortality model) under H4 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H4. Overall, results for H4 would be similar to those for H3.

Stanislaus River

Fall-Run

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the October through January fall-run spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H4 would be 6% to 8% lower than those under Existing Conditions in all months except January, in which flows would be similar between Existing Conditions and H4.

Water temperatures in the Stanislaus River at the confluence with the San Joaquin River were examined during the October through January fall-run spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H3 would not be 5% to 6% higher throughout the period.

San Joaquin River

Fall-Run

Flows in the San Joaquin River at Vernalis were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H4 would be similar to those under Existing Conditions throughout the period, except during January, in which flows would be 6% greater.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Fall-Run

Flows in the Mokelumne River at the Delta were examined for the October through January fall-run Chinook salmon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 would be up to 14% lower than flows under Existing Conditions during October and November and up to 18% greater than flows under Existing Conditions during December and January.

Water temperature modeling was not conducted in the Mokelumne River.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-76 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 4 could be significant because, under the CEQA baseline, the alternative could substantially reduce the amount of suitable habitat of fish, contrary to the NEPA conclusion set forth above. There would be moderate to substantial flow reductions under Alternative 4 in the Feather and American Rivers, and substantial increases in temperatures and temperature exceedances above thresholds in the Sacramento, Feather, and American Rivers, all of which would affect the fall-run Chinook salmon rearing habitat. Biological models, including the Reclamation egg mortality model and SacEFT, predict substantially degraded spawning and egg incubation habitat conditions in the Sacramento, Feather, and American Rivers. These results are generally consistent among scenarios.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to H3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and H3 indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and H3. This indicates that the differences between Existing Conditions and Alternative 4 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 4, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on rearing habitat for fall-/late fall-run Chinook salmon. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-77: Effects of Water Operations on Rearing Habitat for Chinook Salmon (Fall-/Late Fall–Run ESU)

In general, Alternative 4 would not affect the quantity and quality of larval and juvenile rearing habitat for fall-/late fall-run Chinook salmon relative to the NAA.

H3/ESO

Sacramento River

Fall-Run

Sacramento River flows upstream of Red Bluff were examined for the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish*

Analysis). Flows in the Sacramento River upstream of Red Bluff under H3 would be greater than or similar to flows under NAA throughout the period.

Shasta Reservoir storage at the end of September would affect flows during the fall-run larval and juvenile rearing period. As reported in AQUA-58, end of September Shasta Reservoir storage under H3 would be similar to storage under NAA in all water year types (Table 11-4-27).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

SacEFT predicts that there would be a 5% decrease in the percentage of years with good juvenile rearing availability for fall-run Chinook salmon, measured as weighted usable area, under H3 relative to NAA (Table 11-4-56). SacEFT predicts that there would be a 10% increase in the percentage of years with “good” (lower) juvenile stranding risk under H3 relative to NAA.

SALMOD predicts that fall-run smolt equivalent habitat-related mortality under H3 would be similar to mortality under NAA.

Late Fall-Run

Sacramento River flows upstream of Red Bluff were examined for the March through July late fall-run Chinook salmon juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Upstream of Red Bluff, flows under H3 would generally be up to 12% greater than under NAA during May and June, and similar in the remaining months of the period.

Shasta Reservoir storage at the end of September and May would affect flows during the late fall-run larval and juvenile rearing period. As reported in AQUA-156, end of September Shasta Reservoir storage under H3 would be similar to storage under NAA in all water year types (Table 11-4-27).

As reported in AQUA-40, May Shasta storage volume under H3 would be similar to or greater than storage under NAA for all water year types (Table 11-4-19).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the March through July late fall–run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

SacEFT predicts that there would be a 33% decrease in the percentage of years with good juvenile rearing availability for late fall-run Chinook salmon, measured as weighted usable area, under H3 relative to NAA (Table 11-4-58). SacEFT predicts that there would be a 9% reduction in the percentage of years with “good” (lower) juvenile stranding risk under H3 relative to NAA, which would be negligible on an absolute scale (4% difference).

SALMOD predicts that late fall-run smolt equivalent habitat-related mortality under H3 would be similar (<5% difference) to mortality under NAA.

Clear Creek

No water temperature modeling was conducted in Clear Creek.

Fall-Run

Flows in Clear Creek below Whiskeytown Reservoir were examined the January through May fall-run Chinook salmon rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would generally be similar to flows under NAA with few exceptions.

Feather River

Fall-Run

Flows in the Feather River both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) during December through June were reviewed to determine flow-related effects on larval and juvenile fall-run rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Relatively constant flows in the low-flow channel throughout this period under H3 would not differ from those under NAA. In the high-flow channel, flows under H3 would generally be up to 79% greater than flows under NAA during February through June, and would be similar during December and January.

As reported in AQUA-59, May Oroville storage volume under H3 would be similar to storage under NAA in all water year types (Table 11-4-42).

As reported in AQUA-58, September Oroville storage volume under H3 would be similar to volume in wet, above normal, and below normal water years and 11% to 18% greater than volume under NAA during dry and critical water years (Table 11-4-39).

Mean monthly water temperatures in the Feather River in both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were examined during the December through June fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis).* There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period at either location.

American River

Fall-Run

Flows in the American River at the confluence with the Sacramento River were examined for the January through May fall-run larval and juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 during January and May would generally be up to 24% higher than flows under NAA, and similar during January through April.

Mean monthly water temperatures in the American River at the Watt Avenue Bridge were examined during the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

Stanislaus River

Fall-Run

Flows in the Stanislaus River at the confluence with the San Joaquin River for H3 are not different from those under NAA, for the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures throughout the Stanislaus River would be similar between NAA and H3 throughout the January through May fall-run rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

San Joaquin River

Fall-Run

Flows in the San Joaquin River at Vernalis for H3 are not different from those under NAA, for the January through May fall-run larval and juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*)

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Fall-Run

Flows in the Mokelumne River at the Delta for H3 are not different from those under NAA, for the January through May fall-run larval and juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*)

Water temperature modeling was not conducted in the Mokelumne River.

H1/LOS

Sacramento River

Fall-Run

Sacramento River flows upstream of Red Bluff during January through May under H1 would generally be similar to or greater than flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). September Shasta storage volume under H1 would generally be similar to September storage volume under H3 (Table 11-4-27).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period.

Due to similar flows, reservoir storage, and water temperatures between H1 and H3, results for additional analyses (e.g., SacEFT, SALMOD) under H1 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H1. Overall, results for H1 would be similar to those for H3.

Late Fall-Run

Sacramento River flows upstream of Red Bluff during March through July under H1 would generally be similar to or greater than flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). May and September Shasta storage volume under H1 would generally be similar to storage volume under H3 (Table 11-4-19, Table 11-4-27).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the March through July late fall–run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period.

Due to similar flows, reservoir storage, and water temperatures between H1 and H3, results for additional analyses (e.g., SacEFT, SALMOD) under H1 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H1. Overall, results for H1 would be similar to those for H3.

Clear Creek

No water temperature modeling was conducted in Clear Creek.

Fall-Run

Flows in Clear Creek below Whiskeytown Reservoir during January through May under H1 would be similar to those under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Due to similar flows between H1 and H3, results for H1 would be similar to those for H3.

Feather River

Fall-Run

Flows in the Feather River both above (low-flow channel) Thermalito Afterbay during December through June under H1 would be similar to those under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in the high-flow channel under H1 would generally be similar to or greater than flows under H3.

May and September Oroville storage under H1 would generally be similar to or greater than storage under H1 (Table 11-4-39, Table 11-4-45).

Mean monthly water temperatures in the Feather River in both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were examined during the December through June fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis).* There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period at either location.

Due to similar flows, reservoir storage, and water temperatures between H1 and H3, results for H1 would be similar to those for H3.

American River

Fall-Run

Flows in the American River at the confluence with the Sacramento River during January through May under H1 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the American River at the Watt Avenue Bridge were examined during the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period.

Due to similar flows and water temperatures between H1 and H3, results for H1 would be similar to those for H3.

Stanislaus River

Fall-Run

Flows in the Stanislaus River at the confluence with the San Joaquin River for H1 are not different from those under NAA, for the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures throughout the Stanislaus River would be similar between NAA and H1 throughout the January through May fall-run rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

San Joaquin River

Fall-Run

Flows in the San Joaquin River at Vernalis for H1 are not different from those under NAA, for the January through May fall-run larval and juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*)

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Fall-Run

Flows in the Mokelumne River at the Delta for H1 are not different from those under NAA, for the January through May fall-run larval and juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*)

Water temperature modeling was not conducted in the Mokelumne River.

H4/HOS

Sacramento River

Water temperatures in the Sacramento River under H1 would be similar to those under H3.

Fall-Run

Sacramento River flows upstream of Red Bluff during January through May under H4 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). September Shasta storage volume under H4 would generally be similar to September storage volume under H3 (Table 11-4-27).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

Due to similar flows, reservoir storage, and water temperatures between H4 and H3, results for additional analyses (e.g., SacEFT, SALMOD) under H4 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H4. Overall, results for H4 would be similar to those for H3.

Late Fall-Run

Sacramento River flows upstream of Red Bluff during March through July under H1 would generally be similar to or greater than flows under H3, except during June, in which flows would be up to 12% lower depending on water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). This magnitude of flow reduction is not expected to have a biologically meaningful effect on fall-run Chinook salmon rearing habitat. May and September Shasta storage volume under H4 would generally be similar to storage volume under H3 (Table 11-4-19, Table 11-4-36).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the March through July late fall–run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

Due to similar flows, reservoir storage, and water temperatures between H4 and H3, results for additional analyses (e.g., SacEFT, SALMOD) under H4 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H4. Overall, results for H4 would be similar to those for H3.

Clear Creek

No water temperature modeling was conducted in Clear Creek.

Fall-Run

Flows in Clear Creek below Whiskeytown Reservoir during January through May under H4 would be similar to those under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Due to similar flows between H4 and H3, results for H4 would be similar to those for H3.

Feather River

Fall-Run

Flows in the Feather River both above (low-flow channel) Thermalito Afterbay during December through June under H4 would generally be greater than those under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*), except during June, in which flows would be up to 39% lower under H4 than under H3. Because flow reductions would occur in only one month during the seven month period, they are not expected to have biologically meaningful effects on fall-run Chinook salmon rearing habitat.

May and September Oroville storage under H4 would generally be similar to or greater than storage under H3 (Table 11-4-39, Table 11-4-45).

Mean monthly water temperatures in the Feather River in both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were examined during the December through June fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis).* There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period at either location.

Due to similar or increased flows, similar reservoir storage, and similar water temperatures between H4 and H3, results for H4 would be similar to or better than those for H3.

American River

Fall-Run

Flows in the American River at the confluence with the Sacramento River during January through May under H4 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the American River at the Watt Avenue Bridge were examined during the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

Due to similar flows and water temperatures between H4 and H3, results for H4 would be similar to those for H3.

Stanislaus River

Fall-Run

Flows in the Stanislaus River at the confluence with the San Joaquin River for H4 are not different from those under NAA, for the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures throughout the Stanislaus River would be similar between NAA and H4 throughout the January through May fall-run rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

San Joaquin River

Fall-Run

Flows in the San Joaquin River at Vernalis for H4 are not different from those under NAA, for the January through May fall-run larval and juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*)

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Fall-Run

Flows in the Mokelumne River at the Delta for H4 are not different from those under NAA, for the January through May fall-run larval and juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*)

Water temperature modeling was not conducted in the Mokelumne River.

NEPA Effects: Taken together, these results indicate that the effect is not adverse because it does not have the potential to substantially reduce the amount of suitable habitat of fish. Changes in flow rates and water temperatures are generally small and infrequent under Alternative 4 relative to the NAA. Therefore, there would be no biologically meaningful effects to fall- or late fall-run Chinook salmon, except for a moderate reduction in juvenile rearing habitat for late fall-run Chinook salmon as predicted by SacEFT. Because this effect is isolated, it would not cause the impact to be adverse, particularly in combination with modeled flow outputs indicating that flows, which drive rearing habitat availability, would increase during the rearing period. Additionally, SALMOD does not predict habitat-related effects on late fall-run Chinook salmon in the Sacramento River. Results would generally not differ among scenarios.

CEQA Conclusion: In general, Alternative 4 would not affect the quantity and quality of larval and juvenile rearing habitat for fall-/late fall-run Chinook salmon relative to Existing Conditions.

H3/ESO

Sacramento River

Fall-Run

Sacramento River flows upstream of Red Bluff were examined for the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would generally be up to 14% greater than flows under Existing Conditions during May and similar during January through April.

As reported in AQUA-58, end of September Shasta Reservoir storage would be 15% to 33% lower under H3 relative to Existing Conditions, depending on water year type (Table 11-4-27).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H3 in any month or water year type throughout the period.

SacEFT predicts that there would be a 15% increase in the percentage of years with good juvenile rearing availability for fall-run Chinook salmon, measured as weighted usable area, under H3 relative to Existing Conditions (Table 11-4-56). SacEFT predicts that there would be a 29% reduction in the percentage of years with “good” (lower) juvenile stranding risk under H3 relative to Existing Conditions.

SALMOD predicts that fall-run smolt equivalent habitat-related mortality under H3 would be 9% lower than mortality under Existing Conditions.

Late Fall-Run

Sacramento River flows upstream of Red Bluff were examined for the March through July late fall-run Chinook salmon juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would generally be up to 20% greater during May and June, and similar in the remaining months.

As reported in AQUA-58, Shasta Existing Conditions storage volume at the end of September under H3 would be 15% to 33% lower relative to Existing Conditions (Table 11-4-27).

As reported in AQUA-40, Shasta Reservoir storage volume at the end of May under H3 would be similar to volume under Existing Conditions in wet and above normal water years and 8% to 25% lower than volume under Existing Conditions in below normal, dry, and critical water years (Table 11-4-19).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the March through July late fall–run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H3 in any month or water year type throughout the period.

SacEFT predicts that there would be an 7% reduction in the percentage of years with good juvenile rearing availability for late fall-run Chinook salmon, measured as weighted usable area, under H3 relative to Existing Conditions (Table 11-4-58). SacEFT predicts that there would be a 42% reduction in the percentage of years with “good” (lower) juvenile stranding risk under H3 relative to Existing Conditions.

SALMOD predicts that late fall-run smolt equivalent habitat-related mortality under H3 would be 7% higher than mortality under Existing Conditions.

Clear Creek

No temperature modeling was conducted in Clear Creek.

Fall-Run

Flows in Clear Creek below Whiskeytown Reservoir were examined from January through May fall-run Chinook salmon rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would generally be up to 29% greater than flows under Existing Conditions during March and similar to flows under Existing Conditions in the remaining 4 months (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Feather River

Fall-Run

Flows in the Feather River both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) during December through June were reviewed to determine flow-related effects on larval and juvenile fall-run rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Relatively constant flows in the low-flow channel throughout the period under H3 would not differ from those under Existing Conditions. In the high-flow channel, flows under H3 would generally be up to 46% during December, up to 142% greater during March through June, and similar to flows under Existing Conditions during January and February.

As reported under AQUA-59, May Oroville storage volume under H3 would be lower than Existing Conditions by 5% to 20% depending on water year type, except in wet years, in which storage would be similar to Existing Conditions (Table 11-4-42).

As reported in AQUA-58, September Oroville storage volume would be 10% to 35% lower under A4_L H3 LT relative to Existing Conditions depending on water year type (Table 11-4-33).

Mean monthly water temperatures in the Feather River in both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were examined during the December through June fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). In the low-flow channel, mean monthly water temperatures under H3 would be 5% to 9% lower than those under Existing Conditions during December through March, but not different from those under Existing Conditions during April through June. In the high-flow channel, mean monthly water temperatures under H3 would be 6% to 8% lower than those under Existing Conditions during December through February, but not different from those under Existing Conditions during March through June.

American River

Fall-Run

Flows in the American River at the confluence with the Sacramento River were examined for the January through May fall-run larval and juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would generally be up to 31% lower than flows under Existing Conditions during January and May, up to 27% greater than flows under Existing Conditions during February and March, and similar to flows under Existing Conditions during April.

Mean monthly water temperatures in the American River at the Watt Avenue Bridge were examined during the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H3 would be 5% to 7% lower than those under Existing Conditions in all months during the period.

Stanislaus River

Fall-Run

Flows in the Stanislaus River at the confluence with the San Joaquin River for H3 would be up to 36% lower than Existing Conditions in January through May fall-run larval and juvenile rearing period in most water year types (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were examined during the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H3 would be 5% to 7% lower than those under Existing Conditions in all months during the period.

San Joaquin River

Fall-Run

Flows in the San Joaquin River at Vernalis were examined for the January through May fall-run Chinook salmon larval and juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would be similar to flows under Existing Conditions throughout the period except during January, in which flows would be greater under H3.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Fall-Run

Flows in the Mokelumne River at the Delta were examined for January through May fall-run Chinook salmon larval and juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H3 would be 14% greater than flows under Existing Conditions during January, similar to flows under Existing Conditions during February and March, and 8% to 12% lower than flows under Existing Conditions during April and May.

Water temperature modeling was not conducted in the Mokelumne River.

H1/LOS

Sacramento River

Fall-Run

Sacramento River flows upstream of Red Bluff during January through May under H1 would generally be similar to or greater than flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). September Shasta storage volume under H1 would generally be similar to September storage volume under H3 (Table 11-4-27, Due to similar flows, reservoir storage, and water temperatures between H1 and H3, results for additional analyses (e.g., SacEFT, SALMOD) under H1 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H1. Overall, results for H1 would be similar to those for H3.

Late Fall-Run

Sacramento River flows upstream of Red Bluff during March through July under H1 would generally be similar to or greater than flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

May and September Shasta storage volume under H1 would generally be similar to storage volume under H3 (Table 11-4-19, Table 11-4-36).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the March through July late fall–run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H1 in any month or water year type throughout the period.

Due to similar flows, reservoir storage, and water temperatures between H1 and H3, results for additional analyses (e.g., SacEFT, SALMOD) under H1 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H1. Overall, results for H1 would be similar to those for H3.

Clear Creek

No water temperature modeling was conducted in Clear Creek.

Fall-Run

Flows in Clear Creek below Whiskeytown Reservoir during January through May under H1 would be similar to those under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Due to similar flows between H1 and H3, results for H1 would be similar to those for H3.

Feather River

Fall-Run

Flows in the Feather River both above (low-flow channel) Thermalito Afterbay during December through June under H1 would be similar to those under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in the high-flow channel under H1 would generally be similar to or greater than flows under H3. May and September Oroville storage under H1 would generally be similar to or greater than storage under H1 (Table 11-4-39, Table 11-4-45).

Mean monthly water temperatures in the Feather River in both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were examined during the December through June fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). In the low-flow channel, mean monthly water temperatures under H1 would be 5% to 9% lower than those under Existing Conditions during December through March, but not different from those under Existing Conditions during April through June. In the high-flow channel, mean monthly water temperatures under H1 would be 6% to 8% lower than those under Existing Conditions during December through February, but not different from those under Existing Conditions during March through June.

Due to similar flows, reservoir storage, and water temperatures between H1 and H3, results for H1 would be similar to those for H3.

American River

Fall-Run

Flows in the American River at the confluence with the Sacramento River during January through May under H1 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Due to similar flows and water temperatures between H1 and H3, results for H1 would be similar to those for H3.

Mean monthly water temperatures in the American River at the Watt Avenue Bridge were examined during the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H1 would be 5% to 7% lower than those under Existing Conditions in all months during the period.

Stanislaus River

Fall-Run

Flows in the Stanislaus River at the confluence with the San Joaquin River for H1 would be up to 36% lower than Existing Conditions in January through May fall-run larval and juvenile rearing period in most water year types (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were examined during the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H1 would be 5% to 7% lower than those under Existing Conditions in all months during the period except April, in which temperatures would not differ between H1 and Existing Conditions.

San Joaquin River

Fall-Run

Flows in the San Joaquin River at Vernalis were examined for the January through May fall-run Chinook salmon larval and juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H1 would be similar to flows under Existing Conditions throughout the period except during January, in which flows would be 5% greater under H1.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Fall-Run

Flows in the Mokelumne River at the Delta were examined for January through May fall-run Chinook salmon larval and juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H1 would be 14% and 12% greater than flows under Existing Conditions during January and February, respectively, similar to flows under Existing Conditions during March, and 8% and 12% lower than flows under Existing Conditions during April and May, respectively.

Water temperature modeling was not conducted in the Mokelumne River.

H4/HOS

Sacramento River

Fall-Run

Sacramento River flows upstream of Red Bluff during January through May under H4 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). September Shasta storage volume under H4 would generally be similar to September storage volume under H3 (Table 11-4-27). Due to similar flows, reservoir storage, and water temperatures between H4 and H3, results for additional analyses (e.g., SacEFT, SALMOD) under H4 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H4. Overall, results for H4 would be similar to those for H3.

Late Fall-Run

Sacramento River flows upstream of Red Bluff during March through July under H4 would generally be similar to or greater than flows under H3, except during June, in which flows would be up to 12% lower depending on water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). This magnitude of flow reduction is not expected to have a biologically meaningful effect on fall-run Chinook salmon rearing habitat.

May and September Shasta storage volume under H4 would generally be similar to storage volume under H3 (Table 11-4-19, Table 11-4-36).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the March through July late fall–run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H4 in any month or water year type throughout the period.

Due to similar flows, reservoir storage, and water temperatures between H4 and H3, results for additional analyses (e.g., SacEFT, SALMOD) under H4 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H4. Overall, results for H4 would be similar to those for H3.

Clear Creek

No water temperature modeling was conducted in Clear Creek.

Fall-Run

Flows in Clear Creek below Whiskeytown Reservoir during January through May under H4 would be similar to those under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Due to similar flows between H4 and H3, results for H4 would be similar to those for H3.

Feather River

Water temperatures in the Feather River under H4 would be similar to those under H3.

Fall-Run

Flows in the Feather River both above (low-flow channel) Thermalito Afterbay during December through June under H4 would generally be greater than those under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*), except during June, in which flows would be up to 39% lower under H4 than under H3. Because flow reductions would occur in only one month during the seven month period, they are not expected to have biologically meaningful effects on fall-run Chinook salmon rearing habitat. May and September Oroville storage under H4 would generally be similar to or greater than storage under H3 (Table 11-4-39, Table 11-4-45).

Mean monthly water temperatures in the Feather River in both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were examined during the December through June fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). In the low-flow channel, mean monthly water temperatures under H4 would be 5% to 9% lower than those under Existing Conditions during December through March, but not different from those under Existing Conditions during April through June. In the high-flow channel, mean monthly water temperatures under H4 would be 6% to 8% lower than those under Existing Conditions during December through February, but not different from those under Existing Conditions during March through June.

Due to similar or increased flows, similar reservoir storage, and similar water temperatures between H4 and H3, results for H4 would be similar to or better than those for H3.

American River

Fall-Run

Flows in the American River at the confluence with the Sacramento River during January through May under H4 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Due to similar flows and water temperatures between H4 and H3, results for H4 would be similar to those for H3.

Mean monthly water temperatures in the American River at the Watt Avenue Bridge were examined during the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H4 would be 5% to 7% lower than those under Existing Conditions in all months during the period.

Stanislaus River

Fall-Run

Flows in the Stanislaus River at the confluence with the San Joaquin River for H4 would be up to 36% lower than Existing Conditions in January through May fall-run larval and juvenile rearing period in most water year types (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were examined during the January through May fall-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H4 would be 5% to 7% lower than those under Existing Conditions in all months during the period except April, in which temperatures would not differ between H4 and Existing Conditions.

San Joaquin River

Fall-Run

Flows in the San Joaquin River at Vernalis were examined for the January through May fall-run Chinook salmon larval and juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H4 would be similar to flows under Existing Conditions throughout the period except during January, in which flows would be 6% greater under H4.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Fall-Run

Flows in the Mokelumne River at the Delta were examined for January through May fall-run Chinook salmon larval and juvenile rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H4 would be 14% and 12% greater than flows under Existing Conditions during January and February, respectively, similar to flows under Existing Conditions during March, and 8% and 12% lower than flows under Existing Conditions during April and May, respectively.

Water temperature modeling was not conducted in the Mokelumne River.

Summary of CEQA Conclusion

Collectively, these results indicate that the impact would not be significant because it does not have the potential to substantially reduce the amount of suitable habitat of fish, and no mitigation is necessary. Flows in all rivers examined would not be sufficiently high and frequent to cause biologically meaningful effects to fall- and late fall-run Chinook salmon.

Impact AQUA-78: Effects of Water Operations on Migration Conditions for Chinook Salmon (Fall-/Late Fall–Run ESU)

In general, the effects of Alternative 4 on fall- and late fall-run Chinook salmon migration conditions relative to the NAA are uncertain.

Upstream of the Delta

H3/ESO

Sacramento River

Fall-Run

Flows in the Sacramento River upstream of Red Bluff were examined for juvenile fall-run migrants during February through May (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would generally be up to 12% greater than flows under NAA during May and similar to flows under NAA during February through April.

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

Flows in the Sacramento River upstream of Red Bluff were examined for the adult fall-run Chinook salmon upstream migration period (September through October) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would generally be similar to or greater than those under NAA except during above normal years during September (6% lower) and below normal years during September and October (13% and 8% lower, respectively).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the September through October adult fall-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

Late Fall-Run

Flows in the Sacramento River upstream of Red Bluff for juvenile late fall-run migrants (January through March) under H3 would generally be similar to flows under NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the January through March juvenile late fall-run Chinook salmon emigration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

Flows in the Sacramento River upstream of Red Bluff during the adult late fall-run Chinook salmon upstream migration period (December through February) under H3 would be generally be similar to flows under NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the December through February adult late fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

Clear Creek

Water temperature modeling was not conducted in Clear Creek.

Fall-Run

Flows in the Clear Creek below Whiskeytown Reservoir were examined for juvenile fall-run migrants during February through May (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would generally be similar to those under NAA with few exceptions.

Flows in Clear Creek below Whiskeytown Reservoir were examined during the adult fall-run Chinook salmon upstream migration period (September through October) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would generally be similar to flows under NAA with few exceptions.

Feather River

Fall-Run

Flows in the Feather River at the confluence with the Sacramento River were reviewed for the fall-run juvenile migration period (February through May) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would generally be up to 23% greater than flows under NAA during April and May and similar to flows under NAA during February and March.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

Flows in the Feather River at the confluence with the Sacramento River were reviewed for the September through October fall-run Chinook salmon adult migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would generally be up to 27% lower than flows under NAA in September but up to 22% greater than flows under NAA in October.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the September through October fall-run Chinook salmon adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

American River

Fall-Run

Flows in the American River at the confluence with the Sacramento River were examined during the February through May juvenile Chinook salmon fall-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would generally be up to 24% greater than flows under NAA during May, and similar to flows under NAA during February through April.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

Flows in the American River at the confluence with the Sacramento River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows H3 would generally be up to 17% lower during September and similar to flows under NAA during October.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

Stanislaus River

Fall-Run

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would be similar to those under NAA in all months and water year types throughout the period.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would be similar to those under NAA in all months and water year types throughout the period.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

San Joaquin River

Fall-Run

Flows in the San Joaquin River at Vernalis were examined during the February through May juvenile Chinook salmon fall-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would be similar to those under NAA in all months and water year types throughout the period.

Flows in the San Joaquin River at Vernalis were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would be similar to those under NAA in all months and water year types throughout the period.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Fall-Run

Flows in the Mokelumne River at the Delta were examined during the February through May juvenile Chinook salmon fall-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would be similar to those under NAA in all months and water year types throughout the period.

Flows in the Mokelumne River at the Delta were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would be similar to those under NAA in all months and water year types throughout the period.

Water temperature modeling was not conducted in the Mokelumne River.

H1/LOS

Sacramento River

Fall-Run

Flows in the Sacramento River upstream of Red Bluff were examined for the juvenile fall-run Chinook salmon downstream migration period (February through May) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H1 would generally be similar to flows under NAA throughout the period.

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period.

Flows in the Sacramento River upstream of Red Bluff were examined for the adult fall-run Chinook salmon upstream migration period (September through October) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H1 would be 25% lower during September relative to those under NAA, but there would be no difference in flows between NAA and H1 during October.

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the September through October adult fall-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period.

Late Fall-Run

Flows in the Sacramento River upstream of Red Bluff were examined for the juvenile fall-run Chinook salmon downstream migration period (January through March) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H1 would generally be similar to flows under H3 throughout the period.

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the January through March juvenile late fall-run Chinook salmon emigration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period.

Flows in the Sacramento River upstream of Red Bluff were examined for the adult fall-run Chinook salmon upstream migration period (December through February) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows under H1 would generally be similar to flows under H3 throughout the period.

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the December through February adult late fall-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period.

Clear Creek

Water temperature modeling was not conducted in Clear Creek.

Fall-Run

Flows in the Clear Creek below Whiskeytown Reservoir during February through May under H1 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in the Clear Creek below Whiskeytown Reservoir during September through October under H1 would generally be similar to flows under H3. Due to similar flows between H1 and H3, results for H1 would be similar to those for H3.

Feather River

Fall-Run

Flows in the Feather River at the confluence with the Sacramento River during the February through May juvenile late fall-run Chinook salmon emigration period under H1 would be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the January through March juvenile late fall-run Chinook salmon emigration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period.

Flows in the Feather River at the confluence with the Sacramento River during September through October under H1 would be similar to flows under H3 except in wet and above normal water years during September during which flows would be 65% and 40% lower than flows under H3, respectively. Although large reductions, they occur in the wettest water year types and, therefore, are not expected to have biologically meaningful effects on fall-run Chinook salmon.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the September through October fall-run Chinook salmon adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation*

Temperature Model Results utilized in the Fish Analysis). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month throughout the period. There would be a 6% reduction in water temperatures under H1 in wet years during September.

American River

Fall-Run

Flows in the American River at the confluence with the Sacramento River during February through May under H1 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period.

Flows in the American River at the confluence with the Sacramento River during September through October under H1 would generally be similar to flows under H3 except in wet and above normal water years during September during which flows would be 38% and 19% lower than flows under H3, respectively. Although small to moderate reductions, they occur in the wettest water year types and, therefore, are not expected to have biologically meaningful effects on fall-run Chinook salmon.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period.

Stanislaus River

Fall-Run

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H1 would be similar to those under NAA in all months and water year types throughout the period.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period.

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H1 would be similar to those under NAA in all months and water year types throughout the period.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period.

San Joaquin River

Fall-Run

Flows in the San Joaquin River at Vernalis were examined during the February through May juvenile Chinook salmon fall-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H1 would be similar to those under NAA in all months and water year types throughout the period.

Flows in the San Joaquin River at Vernalis were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H1 would be similar to those under NAA in all months and water year types throughout the period.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Fall-Run

Flows in the Mokelumne River at the Delta were examined during the February through May juvenile Chinook salmon fall-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H1 would be similar to those under NAA in all months and water year types throughout the period.

Flows in the Mokelumne River at the Delta were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H1 would be similar to those under NAA in all months and water year types throughout the period.

Water temperature modeling was not conducted in the Mokelumne River.

H4/HOS

Sacramento River

Fall-Run

Flows in the Sacramento River upstream of Red Bluff were examined for the juvenile fall-run Chinook salmon downstream migration period (February through May) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 would generally be similar to flows under NAA throughout the period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the*

Fish Analysis). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

Flows in the Sacramento River upstream of Red Bluff were examined for the adult fall-run Chinook salmon upstream migration period (September through October) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H4 would be 6% higher during September relative to those under NAA, but there would be no difference in flows between NAA and H4 during October.

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the September through October adult fall-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

Late Fall-Run

Flows in the Sacramento River upstream of Red Bluff were examined for the juvenile fall-run Chinook salmon downstream migration period (January through March) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 would generally be similar to flows under NAA throughout the period.

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the January through March juvenile late fall-run Chinook salmon emigration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

Flows in the Sacramento River upstream of Red Bluff were examined for the adult fall-run Chinook salmon upstream migration period (December through February) (Appendix 11C, CALSIM II Model Results utilized in the Fish Analysis). Flows under H4 would generally be similar to flows under NAA throughout the period.

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the December through February adult late fall-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

Clear Creek

Water temperature modeling was not conducted in Clear Creek.

Fall-Run

Flows in the Clear Creek below Whiskeytown Reservoir during February through May under H4 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in the Clear Creek below Whiskeytown Reservoir during September through October under H4 would generally be similar to flows under H3. Due to similar flows between H4 and H3, results for H4 would be similar to those for H3.

Feather River

Fall-Run

Flows in the Feather River at the confluence with the Sacramento River during the February through May juvenile late fall-run Chinook salmon emigration period under H4 would be similar to or greater than flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the January through March juvenile late fall-run Chinook salmon emigration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

Flows in the Feather River at the confluence with the Sacramento River during September through October under H4 would be higher than, similar to, or lower than flows under H1 depending on month and water year type. On average, flows would be 5% and 6% lower under H4 relative to H3 in September, and October, respectively. These reductions would not be of high enough magnitude to have a biologically meaningful effect on fall-run Chinook salmon adult migration.

American River

Water temperatures in the American River under H4 would be the same as those under H3.

Fall-Run

Flows in the American River at the confluence with the Sacramento River during February through May under H4 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

Flows in the American River at the confluence with the Sacramento River under H4 would generally be greater than flows under H3 during September and generally lower than flows under H3 during October depending on water year type. On average, flows under H4 would be 16% higher during September and 8% lower during October. The September increase would have a small to moderate biologically meaningful effect on fall-run Chinook salmon adult migration although October decrease would be too small to have a biologically meaningful effect.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

Stanislaus River

Fall-Run

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 would be similar to those under NAA in all months and water year types throughout the period.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 would be similar to those under NAA in all months and water year types throughout the period.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

San Joaquin River

Fall-Run

Flows in the San Joaquin River at Vernalis were examined during the February through May juvenile Chinook salmon fall-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 would be similar to those under NAA in all months and water year types throughout the period.

Flows in the San Joaquin River at Vernalis were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 would be similar to those under NAA in all months and water year types throughout the period.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Fall-Run

Flows in the Mokelumne River at the Delta were examined during the February through May juvenile Chinook salmon fall-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 would be similar to those under NAA in all months and water year types throughout the period.

Flows in the Mokelumne River at the Delta were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 would be similar to those under NAA in all months and water year types throughout the period.

Water temperature modeling was not conducted in the Mokelumne River.

Through-Delta

Sacramento River

Fall-Run

Juveniles

Alternative 4 operations would generally reduce OMR reverse flows under Scenarios H3 and H1 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*), with a corresponding increase in net positive downstream flows, during the migration period of Chinook salmon through the interior Delta channels. Conditions under Scenario H4 would further improve overall average OMR flows compared to NAA. These improved net positive downstream flows would be substantial benefits of the proposed operations.

Predation risk at the north Delta would be increased due to the installation of the proposed SWP/CVP North Delta intake facilities on the Sacramento River. Bioenergetics modeling with a median predator density predicts a predation loss under Alternative 4 of less than 0.6% of the annual juvenile production (0.25% fall run; 0.58% late fall-run) (Table 11-4-73). A conservative assumption of 5% loss per intake would yield a cumulative loss of about 13% of juvenile fall-run and late fall-run Chinook that reach the north Delta. This assumption is uncertain and represents an upper bound estimate. For a discussion of this topic see Impact AQUA-42 for Alternative 1A.

Table 11-4-73. Fall-Run and Late Fall-Run Chinook Salmon Juvenile Predation Loss at the proposed North Delta Diversion intakes for Alternative 4 (Three Intakes)

Striped Bass at NDD (Three Intakes)			Fall-Run Chinook		Late Fall-Run Chinook	
Density	Bass per 1,000 Feet of Intake	Total Number of Bass	Number Consumed (LLT)	Percentage of Annual Production	Number Consumed (LLT)	Percentage of Annual Production
Low	18	86	23,395	0.04%	3,795	0.09%
Median	119	571	154,665	0.25%	25,089	0.58%
High	219	1,051	284,636	0.46%	46,172	1.07%

Note: Based on bioenergetics modeling of Chinook salmon consumption by striped bass (Appendix 5F Biological Stressors).

H3/ESO and H1/LOS

Flows below the north Delta intakes would be reduced during the juvenile emigration period for fall-run Chinook (February through May) and late fall-run Chinook salmon (January through March), which may increase predation potential. Mean monthly flows would decrease about 14% to 21% under H3, and decrease 15% to 27% under H1, with reductions up to 28% in April of above normal years compared to NAA.

Under Scenario H3, Through-Delta survival of Sacramento River fall-run Chinook salmon, as estimated by the Delta Passage Model, averaged 24.4% across all years, 21.7% in drier years and 29% in wetter years (Table 11-4-74). Compared to NAA, average survival under Scenario H3 would be similar across all years. Juvenile survival under Scenario H1 (low outflow) was similar to Scenario H3.

H4/HOS

Under the high outflow scenario H4, mean monthly flows would decrease by about 5% to 23% during the emigration period, with the greatest relative reduction of 28% in November of below normal years. Under H4, flow decreases in April and May would be less than 10% compared to NAA. Survival under Scenario H4 would be slightly greater than NAA (3% relative difference).

Overall, Alternative 4 would not have an adverse effect on Sacramento River fall-run Chinook salmon juvenile survival due to minor differences in survival for most operations, and slight increase in survival for the high outflow operations Scenario H4.

Table 11-4-74. Through-Delta Survival (%) of Emigrating Juvenile Fall-Run Chinook Salmon under Alternative 4 (Scenarios H3, H1 and H4)

Water Year Type	Average Percentage Survival – Scenario: EXISTING CONDITIONS	NAA	H3	H1	H4	Difference in Percentage Survival (Relative Difference) – EXISTING CONDITIONS vs. Alt 4 Scenario: H3	H1	H4	NAA vs. Alt 4 Scenario: H3	H1	H4
Sacramento											
Wetter	34.5	31.1	29.0	29.0	32.2	-5.5 (-15%)	-5.5 (-16%)	-2.3 (-7%)	-2.1 (-6%)	-2.1 (-7%)	1.1 (3%)
Drier	20.6	20.8	21.7	21.6	21.4	1.1 (7%)	1.0 (5%)	0.8 (4%)	0.9 (4%)	0.8 (4%)	0.6 (3%)
All Years	25.8	24.7	24.4	24.4	25.5	-1.4 (-1%)	-1.4 (-6%)	-0.3 (-1%)	-0.2 (-1%)	-0.3 (-1%)	0.8 (3%)
Mokelumne											
Wetter	17.2	15.7	17.2	17.2	18.0	<0.1 (<1%)	0.0 (0%)	0.8 (5%)	1.5 (9%)	1.5 (10%)	2.3 (15%)
Drier	15.6	15.9	15.8	15.8	16.1	0.2 (1%)	0.2 (1%)	0.5 (3%)	-0.1 (-1%)	-0.1 (-1%)	0.2 (1%)
All Years	16.2	15.9	16.3	16.4	16.8	0.1 (1%)	0.2 (1%)	0.6 (4%)	0.5 (3%)	0.5 (3%)	0.9 (6%)
San Joaquin											
Wetter	19.3	20.3	17.0	17.0	16.7	-2.4 (-12%)	-2.3 (-12%)	-2.6 (-13%)	-3.3 (-16%)	-3.3 (-16%)	-3.6 (-18%)
Drier	10.0	9.5	11.0	11.0	10.7	1.0 (10%)	1.0 (10%)	0.7 (7%)	1.4 (14%)	1.5 (16%)	1.2 (13%)
All Years	13.5	13.6	13.2	13.2	12.9	-0.3 (-2%)	-0.3 (-2%)	-0.6 (-4%)	-0.3 (-3%)	-0.4 (-3%)	-0.7 (-5%)

Note: Average Delta Passage Model results for survival to Chipps Island.
Wetter = Wet and Above Normal Water Years (6 years).
Drier = Below Normal, Dry and Critical Water Years (10 years).
H3 =ESO operations, H1 = Low Outflow, H4 = High Outflow.

Adults

Attraction flows and olfactory cues in the west Delta for migrating adults would be altered because of shifts in exports from the south Delta to the North Delta under Alternative 4. Sacramento River flows downstream of the north Delta diversion would be reduced, with concomitant increase in San Joaquin River flow contribution.

Results of fingerprint simulation modeling (DSM2 modeling of percentage of water at Collinsville that originated in the Sacramento River water) for Scenario H3 predicted a minimal reduction in Sacramento River source water September–November (1–3% less) compared with NAA (Table 11-4-75). The effect would be even lower under Scenario H4 because exports from the north Delta would be lower than under Scenario H3 and H1. Studies indicate that a 10% or less reduction in source flows that provides olfactory cues would not adversely affect adult attraction (Fretwell 1989). The reduction in olfactory cues under Scenario H3 is small and is expected to be within the broad range of olfactory cues and migration conditions that currently occur within the lower reach of the Sacramento River.

Table 11-4-75. Percentage (%) of Water at Collinsville that Originated in the Sacramento River and San Joaquin River during the Adult Fall-Run and Late Fall-Run Chinook Salmon Migration Period for Alternative 4 (Scenario H3)

	Scenario			Percentage Difference	
Month	EXISTING CONDITIONS	NAA	A4 (H3)	EXISTING CONDITIONS vs. A4 (H3)	NAA vs. A4 (H3)
Fall-Run—Sacramento River					
September	60	65	63	3	-2
October	60	68	67	7	-1
November	60	66	63	3	-3
December	67	66	66	-1	0
Fall-Run—San Joaquin River					
September	0.3	0.1	1.2	0.9	1.1
October	0.2	0.3	3.3	3.1	3
November	0.4	1.0	4.9	4.5	3.9
December	0.9	1.0	2.9	2	1.9
Late Fall-Run—Sacramento River					
December	67	66	66	-1	0
January	76	75	73	-3	-2
February	75	72	68	-7	-4
March	78	76	68	-10	-8

Shading indicates 10% or greater absolute difference.

Late Fall-Run

Juveniles

Alternative 4 operations would generally reduce OMR reverse flows under all flow scenarios (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*), with a corresponding increase in net positive downstream flows that would benefit juveniles migrating through the Delta. Reduced flows below the north Delta intakes may increase predation potential. Through-Delta survival by emigrating juvenile late fall-run Chinook salmon under Scenario H3 averaged 23% across all years, 20.5% in drier years, and 27.3% in wetter years (Table 11-4-76). Juvenile survival under the Scenario H3 was similar or slightly greater than under NAA for drier, wetter and all years averaged (around 1% more in relative difference) (Table 11-4-76). Overall, Alternative 4 would not have an adverse effect on late fall-run Chinook salmon juvenile survival due to similar survival between Alternative 4 and NAA during all water year types.

Table 11-4-76. Through-Delta Survival (%) of Emigrating Juvenile Late Fall-Run Chinook Salmon under Alternative 4 (Scenarios H3, H1, and H4)

Water Year Type	Average Percentage Survival					Difference in Percentage Survival (Relative Difference)					
	Scenario					EXISTING CONDITIONS vs. Alt 4 Scenario			NAA vs. Alt 4 Scenario		
	EXISTING CONDITIONS	NAA	H3	H1	H4	H3	H1	H4	H3	H1	H4
Wetter	28.8	27.3	27.3	26.9	27.2	-1.4 (-5%)	-1.9 (-7%)	-1.6 (-5%)	0.0 (0%)	-0.4 (-2%)	-0.1 (0%)
Drier	18.8	20.2	20.5	19.7	20.2	1.7 (9%)	0.9 (5%)	1.4 (7%)	0.3 (1%)	-0.5 (-2%)	0.0 (0%)
All Years	22.5	22.9	23.0	22.4	22.8	0.5 (2%)	-0.1 (0%)	0.3 (1%)	0.2 (1%)	-0.5 (-2%)	-0.1 (0%)

Note: Delta Passage Model results for survival to Chipps Island.
Wetter = Wet and Above Normal Water Years (6 years).
Drier = Below Normal, Dry and Critical Water Years (10 years)

Adults

Flows in the Sacramento River downstream of the north Delta intake diversions would be reduced under Alternative 4, with concomitant proportional increases in San Joaquin River flows. Under Scenario H3, the percentage of Sacramento River water at Collinsville would be unchanged in December, and slightly reduced (2% to 8%) in January through March compared to NAA (Table 11-4-75). This effect would be less under Scenario H4 compared to Scenarios H3 and H1 because it would involve fewer exports from the north Delta. The effect on olfactory cues for migrating adults late fall-run Chinook salmon would be negligible because the change in flow proportions is less than 10%.

Mokelumne River

Fall-Run

Juveniles

Through-Delta survival of Mokelumne River fall-run Chinook salmon under Scenario H3 averaged 16% across all years and water year types (Table 11-4-58). Survival under Scenario H3 was similar to NAA averaged across all years (0.5% greater, or 3% more in relative difference) and in drier years (a 1% relative difference), and 1.5% increase in survival (an 9% relative difference) in wetter years. Juvenile survival under Scenario H1 (low outflow) and H4 (high outflow) was similar to Scenario H3 and NAA in drier years, slightly increased averaged across all years. In wetter years, survival increased 1.5% (10% relative difference) under Scenario H1 and 2.3% under Scenario H4 (a 15% relative difference). Overall, Alternative 4 would not have an adverse effect on fall-run Chinook salmon juvenile survival due to minor differences in survival for most operations, and slight increase in survival for the high outflow years or operations Scenario H4.

San Joaquin River

Fall-Run

Juveniles

Under Alternative 4 Scenario H3 operations, through-Delta survival by juvenile fall-run Chinook salmon emigrating from the San Joaquin River averaged 13% across all years, 11% in drier years, and 17% in wetter years (Table 11-4-74). Compared to NAA, average survival was similar for all years averaged for all operations scenarios (H3, H1, and H4). Survival is slightly increased in drier years (1% greater, a 13-16% relative difference). Survival is greatest in wetter years, but is slightly reduced relative to NAA by about 3% (16–18% relative difference for Scenarios H1, H3, and H4). Overall, Alternative 4 would not have an adverse effect on through-Delta migration due to minor differences in survival.

Adults

The percentage of water at Collinsville that originated from the San Joaquin River is very small (no more than 1% under NAA) during the fall-run migration period (September to December). The fingerprinting analysis showed a small increase in olfactory cues from the San Joaquin River passing downstream through the Delta under Scenario H3 (Table 11-4-75). Although the relative change is substantial (i.e., close to double the percentage of flow in the San Joaquin under Scenario H3 than under NAA), the percentage of flow attributable to San Joaquin River water under all scenarios is quite low (no more than 5%). Scenario H4 would not have as great a relative change because exports at the north Delta diversion would be lower than under Scenarios H3 and H1. Overall, Alternative 4 operations conditions would incremental increase olfactory cues associated with attraction flows in the lower San Joaquin River, but the increase would be small. This would not be an adverse effect on adult fall-run Chinook salmon migrating to the San Joaquin River.

NEPA Effects: Upstream of the Delta, these results indicate that the effect would not be adverse because it does not have the potential to substantially interfere with the movement of fish. Although some flow reductions are predicted, these flows would not be of sufficient magnitude to cause biologically meaningful effect on fall- and late fall-run Chinook salmon migration.

Near-field effects of Alternative 4 NDD on fall- and late fall-run Chinook salmon related to impingement and predation associated with three new intake structures could result in negative effects on juvenile migrating fall- and late fall-run Chinook salmon, although there is high uncertainty regarding the overall effects. It is expected that the level of near-field impacts would be directly correlated to the number of new intake structures in the river and thus the level of impacts associated with 3 new intakes would be considerably lower than those expected from having 5 new intakes in the river. Estimates within the effects analysis range from very low levels of effects (<1% mortality) to more significant effects (~ 13% mortality above current baseline levels). CM15 would be implemented with the intent of providing localized and temporary reductions in predation pressure at the NDD. Additionally, several pre-construction surveys to better understand how to minimize losses associated with the three new intake structures will be implemented as part of the final NDD screen design effort. Alternative 4 also includes an Adaptive Management Program and Real-Time Operational Decision-Making Process to evaluate and make limited adjustments intended to provide adequate migration conditions for fall- and late fall-run Chinook. However, at this time, due to the absence of comparable facilities anywhere in the lower Sacramento River/Delta, the degree of mortality expected from near-field effects at the NDD remains highly uncertain.

Two recent studies (Newman 2003 and Perry 2010) indicate that far-field effects associated with the new intakes could cause a reduction in smolt survival in the Sacramento River downstream of the NDD intakes due to reduced flows in this area. The analyses of other elements of Alternative 4 predict improvements in smolt condition and survival associated with increased access to the Yolo Bypass, reduced interior Delta entry, and reduced south Delta entrainment. The overall magnitude of each of these factors and how they might interact and/or offset each other in affecting salmonid survival through the plan area is uncertain, and remains an area of active investigation for the BDCP.

The DPM is a flow-based model being developed for BDCP which attempts to combine the effects of all of these elements of BDCP operations and conservation measures to predict smolt migration survival throughout the entire Plan Area. The current draft of this model predicts that smolt migration survival under Alternative 4 would be similar to those estimated for NAA. Further refinement and testing of the DPM, along with several ongoing and planned studies related to salmonid survival at and downstream of, the NDD are expected to be completed in the foreseeable future. These efforts are expected to improve our understanding of the relationships and interactions among the various factors affecting salmonid survival, and reduce the uncertainty around the potential effects of BDCP implementation on migration conditions for Chinook salmon. However, until these efforts are completed and their results are fully analyzed, the overall cumulative effect of Alternative 4 on fall- and late fall-run Chinook salmon migration remains uncertain. Similarly, the impact on the fall-run Chinook salmon commercial fishery would be uncertain.

CEQA Conclusion: In general, Alternative 4 would not affect the migration conditions for fall-/late fall-run Chinook salmon relative to Existing Conditions.

Upstream of the Delta

H3/ESO

Sacramento River

Fall-Run

Flows in the Sacramento River upstream of Red Bluff were examined for juvenile fall-run migrants during February through May (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would generally be up to 14% greater than those under Existing Conditions during May, and similar to flows under Existing Conditions during February through April.

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H3 in any month throughout the period. There would be a 5% increase in water temperatures in wet water years during May.

Flows in the Sacramento River upstream of Red Bluff were examined during the adult fall-run Chinook salmon upstream migration period (September through October) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would generally be similar to or those under Existing Conditions with some exceptions.

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the September through October adult fall-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H3 would be 5% and 6% greater than those under H3 during September and October, respectively.

Late Fall-Run

Flows in the Sacramento River upstream of Red Bluff for juvenile late fall-run migrants (January through March) under H3 would generally be similar to flows under Existing Conditions, with few exceptions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the January through March juvenile late fall-run Chinook salmon emigration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H3 in any month or water year type, except in critical years during January (5% higher).

Flows in the Sacramento River upstream of Red Bluff during the adult late fall-run Chinook salmon upstream migration period (December through February) under H3 would generally be similar to flows under Existing Conditions, with few exceptions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the December through February adult late fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H3 in any month throughout the period, except in critical years during January (5% higher).

Clear Creek

Fall-Run

Flows in Clear Creek below Whiskeytown Reservoir were examined during the juvenile fall-run Chinook salmon upstream migration period (February through May). Flows under H3 would generally be greater than those under Existing Conditions during March and similar to flows under Existing Conditions during February, April, and May (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flows in Clear Creek below Whiskeytown Reservoir during the adult fall-run Chinook salmon upstream migration period (September through October) under H3 would generally be similar to those under Existing Conditions with few exceptions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Water temperature modeling was not conducted in Clear Creek

Feather River

Fall-Run

Flows in the Feather River at the confluence with the Sacramento River during the fall-run juvenile migration period (February through May) under H3 would generally be similar to flows under Existing Conditions, with few exceptions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H3 in any month throughout the period.

Flows in the Feather River at the confluence with the Sacramento River were examined during the September through October fall-run Chinook salmon adult migration period. Flows under H3 would generally be up to 108% greater than flows under Existing Conditions during both months (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the September through October fall-run Chinook salmon adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H3 in any month throughout the period.

American River

Fall-Run

Flows in the American River at the confluence with the Sacramento River were examined during the February through May juvenile Chinook salmon fall-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would generally be up to 27% greater than flows under Existing Conditions during February and March, up to 31% lower during May, and similar to flows under Existing Conditions during April.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H3 would be 5% to 7% higher than under Existing Conditions in all month except April, in which there would be no difference.

Flows in the American River at the confluence with the Sacramento River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would be 27% to 51% lower than flows under Existing Conditions during September and similar to flows under Existing Conditions during October.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H3 would be 6% and 12% higher than those under Existing Conditions during September and October, respectively.

Stanislaus River

Fall-Run

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 throughout this period would generally be lower than Existing Conditions (up to 36% lower), except in wet water years, in which flows would be similar or up to 8% greater than flows under Existing Conditions.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H3 would be 6% higher than those under Existing Conditions in every month of the period.

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would be up to 17%lower than flows under Existing Conditions.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H3 would be 6% higher than those under Existing Conditions during September but there would be no difference in mean monthly water temperatures between H3 and Existing Conditions during October.

San Joaquin River

Fall-Run

Flows in the San Joaquin River at Vernalis were examined during the February through May juvenile Chinook salmon fall-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H3 would generally be similar to flows under Existing Conditions in all months. Wetter water years under H3 would have similar or greater flows than those under Existing Conditions, whereas drier years would have lower flows under H3.

Flows in the San Joaquin River at Vernalis were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H3 would be 8% lower than those under Existing Conditions in September and similar in October.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Fall-Run

Flows in the Mokelumne River at the Delta were examined during the February through May juvenile Chinook salmon fall-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would be similar to or up to 15% greater than those under Existing Conditions during February and March, but up to 18% lower than flows under Existing Conditions during April and May.

Flows in the Mokelumne River at the Delta were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would be 27% lower than under Existing Conditions during September but would be similar during October.

Water temperature modeling was not conducted in the Mokelumne River.

H1/LOS

Sacramento River

Fall-Run

Mean monthly flows and water temperatures in the Sacramento River at Red Bluff were examined during the February through May juvenile fall-run Chinook salmon migration period. Flows under H1 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H1 in any month throughout the period, except in wet water years during May (5% increase) (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

Mean monthly flows and water temperatures in the Sacramento River at Red Bluff were examined during the September through October adult fall-run Chinook salmon upstream migration period. Flows under H1 would generally be similar to flows under H3(Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H1 would be 5% and 6% greater than those under Existing Conditions during September and October, respectively (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

Due to similar flows and water temperatures between H1 and H3, results for H1 would be similar to those for H3.

Late Fall-Run

Mean monthly flows and water temperatures in the Sacramento River at Red Bluff were examined during the January through March juvenile late fall-run Chinook salmon emigration period. Mean monthly flows under H1 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H1 in any month or water year type, except in critical years during January (5% higher). (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

Mean monthly flows and water temperatures in the Sacramento River at Red Bluff were examined during the December through February adult late fall-run Chinook salmon migration period. Mean monthly flows under H1 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H1 in any month throughout the period, except in critical years during January (5% higher) (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

Due to similar flows and water temperatures between H1 and H3, results for H1 would be similar to those for H3.

Clear Creek

Fall-Run

Flows in the Clear Creek below Whiskeytown Reservoir during February through May under H1 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in the Clear Creek below Whiskeytown Reservoir during September through October under H1 would generally be similar to flows under H3. Due to similar flows between H1 and H3, results for H1 would be similar to those for H3.

Water temperature modeling was not conducted in Clear Creek.

Feather River

Water temperatures under H1 would be similar to flows under H3.

Fall-Run

Mean monthly flows and water temperatures in the Feather River at the confluence with the Sacramento River were examined during the February through May juvenile fall-run Chinook salmon migration period. Flows under H1 would be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H1 in any month throughout the period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

Mean monthly flows and water temperatures in the Feather River at the confluence with the Sacramento River were examined during the September through October fall-run Chinook salmon adult upstream migration period. Flows under H1 would be similar to flows under H3 except in wet and above normal water years during September during which flows would be 65% and 40% lower than flows under H3, respectively (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Although large reductions, they occur in the wettest water year types and, therefore, are not expected to have biologically meaningful effects on fall-run Chinook salmon. Mean monthly water temperatures during September would be 6% higher under H1 than under Existing Conditions, but there would be no differences during October (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

American River

Fall-Run

Mean monthly flows and water temperatures in the American River at the confluence with the Sacramento River were examined during the February through May juvenile fall-run Chinook salmon migration period. Flows under H1 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H1 would be 5% to 7% higher than under Existing Conditions in all month except April, in which there would be no difference (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were examined during the September and October adult fall-run Chinook salmon upstream migration period Flows during September through October under H1 would generally be similar to flows under H3 except in wet and above normal water years during September during which flows would be 38% and 19% lower than flows under H3, respectively (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Although small to moderate reductions, they occur in the wettest water year types and, therefore, are not expected to have biologically meaningful effects on fall-run Chinook salmon. Mean monthly water temperatures under H1 would be 7% and 10% higher than those under Existing Conditions during September and October, respectively (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

Stanislaus River

Fall-Run

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H1 throughout this period would generally be lower than Existing Conditions (up to 36% lower), except in wet water years, in which flows would be similar or up to 7% greater than flows under Existing Conditions.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H1 would be 6% higher than those under Existing Conditions in every month of the period.

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H1 would be up to 17% lower than flows under Existing Conditions.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H1 would be 6% higher than those under Existing Conditions during September but there would be no difference in mean monthly water temperatures between H1 and Existing Conditions during October.

Flows and water temperatures in the Stanislaus River would be similar between H1 and H3. Therefore, results for H1 would be similar to those for H3.

San Joaquin River

Fall-Run

Flows in the San Joaquin River at Vernalis were examined during the February through May juvenile Chinook salmon fall-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H1 would generally be similar to flows under Existing Conditions in all months. Wetter water years under H1 would have similar or greater flows than those under Existing Conditions, whereas drier years would have lower flows under H1.

Flows in the San Joaquin River at Vernalis were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H1 would be 8% and 5% lower than those under Existing Conditions in September and October, respectively.

Water temperature modeling was not conducted in the San Joaquin River.

Flows in the San Joaquin River would generally be similar between H1 and H3. Therefore, results for H1 would be similar to those for H3

Mokelumne River

Fall-Run

Flows in the Mokelumne River at the Delta were examined during the February through May juvenile Chinook salmon fall-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H1 would be similar to or up to 15% higher than those under Existing Conditions during February and March, but up to 18% lower than flows under Existing Conditions during April and May.

Flows in the Mokelumne River at the Delta were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H1 would be 27% lower than under Existing Conditions during September but would be similar during October.

Water temperature modeling was not conducted in the Mokelumne River.

Flows in the Mokelumne River would be similar between H1 and H3. Therefore, results for H1 would be similar to those for H3.

H4/HOS

Sacramento River

Fall-Run

Mean monthly flows and water temperatures in the Sacramento River at Red Bluff were examined during the February through May juvenile fall-run Chinook salmon migration period. Flows under H4 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H4 in any month throughout the period, except in wet water years during May (5% increase) (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

Mean monthly flows and water temperatures in the Sacramento River at Red Bluff were examined during the September through October adult fall-run Chinook salmon upstream migration period. Flows under H4 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H4 would not be different from those under Existing Conditions during September but would be 6% greater than those under Existing Conditions during October (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

Due to generally similar flows and water temperatures between H4 and H3, results for H4 would be similar to those for H3.

Late Fall-Run

Mean monthly flows and water temperatures in the Sacramento River at Red Bluff were examined during the January through March juvenile late fall-run Chinook salmon emigration period. Mean monthly flows under H4 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in water temperature between Existing Conditions and H4 in any month or water year type. (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

Mean monthly flows and water temperatures in the Sacramento River at Red Bluff were examined during the December through February adult late fall-run Chinook salmon migration period. Mean monthly flows under H4 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H4 in any month throughout the period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

Due to similar flows and water temperatures between H4 and H3, results for H4 would be similar to those for H3.

Clear Creek

Fall-Run

Flows in the Clear Creek below Whiskeytown Reservoir during February through May under H4 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the*

Fish Analysis). Flows in the Clear Creek below Whiskeytown Reservoir during September through October under H4 would generally be similar to flows under H3. Due to similar flows between H4 and H3, results for H4 would be similar to those for H3.

Water temperature modeling was not conducted in Clear Creek.

Feather River

Water temperatures under H4 would be similar to flows under H3.

Fall-Run

Mean monthly flows and water temperatures in the Feather River at the confluence with the Sacramento River were examined during the February through May juvenile fall-run Chinook salmon migration period. Flows under H4 would be similar to or greater than flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H4 in any month throughout the period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

Mean monthly flows and water temperatures in the Feather River at the confluence with the Sacramento River were examined during the September through October fall-run Chinook salmon adult upstream migration period. Flows under H4 would be higher than, similar to, or lower than flows under H3 depending on month and water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). On average, flows would be 5% and 6% lower under H4 relative to H3 in September, and October, respectively. These reductions would not be of high enough magnitude to have a biologically meaningful effect on fall-run Chinook salmon adult migration. Mean monthly water temperatures under H4 would be similar to those under Existing Conditions during September, but 5% higher during October (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

American River

Fall-Run

Mean monthly flows and water temperatures in the American River at the confluence with the Sacramento River were examined during the February through May juvenile fall-run Chinook salmon migration period. Flows under H4 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H4 would be 5% to 7% higher than under Existing Conditions in all month except April, in which there would be no difference (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were examined during the September and October adult fall-run Chinook salmon upstream migration period Flows under H4 would generally be greater than flows under H3 during September and generally lower than flows under H3 during October depending on water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). On average, flows under H4 would be 16% higher during September and 8% lower during October. The September increase would have a small to moderate biologically meaningful effect on fall-run Chinook salmon adult migration although October decrease would be too small to have a biologically meaningful effect. Mean monthly water temperatures under H4 would be 6% and 11% higher than those under Existing Conditions during

September and October, respectively (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

Stanislaus River

Fall-Run

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 throughout this period would generally be lower than Existing Conditions (up to 36% lower), except in wet water years, in which flows would be similar or up to 7% greater than flows under Existing Conditions.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were examined during the February through May juvenile fall-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H4 would be 6% higher than those under Existing Conditions in every month of the period.

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 would be up to 17% lower than flows under Existing Conditions.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H4 would be 6% higher than those under Existing Conditions during September but there would be no difference in mean monthly water temperatures between H4 and Existing Conditions during October.

Flows and water temperatures in the Stanislaus River would be similar between H4 and H3. Therefore, results for H4 would be similar to those for H3.

San Joaquin River

Fall-Run

Flows in the San Joaquin River at Vernalis were examined during the February through May juvenile Chinook salmon fall-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H4 would generally be similar to flows under Existing Conditions in all months. Wetter water years under H4 would have similar or greater flows than those under Existing Conditions, whereas drier years would have lower flows under H4.

Flows in the San Joaquin River at Vernalis were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H4 would be 8% lower than those under Existing Conditions in September but similar during October, respectively.

Water temperature modeling was not conducted in the San Joaquin River.

Flows in the San Joaquin River would be generally similar between H4 and H3. Therefore, results for H4 would be similar to those for H3.

Mokelumne River

Fall-Run

Flows in the Mokelumne River at the Delta were examined during the February through May juvenile Chinook salmon fall-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 would be similar to or up to 15% higher than those under Existing Conditions during February and March, but up to 18% lower than flows under Existing Conditions during April and May.

Flows in the Mokelumne River at the Delta were examined during the September and October adult fall-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 would be 27% lower than under Existing Conditions during September but would be similar during October.

Water temperature modeling was not conducted in the Mokelumne River.

Flows in the Mokelumne River would be similar between H4 and H3. Therefore, results for H4 would be similar to those for H3.

Through-Delta

Sacramento River

Fall-Run

Juveniles

As described above, Scenario H3 operations would reduce overall OMR reverse flows and reduce Sacramento River flows below the north Delta diversions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Survival of Sacramento River juveniles under Scenarios H3 and H1 averaged for all years was similar to Existing Conditions, with a slight increase in drier years (about 1% greater, or a 5% relative difference) and about 5% decrease (a 16% relative difference) in wetter years (Table 11-4-74). Under Scenario H4 average survival was similar (1% relative decrease) to Existing Conditions for all years, drier years and wetter years.

Adults

The percentage of Sacramento River origin flow at Collinsville, would be slightly increased (3–7% in September to November) under Scenario H3 compared to Existing Conditions (Table 11-4-75). This would not significantly affect olfactory cues for adults migrating to the Sacramento River because the change is less than 10%.

Late Fall-Run

Juveniles

As described above, Alternative 4 operations would reduce OMR reverse flows and reduce Sacramento River flows below the north Delta diversions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Conditions under Scenario H4 would further improve OMR flow conditions relative to the Scenario H3 and LOS. As estimated by DPM, through-Delta survival by emigrating juvenile late fall-run Chinook salmon under Scenario H3 was slightly increased averaged across all years (0.5% greater survival, a 2% relative difference) compared to Existing Conditions (Table 11-4-76). Survival was greater in drier years (1.7% increase, a 9% relative difference) but reduced in wetter years (1.4%, a 5% relative difference).

Adults

As described above, the percentage of Sacramento River water would be slightly reduced in December and March (1% to 10% less) compared to NAA (Table 11-4-75). This effect would be less under Scenario H4 compared to Scenarios H3 and H1 due to reduced north Delta exports. Olfactory cues would be slightly decreased, but the impact would be less minor because flow changes are than 10% for the bulk of the late fall-run migration.

Overall, the impact on migration conditions from Alternative 4 operations (Scenarios H3, H1 and H4) is considered less than significant due to similar juvenile survival during all water year types and minor effect on olfactory cues.

Overall, conditions would be similar across all flow scenarios under Alternative 4. No mitigation would be required.

Mokelumne River

Fall-Run

Through-Delta survival of emigrating juveniles estimated by DPM under Alternative 4 operations (Scenarios H3, H1, and H4) was similar to Existing Conditions for all years, drier years, and wetter years (less than 1% absolute difference in survival, and no more than 5% relative difference) (Table 11-4-74).

San Joaquin River

Fall-Run

Juveniles

Under Alternative 4 (all operation Scenarios H3, H1 and H4), mean survival of juveniles migrating from the San Joaquin River averaged around 13% (Table 11-4-74). Alternative 4 survival was similar to Existing Conditions for all years (less than 1% absolute difference, a 2–4% relative difference). Survival was slightly greater in drier years (about 1 % greater survival, or 10% more in relative difference) and slightly reduced in wetter years (about 2% decrease, or 12–13% less in relative difference).

Adults

As described above, the percentage of San Joaquin River water is very small (no more than 1% under NAA) during the fall-run migration period (September to December). Under Scenario H3 operations, this would increase by 1–3% in September and October, 4.5% in November, and 2% in December (Table 11-4-75). Olfactory cues for adults migrating to the San Joaquin River would be slightly increased under all flows scenarios for Alternative 4.

Summary of CEQA Conclusion

Collectively, these results indicate that the impact is less than significant because movement conditions would not be substantially reduced, and no mitigation is necessary. Flows under Alternative 4 would generally be similar to or higher than flows under Existing Conditions in all rivers except the American River. In the American River, there would be flow reductions during half of the adult migration period. However, these flow reductions are not expected to affect the fall-run population at a population scale. These results would be similar among scenarios. The impact of Alternative 4 across the operational range (Scenarios H3, H1 low outflow, and H4 high outflow) on through-Delta migration conditions would be negligible due to similar juvenile survival and minor effect on olfactory cues for adults. Similarly, the impact on the fall-run Chinook salmon commercial fishery would be less than significant. No mitigation would be required.

Restoration Measures (CM2, CM4–CM7, and CM10)

Alternative 4 has the same Restoration Measures as Alternative 1A. Because no substantial differences in restoration-related fish effects are anticipated anywhere in the affected environment under Alternative 4 compared to those described in detail for Alternative 1A, the fish effects of restoration measures described for fall- and late fall-run Chinook salmon under Alternative 1A (Impacts AQUA-79 through AQUA-81) also appropriately characterize effects under Alternative 4.

The following impacts are those presented under Alternative 1A that are identical for Alternative 4.

Impact AQUA-79: Effects of Construction of Restoration Measures on Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-80: Effects of Contaminants Associated with Restoration Measures on Chinook Salmon (Fall-/Late Fall–Run ESU)

Impact AQUA-81: Effects of Restored Habitat Conditions on Chinook Salmon (Fall-/Late Fall–Run ESU)

NEPA Effects: Detailed discussions regarding the potential effects of these three impact mechanisms on fall- and late fall-run Chinook salmon are the same as those described under Alternative 1A (Impacts AQUA-79 through AQUA-81). The effects would not be adverse, and would generally be beneficial. Specifically for AQUA-80, the effects of contaminants on fall- and late fall-run Chinook salmon with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on fall- and late fall-run Chinook salmon are uncertain.

CEQA Conclusion: All of the impact mechanisms listed above would be at least slightly beneficial, or less than significant, and no mitigation is required.

Other Conservation Measures (CM12–CM19 and CM21)

Alternative 4 has the same other conservation measures as Alternative 1A. Because no substantial differences in other conservation-related fish effects are anticipated anywhere in the affected environment under Alternative 4 compared to those described in detail for Alternative 1A, the fish effects of other conservation measures described for fall- and late fall-run Chinook salmon under Alternative 1A (Impacts AQUA-82 through AQUA-90) also appropriately characterize effects under Alternative 4.

The following impacts are those presented under Alternative 1A that are identical for Alternative 4.

Impact AQUA-82: Effects of Methylmercury Management on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM12)

Impact AQUA-83: Effects of Invasive Aquatic Vegetation Management on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM13)

Impact AQUA-84: Effects of Dissolved Oxygen Level Management on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM14)

Impact AQUA-85: Effects of Localized Reduction of Predatory Fish on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM15)

Impact AQUA-86: Effects of Nonphysical Fish Barriers on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM16)

Impact AQUA-87: Effects of Illegal Harvest Reduction on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM17)

Impact AQUA-88: Effects of Conservation Hatcheries on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM18)

Impact AQUA-89: Effects of Urban Stormwater Treatment on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM19)

Impact AQUA-90: Effects of Removal/Relocation of Nonproject Diversions on Chinook Salmon (Fall-/Late Fall–Run ESU) (CM21)

NEPA Effects: Detailed discussions regarding the potential effects of these nine impact mechanisms on fall-run and late fall-run Chinook salmon are the same as those described under Alternative 1A (Impacts AQUA-82 through AQUA-90). The effects range from no effect, to not adverse, to beneficial.

CEQA Conclusion: The effects of the nine impact mechanisms listed above range from no impact, to less than significant, to beneficial, and no mitigation is required.

Steelhead

Construction and Maintenance of CM1

Impact AQUA-91: Effects of Construction of Water Conveyance Facilities on Steelhead

The potential effects of construction of the water conveyance facilities on steelhead would be similar to those described for Alternative 1A, Impact AQUA-91, except Alternative 4 would include three intakes compared to five intakes under Alternative 1A, so the effects would be proportionally less under this alternative. This would convert about 6,360 lineal feet of existing shoreline habitat into intake facility structures and would require about 17.1 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. Alternative 4 would use five barge locations rather than six as under Alternative 1A so those effects would also be proportionally less. Additionally, construction and excavation at Clifton

Court Forebay would be done in the dry via installation of cofferdams for isolation and dewatering of work areas. Implementation of Appendix 3B, *Environmental Commitments*, including construction BMPs and 3B.8–*Fish Rescue and Salvage Plan*, would minimize adverse effects as described for Alternative 1A. Mitigation measures would also be available to avoid and minimize potential effects.

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-91, the effect would not be adverse for steelhead.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-91, the impact of the construction of the water conveyance facilities on steelhead would not be significant except for construction noise associated with pile driving. Potential pile driving impacts would be less than Alternative 1A because only three intakes would be constructed rather than five. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in the discussion of Alternative 1A.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in the discussion of Alternative 1A.

Impact AQUA-92: Effects of Maintenance of Water Conveyance Facilities on Steelhead

NEPA Effects: The potential effects of the maintenance of water conveyance facilities under Alternative 4 would be the same as those described for Alternative 1A, Impact AQUA-92, except that only three intakes would be maintained under Alternative 4 rather than five under Alternative 1A. As concluded in Impact AQUA-92, the impact would not be adverse for steelhead.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-92, the impact of the maintenance of water conveyance facilities on steelhead would be less than significant and no mitigation is required.

Water Operations of CM1

Impact AQUA-93: Effects of Water Operations on Entrainment of Steelhead

Water Exports from SWP/CVP South Delta Facilities

Alternative 4 south Delta export facilities, as estimated by the salvage density method, by about 51% (~4,500 fish; Table 11-4-77) across all years compared to NAA. Losses under Scenario H3 would be greatest in below normal (~7,500 fish) and lowest in wet water years (~2,000 fish). Conditions under Scenario H1 would be similar to Scenario H3, while conditions under Scenario H4 would further reduce entrainment loss at the south Delta facilities due to decreased exports.

Table 11-4-77. Juvenile Steelhead Annual Entrainment at the SWP and CVP Salvage Facilities—Differences between Model Scenarios for Alternative 4 (Scenario H3)

	Absolute Difference (Percent Difference)	
Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
Wet	-4,179 (-67%)	-4,271 (-68%)
Above Normal	-7,045 (-54%)	-7,389 (-55%)
Below Normal	-4,368 (-37%)	-3,638 (-33%)
Dry	-2,181 (-29%)	-1,591 (-23%)
Critical	-1,208 (-21%)	-858 (-16%)
All Years	-4,648 (-52%)	-4,506 (-51%)
	Shading indicates 10% or greater increased entrainment.	

Note: Estimated annual number of fish lost, based on normalized data.

Water Exports from SWP/CVP North Delta Intake Facilities

The impact would be similar in type to Alternative 1A, Impact AQUA-93, but the degree would be less because Alternative 4 would have fewer intakes, therefore, under Alternative 4 there would be about a 40% reduction in impingement and predation risk relative to Alternative 1A.

Water Export with a Dual Conveyance for the SWP North Bay Aqueduct

The impact and conclusion are the same as for Alternative 1A (Impact AQUA-93). Entrainment and impingement effects on juvenile steelhead would be minimal for Alternative 4 because intakes would have state-of-the-art screens installed.

Predation Associated with Entrainment

Entrainment-related predation loss at the south Delta facilities would be no greater and may be lower than baseline (NAA), due to a reduction in entrainment. Conditions under Scenario H4 would further reduce entrainment-related predation loss compared to Scenario H3, while conditions under Scenario H1 would be similar to Scenario H3.

Predation at the north Delta would be increased due to the construction of the proposed SWP/CVP water export facilities on the Sacramento River. It is assumed that per capita steelhead predation losses would be similar to those predicted for spring-run Chinook salmon, although slightly reduced because of the larger size of steelhead outmigrants. Bioenergetics modeling with a median predator density of 0.12 predators per foot (0.39 predators per meter) of intake predicts a predation loss of about 0.2% of the juvenile spring-run juvenile population (Table 11-4-30).

NEPA Effects: In conclusion, operations under Alternative 4 under all flow scenarios (e.g., H3, H1, H4) would reduce entrainment at the south Delta facilities and minimize or avoid entrainment with screens at the north Delta intakes and NBA alternative intake. Predation loss at the south Delta would be reduced and predation at the north Delta intakes would likely have a very minor impact on the overall steelhead population. The overall effect under Alternative 4 would not be adverse.

CEQA Conclusion: As described above, entrainment losses of juvenile steelhead would decrease under Alternative 4 (A4_LLT) compared to existing biological conditions at the south Delta export facilities (Table 11-4-77). The screened intakes of the north Delta diversion and NBA alternative intake, as designed, would exclude juvenile salmonids. The impact of predation associated with entrainment would be the same as described above as predation loss at the south Delta (no greater and possibly lower compared with Existing Conditions), but increased slightly at the north Delta intakes. There would likely be a minor increase in predation loss under Alternative 4, but the population level effect would likely be small. Entrainment loss under Scenario H4 is expected to be less compared to Scenario H3 and Scenario H1. Overall, the impact would be less than significant, no mitigation is required.

Impact AQUA-94: Effects of Water Operations on Spawning and Egg Incubation Habitat for Steelhead

In general, Alternative 4 would have negligible effects on spawning and egg incubation habitat for steelhead relative to the NAA.

H3/ESO

Sacramento River

The primary steelhead spawning and egg incubation period extends from January through April. Results of the CALSIM analyses of instream flows within the reach where the majority of steelhead spawning occurs (Keswick Dam to upstream of RBDD) were summarized by month and water-year type based on estimated flows at RBDD (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Lower flows can reduce the instream area available for spawning and egg incubation, and rapid reductions in flow can expose redds leading to mortality. Mean monthly flows under H3 would be similar to those under NAA, except for a small increase in mean monthly flow during February in below normal years (6%). Overall results indicate negligible project-related effects on flow.

SacEFT predicts that there would be negligible differences (≤5%) between NAA and H3 in spawning metrics including percentage of years with good spawning availability, measured as weighted usable area, redd scour risk, percentage of years with good (lower) egg incubation conditions, and redd dewatering risk. Results indicate negligible project-related effects on steelhead habitat metrics related to spawning and egg incubation in the Sacramento River.

Mean monthly water temperatures in the Sacramento River at Keswick and Red Bluff were examined during the January through April primary steelhead spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period at either location Based on negligible effects (≤5%) on mean monthly flow, SacEFT metrics related to spawning and egg incubation, and water temperature conditions compared to NAA, project-related effects of H3 on flow would not affect steelhead spawning conditions in the Sacramento River.

Table 11-4-78. Difference and Percent Difference in Percentage of Years with "Good" Conditions for Steelhead Habitat Metrics in the Upper Sacramento River (from SacEFT)

Metric	EXISTING CONDITIONS vs. H3	NAA vs. H3
Spawning WUA	-2 (-4%)	-5 (-10%)
Redd Scour Risk	-3 (-4%)	0 (0%)
Egg Incubation	0 (0%)	0 (0%)
Redd Dewatering Risk	0 (0%)	3 (6%)
Juvenile Rearing WUA	-6 (-15%)	-10 (-22%)
Juvenile Stranding Risk	-12 (-35%)	2 (10%)

WUA = Weighted Usable Area.

Clear Creek

The primary spawning and egg incubation period for Clear Creek is January through April. Results of the CALSIM analyses of instream flows for the Clear Creek were summarized by month and water-year type for January through April (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Lower flows can reduce the instream area available for spawning and egg incubation, and rapid reductions in flow can expose redds leading to mortality.

Flows in Clear Creek during January through April under H3 would generally be similar to those under NAA. Therefore, H3 would have negligible effects on mean monthly flows in Clear Creek for the primary steelhead spawning and egg incubation period of January to April.

Redd dewatering risk was evaluated for Clear Creek based on flow reductions for each month during the incubation period (January through April); results are summarized in Table 11-4-79. The greatest monthly reduction in flows under H3 would be similar to that under NAA.

No water temperature modeling was conducted in Clear Creek.

Based on mean monthly flows and flow reductions, there would be no effects of H3 on steelhead spawning and egg incubation habitat conditions.

Table 11-4-79. Comparisons of Greatest Monthly Reduction (Percent Change) in Instream Flow under Model Scenarios in Clear Creek during the January–April Steelhead Spawning and Egg Incubation Period[a]

Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
Wet	-25 (-38%)	0 (0%)
Above Normal	0 (NA)	0 (NA)
Below Normal	0 (NA)	0 (NA)
Dry	0 (NA)	0 (NA)
Critical	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.

[a] Redd dewatering risk not applicable for months when flows during the egg incubation period were at or greater than flows in the month when spawning is assumed to occur. A negative value indicates that the greatest monthly reduction would be of greater magnitude (worse) under the alternative than under the baseline.

Feather River

Effects of H3 on flow during the spawning and egg incubation period (January through April) in the Feather River were evaluated using the results of CALSIM analyses of instream flows within the reach where the majority of steelhead spawning occurs (low-flow channel) based on estimated flows above Thermalito Afterbay (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in the high-flow channel were characterized based on information in the Feather River at Thermalito Afterbay (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Lower flows can reduce the instream area available for spawning and egg incubation, and rapid reductions in flow can expose redds leading to mortality.

Flows in the Feather River high-flow channel during January through April under H3 would be similar to or greater than flows under NAA, with few exceptions. The increases in flow would have beneficial effects of varying magnitudes on spawning and egg incubation habitat in all water year types.

Steelhead spawning and egg incubation on the Feather River occurs primarily in Hatchery Ditch and the low-flow channel in the general vicinity of the Feather River Hatchery. Instream flows affect physical habitat quality and availability through changes in wetted channel width, water depth, and water velocities. Results of IFIM studies (WUA versus flow relationships) provide information on the spawning habitat conditions in the low-flow channel. Results of CALSIM modeling show that instream flows in the Feather River low-flow channel were the same for NAA and H3 regardless of month and water year type and range from 700 to 800 cfs under all conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Therefore, H3 is not expected to affect physical habitat conditions for steelhead spawning and egg incubation within the Feather River low-flow channel.

Water temperatures in the low-flow channel of the Feather River are determined largely by cold water pool storage in Oroville Reservoir and instream flow releases. Because instream flows in the low-flow channel would be the same under H3 and NAA, any simulated changes in water temperatures under H3 would be attributed to changes in reservoir storage. Reservoir storage in May and September provides an indicator of cold water pool availability. May Oroville storage volume under H3 would be similar to storage under NAA in all water year types (Table 11-4-45). September Oroville storage volume under H3 would be similar to volume in wet, above normal, and below normal water years and 11% to 18% greater than volume under NAA during dry and critical water years (Table 11-4-39).

Effects of H3 on water temperature-related spawning and egg incubation conditions for steelhead in the Feather River were analyzed by comparing the percent of months between January through April over the 82-year CALSIM modeling period that exceed a 56°F temperature threshold in the low-flow channel (above Thermalito Afterbay) (Table 11-4-80). Differences in the percent of months exceeding the threshold between NAA and H3 would be negligible (<5% on an absolute scale).

Table 11-4-80. Differences between Baseline and H3 Scenarios in Percent of Months during the 82-Year CALSIM Modeling Period during Which Water Temperatures in the Feather River above Thermalito Afterbay Exceed the 56°F Threshold, January through April

	Degrees Above Threshold				
Month	>1.0	>2.0	>3.0	>4.0	>5.0
EXISTING CONDITIONS vs. H3					
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
March	10 (800%)	2 (NA)	1 (NA)	1 (NA)	1 (NA)
April	44 (514%)	23 (475%)	15 (NA)	7 (NA)	2 (NA)
NAA vs. H3					
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
March	1 (13%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
April	0 (0%)	-4 (-12%)	-2 (-14%)	1 (20%)	1 (100%)

NA = could not be calculated because the denominator was 0.

The effects of H3 on water temperature-related spawning and egg incubation conditions for steelhead in the Feather River were also analyzed by comparing the total degree-months for months that exceed the 56°F NMFS threshold during the January through Aril steelhead spawning period for all 82 years (Table 11-4-81). There would be no difference (<5% on a relative scale) in total degree-months exceeded between NAA and H3 for any month or water year type.

Overall for the Feather River, these results indicate that the effects of H3 on flow and water temperatures would not affect steelhead spawning conditions in the Feather River.

Table 11-4-81. Differences between Baseline and H3 Scenarios in Total Degree-Months (°F-Months) by Month and Water Year Type for Water Temperature Exceedances above 56°F in the Feather River above Thermalito Afterbay, January through April

Month	Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
January	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
February	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
March	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	2 (NA)	0 (0%)
	Dry	3 (NA)	1 (50%)
	Critical	8 (800%)	0 (0%)
	All	13 (1,300%)	1 (8%)
April	Wet	4 (NA)	1 (33%)
	Above Normal	12 (600%)	1 (8%)
	Below Normal	15 (375%)	-1 (-5%)
	Dry	24 (480%)	-2 (-6%)
	Critical	20 (NA)	-3 (-13%)
	All	75 (682%)	-4 (-4%)

NA = could not be calculated because the denominator was 0.

American River

The primary steelhead spawning and egg incubation period for the American River extends from January through April. Results of the CALSIM analyses of instream flows within the lower American River at the confluence with the Sacramento River were summarized by month and water-year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Lower flows can reduce the instream area available for spawning and egg incubation and rapid reductions in flow can dewater redds leading to mortality. Mean monthly flows under H3 would be similar to flows under NAA during all months and water year types with few exceptions.

Mean monthly water temperatures in the American River at the Watt Avenue Bridge were evaluated during the January through April steelhead spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

The percent of months exceeding the 56°F temperature threshold in the American River at the Watt Avenue Bridge was evaluated during November through April (Table 11-4-64). Steelhead spawn and eggs incubate in the American River between January and April. During this period, the percent of months exceeding the threshold under H3 would similar to or up to 5% lower (absolute scale) than the percent under NAA.

Total degree-months exceeding 56°F were summed by month and water year type at the Watt Avenue Bridge during November through April (Table 11-4-65). During the January through April steelhead spawning and egg incubation period, total degree-months would be similar between NAA and H3.

Based on mean monthly flows and water temperature effects, effects under H3 in the American River would consist primarily of negligible effects (<5%) on mean monthly flows and water temperatures and would not have biologically meaningful effects on steelhead spawning and egg incubation conditions in the American River.

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the January through April steelhead spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 throughout this period would generally be identical to flows under NAA.

Water temperatures throughout the Stanislaus River would be similar under NAA and H3 throughout the January through April steelhead spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

San Joaquin River

The mainstem San Joaquin River does not provide habitat for steelhead spawning or egg incubation.

Mokelumne River

Flows in the Mokelumne River at the Delta were examined during the January through April steelhead spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 throughout this period would generally be identical to flows under NAA.

Water temperature modeling was not conducted in the Mokelumne River.

H1/LOS

Sacramento River

Flows in the Sacramento River at Keswick and upstream of Red Bluff during January through April under H1 would generally be similar to or greater than flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Water temperatures would be similar between H1 and H3. Due to similar flows and water temperatures between H1 and H3, results for additional analyses (e.g., SacEFT) under H1 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H1. Overall, results for H1 would be similar to or better than those for H3.

Mean monthly water temperatures in the American River at the Watt Avenue Bridge were evaluated during the January through April steelhead spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period.

The percent of months exceeding the 56°F temperature threshold in the American River at the Watt Avenue Bridge was evaluated during November through April (Table 11-4-71). Steelhead spawn and eggs incubate in the American River between January and April. During this period, the percent of months exceeding the threshold under H1 would similar to or up to 11% lower (absolute scale) than the percent under NAA.

Total degree-months exceeding 56°F were summed by month and water year type at the Watt Avenue Bridge during November through April (Table 11-4-72). During the January through April steelhead spawning and egg incubation period, total degree-months would be similar between NAA and H1.

Clear Creek

Flows in the Clear Creek during January through April under H1 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). No water temperature modeling was conducted in Clear Creek. Due to similar flows between H1 and H3, results for additional analyses (e.g., redd dewatering risk,) under H1 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H1. Overall, results for H1 would be similar to those for H3.

Feather River

Flows in the Feather River above Thermalito Afterbay (low-flow channel) during January through April under H1 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in the Feather River below Thermalito Afterbay (high-flow channel) during January through April under H1 would generally be similar to or greater than flows under H3. May and September Oroville storage under H1 would generally be similar to or greater than storage under H3 (Table 11-4-45, Table 11-4-39).

Differences in the percent of months exceeding the 56°F threshold between NAA and H1 would generally be negligible (<5% on an absolute scale) during January through March (Table 11-4-82). During April, the percent of months exceeding the threshold under H1 would be similar to or up to 12% lower (absolute scale) than the percent under NAA. This represents a small benefit of H1 to steelhead spawning habitat conditions in the Feather River.

Table 11-4-82. Differences between Baselines and H1 and H4 Scenarios in Percent of Months during the 82-Year CALSIM Modeling Period during Which Water Temperatures in the Feather River above Thermalito Afterbay Exceed the 56°F Threshold, January through April

	Degrees Above Threshold				
Month	>1.0	>2.0	>3.0	>4.0	>5.0
EXISTING CONDITIONS vs. H1					
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
March	4 (300%)	2 (NA)	1 (NA)	1 (NA)	0 (NA)
April	32 (371%)	16 (325%)	12 (NA)	4 (NA)	1 (NA)
NAA vs. H1					
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
March	-5 (-50%)	0 (0%)	0 (0%)	0 (0%)	-1 (-100%)
April	-12 (-23%)	-11 (-35%)	-5 (-29%)	-2 (-40%)	0 (0%)
EXISTING CONDITIONS vs. H4					
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
March	5 (400%)	1 (NA)	1 (NA)	1 (NA)	0 (NA)
April	27 (314%)	14 (275%)	14 (NA)	2 (NA)	1 (NA)
NAA vs. H4					
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
March	-4 (-38%)	-1 (-50%)	0 (0%)	0 (0%)	-1 (-100%)
April	-17 (-33%)	-14 (-42%)	-4 (-21%)	-4 (-60%)	0 (0%)

NA = could not be calculated because the denominator was 0.

Total degree-months above the 56°F threshold under H1 would be similar to (<3 degree months) those under NAA throughout the period regardless of month or water year type (Table 11-4-83).

Table 11-4-83. Differences between Baselines and H1 and H4 Scenarios in Total Degree-Months (°F-Months) by Month and Water Year Type for Water Temperature Exceedances above 56°F in the Feather River at above Thermalito Afterbay, January through April

Month	Water Year Type	EXISTING CONDITIONS vs. H1	NAA vs. H1	EXISTING CONDITIONS vs. H4	NAA vs. H4
January	Wet	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)	0 (NA)	0 (NA)
February	Wet	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)	0 (NA)	0 (NA)
March	Wet	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Below Normal	2 (NA)	0 (0%)	3 (NA)	1 (50%)
	Dry	3 (NA)	1 (50%)	2 (NA)	0 (0%)
	Critical	6 (600%)	-2 (-22%)	7 (700%)	-1 (-11%)
	All	11 (1,100%)	-1 (-8%)	12 (1,200%)	0 (0%)
April	Wet	5 (NA)	2 (67%)	3 (NA)	0 (0%)
	Above Normal	12 (600%)	1 (8%)	6 (300%)	-5 (-38%)
	Below Normal	15 (375%)	-1 (-5%)	11 (275%)	-5 (-25%)
	Dry	23 (460%)	-3 (-10%)	25 (500%)	-1 (-3%)
	Critical	21 (NA)	-2 (-9%)	24 (NA)	1 (4%)
	All	77 (700%)	-2 (-2%)	68 (618%)	-11 (-12%)

NA = could not be calculated because the denominator was 0.

Due to similar or better flows, reservoir storage, and water temperatures between H1 and H3, results for H1 would be similar to or better than those for H3.

American River

Flows in the American River at the confluence with the Sacramento River during January through April under H1 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Water temperatures would be similar between H1 and H3. Due to similar flows and water temperatures between H1 and H3, results for H1 would be similar to those for H3.

H4/HOS

Sacramento River

Flows in the Sacramento River at Keswick and upstream of Red Bluff during January through April under H4 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the American River at the Watt Avenue Bridge were evaluated during the January through April steelhead spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

The percent of months exceeding the 56°F temperature threshold in the American River at the Watt Avenue Bridge was evaluated during November through April (Table 11-4-71). Steelhead spawn and eggs incubate in the American River between January and April. During this period, the percent of months exceeding the threshold under H4 would similar to or up to 11% lower (absolute scale) than the percent under NAA.

Total degree-months exceeding 56°F were summed by month and water year type at the Watt Avenue Bridge during November through April (Table 11-4-72). During the January through April steelhead spawning and egg incubation period, total degree-months would be similar between NAA and H4.

Due to similar flows and water temperatures between H4 and H3, results for additional analyses (e.g., SacEFT) under H4 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H4. Overall, results for H4 would be similar to those for H3.

Clear Creek

Flows in the Clear Creek during January through April under H4 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). No water temperature modeling was conducted in Clear Creek. Due to similar flows between H4 and H3, results for additional analyses (e.g., redd dewatering risk,) under H4 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H4. Overall, results for H4 would be similar to those for H3.

Feather River

Flows in the Feather River above Thermalito Afterbay (low-flow channel) during January through April under H4 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in the Feather River below Thermalito Afterbay (high-flow channel) during January through April under H4 would generally be similar to or greater than flows under H3.

May storage would be 11% to 15% lower under H4 relative to H3 in wet, above normal, and below normal water years (Table 11-4-39). September Oroville storage under H4 would generally be similar to or greater than storage under H4 (Table 11-4-45).

Differences in the percent of months exceeding the 56°F threshold in the Feather River at Gridley between NAA and H4 would generally be negligible (<5% on an absolute scale) during January through March (Table 11-4-69). The percent of months exceeding the threshold under H4 would be similar to or up to 25% lower (absolute scale) than the percent under NAA. This represents a small benefit of H4 to steelhead spawning habitat conditions in the Feather River.

Total degree-months above the 56°F threshold in the Feather River at Gridley under H4 would be similar to those under NAA during October through February (Table 11-4-70). During March and April, degree-months under H4 would be 5% to 19% lower under H4, representing a small benefit of H4 to steelhead spawning habitat conditions in the Feather River.

Due to similar or better flows, reservoir storage, and water temperatures between H4 and H3, results for H4 would be similar to or better than those for H3.

American River

Flows in the American River at the confluence with the Sacramento River during January through April under H4 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Differences in the percent of months exceeding the 56°F threshold between NAA and H4 would generally be negligible (<5% on an absolute scale) during January through March (Table 11-4-82). During April, the percent of months exceeding the threshold under H4 would be similar to or up to 17% lower (absolute scale) than the percent under NAA. This represents a small benefit of H4 to steelhead spawning habitat conditions in the Feather River.

Total degree-months above the 56°F threshold under H4 would be similar to (<3 degree months) those under NAA during January through March (Table 11-4-83). During April, degree-months under H4 would be 11 degree-months (12%) lower than under NAA, representing a small benefit of H4 to steelhead spawning habitat conditions in the Feather River.

Due to similar or better flows and water temperatures between H4 and H3, results for H1 would be similar to or better than those for H3.

NEPA Effects: Collectively, these results indicate that the effects of Alternative 4 on flow would not be adverse because they would not substantially reduce suitable spawning habitat or substantially reduce the number of fish as a result of egg development. There would be negligible effects on mean monthly flows water temperatures, and reservoir storage, for the applicable locations analyzed. There would be beneficial effects from increases in mean monthly flow (to 44%) for some months and water year types during the spawning period in the Feather River below Thermalito Afterbay, and a beneficial effect from a moderate increase (18%) in cold water pool availability in Oroville Reservoir which would help offset increased water temperatures in the Feather River attributable to the project (10%)Further, the SacEFT model predicts that there would be no effects to spawning and egg incubation habitat in the Sacramento River.

CEQA Conclusion: In general, under all the Alternative 4 water operations scenarios, spawning and egg incubation habitat for steelhead would not be affected relative to the CEQA baseline.

H3/ESO

Sacramento River

The primary steelhead spawning and egg incubation period extends from January through April. Results of the CALSIM analyses of instream flows within the reach where the majority of steelhead spawning occurs (Keswick Dam to upstream of RBDD) were summarized by month and water-year type based on estimated flows at RBDD (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Lower flows can reduce the instream area available for spawning and egg incubation and rapid reductions in flow can dewater redds leading to mortality. Comparisons of Alternative 4 to Existing Conditions, indicate primarily negligible effects (<5%) on mean monthly flow during January through April, with the exception of small increases in flow (to 15%) in wet and critical water years, and a single, small decrease (-10%) during March in below normal years that would not have biologically meaningful negative effects. The small to moderate increases in flow would have a beneficial effect on spawning conditions, particularly in critical water years (January and March).

SacEFT predicts no changes (0% difference) or negligible effect (<5% difference) in spawning habitat, egg incubation, redd dewatering risk, and redd scour risk for Alternative 4 compared to Existing Conditions (Table 11-4-78).

Mean monthly water temperatures in the Sacramento River at Keswick and Red Bluff were examined during the January through April primary steelhead spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H3 in any month or water year type throughout the period at either location.

Overall in the Sacramento River, effects of H3 on flow would consist of negligible effects (<5%) or small increases (to 15%) in mean monthly flow throughout the January to April spawning period, and negligible effects (<5%) on spawning metrics calculated with SacEFT, and negligible effects on water temperature.

Clear Creek

Results of the CALSIM analyses of instream flows for Clear Creek were summarized by month and water-year type for January through April (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Lower flows can reduce the instream area available for spawning and egg incubation and rapid reductions in flow can dewater redds leading to mortality. Comparisons of H3 to Existing Conditions, indicate no meaningful reductions (>5%) in mean monthly flow for any month or water type year. There would be primarily negligible effects (<5%), with small to substantial increases in mean monthly flow in wet years for January through March, ranging from 17% to 54%, and small increases in critical years for January through April (8% to 10%). Increases in flow would have a beneficial effect on spawning conditions. These results indicate that effects of flow under H3 would not have negative effects on steelhead spawning conditions in Clear Creek.

In terms of redd dewatering risk, comparison of greatest monthly flow reduction (Table 11-4-79) indicates no project-related effects (all values 0%) with the exception of an increase in the greatest monthly flow reduction in wet years (-38%) for H3 relative to Existing Conditions. Based on the fact that this flow reduction is in wet years, it would not have biologically meaningful negative effects on steelhead redd dewatering risk.

No water temperature modeling was conducted in Clear Creek.

The effects of H3 on mean monthly Clear Creek flows would consist of negligible effects and beneficial increases in flow (to 54%) with no reductions in flow for any month or water year type throughout the spawning period, and a moderate increase in flow reductions during wet years (-38%), when effects of flow reductions would be less critical for redd dewatering. Overall, H3 would not cause biologically meaningful effects on steelhead spawning conditions.

Feather River

Results of the CALSIM analyses of instream flows for the Feather River below Thermalito Afterbay (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for January through April indicate variable effects depending on the specific month and water year type, with primarily decreases in mean monthly flows during January and February (-6% to -46%) for all but wet water years (negligible effects during January and an increase of 31% during February). Effects of H3 during March and April would consist primarily of increases in flow ranging from 12% to 58% with the exception of a substantial decrease (-58%) during March in below normal years and negligible effects (<5%) during March in drier water year types and during April in wetter water year types. The most substantial decreases in flow would occur in below normal years for January through March and would be somewhat offset by a substantial increase during April, although this would occur late in the spawning period. In general, for the remaining water year types, decreases in flow during January and February would be somewhat offset by increases during March and April and net effects would not have biologically meaningful negative effects on spawning conditions.

Comparisons for the low-flow channel indicate there would be no changes in conditions for H3 relative to Existing Conditions. Flows are predicted to range from 700 to 800 cfs under all conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Therefore, H3 is not expected to affect physical habitat conditions for steelhead spawning and egg incubation within the Feather River low-flow channel.

Water temperatures in the low-flow channel of the Feather River are determined largely by coldwater pool storage in Oroville Reservoir and instream flow releases. Because instream flows in the low-flow channel would be the same under H3 and Existing Conditions, any simulated changes in water temperatures under H3 would be attributed to changes in reservoir storage. Reservoir storage in May and September provides an indicator of coldwater pool availability. Results of CALSIM modeling of Oroville Reservoir storage in May are shown in Table 11-4-45, and results for September are shown in Table 11-4-39.

Comparison of results indicates that May storage in Oroville Reservoir for H3 would be reduced relative to Existing Conditions for all water year types, with negligible (≤5%) effects in wet and above normal years and small (-11%) to moderate (-20%) reductions for the remaining water years (Table 11-4-45). Results for September storage indicate that effects on storage from H3 would consist of substantial (to -35%) decreases in storage for wetter water years and small (-10%) to moderate (-28%) reductions for the drier water year types (Table 11-4-39). The reductions in storage would reduce cold water pool availability and would contribute to negative effects on water temperature in the Feather River.

Mean monthly water temperatures in the Feather River low-flow channel (upstream of Thermalito Afterbay) and high-flow channel (at Thermalito Afterbay) were examined during the January through April steelhead spawning and egg incubation period (Appendix 11D, *Sacramento River*

Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis). In the low-flow channel, mean monthly water temperatures under H3 would be 5% to 7% greater than those under Existing Conditions during January through March and similar to temperatures under Existing Conditions during April. In the high-flow channel, mean monthly water temperatures under H3 would be 6% greater than those under Existing Conditions during January and February and similar to temperatures under Existing Conditions during March and April.

Effects of H3 on water temperature-related spawning and egg incubation conditions for steelhead in the Feather River were analyzed by comparing the percent of months between January through April over the 82-year CALSIM modeling period that exceed a 56°F temperature threshold in the low-flow channel (above Thermalito Afterbay) (Table 11-4-80). Differences in the percent of months exceeding the threshold between Existing Conditions and H3 would be negligible (<5% on an absolute scale) during January and February and for most degrees above the threshold evaluated for March, except for the >1.0 degree category. During April, the percent of months exceeding the threshold under H3 would be similar to or up to 44% (absolute scale) higher than the percent under Existing Conditions.

The effects of H3 on water temperature-related spawning and egg incubation conditions for steelhead in the Feather River were also analyzed by comparing the total degree-months for months that exceed the 56°F NMFS threshold during the January through Aril steelhead spawning period for all 82 years (Table 11-4-81). There would be no difference (<5% on a relative scale) in total degree-months exceeded between Existing Conditions and H3 during January, February, and in all water years types except critical during March, in which there would be 8 more degree-months (800% increase) under H1 relative to Existing Conditions. An increase of 8 degree-months, although relatively large, is not expected to cause a biologically meaningful effect to steelhead. During April, the total number of degree months would be 4 to 24 degree-months (up to 600%) higher under H1 compared to Existing Conditions.

Overall, the effects of H3 on flows in the Feather River above Thermalito Afterbay would include substantial decreases in mean monthly flow (to -46%) during some months and water year types that would be partially offset by increases in other months and/or water year types, with the exception of more persistent, substantial reductions in flow in below normal years. There would be substantial increases in the exceedance of water temperature thresholds in the low-flow channel during April, coupled with a reduction in coldwater pool availability in the Oroville Reservoir (to -35% depending on month and water year type), that would affect steelhead egg survival.

American River

Results of the CALSIM analyses of instream flows within the lower American River at the confluence with the Sacramento River were summarized by month and water-year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for January through April. Lower flows can reduce the instream area available for spawning and egg incubation and rapid reductions in flow can dewater redds leading to mortality. Comparisons indicate there would be primarily increases in mean monthly flows (to 27%) for H3 compared to Existing Conditions in wetter water years for January through March, and decreases (to -19%) in drier water years when flow changes would have more substantial effects on spawning conditions. Effects during April consist of negligible effects or small increases or decreases that would occur toward the end of the spawning period and would not have biologically meaningful effects. Flow decreases in drier water years would be most substantial in January, at the start of the spawning period, and would be partially offset by small increases in

February and March, with the exception of critical water years when flow reductions would persist. These results indicate that the effects of H3 on flows in the American River at the confluence during the steelhead spawning and egg incubation period would include moderate reductions in mean monthly flow (to –19%) that would have biologically meaningful effects on spawning conditions in drier water years, particularly in critical years. Mean monthly water temperatures in the American River at the Watt Avenue Bridge were evaluated during the January through April steelhead spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperature under H3 would be 5% to 7% lower than those under Existing Conditions during January through March, and temperatures would not differ between H3 and Existing Conditions during April.

The percent of months exceeding the 56°F temperature threshold in the American River at the Watt Avenue Bridge was evaluated during November through April (Table 11-4-64). Steelhead spawn and eggs incubate in the American River between January and April. During January and February, the percent of month exceeding the threshold under Existing Conditions and H3 would be similar. During March and April, the percent of months exceeding the threshold under H3 would be up to 38% greater (absolute scale) than the percent under Existing Conditions.

Total degree-months exceeding 56°F were summed by month and water year type at the Watt Avenue Bridge during November through April (Table 11-4-65). During the January and February, there would be no difference in total degree-months above the threshold between Existing Conditions and H3. During March and April, total degree-months under H3 would be 395% and 98% greater than those under Existing Conditions, respectively.

Overall in the American River, effects of flow reductions in drier water years, particularly critical years, would contribute incremental negative effects to regional steelhead spawning conditions.

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the January through April steelhead spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 throughout this period would be up to 36% lower flows under Existing Conditions in all months with few exceptions.

Water temperatures in the Stanislaus River at the confluence with the San Joaquin River was evaluated during the January through April steelhead spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H3 would be 6% higher than those under Existing Conditions in all months.

San Joaquin River

The mainstem San Joaquin River does not provide habitat for steelhead spawning or egg incubation.

Mokelumne River

Flows in the Mokelumne River at the Delta were examined during the January through April steelhead spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would generally be similar to flows under Existing Conditions during March, up to 18% greater during February, and up to 14% lower during April.

Water temperature modeling was not conducted in the Mokelumne River.

H1/LOS

Sacramento River

Flows in the Sacramento River at Keswick and upstream of Red Bluff during January through April under H1 would generally be similar to or greater than flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Keswick and Red Bluff were examined during the January through April primary steelhead spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H1 in any month or water year type throughout the period at either location, except for critical years during January at Red Bluff (5% higher).

Due to similar flows and water temperatures between H1 and H3, results for additional analyses (e.g., SacEFT) under H1 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H1. Overall, results for H1 would be similar to or better than those for H3.

Clear Creek

Flows in the Clear Creek during January through April under H1 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). No water temperature modeling was conducted in Clear Creek. Due to similar flows between H1 and H3, results for additional analyses (e.g., redd dewatering risk,) under H1 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H1. Overall, results for H1 would be similar to those for H3.

Feather River

Flows in the Feather River above Thermalito Afterbay (low-flow channel) during January through April under H1 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in the Feather River below Thermalito Afterbay (high-flow channel) during January through April under H1 would generally be similar to or greater than flows under H3. May and September Oroville storage under H1 would generally be similar to or greater than storage under H3 (Table 11-4-39, Table 11-4-45).

Mean monthly water temperatures in the Feather River low-flow channel (upstream of Thermalito Afterbay) and high-flow channel (at Thermalito Afterbay) were examined during the January through April steelhead spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). In the low-flow channel, mean monthly water temperatures under H1 would be 5% to 7% greater than those under Existing Conditions during January through March and similar to temperatures under Existing Conditions during April. In the high-flow channel, mean monthly water temperatures under H1 would be 6% greater than those under Existing Conditions during January and February and similar to temperatures under Existing Conditions during March and April.

Differences in the percent of months exceeding the 56°F threshold between Existing Conditions and H1 would generally be negligible (<5% on an absolute scale) during January through March (Table 11-4-82). During April, the percent of months exceeding the threshold under H1 would be similar to or up to 32% higher (absolute scale) than the percent under Existing Conditions. This represents a small negative effect of H1 to steelhead spawning habitat conditions in the Feather River.

Total degree-months above the 56°F threshold under H1 would be similar to those under Existing Conditions during January, February, and all water year types except critical water years in March, in which there would be 6 more degree-months (600% increase) under H1 relative to Existing Conditions (Table 11-4-83). An increase of 6 degree-months, although relatively large, is not expected to cause a biologically meaningful effect to steelhead. During April, the total number of degree months would be 4 to 24 degree-months (up to 600%) higher under H1 compared to Existing Conditions.

Due to similar or better flows, reservoir storage, and water temperatures between H1 and H3, results for H1 would be similar to or better than those for H3.

American River

Flows in the American River at the confluence with the Sacramento River during January through April under H1 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the American River at the Watt Avenue Bridge were evaluated during the January through April steelhead spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperature under H1 would be 5% to 7% lower than those under Existing Conditions during January through March, and temperatures would not differ between H1 and Existing Conditions during April.

The percent of months exceeding the 56°F temperature threshold in the American River at the Watt Avenue Bridge was evaluated during November through April (Table 11-4-71). Steelhead spawn and eggs incubate in the American River between January and April. During January and February, the percent of month exceeding the threshold under Existing Conditions and H1 would be similar. During March and April, the percent of months exceeding the threshold under H1 would be up to 11% greater (absolute scale) than the percent under Existing Conditions.

Total degree-months exceeding 56°F were summed by month and water year type at the Watt Avenue Bridge during November through April (Table 11-4-72). During the January and February, there would be no difference in total degree-months above the threshold between Existing Conditions and H1. During March and April, total degree-months under H1 would be 384% and 95% greater than those under Existing Conditions, respectively.

Due to similar flows and water temperatures between H1 and H3, results for H1 would be similar to those for H3.

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the January through April steelhead spawning and egg incubation period (Appendix 11C, *CALSIM II*

Model Results utilized in the Fish Analysis). Flows under H1 throughout this period would be up to 36% lower flows under Existing Conditions in all months with few exceptions.

Water temperatures in the Stanislaus River at the confluence with the San Joaquin River was evaluated during the January through April steelhead spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H1 would be 6% higher than those under Existing Conditions in all months.

San Joaquin River

The mainstem San Joaquin River does not provide habitat for steelhead spawning or egg incubation.

Mokelumne River

Flows in the Mokelumne River at the Delta were examined during the January through April steelhead spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H1 would generally be similar to flows under Existing Conditions during March, up to 18% greater during February, and up to 14% lower during April.

Water temperature modeling was not conducted in the Mokelumne River.

H4/HOS

Sacramento River

Flows in the Sacramento River at Keswick and upstream of Red Bluff during January through April under H4 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Keswick and Red Bluff were examined during the January through April primary steelhead spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H1 in any month or water year type throughout the period at either location, except for critical years during January at Red Bluff (5% higher).

Due to similar flows and water temperatures between H4 and H3, results for additional analyses (e.g., SacEFT) under H4 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H4. Overall, results for H4 would be similar to those for H3.

Clear Creek

Flows in the Clear Creek during January through April under H4 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). No water temperature modeling was conducted in Clear Creek. Due to similar flows between H4 and H3, results for additional analyses (e.g., redd dewatering risk) under H4 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H4. Overall, results for H4 would be similar to those for H3.

Feather River

Flows in the Feather River above Thermalito Afterbay (low-flow channel) during January through April under H4 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in the Feather River below Thermalito Afterbay (high-flow channel) during January through April under H4 would generally be similar to or greater than flows under H3.

May storage would be 11% to 15% lower under H4 relative to H3 in wet, above normal, and below normal water years (Table 11-4-45). Regardless, there would be no differences in water temperatures between H4 and H3 scenarios during any month or water year type. September Oroville storage under H4 would generally be similar to or greater than storage under H4 (Table 11-4-39).

Mean monthly water temperatures in the Feather River low-flow channel (upstream of Thermalito Afterbay) and high-flow channel (at Thermalito Afterbay) were examined during the January through April steelhead spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). In the low-flow channel, mean monthly water temperatures under H4 would be 5% to 7% greater than those under Existing Conditions during January through March and similar to temperatures under Existing Conditions during April. In the high-flow channel, mean monthly water temperatures under H4 would be 6% greater than those under Existing Conditions during January and February and similar to temperatures under Existing Conditions during March and April.

Differences in the percent of months exceeding the 56°F threshold between Existing Conditions and H4 would generally be negligible (<5% on an absolute scale) during January through March except for the >1.0 degree category for March (5% higher) (Table 11-4-82). During April, the percent of months exceeding the threshold under H4 would be similar to or up to 27% higher (absolute scale) than the percent under Existing Conditions. This represents a small negative effect of H4 to steelhead spawning habitat conditions in the Feather River.

Total degree-months above the 56°F threshold under H4 would be similar to those under Existing Conditions during January, February, and all water year types except critical water years in March, in which there would be 7 more degree-months (700% increase) under H1 relative to Existing Conditions (Table 11-4-83). An increase of 7 degree-months, although relatively large, is not expected to cause a biologically meaningful effect to steelhead. During April, the total number of degree months would be 3 to 25 degree-months (up to 500%) higher under H1 compared to Existing Conditions.

Due to similar flows, reservoir storage, and water temperatures between H4 and H3, results for H4 would be similar to or better than those for H3.

American River

Flows in the American River at the confluence with the Sacramento River during January through April under H4 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the American River at the Watt Avenue Bridge were evaluated during the January through April steelhead spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the*

Fish Analysis). Mean monthly water temperature under H4 would be 5% to 7% lower than those under Existing Conditions during January through March, and temperatures would not differ between H4 and Existing Conditions during April.

The percent of months exceeding the 56°F temperature threshold in the American River at the Watt Avenue Bridge was evaluated during November through April (Table 11-4-71). Steelhead spawn and eggs incubate in the American River between January and April. During January and February, the percent of month exceeding the threshold under Existing Conditions and H4 would be similar. During March and April, the percent of months exceeding the threshold under H4 would be up to 30% greater (absolute scale) than the percent under Existing Conditions.

Total degree-months exceeding 56°F were summed by month and water year type at the Watt Avenue Bridge during November through April (Table 11-4-72). During the January and February, there would be no difference in total degree-months above the threshold between Existing Conditions and H4. During March and April, total degree-months under H4 would be 395% and 95% greater than those under Existing Conditions, respectively.

Due to similar flows and water temperatures between H4 and H3, results for H4 would be similar to those for H3.

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined during the January through April steelhead spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 throughout this period would be up to 36% lower flows under Existing Conditions in all months with few exceptions.

Water temperatures in the Stanislaus River at the confluence with the San Joaquin River was evaluated during the January through April steelhead spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H4 would be 6% higher than those under Existing Conditions in all months.

San Joaquin River

The mainstem San Joaquin River does not provide habitat for steelhead spawning or egg incubation.

Mokelumne River

Flows in the Mokelumne River at the Delta were examined during the January through April steelhead spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 would generally be similar to flows under Existing Conditions during March, up to 18% greater during February, and up to 14% lower during April.

Water temperature modeling was not conducted in the Mokelumne River.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-94 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 4 could be significant because, under the CEQA baseline, the alternative could substantially reduce suitable spawning habitat and substantially reduce the number of fish as a result of egg mortality, contrary to the NEPA conclusion set forth above.

Alternative 4 would reduce steelhead spawning conditions through reduced mean monthly flows (to -58%), substantial increases in exposure to critical water temperatures, and substantial reductions in cold water pool availability that would also affect water temperatures in the Feather River, and through moderate reductions in mean monthly flows in the American River, particularly during drier water years. These effects would degrade spawning conditions and increase egg mortality. Alternative 4 would not have significant effects on steelhead spawning conditions in the Sacramento River and Clear Creek. Results would generally be similar among scenarios.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to H3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and H3 indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and H3. This indicates that the differences between Existing Conditions and Alternative 4 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 4, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on migration conditions for steelhead. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-95: Effects of Water Operations on Rearing Habitat for Steelhead

In general, the effects of Alternative 4 on steelhead rearing conditions would be negligible relative to the NAA

H3/ESO

Sacramento River

Juvenile steelhead rear within the Sacramento River and its tributaries throughout the year because juveniles inhabit upstream areas for a period of 1 to 2 years before migrating downstream to the ocean. Results of the CALSIM analyses of instream flows within the reach where the majority of steelhead spawning occurs (Keswick Dam to upstream of Red Bluff) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) were evaluated for effects of H3. Lower flows can reduce the instream area available for rearing and rapid reductions in flow can strand fry and juveniles, leading to mortality.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the year-round steelhead juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period at either location.

In general, effects of H3 on mean monthly flow would consist of primarily negligible increases in flow (to 20%) relative to NAA throughout the year, with the exception of isolated, small reductions in flow and more persistent flow reductions in all water year types during November (to -23%).

SacEFT predicts that there would be a 22% reduction in years classified as good juvenile rearing habitat conditions under H3 compared to NAA, but there would be a 10% increase in the percentage of years classified "good" with respect to juvenile stranding risk (Table 11-4-78). The decrease in the percentage of years when juvenile rearing habitat is classified as good for H3 would contribute to an incremental reduction in good habitat conditions and an increase in the risk of mortality to juvenile steelhead resulting from stranding.

Based on mean monthly flows, SacEFT rearing metrics, and water temperature effects, project-related effects under Alternative 4 in the Sacramento River would not have biologically meaningful negative effects on steelhead rearing conditions. Effects of H3 consist primarily of negligible effects that would not have biologically meaningful effects on rearing success with the exception of a moderate decrease (-22%) in rearing habitat conditions based on SacEFT, that would be partially offset by a small beneficial effect on stranding risk (10%).

Clear Creek

Steelhead rear in Clear Creek throughout the year. Lower flows can reduce the instream area available for rearing and rapid reductions in flow can strand fry and juveniles leading to mortality. Instream flows estimated from the modeling each month and water-year type were used to compare among model scenarios (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). In general, flows under H3 would generally be similar to those under NAA with few exceptions.

Evaluation of the minimum instream flows in Clear Creek indicates that H3 would have no effect (0%) on minimum instream flows in any water year type (Table 11-4-84).

Table 11-4-84. Minimum Monthly Instream Flow (cfs) for Model Scenarios in Clear Creek during the Year-Round Juvenile Steelhead Rearing Period

Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
Wet	-50 (-100%)	0 (0%)
Above Normal	0 (0%)	0 (0%)
Below Normal	0 (0%)	0 (0%)
Dry	-50 (-100%)	0 (0%)
Critical	-50 (-100%)	0 (NA)

Note: Minimum flows occurred between October and March.
NA = could not be calculated because the denominator was 0.

Denton (1986) developed flow recommendations for steelhead in Clear Creek using IFIM (Figure 11-1A-4). The current Clear Creek management regime uses flows slightly lower than those recommended by Denton. Results from a new IFIM study on Clear Creek are currently being analyzed. Depending on results of this study the flow regime could be adjusted in the future. It is expected that the modeled flows will be suitable for the existing steelhead populations in Clear Creek. No change in effect on steelhead in Clear Creek is anticipated.

No water temperature modeling was conducted in Clear Creek.

These results indicate that effects of H3 on flows would not affect juvenile steelhead rearing habitats in Clear Creek.

Feather River

The low-flow channel is the primary reach of the Feather River utilized by steelhead spawning and rearing. Although there is relatively little natural steelhead production in the river, most steelhead spawning and rearing appears to occur in the low-flow channel in habitats associated with well-vegetated side channels (Cavallo et al. 2003; California Department of Water Resources unpublished data). Because these habitats are relatively uncommon they could limit natural steelhead production. Lower flows can reduce the instream area available for rearing and rapid reductions in flow can strand fry and juveniles leading to mortality.

There would be no change in flows for H3 relative to NAA in the low-flow channel. Flow in the low-flow channel is projected to remain between 700 and 800 cfs except during occasional flood control releases. This flow is less than pre-dam levels during all months of the year as a result of water diversions through the Thermalito Afterbay. The significance of these flow conditions for steelhead spawning and rearing is uncertain. Feather River screw trap data indicate that Chinook salmon initiate emigration regardless of flow regime (i.e., they do not wait for a high-flow pulse). This is likely true for steelhead as well.

The river channel downstream of Thermalito (high-flow channel) offers few of the habitat types upon which steelhead appear to rely in the low-flow channel. Experiments and fish observations also indicate that predation risk for juvenile steelhead is higher downstream of the Thermalito outlet (California Department of Water Resources 2004). Increased predation risk is likely a function of water temperature, where warm water nonnative species such as striped bass, largemouth bass, and smallmouth bass are more prevalent, and in general, predators have greater metabolic requirements. Thus, summer temperatures that exceed 65°F and the absence of preferred steelhead habitat currently appear to limit steelhead rearing in the river downstream of the Thermalito outlet. Comparisons of CALSIM data by month and water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) indicate that flows under H3 would generally be greater than or similar to those under NAA in the high-flow channel in all months except July through September. During July through September, flows under H3 would be up to 50% lower than those under NAA depending on month, water-year type and comparison.

Mean monthly water temperatures in the Feather River in both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were examined during the year-round steelhead juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis).* There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period at either location.

Effects of H3 on water temperature-related juvenile rearing conditions for steelhead in the Feather River were analyzed by comparing the percent of months between May through August over the 82-year CALSIM modeling period that exceed a 63°F temperature threshold in the low-flow channel (above Thermalito Afterbay) and by comparing the percent of months between October and April that exceed a 56°F threshold at Gridley. Results for the low-flow channel (above Thermalito Afterbay) and Gridley are presented for spring-run rearing and fall-run spawning and egg incubation in Impacts AQUA-59 and AQUA-76, respectively. In the low-flow channel and at Gridley, there would generally be no differences between NAA and H3 on the percent of months exceeding the threshold.

The effects of H3 on water temperature-related juvenile rearing conditions for spring-run Chinook salmon in the Feather River were also analyzed by comparing the total degree-months for months that exceed the 63°F NMFS threshold during May through August in the low-flow channel and the 56°F threshold during October through April at Gridley. Results for the low-flow channel (above Thermalito Afterbay) and Gridley are presented for spring-run rearing and fall-run spawning and egg incubation in Impacts AQUA-59 and AQUA-76, respectively. In the low flow channel and at Gridley, there would be small increases and decreases in exceedances above the thresholds, but overall no biologically meaningful effects.

American River

Flows in the American River at the confluence with the Sacramento River were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would generally be greater than or similar to flows under NAA in all months except August and September. Flows during August and September would be up to 28% lower under H3 than under NAA. Because these reductions would occur only during these months and would be generally low to moderate, they are not expected to cause biologically meaningful effects on steelhead juvenile rearing habitat.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River and the Watt Avenue Bridge were examined during the year-round steelhead rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

The percent of months exceeding a 65°F temperature threshold in the American River at the Watt Avenue Bridge was evaluated during May through October (Table 11-4-85). During May, June, and October, the percent of months exceeding the threshold under H3 would similar to or up to 14% lower (absolute scale) than the percent under NAA. During July through September, the percent of months exceeding the threshold would mostly be similar between NAA and H3 with one or two degree categories in which there would be increases of up to 7% on an absolute scale in percent of months exceeding the threshold under H3.

Table 11-4-85. Differences between Baseline and H3 Scenarios in Percent of Months during the 82-Year CALSIM Modeling Period during Which Water Temperatures in the American River at the Watt Avenue Bridge Exceed the 65°F Threshold, May through October

	Degrees Above Threshold				
Month	>1.0	>2.0	>3.0	>4.0	>5.0
EXISTING CONDITIONS vs. H3					
May	41 (206%)	33 (225%)	23 (211%)	21 (340%)	10 (200%)
June	35 (54%)	35 (65%)	32 (79%)	21 (68%)	17 (82%)
July	0 (0%)	1 (1%)	36 (57%)	42 (117%)	42 (243%)
August	0 (0%)	2 (3%)	19 (23%)	51 (105%)	67 (216%)
September	15 (17%)	46 (86%)	58 (181%)	63 (392%)	53 (717%)
October	75 (1,525%)	63 (2,550%)	42 (NA)	27 (NA)	12 (NA)
NAA vs. H3					
May	-4 (-6%)	-1 (-3%)	-5 (-13%)	-5 (-15%)	-2 (-14%)
June	0 (0%)	-4 (-4%)	-9 (-11%)	-14 (-21%)	-10 (-21%)
July	0 (0%)	0 (0%)	1 (1%)	6 (9%)	4 (7%)
August	0 (0%)	0 (0%)	0 (0%)	2 (3%)	7 (8%)
September	0 (0%)	1 (1%)	5 (6%)	5 (7%)	0 (0%)
October	0 (0%)	0 (0%)	-4 (-8%)	-2 (-8%)	1 (11%)

NA = could not be calculated because the denominator was 0.

Total degree-months exceeding 65°F were summed by month and water year type at the Watt Avenue Bridge during May through October (Table 11-4-86). Total degree-months exceeding the threshold would be similar between NAA and H3 or up to 12% lower under H3 in all months except July, in which degree-months would be 8% higher under H3.

Table 11-4-86. Differences between Baseline and H3 Scenarios in Total Degree-Months (°F-Months) by Month and Water Year Type for Water Temperature Exceedances above 65°F in the American River at the Watt Avenue Bridge, May through October

Month	Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
May	Wet	20 (333%)	-1 (-4%)
	Above Normal	24 (NA)	-3 (-11%)
	Below Normal	18 (600%)	-5 (-19%)
	Dry	24 (109%)	-10 (-18%)
	Critical	34 (179%)	2 (4%)
	All	120 (240%)	-17 (-9%)
June	Wet	47 (276%)	-21 (-25%)
	Above Normal	21 (88%)	-11 (-20%)
	Below Normal	28 (97%)	-10 (-15%)
	Dry	35 (51%)	-5 (-5%)
	Critical	47 (94%)	-3 (-3%)
	All	178 (95%)	-50 (-12%)
July	Wet	54 (69%)	5 (4%)
	Above Normal	10 (37%)	4 (12%)
	Below Normal	26 (76%)	5 (9%)
	Dry	71 (115%)	20 (18%)
	Critical	48 (59%)	2 (2%)
	All	209 (74%)	36 (8%)
August	Wet	106 (134%)	-2 (-1%)
	Above Normal	32 (78%)	-1 (-1%)
	Below Normal	54 (96%)	17 (18%)
	Dry	91 (134%)	10 (7%)
	Critical	69 (87%)	5 (3%)
	All	352 (109%)	29 (4%)
September	Wet	83 (346%)	9 (9%)
	Above Normal	46 (288%)	10 (19%)
	Below Normal	49 (175%)	2 (3%)
	Dry	81 (193%)	-5 (-4%)
	Critical	55 (112%)	2 (2%)
	All	314 (197%)	18 (4%)
October	Wet	48 (4,800%)	-6 (-11%)
	Above Normal	27 (NA)	1 (4%)
	Below Normal	39 (NA)	0 (0%)
	Dry	37 (NA)	0 (0%)
	Critical	31 (620%)	1 (3%)
	All	182 (3,033%)	-4 (-2%)

NA = could not be calculated because the denominator was 0.

These results indicate that effects of H3 on flow and water temperatures would not reduce juvenile rearing conditions in the American River.

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would be similar to flows under NAA throughout the period.

Mean monthly water temperatures throughout the Stanislaus River would be similar under NAA and H3 throughout the year-round period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

San Joaquin River

Flows in the San Joaquin River at Vernalis were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would be similar to flows under NAA throughout the period.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Flows in the Mokelumne River at the Delta were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would be similar to flows under NAA throughout the period.

Water temperature modeling was not conducted in the Mokelumne River.

H1/LOS

Sacramento River

Year-round flows in the Sacramento River at Keswick and upstream of Red Bluff under H1 would generally be similar to flows under H3, except during September and November, during which flows would be up to 46% lower (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These isolated reductions would not have biologically meaningful effects on steelhead fry and juvenile rearing habitat.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the year-round steelhead juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period at either location.

Due to similar flows and water temperatures between H1 and H3, results for additional analyses (e.g., SacEFT, minimum mean monthly flow comparisons) under H1 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H1. Overall, results for H1 would be similar to those for H3.

Clear Creek

Year-round flows in the Clear Creek under H1 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). No water temperature modeling was conducted in Clear Creek. Due to similar flows between H1 and H3, results for additional analyses (e.g., minimum mean monthly flow comparisons) under H1 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H1. Overall, results for H1 would be similar to those for H3.

Feather River

Year-round flows in the Feather River above Thermalito Afterbay (low-flow channel) under H1 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Year-round flows in the Feather River below Thermalito Afterbay (high-flow channel) under H1 would generally be similar to or greater than flows under H3, except during September during which flows would be up to 83% lower than flows under NAA. This isolated reduction would not have biologically meaningful effects on steelhead fry and juvenile rearing habitat.

May and September Oroville storage under H1 would generally be similar to or greater than storage under H3 (Table 11-4-45, Table 11-4-39).

Mean monthly water temperatures in the Feather River in both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were examined during the year-round steelhead juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis).* There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period at either location.

The analysis evaluating the percent of months exceeding water temperature thresholds from NMFS presented in Impacts AQUA-59 and AQUA-76 indicates that there would be a small benefit of H1 relative to NAA in the low flow channel and at Gridley.

The analysis evaluating the total degree-months exceeding water temperature thresholds from NMFS presented in Impacts AQUA-59 and AQUA-76 indicates that exceedances under H1 would generally be similar to or lower than those under NAA in the low flow channel and at Gridley, representing a small benefit of H1.Due to similar flows, reservoir storage, and water temperatures between H1 and H3, results for H1 would be similar to or better than those for H3.

American River

Year-round flows in the American River at the confluence with the Sacramento River under H1 would generally be similar to flows under H3, except during September, during which flows would be up to 38% (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These isolated flow reductions would not have biologically meaningful effects on steelhead fry and juvenile habitat because they only occur during one of 12 months.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River and the Watt Avenue Bridge were examined during the year-round steelhead rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period.

The percent of months exceeding a 65°F temperature threshold in the American River at the Watt Avenue Bridge was evaluated during May through October (Table 11-4-87). During May, June, and October, the percent of months exceeding the threshold under H1 would similar to or up to 26% lower (absolute scale) than the percent under NAA. During July through September, the percent of months exceeding the threshold would mostly be similar between NAA and H1 with one or two degree categories in which there would be increases of up to 10% on an absolute scale and decreases of up to 9% on an absolute scale in percent of months exceeding the threshold under H1.

Table 11-4-87. Differences between Baseline Scenarios and H1 and H4 Scenarios in Percent of Months during the 82-Year CALSIM Modeling Period during Which Water Temperatures in the American River at the Watt Avenue Bridge Exceed the 65°F Threshold, May through October

	Degrees Above Threshold				
Month	>1.0	>2.0	>3.0	>4.0	>5.0
EXISTING CONDITIONS vs. H1					
May	20 (100%)	16 (108%)	5 (44%)	5 (80%)	1 (25%)
June	19 (29%)	19 (35%)	11 (27%)	9 (28%)	7 (35%)
July	0 (0%)	1 (1%)	9 (14%)	15 (41%)	11 (64%)
August	0 (0%)	2 (3%)	17 (21%)	46 (95%)	46 (148%)
September	14 (16%)	31 (58%)	32 (100%)	28 (177%)	21 (283%)
October	11 (225%)	7 (300%)	5 (NA)	2 (NA)	0 (NA)
NAA vs. H1					
May	-10 (-15%)	-2 (-5%)	-7 (-19%)	-11 (-35%)	-6 (-36%)
June	-1 (-1%)	-5 (-5%)	-26 (-32%)	-26 (-40%)	-21 (-44%)
July	0 (0%)	0 (0%)	-9 (-9%)	-1 (-2%)	-2 (-4%)
August	0 (0%)	0 (0%)	0 (0%)	1 (1%)	4 (4%)
September	0 (0%)	2 (3%)	10 (12%)	6 (8%)	1 (2%)
October	-11 (-14%)	-20 (-30%)	-16 (-35%)	-16 (-54%)	-4 (-33%)
EXISTING CONDITIONS vs. H4					
May	40 (200%)	32 (217%)	21 (189%)	19 (300%)	9 (175%)
June	33 (52%)	37 (70%)	26 (64%)	21 (68%)	22 (106%)
July	0 (0%)	1 (1%)	28 (45%)	33 (93%)	35 (200%)
August	0 (0%)	2 (3%)	17 (21%)	44 (92%)	57 (184%)
September	14 (16%)	42 (79%)	47 (146%)	48 (300%)	43 (583%)
October	72 (1,450%)	41 (1,650%)	36 (NA)	21 (NA)	9 (NA)
NAA vs. H4					
May	-5 (-8%)	-2 (-5%)	-7 (-19%)	-7 (-23%)	-4 (-21%)
June	-1 (-1%)	-1 (-1%)	-15 (-18%)	-14 (-21%)	-5 (-10%)
July	0 (0%)	0 (0%)	-6 (-6%)	-2 (-3%)	-4 (-7%)
August	0 (0%)	0 (0%)	-1 (-1%)	-4 (-4%)	-2 (-3%)
September	-1 (-1%)	-2 (-3%)	-6 (-7%)	-10 (-13%)	-10 (-16%)
October	-4 (-5%)	-22 (-34%)	-10 (-22%)	-9 (-29%)	-2 (-22%)

NA = could not be calculated because the denominator was 0.

Total degree-months exceeding 65°F were summed by month and water year type at the Watt Avenue Bridge during May through October (Table 11-4-88). Total degree-months exceeding the threshold would be similar between NAA and H1 or up to 12% lower under H1 in all months except July and September, in which degree-months would be 10% and 9%, higher, respectively, under H1.

Table 11-4-88. Differences between Baseline Scenarios and H1 and H4 Scenarios in Total Degree-Months (°F-Months) by Month and Water Year Type for Water Temperature Exceedances above 65°F in the American River at the Watt Avenue Bridge, May through October

Month	Water Year Type	EXISTING CONDITIONS vs. H1	NAA vs. H1	EXISTING CONDITIONS vs. H4	NAA vs. H4
May	Wet	21 (350%)	0 (0%)	22 (367%)	1 (4%)
	Above Normal	23 (NA)	-4 (-15%)	25 (NA)	-2 (-7%)
	Below Normal	16 (533%)	-7 (-27%)	24 (800%)	1 (4%)
	Dry	27 (123%)	-7 (-13%)	29 (132%)	-5 (-9%)
	Critical	32 (168%)	0 (0%)	32 (168%)	0 (0%)
	All	120 (240%)	-17 (-9%)	131 (262%)	-6 (-3%)
June	Wet	45 (265%)	-23 (-27%)	63 (371%)	-5 (-6%)
	Above Normal	21 (88%)	-11 (-20%)	34 (142%)	2 (4%)
	Below Normal	13 (45%)	-25 (-37%)	35 (121%)	-3 (-4%)
	Dry	34 (50%)	-6 (-6%)	44 (65%)	4 (4%)
	Critical	39 (78%)	-11 (-11%)	41 (82%)	-9 (-9%)
	All	152 (81%)	-76 (-18%)	218 (116%)	-10 (-2%)
July	Wet	51 (65%)	2 (2%)	51 (65%)	2 (2%)
	Above Normal	11 (41%)	5 (15%)	12 (44%)	6 (18%)
	Below Normal	36 (106%)	15 (27%)	26 (76%)	5 (9%)
	Dry	66 (106%)	15 (13%)	55 (89%)	4 (4%)
	Critical	54 (67%)	8 (6%)	47 (58%)	1 (1%)
	All	218 (77%)	45 (10%)	191 (68%)	18 (4%)
August	Wet	106 (134%)	-2 (-1%)	97 (123%)	-11 (-6%)
	Above Normal	31 (76%)	-2 (-3%)	27 (66%)	-6 (-8%)
	Below Normal	55 (98%)	18 (19%)	40 (71%)	3 (3%)
	Dry	93 (137%)	12 (8%)	83 (122%)	2 (1%)
	Critical	64 (81%)	0 (0%)	66 (84%)	2 (1%)
	All	350 (108%)	27 (4%)	313 (97%)	-10 (-2%)
September	Wet	107 (446%)	33 (34%)	75 (313%)	1 (1%)
	Above Normal	49 (306%)	13 (25%)	37 (231%)	1 (2%)
	Below Normal	48 (171%)	1 (1%)	45 (161%)	-2 (-3%)
	Dry	83 (198%)	-3 (-2%)	80 (190%)	-6 (-5%)
	Critical	52 (106%)	-1 (-1%)	52 (106%)	-1 (-1%)
	All	339 (213%)	43 (9%)	289 (182%)	-7 (-2%)
October	Wet	43 (4,300%)	-11 (-20%)	47 (4,700%)	-7 (-13%)
	Above Normal	26 (NA)	0 (0%)	29 (NA)	3 (12%)
	Below Normal	29 (NA)	-10 (-26%)	38 (NA)	-1 (-3%)
	Dry	32 (NA)	-5 (-14%)	34 (NA)	-3 (-8%)
	Critical	28 (560%)	-2 (-6%)	27 (540%)	-3 (-9%)
	All	157 (2,617%)	-29 (-15%)	175 (2,917%)	-11 (-6%)

NA = could not be calculated because the denominator was 0.

Due to similar flows and water temperatures between H1 and H3, results for H1 would be similar to those for H3.

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H1 would be similar to flows under NAA throughout the period.

Mean monthly water temperatures throughout the Stanislaus River would be similar under NAA and H1 throughout the year-round period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

San Joaquin River

Flows in the San Joaquin River at Vernalis were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H1 would be similar to flows under NAA throughout the period.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Flows in the Mokelumne River at the Delta were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H1 would be similar to flows under NAA throughout the period.

Water temperature modeling was not conducted in the Mokelumne River.

H4/HOS

Sacramento River

Year-round flows in the Sacramento River at Keswick and upstream of Red Bluff under H4 would generally be similar to flows under H3, except during May and June, during which flows would be up to 13% lower (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These small and isolated reductions would not have biologically meaningful effects on steelhead fry and juvenile rearing habitat.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the year-round steelhead juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period at either location.

Due to similar flows and water temperatures between H4 and H3, results for additional analyses (e.g., SacEFT, minimum mean monthly flow comparisons) under H4 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H4. Overall, results for H4 would be similar to those for H3.

Clear Creek

Year-round flows in the Clear Creek under H4 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). No water temperature modeling was conducted in Clear Creek. Due to similar flows between H4 and H3, results for additional analyses (e.g., minimum mean monthly flow comparisons) under H4 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H4. Overall, results for H4 would be similar to those for H3.

Feather River

Year-round flows in the Feather River above Thermalito Afterbay (low-flow channel) under H4 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in the Feather River below Thermalito Afterbay (high-flow channel) under H4 during January through May and November through December would generally be similar to or greater than flows under H3. However, flows during June through October would generally be up to 39% lower under H4.

Mean monthly water temperatures in the Feather River in both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were examined during the year-round steelhead juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis).* There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period at either location.

The analysis evaluating the percent of months exceeding water temperature thresholds from NMFS presented in Impacts AQUA-59 and AQUA-76 indicates that there would be a small to moderate benefits of H4 relative to NAA in the low-flow channel and at Gridley.

The analysis evaluating the total degree-months exceeding water temperature thresholds from NMFS presented in Impacts AQUA-59 and AQUA-76 indicates that exceedances under H4 would generally be similar to or lower than those under NAA in the low flow channel and at Gridley, representing a small benefit of H4.

May storage would be 11% to 15% lower under H4 relative to H3 in wet, above normal, and below normal water years (Table 11-4-45). September Oroville storage under H4 would generally be similar to or greater than storage under H4 (Table 11-4-39).

Due to similar flows, reservoir storage, and water temperatures between H4 and H3, results for H4 would be similar to or better than those for H3.

American River

Year-round flows in the American River at the confluence with the Sacramento River under H4 would generally be similar to flows under H3, except during June and October, during which flows would be up to 22% (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These isolated flow reductions would not have biologically meaningful effects on steelhead fry and juvenile habitat because they only occur during two of 12 months.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River and the Watt Avenue Bridge were examined during the year-round steelhead rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results* *utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

The percent of months exceeding a 65°F temperature threshold in the American River at the Watt Avenue Bridge was evaluated during May through October (Table 11-4-87). During May, June, and October, the percent of months exceeding the threshold under H4 would similar to or up to 26% lower (absolute scale) than the percent under NAA. The percent of months exceeding the threshold would generally be similar between NAA and H4 throughout the period, except during August, in which there would be no differences between NAA and H4.

Total degree-months exceeding 65°F were summed by month and water year type at the Watt Avenue Bridge during May through October (Table 11-4-88). Total degree-months exceeding the threshold would be similar between NAA and H4 throughout the period, except during September, in which total degree-months would be 13% lower under H4.

Due to similar flows and water temperatures between H4 and H3, results for H4 would be similar to those for H3.

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 would be similar to flows under NAA throughout the period.

Mean monthly water temperatures throughout the Stanislaus River would be similar under NAA and H4 throughout the year-round period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

San Joaquin River

Flows in the San Joaquin River at Vernalis were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 would be similar to flows under NAA throughout the period.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Flows in the Mokelumne River at the Delta were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 would be similar to flows under NAA throughout the period.

Water temperature modeling was not conducted in the Mokelumne River.

NEPA Effects: Collectively, these results indicate that the effect of Alternative 4 is not adverse because it would not substantially reduce rearing habitat or substantially reduce the number of fish as a result of fry and juvenile mortality. Effects of Alternative 4 on flows and water temperatures would be small and infrequent in the Sacramento River and Clear Creek, and effects in the Feather River and the American River would be more variable, but in general, the overall effects are expected to be slightly beneficial, despite the increased flow variations Water temperatures in the Sacramento, Feather, American and Stanislaus Rivers would not be affected by Alternative 4. Reduced June through October flows under H4 in the Feather River high-flow channel would affect the steelhead population there, but flows in the low-flow channel would be unaffected by H4. Overall, Alternative 4 is not expected to have biologically meaningful negative effects on steelhead rearing conditions.

CEQA Conclusion: In general, under all the Alternative 4 water operations scenarios, the quantity and quality of rearing habitat for steelhead would not be affected relative to the CEQA baseline.

H3/ESO

Sacramento River

Comparisons of CALSIM outputs of flow by month and water year type for the Sacramento River at Red Bluff (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) were used to evaluate effects of H3 compared to Existing Conditions. Results indicate negligible effects with isolated, small decreases in flow (to -17%) and more frequent, beneficial increases in flow (to 55%) throughout the year, with the exception of a greater prevalence of small to moderate flow reductions in drier water years during August, September and November (to -26%). The most substantial effects on juvenile rearing habitats would occur from reductions in flow in drier water year types in August (-26%) and September (-14%). Based on the infrequency and magnitude of these decreases, and negligible effects or beneficial increases in flow for the remainder of the year, the flow reductions are not expected to have biologically meaningful negative effects on juvenile steelhead rearing conditions in the Sacramento River.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the year-round steelhead juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). At both locations, mean monthly water temperatures under H3 would generally be similar to those under Existing Conditions, except during August through October, in which there would be 5% to 6% higher temperatures under H3.

SacEFT predicts that there would be a 15% decrease in the percentage of years with good juvenile rearing habitat under H3 compared to Existing Conditions (Table 11-4-78). SacEFT predicts there would be a decrease of 35% in occurrence of years with "good" conditions for juvenile stranding risk (Table 11-4-78). This would contribute incrementally to decreased juvenile habitat conditions and could increase the potential for mortality due to stranding.

Based on the incremental effects of reductions in mean monthly flows (up to 26% lower) for several months during drier water year types, including the warmer summer/early fall months of August and September, and increased risk of juvenile stranding (35%), effects of H3 on flows would have biologically meaningful effects on juvenile rearing conditions in the Sacramento River.

Clear Creek

Comparisons of mean monthly flows for Clear Creek were used to evaluate effects of H3 relative to Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Lower flows can reduce the instream area available for rearing and rapid reductions in flow can strand fry and juveniles leading to mortality. Effects of H3 year-round consist primarily of no change (0%) or negligible change (<5%) with respect to Existing Conditions, with the exception of isolated decreases in flow in critical years during August (-25%), September (-28%), and October (-6%), and occasional increases in flow (to 54% during January in wet years; otherwise to 17% and typically in wet or critical years) that would have beneficial effects. The decreases in flow would be of a frequency and magnitude to not cause biologically meaningful negative effects.

Evaluation of minimum instream flows for H3 relative to Existing Conditions (Table 11-4-84) indicates no effect (0%) for above normal and below normal years, and decreases for the remaining water year types (-50 cfs or -100%). This reduction corresponds to a substantial decrease in total flow during drier water years based on relatively small quantities of flow (e.g., as low as 85 cfs in the summer months in drier water years, and more typically between 150 and 200 in other months). These reductions in minimum instream flows would affect juvenile rearing habitat and could increase stranding risk, particularly in drier water years.

No water temperature modeling was conducted in Clear Creek.

While effects of H3 on mean monthly flow would consist predominantly of negligible effects, there would be moderate to substantial reductions in minimum instream flows, particularly during drier water years, that would affect juvenile rearing habitat and increase stranding risk in Clear Creek.

Feather River

The low-flow channel is the primary reach of the Feather River utilized by steelhead spawning and rearing. There would be no change in flows for H3 relative to Existing Conditions in the low-flow channel (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Comparisons using CALSIM data by month and water year type for the Feather River at Thermalito (high-flow channel) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) indicate variable effects of H3 relative to Existing Conditions. H3 would cause some substantial increases in mean monthly flows for some months and water year types. With some exceptions for specific water year types, there would be increases in mean monthly flows during March through June (to 135%), wetter years during July through September (to 209%), and October (to 33%). These are some of the most substantial flow increases calculated for H3 relative to Existing Conditions; effects in drier water year types would be particularly beneficial for juvenile rearing habitats. H3 would cause decreases in mean monthly flow for some of the remaining months/water year types; moderate (greater than approximately 12%) decreases would occur in drier water year types (with greater potential for adverse effects) during January (-46% in below normal years), February (-45% in below normal years and -10% in dry years), March (-53% in below normal years), July (to -61% in all drier year types), and September (to -46% in below normal and dry years). This constitutes a fairly broad range of substantial flow reductions throughout the year occurring in drier water years when potential effects on juvenile rearing conditions would be greatest.

Mean monthly water temperatures in the Feather River in both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were examined during the year-round steelhead juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). In the low-flow channel, mean monthly water temperatures under H3 would be similar to those under Existing Conditions between April and September, but would be 5% to 10% higher between October and March. In the high-flow channel, mean monthly water temperatures under H3 would be 5% to 8% higher than those under Existing Conditions during October through February, and similar in the remaining months.

Effects of H3 on water temperature-related juvenile rearing conditions for steelhead in the Feather River were analyzed by comparing the percent of months between May through August over the 82-year CALSIM modeling period that exceed a 63°F temperature threshold in the low-flow channel (above Thermalito Afterbay) and by comparing the percent of months between October and April that exceed a 56°F threshold at Gridley. Results for the low-flow channel (above Thermalito Afterbay) and Gridley are presented for spring-run rearing and fall-run spawning and egg incubation in Impacts AQUA-59 and AQUA-76, respectively. In the low-flow channel and at Gridley, there would generally be moderate to large increases in the percent of months exceeding the threshold between H3 and Existing Conditions. This comparison includes the effects of climate change.

The effects of H3 on water temperature-related juvenile rearing conditions for spring-run Chinook salmon in the Feather River were also analyzed by comparing the total degree-months for months that exceed the 63°F NMFS threshold during May through August in the low-flow channel and the 56°F threshold during October through April at Gridley. Results for the low-flow channel (above Thermalito Afterbay) and Gridley are presented for spring-run rearing and fall-run spawning and egg incubation in Impacts AQUA-59 and AQUA-76, respectively. In the low-flow channel and at Gridley, there would be moderate to large increases in total degree-months exceeding the temperature threshold during some months. This comparison includes the effects of climate change.

Overall in the Feather River, effects of H3 on mean monthly flow would consist of substantial increases and decreases for various months and water year types. There would be relatively frequent, substantial flow reductions in drier water years that would affect juvenile rearing habitat conditions and contribute to stranding risk. Further, there would be moderate to large increases in the exceedance of temperature thresholds in the low-flow channel and at Gridley.

American River

CALSIM outputs were used to compare mean monthly flows by month and water year type for H3 for the American River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Lower flows can reduce the instream area available for rearing and rapid reductions in flow can strand fry and juveniles leading to mortality. Comparisons of H3 to Existing Conditions indicate highly variable results, with primarily decreases in mean monthly flow for H3 relative to Existing Conditions, but some moderate increases in flow for certain months and water year types. Increases would primarily occur during January through March and June, with the largest increases generally occurring in wetter water years (to 25%) and less prevalent and/or smaller flow increases in drier water years. There would be primarily decreases in mean monthly flow during January in drier water years (to -19%), and for most water year types during May, and July through December (to -54%). The effects of H3 on mean monthly flow would consist of decreases in mean monthly flow in below normal, dry, and/or critical water years during each month of the year with reductions ranging from -9% to -54% depending on the specific month and water year type. This constitutes prevalent, substantial reductions in mean monthly flow, particularly during drier water years, that would have biologically meaningful effects on juvenile rearing conditions in the American River.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River and the Watt Avenue Bridge were examined during the year-round steelhead rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperature under H3 would be 5% to 11% lower than those under Existing Conditions during January through March, May, and September through November, and similar in the remaining 5 months.

The percent of months exceeding a 65°F temperature threshold in the American River at the Watt Avenue Bridge was evaluated during May through October (Table 11-4-85). The percent of months under H3 would be greater by up to 75% (absolute difference) than those under Existing Conditions during all months examined.

Total degree-months exceeding 65°F were summed by month and water year type at the Watt Avenue Bridge during May through October (Table 11-4-86). Total degree-months exceeding the threshold under H3 would be 74% to 3,033% greater than those under Existing Conditions for all months.

These results indicate that effects of H3 on flows (reductions to -54% during each month of the year in drier water year types) and water temperatures would affect juvenile steelhead rearing conditions in the American River throughout most of the year, particularly during drier water years.

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). There would be flow reductions (up to 36%) under H3 relative to Existing Conditions in all months.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were evaluated during the year-round juvenile steelhead rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H3 would be 5% to 6% lower in all months except June, July, and October.

San Joaquin River

Flows in the San Joaquin River at Vernalis were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would be 5% to 33% lower than flows under Existing Conditions during May through October, similar to flows under Existing Conditions during November through April.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Flows in the Mokelumne River at the Delta were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would be similar to flows under Existing Conditions during March, up to 14% greater than flows under Existing Conditions during December through February, and up to 46% lower than flows under Existing Conditions during the remaining 8 months.

Water temperature modeling was not conducted in the Mokelumne River.

H1/LOS

Sacramento River

Year-round flows in the Sacramento River at Keswick and upstream of Red Bluff under H1 would generally be similar to flows under H3, except during September and November, during which flows would be up to 46% lower than flows under NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These isolated reductions would not have biologically meaningful effects on steelhead fry and juvenile rearing habitat.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the year-round steelhead juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H1 would be 5% to 6% higher under H1 than those under Existing Conditions during August through October, but would not differ in other months.

Due to similar flows and water temperatures between H1 and H3, results for additional analyses (e.g., SacEFT, minimum mean monthly flow comparisons) under H1 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H1. Overall, results for H1 would be similar to those for H3.

Clear Creek

Year-round flows in the Clear Creek under H1 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). No water temperature modeling was conducted in Clear Creek. Due to similar flows between H1 and H3, results for additional analyses (e.g., minimum mean monthly flow comparisons) under H1 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H1. Overall, results for H1 would be similar to those for H3.

Feather River

Year-round flows in the Feather River above Thermalito Afterbay (low-flow channel) under H1 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Year-round flows in the Feather River below Thermalito Afterbay (high-flow channel) under H1 would generally be similar to or greater than flows under H3, except during September during which flows would be up to 83% lower than flows under NAA. This isolated reduction would not have biologically meaningful effects on steelhead fry and juvenile rearing habitat.

Mean monthly water temperatures in the Feather River in both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were examined during the year-round steelhead juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). In the low-flow channel, mean monthly water temperatures under H1 would be similar to those under Existing Conditions between April and September, but would be 5% to 9% higher between October and March. In the high-flow channel, mean monthly water temperatures under H1 would be 6% to 8% higher than those under Existing Conditions during October through February, and similar in the remaining months.

The analysis evaluating the percent of months exceeding water temperature thresholds from NMFS presented in Impacts AQUA-59 and AQUA-76 indicates that there would be a small to moderate negative effects of H1 relative to Existing Conditions in multiple months in the low flow channel and at Gridley. This comparison includes the effects of climate change.

The analysis evaluating the total degree-months exceeding water temperature thresholds from NMFS presented in Impacts AQUA-59 and AQUA-76 indicates that there would be small to moderate negative effects of H1 relative to Existing Conditions in multiple months in the low flow channel and at Gridley. This comparison includes the effects of climate change.

May and September Oroville storage under H1 would generally be similar to or greater than storage under H3 (Table 11-4-45, Table 11-4-39).

Due to similar flows and water temperatures, and similar or greater reservoir storage under H1 compared to H3, results for H1 would be similar to or better than those for H3.

American River

Year-round flows in the American River at the confluence with the Sacramento River under H1 would generally be similar to flows under H3, except during September, during which flows would be up to 38% (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These isolated flow reductions would not have biologically meaningful effects on steelhead fry and juvenile habitat because they only occur during one of 12 months.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River and the Watt Avenue Bridge were examined during the year-round steelhead rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperature under H1 would be 5% to 10% lower than those under Existing Conditions during August through March and May through December, and similar in the remaining 3 months.

The percent of months exceeding a 65°F temperature threshold in the American River at the Watt Avenue Bridge was evaluated during May through October (Table 11-4-87). The percent of months under H1 would be greater by up to 46% (absolute difference) than those under Existing Conditions during all months examined.

Total degree-months exceeding 65°F were summed by month and water year type at the Watt Avenue Bridge during May through October (Table 11-4-88). Total degree-months exceeding the threshold under H1 would be 77% to 2,617% greater than those under Existing Conditions for all months.

Due to similar flows and water temperatures between H1 and H3, results for H1 would be similar to those for H3.

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). There would be flow reductions (up to 36%) under H1 relative to Existing Conditions in all months.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were evaluated during the year-round juvenile steelhead rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H1 would be 5% to 6% lower in all months except June, July, and October.

San Joaquin River

Flows in the San Joaquin River at Vernalis were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H1 would be 5% to 33% lower than flows under Existing Conditions during May through October, similar to flows under Existing Conditions during November through April.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Flows in the Mokelumne River at the Delta were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H1 would be similar to flows under Existing Conditions during March, up to 14% greater than flows under Existing Conditions during December through February, and up to 46% lower than flows under Existing Conditions during the remaining 8 months.

Water temperature modeling was not conducted in the Mokelumne River.

H4/HOS

Sacramento River

Year-round flows in the Sacramento River at Keswick and upstream of Red Bluff under H4 would generally be similar to flows under H3, except during May and June, during which flows would be up to 13% lower than flows under NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These small and isolated reductions would not have biologically meaningful effects on steelhead fry and juvenile rearing habitat.

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the year-round steelhead juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). At both locations, mean monthly water temperatures under H4 would generally be similar to those under Existing Conditions, except during August through October, in which there would be 5% to 6% higher temperatures under H4.

Due to similar flows and water temperatures between H4 and H3, results for additional analyses (e.g., SacEFT, minimum mean monthly flow comparisons) under H4 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H4. Overall, results for H4 would be similar to those for H3.

Clear Creek

Year-round flows in the Clear Creek under H4 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). No water temperature modeling was conducted in Clear Creek. Due to similar flows between H4 and H3, results for additional analyses (e.g., minimum mean monthly flow comparisons) under H4 would be similar to results for analyses under H3. As a result, these additional analyses were not conducted for H4. Overall, results for H4 would be similar to those for H3.

Feather River

Year-round flows in the Feather River above Thermalito Afterbay (low-flow channel) under H4 would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in the Feather River below Thermalito Afterbay (high-flow channel) under H4 during January through May and November through December would generally be similar to or greater than flows under H3. However, flows during June through October would generally be up to 39% lower under H4. Despite these differences, very few steelhead rear in the high-flow channel and, therefore, these reductions are not expected to cause a biologically meaningful effect.

Mean monthly water temperatures in the Feather River in both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were examined during the year-round steelhead juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). In the low-flow channel, mean monthly water temperatures under H1 would be similar to those under Existing Conditions between April and September, but would be 5% to 19% higher between October and March. In the high-flow channel, mean monthly water temperatures under H1 would be 5% to 8% higher than those under Existing Conditions during July, August, and October through February, and similar in the remaining 5 months.

The analysis evaluating the percent of months exceeding water temperature thresholds from NMFS presented in Impacts AQUA-59 and AQUA-76 indicates that there would be a small to moderate negative effects of H4 relative to Existing Conditions in multiple months in the low flow channel and at Gridley. This comparison includes the effects of climate change.

The analysis evaluating the total degree-months exceeding water temperature thresholds from NMFS presented in Impacts AQUA-59 and AQUA-76 indicates that there would be small to moderate negative effects of H4 relative to Existing Conditions in multiple months in the low flow channel and at Gridley. This comparison includes the effects of climate change.

May storage would be 11% to 15% lower under H4 relative to H3 in wet, above normal, and below normal water years (Table 11-4-45). September Oroville storage under H4 would generally be similar to or greater than storage under H4 (Table 11-4-39).

American River

Year-round flows in the American River at the confluence with the Sacramento River under H4 would generally be similar to flows under H3, except during June and October, during which flows would be up to 22% (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These isolated flow reductions would not have biologically meaningful effects on steelhead fry and juvenile habitat because they only occur during two of 12 months.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River and the Watt Avenue Bridge were examined during the year-round steelhead rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperature under H4 would be 5% to 11% lower than those under Existing Conditions during May and August through March, and similar in the remaining 3 months.

The percent of months exceeding a 65°F temperature threshold in the American River at the Watt Avenue Bridge was evaluated during May through October (Table 11-4-87). The percent of months under H4 would be greater by up to 72% (absolute difference) than those under Existing Conditions during all months examined.

Total degree-months exceeding 65°F were summed by month and water year type at the Watt Avenue Bridge during May through October (Table 11-4-88). Total degree-months exceeding the threshold under H4 would be 68% to 2,917% greater than those under Existing Conditions for all months.

Due to similar flows and water temperatures between H4 and H3, results for H4 would be similar to those for H3.

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). There would be flow reductions (up to 36%) under H4 relative to Existing Conditions in all months.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were evaluated during the year-round juvenile steelhead rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H4 would be 5% to 6% lower in all months except June, July, and October.

San Joaquin River

Flows in the San Joaquin River at Vernalis were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 would be 5% to 33% lower than flows under Existing Conditions during May through October, similar to flows under Existing Conditions during November through April.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Flows in the Mokelumne River at the Delta were examined for the year-round steelhead rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 would be similar to flows under Existing Conditions during March, up to 14% greater than flows under Existing Conditions during December through February, and up to 46% lower than flows under Existing Conditions during the remaining 8 months.

Water temperature modeling was not conducted in the Mokelumne River.

Summary of CEQA Conclusion

Collectively, these results of the Impact AQUA-95 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 4 could be significant because, under the CEQA baseline, the alternative could substantially reduce rearing habitat and substantially reduce the number of fish as a result of fry and juvenile mortality, contrary to the NEPA conclusion set forth above. Juvenile rearing conditions in all locations analyzed would be negatively affected under Alternative 4 by moderate to substantial reductions in mean monthly flows for large portions of the year-round rearing period in the Feather, American, Stanislaus, San Joaquin, and Mokelumne Rivers. Water temperatures and the exceedances above applicable NMFS thresholds would be higher in the Sacramento, Feather, American, and Stanislaus Rivers. Degraded rearing conditions for juvenile steelhead would reduce their survival and growth in these waterways.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to H3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and H3 indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and H3. This indicates that the differences between Existing Conditions and Alternative 4 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 4, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on rearing habitat for steelhead. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-96: Effects of Water Operations on Migration Conditions for Steelhead

Upstream of the Delta

In general, the effects of Alternative 4 on steelhead migration conditions relative to the NAA are uncertain.

H3/ESO

Sacramento River

Juveniles

Sacramento River flow upstream of Red Bluff during the juvenile steelhead migration period (October through May) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) is used to represent flow conditions in the mainstem of the upper river below Keswick Dam. Flows under H3 during this period would generally be similar to flows under NAA, except during November, during which flows would be up to 18% lower than flows under NAA. These reductions would not have a biologically meaningful effect on steelhead juvenile migration because reductions occur during only one of eight months of the period.

Mean monthly water temperatures in the Sacramento River upstream of Red Bluff were evaluated during the October through May juvenile steelhead migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

Overall, these results indicate that H3 would not have biologically meaningful effects on juvenile migration conditions.

Adults

Instream flows upstream of Red Bluff were compared monthly over the period from September through March under H3 and NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 during this period would generally be similar to flows under NAA, except during November, during which flows would be up to 18% lower than flows under NAA. These reductions would not have a biologically meaningful effect on steelhead adult migration because reductions occur during only one of seven months of the period.

Mean monthly water temperatures in the Sacramento River upstream of Red Bluff were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

Kelts

Average Sacramento River flows upstream of Red Bluff under H3 during March and April (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) would generally be similar to flows under NAA. Therefore, H3 would not affect kelt migration in the Sacramento River.

Mean monthly water temperatures in the Sacramento River upstream of Red Bluff were evaluated during the March through April steelhead kelt downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

Overall in the Sacramento River, these results indicate that H3 would not have biologically meaningful effects on juvenile, adult, or kelt steelhead migration in the Sacramento River.

Clear Creek

No water temperature modeling was conducted in Clear Creek.

Juveniles

Flows in Clear Creek at Whiskeytown were evaluated for the juvenile steelhead migration period (October through May) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would be similar to or greater than flows under NAA throughout the period. These results indicate that effects of H3 on flows would not affect juvenile steelhead migration conditions in Clear Creek.

Adults

Flows in Clear Creek at Whiskeytown were evaluated for the September through March adult steelhead migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would be similar to or greater than flows under NAA throughout the period. These results indicate that effects of Alternative 4 on flows would not affect adult steelhead migration conditions in Clear Creek.

Kelts

Flows in Clear Creek at Whiskeytown were evaluated for the March through April kelt steelhead migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would be similar to or greater than flows under NAA throughout the period. These results indicate that H3 would not affect kelt steelhead migration conditions in Clear Creek.

Overall in Clear Creek, these results indicate that effects of H3 on flows would not affect juvenile, adult, or kelt steelhead migration.

Feather River

Juveniles

Flows in the Feather River at Thermalito Afterbay (high-flow channel) and at the confluence with the Sacramento River were evaluated during the October through May juvenile steelhead migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in the high-flow channel under H3 would generally be similar to or greater than flows under NAA throughout the period. Increases in flow would have a beneficial effect on migration conditions, particularly in drier water years during some months (up to 54% greater flows).

Flows under H3 in the Feather River at the confluence with the Sacramento River during October through May would generally be similar to or greater than flows under NAA, except in above normal water years during November (6% lower) and December (8% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These isolated reductions would not have biologically meaningful effects on juvenile steelhead migration conditions.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were evaluated during the October through May juvenile steelhead migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

Overall, there would be no biologically meaningful effects H3 on juvenile migration conditions in the Feather River.

Adults

Flows in the Feather River at Thermalito Afterbay (high-flow channel) and at the confluence with the Sacramento River were evaluated during the September through March adult migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). e Flows in the high-flow channel under H3 would generally be similar to or greater than flows under NAA, except during September, in which flows would be up to 42% lower depending on water year type. These flow reductions would be isolated and would, therefore, not have a biologically meaningful effect on adult steelhead migration conditions. Flows in the Feather River at the confluence with the Sacramento River under H3 would generally be similar to or greater than flows under NAA, except during September, in which flows would be up to 27% lower depending on water year type. These flow reductions would be isolated and would, therefore, not have a biologically meaningful effect on adult steelhead migration conditions.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were evaluated during the September through March steelhead adult upstream migration period

(Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

Kelts

Flows in the Feather River at the Thermalito Afterbay and at the confluence with the Sacramento River were evaluated during the March and April kelt migration period. Flows at Thermalito under H3 during March and April would generally be similar to or up to 54% greater than flows under NAA. Flows at the confluence with the Sacramento River would generally be similar to or up to 14% greater than flows under NAA. These results indicate that H3 would not affect kelt steelhead migration conditions in the Feather River.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were evaluated during the March through April steelhead kelt downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

Overall in the Feather River, H3 would not have biologically meaningful effects on juvenile, adult, or kelt steelhead migration.

American River

Juveniles

Flows in the American River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) were evaluated for the juvenile steelhead migration period (October through May). Flows under H3 would generally be similar to flows under NAA, except during November, in which flows would be up to 8% lower depending on water year type, and during May, in which flows would be up to 24% greater depending on water year type. Increases and decreases would be too rare to have biologically meaningful effects on juvenile steelhead migration.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were evaluated during the October through May juvenile steelhead migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

Based on generally negligible effects or increases in mean monthly flow and negligible effects on water temperature, effects of H3 on flows would not affect juvenile steelhead migration in the American River.

Adults

Flows in the American River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) were evaluated for the September through March adult migration period. Flows would generally be similar to flows under NAA, except during September and November, in which flows would be up to 18% lower depending on month and water year type.

These reductions would be too rare to cause biologically meaningful effects on adult steelhead migration.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

Kelts

Flows in the American River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) were evaluated for the March through April kelt migration period. Flows under H3 would generally be similar to flows under NAA during this period, except for small reductions in flows in dry and critical years during March (5% to 6% lower).

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were evaluated during the March through April steelhead kelt downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

Overall in the American River, the effects of H3 on flows would not affect juvenile, adult, or kelt migration conditions.

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River for H3 are not different from flows under NAA for any month. Therefore, there would be no effect of H3 on juvenile, adult, or kelt migration in the Stanislaus River.

Further, mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River for H3 are not different from flows under NAA for any month. Therefore, there would be no effect of H3 on juvenile, adult, or kelt migration in the Stanislaus River.

San Joaquin River

Flows in the San Joaquin River at Vernalis for H3 are not different from flows under NAA for any month. Therefore, there would be no effect of H3 on juvenile, adult, or kelt migration in the San Joaquin River.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Flows in the Mokelumne River at the Delta for H3 are not different from flows under NAA for any month. Therefore, there would be no effect of H3 on juvenile, adult, or kelt migration in the Mokelumne River.

Water temperature modeling was not conducted in the Mokelumne River.

H1/LOS

Sacramento River

Juveniles

Flows under H1 in the Sacramento River upstream of Red Bluff during the October through May juvenile steelhead migration period would generally be similar to flows under H3, except during November, in which flows would be up to 12% lower depending on water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). This reduction would not occur at a high enough frequency to have a meaningful effect on juvenile steelhead migration habitat.

Mean monthly water temperatures in the Sacramento River upstream of Red Bluff were evaluated during the October through May juvenile steelhead migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period.

Overall, results for H1 would be similar to those for H3.

Adults

Flows under H1 in the Sacramento River upstream of Red Bluff during the September through March adult steelhead migration period would generally be similar to flows under H3, except during November, in which flows would be up to 12% lower depending on water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*. This reduction would not occur at a high enough frequency to have a meaningful effect on juvenile steelhead migration habitat.

Mean monthly water temperatures in the Sacramento River upstream of Red Bluff were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period.

Overall results for H1 would be similar to those for H3.

Kelts

Flows under H1 in the Sacramento River upstream of Red Bluff during the March through April adult steelhead migration period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River upstream of Red Bluff were evaluated during the March through April steelhead kelt downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period.

Overall results for H1 would be similar to those for H3.

Clear Creek

No water temperature modeling was conducted in Clear Creek.

Juveniles

Flows under H1 in Clear Creek at Whiskeytown during the October through May juvenile migration period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Overall results for H1 would be similar to those for H3.

Adults

Flows under H1 in Clear Creek at Whiskeytown during the September through March adult migration period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Overall results for H1 would be similar to those for H3.

Kelts

Flows under H1 in Clear Creek at Whiskeytown during the March through April kelt migration period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Overall results for H1 would be similar to those for H3.

Feather River

Juveniles

Flows under H1 in the Feather River at Thermalito Afterbay and the confluence with the Sacramento River during the October through May juvenile migration period would generally be similar to or greater than flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were evaluated during the October through May juvenile steelhead migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period.

Overall results for H1 would be similar to those for H3.

Adults

Flows under H1 in the Feather River at Thermalito Afterbay and the confluence with the Sacramento River during the September through March adult migration period would generally be similar to or greater than flows under H3, except during September, in which flows would be up to 83% lower depending on water year type and location (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Although large, these flow reductions would not have biologically meaningful effects because they occur in only one of seven months.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period.

Overall results for H1 would be similar to those for H3.

Kelts

Flows under H1 in the Feather River at Thermalito Afterbay and the confluence with the Sacramento River during the March through April kelt migration period would generally be similar to or greater than flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were evaluated during the March through April steelhead kelt downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period.

Overall results for H1 would be similar to those for H3.

American River

Juveniles

Flows under H1 in the American River at the confluence with the Sacramento River during the October through May juvenile migration period would generally be similar to flows under H3 with few exceptions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were evaluated during the October through May juvenile steelhead migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period.

Overall results for H1 would be similar to those for H3.

Adults

Flows under H1 in the American River at the confluence with the Sacramento River during the September through March adult migration period would generally be similar to flows under H3 with few exceptions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

Overall results for H1 would be similar to those for H3.

Kelts

Flows under H1 in the American River at the confluence with the Sacramento River during the March through April kelt migration period would generally be similar to flows under H3 with few exceptions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were evaluated during the March through April steelhead kelt downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results* *utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period.

Overall results for H1 would be similar to those for H3.

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River for H1 are not different from flows under NAA for any month. Therefore, there would be no effect of H1on juvenile, adult, or kelt migration in the Stanislaus River.

Further, mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River for H1 are not different from flows under NAA for any month. Therefore, there would be no effect of H1 on juvenile, adult, or kelt migration in the Stanislaus River.

San Joaquin River

Flows in the San Joaquin River at Vernalis for H1 are not different from flows under NAA for any month. Therefore, there would be no effect of H1 on juvenile, adult, or kelt migration in the San Joaquin River.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Flows in the Mokelumne River at the Delta for H1 are not different from flows under NAA for any month. Therefore, there would be no effect of H1 on juvenile, adult, or kelt migration in the Mokelumne River.

Water temperature modeling was not conducted in the Mokelumne River.

H4/HOS

Sacramento River

Juveniles

Flows under H4 in the Sacramento River upstream of Red Bluff during the October through May juvenile steelhead migration period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*.

Mean monthly water temperatures in the Sacramento River upstream of Red Bluff were evaluated during the October through May juvenile steelhead migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

Overall, results for H4 would be similar to those for H3.

Adults

Flows under H4 in the Sacramento River upstream of Red Bluff during the September through March adult steelhead migration period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River upstream of Red Bluff were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

Overall results for H4 would be similar to those for H3.

Kelts

Flows under H4 in the Sacramento River upstream of Red Bluff during the March through April adult steelhead migration period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River upstream of Red Bluff were evaluated during the March through April steelhead kelt downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

Overall results for H4 would be similar to those for H3.

Clear Creek

No water temperature modeling was conducted in Clear Creek.

Juveniles

Flows under H4 in Clear Creek at Whiskeytown during the October through May juvenile migration period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Overall results for H4 would be similar to those for H3.

Adults

Flows under H4 in Clear Creek at Whiskeytown during the September through March adult migration period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Overall results for H4 would be similar to those for H3.

Kelts

Flows under H4 in Clear Creek at Whiskeytown during the March through April kelt migration period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Overall results for H4 would be similar to those for H3.

Feather River

Juveniles

Flows under H4 in the Feather River at Thermalito Afterbay and the confluence with the Sacramento River during the October through May juvenile migration period would generally be similar to or greater than flows under H3, except during October, in which flows would be up to 27% lower depending on water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

These flow reductions would not cause biologically meaningful effects on juvenile steelhead migration conditions because they occur during only one of eight months during the period.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were evaluated during the October through May juvenile steelhead migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

Overall results for H4 would be similar to those for H3.

Adults

Flows under H4 in the Feather River at Thermalito Afterbay and the confluence with the Sacramento River during the September through March adult migration period would generally be similar to flows under H3, except during September and October, in which flows would be up to 32% lower depending on water year type and location (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These flow reductions would be high enough and would occur at a high enough frequency to have biologically meaningful effects on adult migration conditions.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

Overall results for H4 would be worse for adult migration conditions than those for H3.

Kelts

Flows under H4 in the Feather River at Thermalito Afterbay and the confluence with the Sacramento River during the March through April kelt migration period would generally be similar to or greater than flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were evaluated during the March through April steelhead kelt downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

Overall results for H4 would be similar to those for H3.

American River

Juveniles

Flows under H4 in the American River at the confluence with the Sacramento River during the October through May juvenile migration period would generally be similar to flows under H3, except during October in which flows would be up to 13% lower under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These reductions would not be large or frequent enough to have biologically meaningful effects on juvenile steelhead migration conditions.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were evaluated during the October through May juvenile steelhead migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

Overall results for H4 would be similar to those for H3.

Adults

Flows under H4 in the American River at the confluence with the Sacramento River during the September through March adult migration period would generally be similar to flows under H3, except during October in which flows would be up to 13% lower under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These reductions would not be large or frequent enough to have biologically meaningful effects on adult steelhead migration conditions.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

Overall results for H4 would be similar to those for H3.

Kelts

Flows under H4 in the American River at the confluence with the Sacramento River during the March through April kelt migration period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were evaluated during the March through April steelhead kelt downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

Overall results for H4 would be similar to those for H3.

Stanislaus River

Flows in the Stanislaus River at the confluence with the San Joaquin River for H4 are not different from flows under NAA for any month. Therefore, there would be no effect of H4 on juvenile, adult, or kelt migration in the Stanislaus River.

Further, mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River for H4 are not different from flows under NAA for any month. Therefore, there would be no effect of H4 on juvenile, adult, or kelt migration in the Stanislaus River.

San Joaquin River

Flows in the San Joaquin River at Vernalis for H4 are not different from flows under NAA for any month. Therefore, there would be no effect of H4 on juvenile, adult, or kelt migration in the San Joaquin River.

Water temperature modeling was not conducted in the San Joaquin River.

Mokelumne River

Flows in the Mokelumne River at the Delta for H4 are not different from flows under NAA for any month. Therefore, there would be no effect of H4 on juvenile, adult, or kelt migration in the Mokelumne River.

Water temperature modeling was not conducted in the Mokelumne River.

Through-Delta

Sacramento River

Juveniles

Alternative 4 operations would generally reduce OMR reverse flows under all flow scenarios, with a corresponding increase in net positive downstream flows, during the outmigration period of steelhead through the interior Delta channels (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Conditions under Scenario H4 would further improve overall average OMR flows relative to other flow scenarios under Alternative 4. These improved net positive downstream flows would be substantial benefits of the proposed operations.

Predation at the north Delta would be increased due to the construction of the proposed SWP/CVP water export facilities on the Sacramento River. It is assumed that per capita steelhead predation losses would be similar to those predicted for spring-run Chinook salmon, although slightly reduced because of the larger size of steelhead outmigrants. Bioenergetics modeling with a median predator density of 0.12 predators per foot (0.39 predators per meter) of intake predicts a predation loss of about 0.2% of the juvenile spring-run population (Table 11-4-26).

Based on DPM results for Chinook salmon (Impact 42 for Alternative 4), steelhead survival would not be expected to change more than 1% under Alternative 4. Also, steelhead juveniles are larger than Chinook salmon juveniles in general, and therefore would be less vulnerable to predation during migration. Therefore the effect on juvenile steelhead outmigration success through the Delta under Alternative 4 would not be adverse.

Adults

The upstream adult steelhead migration occurs from September–March, peaking during December-February. The steelhead kelt downstream migration occurs from January–April. The proportion of Sacramento River water in the Delta under Alternative 4 would to be similar (<10% difference) to NAA throughout the adult steelhead upstream migration (Table 11-4-89). Under Alternative 4 Scenario H3 Sacramento River flows at Rio Vista would be reduced, but the effect would similar or improved relative to Alternative 1A's effects (Impact AQUA-96) in all months of the adult upstream migration and kelt downstream migration periods, except in October. Rio Vista flows would be similar between all the flow scenarios under Alternative 4 from October–March. However, in September, average flows under Scenario H4 at Rio Vista would be 46% less compared to Scenario H3 and 67% less compared to NAA. Because the effect under Alternative 1A would not be adverse, Alternative 4 would also not have an adverse effect on adult and kelt steelhead migration through the Delta.

San Joaquin River

Juveniles

The only changes to San Joaquin River flows at Vernalis would result from the modeled effects of climate change on inflows to the river downstream of Friant Dam and reduced tributary inflows. There no flow changes associated with the Alternatives. Alternative 4 would have no effect on steelhead migration success through the Delta.

Adults

Alternative 4 Scenario H3 would slightly increase the proportion of San Joaquin River water in the Delta in September through December by 1.1 to 3.9 % (compared to NAA) (Table 11-4-89). The proportion of San Joaquin River water under Scenario H3 would be similar or slightly more than NAA. Conditions under Scenario H4 are expected to reduce the magnitude of this effect because it would involve fewer exports from the north Delta compared to Scenario H3 and the LOS.

Table 11-4-89. Percentage (%) of Water at Collinsville that Originated in the Sacramento River and San Joaquin River during the Adult Steelhead Migration Period for Alternative 4

Month	EXISTING CONDITIONS	NAA	A4	EXISTING CONDITIONS vs. A4	NAA vs. A4
Sacramento River					
September	60	65	63	3	-2
October	60	68	67	7	-1
November	60	66	63	3	-3
December	67	66	66	-1	0
January	76	75	73	-3	-2
February	75	72	68	-7	-4
March	78	76	68	-10	-8
San Joaquin River					
September	0.3	0.1	1.2	0.9	1.1
October	0.2	0.3	3.3	3.1	3
November	0.4	1.0	4.9	4.5	3.9
December	0.9	1.0	2.9	2	1.9
January	1.6	1.7	3.1	1.5	1.4
February	1.4	1.5	3.4	2	1.9
March	2.6	2.8	5.5	2.9	2.7
	Shading indicates 10% or greater absolute difference.				

NEPA Effects: Upstream of the Delta, these results indicate that the effect is not adverse because it would not substantially reduce the amount of suitable habitat or substantially interfere with the movement of fish. Effects of Alternative 4 in all locations analyzed would consist primarily of negligible effects on mean monthly flow and water temperatures for the juvenile, adult, and kelt migration periods. Effects of Alternative 4 on upstream water temperatures would also be negligible.

Near-field effects of Alternative 4 NDD on Sacramento River steelhead related to impingement and predation associated with three new intake structures could result in negative effects on juvenile migrating steelhead, although there is high uncertainty regarding the overall effects. It is expected that the level of near-field impacts would be directly correlated to the number of new intake structures in the river and thus the level of impacts associated with 3 new intakes would be considerably lower than those expected from having 5 new intakes in the river. Estimates within the effects analysis range from very low levels of effects (<1% mortality) to more significant effects (~ 12% mortality above current baseline levels). CM15 would be implemented with the intent of providing localized and temporary reductions in predation pressure at the NDD. Additionally, several pre-construction surveys to better understand how to minimize losses associated with the three new intake structures will be implemented as part of the final NDD screen design effort. Alternative 4 also includes an Adaptive Management Program and Real-Time Operational Decision-Making Process to evaluate and make limited adjustments intended to provide adequate migration conditions for steelhead. However, at this time, due to the absence of comparable facilities anywhere in the lower Sacramento River/Delta, the degree of mortality expected from near-field effects at the NDD remains highly uncertain.

Two recent studies (Newman 2003 and Perry 2010) indicate that far-field effects associated with the new intakes could cause a reduction in smolt survival in the Sacramento River downstream of the NDD intakes due to reduced flows in this area. The analyses of other elements of Alternative 4 predict improvements in smolt condition and survival associated with increased access to the Yolo Bypass, reduced interior Delta entry, and reduced south Delta entrainment. The overall magnitude of each of these factors and how they might interact and/or offset each other in affecting salmonid survival through the plan area is uncertain, and remains an area of active investigation for the BDCP.

The DPM is a flow-based model being developed for BDCP which attempts to combine the effects of all of these elements of BDCP operations and conservation measures to predict smolt migration survival throughout the entire Plan Area. The current draft of this model predicts that smolt migration survival under Alternative 4 would be similar to those estimated for NAA. Further refinement and testing of the DPM, along with several ongoing and planned studies related to salmonid survival at and downstream of, the NDD are expected to be completed in the foreseeable future. These efforts are expected to improve our understanding of the relationships and interactions among the various factors affecting salmonid survival, and reduce the uncertainty around the potential effects of BDCP implementation on migration conditions for steelhead. However, until these efforts are completed and their results are fully analyzed, the overall cumulative effect of Alternative 4 on steelhead migration remains uncertain.

CEQA Conclusion: In general, under all the Alternative 4 water operations scenarios, the quantity and quality of migration habitat for steelhead would not be reduced relative to Existing Conditions.

Upstream of the Delta

H3/ESO

Sacramento River

Juveniles

Flows in the Sacramento River just upstream of Red Bluff Diversion Dam were evaluated for the juvenile migration period (October through May) (Appendix 11C, *CALSIM II Model Results utilized in* *the Fish Analysis*). Effects of H3 compared to Existing Conditions consist primarily of negligible effects (<5%) during October through May, with small increases (to 15%) or decreases (to -17%) in flow. Increases would have a beneficial effect on migration conditions and decreases would be infrequent, would be of greatest magnitude in wetter water years when effects on migration conditions would be less critical, and therefore are not expected to have biologically meaningful negative effects on migration conditions.

Mean monthly water temperatures in the Sacramento River upstream of Red Bluff were evaluated during the October through May juvenile steelhead migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H3 in all months but October, in which temperatures under H3 would be 6% greater than those under Existing Conditions.

Adults

Flows during the adult migration period (September through March) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) would be as described for that portion of the juvenile migration period immediately above with the addition of September. Effects of H3 in September consist of substantial increases in mean monthly flow in wet (39%) and above normal (55%) years, small decreases in below normal (-11%) and dry years (to -14%), and negligible effects in critical years. These effects would not alter the conclusion of no biologically meaningful negative effects for the entire migration period of September through March.

Mean monthly water temperatures in the Sacramento River upstream of Red Bluff were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H3 in all months except September and October, in which temperatures under H3 would be 6% greater than those under Existing Conditions.

Kelts

Effects of H3 on flows during the kelt migration period of March and April consist primarily of negligible effects (<5%), with infrequent, small increases (to 6%) and a single decrease in flow (-10%) during March in below normal water years that would not have biologically meaningful effects on migration conditions. These results indicate that effects of H3 on flows would not affect kelt migration in the Sacramento River at Red Bluff.

Mean monthly water temperatures in the Sacramento River upstream of Red Bluff were evaluated during the March through April steelhead kelt downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H3 in any month or water year type throughout the period.

Overall in the Sacramento River, the effects of H3 on flows would not affect juvenile, adult, or kelt steelhead migration.

Clear Creek

No water temperature modeling was conducted in Clear Creek.

Juveniles

Flows in Clear Creek were evaluated for the juvenile migration period (October through May) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Effects of H3 compared to Existing Conditions consist primarily of negligible effects (<5%) for October through May or small increases (to 10%) in flow and a single, small decrease (-6% during October in critical years) in mean monthly flow that would not have biologically meaningful effects on migration conditions, with the exception of more substantial increases in mean monthly flows during January through March in wet years (to 54%) which would have beneficial effects on migration conditions. As discussed for effects of H3 on rearing conditions in Clear Creek above, no water temperature modeling was conducted in Clear Creek.

Adults

Effects of H3 on flows in Clear Creek during the adult migration period (September through March) would be as described for that portion of the juvenile migration period immediately above with the addition of September. Effects of H3 in September consist of negligible effects for all water year types except for a decrease in mean monthly flow in critical years of -28%. Based on the limited occurrence of this flow reduction, overall effects of H3 on flows would not have biologically meaningful effects on adult migration conditions. No water temperature modeling was conducted in Clear Creek.

Kelts

Effects of H3 on flows during the kelt migration period of March and April consist of negligible effects (<5%) or infrequent, small to moderate increases in mean monthly flow (to 29%) that would not affect migration conditions.

Overall in Clear Creek, the effects of H3 on flows would not affect juvenile, adult, or kelt steelhead migration.

Feather River

Juveniles

Flows in the Feather River above the Thermalito Afterbay (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) were evaluated for the juvenile migration period (October through May). Effects of H3 compared to Existing Conditions consist of primarily increases in mean monthly flow for most water years during October (7% to 33%), critical years during January (18%), wet years during February (31%), wetter water years during March (12% and 22%), and drier water years during April (18% to 58%). Effects of H3 consist primarily of decreases in mean monthly flow during October and November in wet (to -27%) and below normal years (-9%), most water years in December (-38% in wet years, to -7% in drier water years), most water years during January and February (to -46%, with maximum reduction in below normal years), and another substantial reduction (-53%) during March in below normal years. Overall, the decreases in flows during drier water year types for a substantial portion of the juvenile migration period would have biologically meaningful effects on juvenile migration for this location.

Flows in the Feather River at the confluence with the Sacramento River were evaluated for the juvenile migration period (October through May) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Effects of H3 compared to Existing Conditions consist of primarily increases in mean monthly flow during October (6% to 30%), during January through March in wetter water years (7% to 20%), and during April and May in drier water years (to 18%). There would be negligible effects (<5%) or decreases in mean monthly flow during November and December in wet years (to -20%), during January through March in below normal years (to -20%), and during May in wet years (-26%). Effects in drier water years would be most critical for migration conditions and would include negligible effects and relatively small increases (to 18%) or decreases (to -20%) in flow with no persistent trend throughout the migration period with the exception of small to moderate reductions during most months in below normal water years that would have negative effects on juvenile migration conditions at this location for that specific water year type.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were evaluated during the October through May juvenile steelhead migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H3 in all months except November and December, in which temperatures under H3 would be 5% greater than temperatures under Existing Conditions.

Adults

Effects of H3 on flows in the Feather River above the Thermalito Afterbay during the adult migration period (September through March) would be as described for that portion of the juvenile migration period immediately above with the addition of September. Effects of H3 in September consist of substantial increases in mean monthly flow during wet (209%), above normal (128%) and critical (15%) years, and decreases during below normal (-27%) and dry (-46%) years. The substantial reductions in flows during drier water years would have biologically meaningful effects on migration conditions during September through March. Increases in flow in wet years are substantial (128 to 208%) and effects on migration would be positive. Effects of H3 on water temperatures were evaluated for adult migration conditions.

Effects of H3 on flows in the Feather River at the confluence during the adult migration period (September through March) would be as described for that portion of the juvenile migration period immediately above with the addition of September. Effects of H3 in September consist of variable effects depending on water year type with increases in mean monthly flow during wet (108%), above normal (68%), and critical (12%) years, and decreases during below normal (-18%) and dry (-28%) years. Effects of these substantial increases on flows in wetter water years (108%, 68%) would be beneficial. Effects of the reductions in flows for some drier water years would contribute incremental negative effects for the adult migration period and would have negative effects on migration condition in below normal water years.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H3 in all months except November and December, in which temperatures under H3 would be 5% greater than temperatures under Existing Conditions.

These results indicate the effects of H3 on water temperatures in the Feather River would have negative effects on juvenile and adult migration conditions that could affect survival.

Kelts

Effects of H3 on flows during the kelt migration period of March and April consist of primarily negligible effects (<5%) or increases in mean monthly flow (to 58%) with the exception of a single decrease in flow during March in below normal years (-53%), that would occur following equally substantial flow reductions in below normal years during January and February. This negative effect would be partially offset by a substantial increase in flow during April in below normal years (43%) but could substantially affect migration conditions for the first half of the relatively short migration period for that water year type. Overall this effect is not expected to have biologically meaningful negative effects on kelt migration success. Effects of H3 on flows during the kelt migration period of March and April consist of primarily negligible effects (<5%) and increases in mean monthly flow (to 13%) with the exception of a single, moderate decrease (-20%) in below normal years that would not have biologically meaningful effects on kelt migration conditions.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were evaluated during the March through April steelhead kelt downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H3 in any month or water year type throughout the period.

Overall in the Feather River, the effect of H3 on flows would consist of persistent and/or substantial reductions in flows during drier water years, and increased exposure to critical water temperatures, that would affect juvenile and adult migration conditions, particularly in drier water years, and would generally not affect kelt migration.

American River

Juveniles

Flows in the American River at the confluence with the Sacramento River were evaluated for the juvenile migration period (October through May) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Effects of H3 compared to Existing Conditions consist of primarily increases in mean monthly flow during October (to 26%), wetter water years during January (to 25%), and all but critical years during February and March (to 27%). There would be reductions in flow for most/all water year types during November (to -33%), December (to -25%), drier water years during January (to -19%), critical years during February and March (to -15%), and all but dry years during May (to -31%). Flow reductions during most of the migration period in drier water year types would have biologically meaningful effects on juvenile migration.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were evaluated during the October through May juvenile steelhead migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H3 would be 5% to 11% lower than those under Existing Conditions in all months during the period except December and April, in which there would be no difference in water temperatures between Existing Conditions and H3.

Adults

Effects of H3 on flows in the American River during the adult migration period (September through March) would be as described for that portion of the juvenile migration period immediately above with the addition of September. Effects of H3 in September consist of substantial decreases in mean monthly flow during all water year types ranging from -25% to -33%. This combined with the conclusions for the rest of the migration period described above as part of the juvenile migration period indicates that effects of H3 on flow reductions during most of the migration period in drier water year types would have biologically meaningful effects on adult migration. Effects of H3 on water temperatures were evaluated for adult migration conditions.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H3 would be 5% to 11% lower than those under Existing Conditions in all months during the period except December, in which there would be no difference in water temperatures between Existing Conditions and H3.

Kelts

Effects of H3 on flows during the kelt migration period of March and April consist primarily of relatively small increases (to 16%) and decreases (to -9%) in flow that would tend to balance out effects during the kelt migration period and would not result in biologically meaningful negative effects.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were evaluated during the March and April steelhead kelt downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H3 would be 5% higher than those under Existing Conditions in March but temperatures would be similar between Existing Conditions and H3 during April.

Overall in the American River, the impacts of H3 on flows would affect juvenile and adult migration conditions and would negatively affect kelt migration conditions.

Stanislaus River

Juveniles

Flows in the Stanislaus River at the confluence with the San Joaquin River were evaluated for the October through May steelhead juvenile downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H3 would be 6% to 16% lower than flows under Existing Conditions depending on month except during January, in which there would be no difference.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were evaluated during the October through May steelhead juvenile downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H3 would be 6% higher than those under Existing Conditions in all months during the period except October, in which temperature would be similar between Existing Conditions and H3.

Adults

Flows in the Stanislaus River at the confluence with the San Joaquin River were evaluated for the September through March steelhead adult upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H3 would be 6% to 16% lower than flows under Existing Conditions depending on month, except during January, in which there would be no differences.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H3 would be 6% higher than those under Existing Conditions in all months during the period except October, in which temperature would be similar between Existing Conditions and H3.

Kelt

Flows in the Stanislaus River at the confluence with the San Joaquin River were evaluated for the March and April steelhead kelt downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H3 would be 8% to 11% lower than flows under Existing Conditions during March and April, respectively.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were evaluated during the March and April steelhead kelt downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H3 would be 6% higher than those under Existing Conditions during March and April.

San Joaquin River

Water temperature modeling was not conducted in the San Joaquin River.

Juveniles

Flows in the San Joaquin River at Vernalis were evaluated for the October through May steelhead juvenile downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H3 would 5% greater than flows under Existing Conditions during January, and similar in the remaining 7 months of the period.

Adults

Flows in the San Joaquin River at Vernalis were evaluated for the September through March steelhead adult upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H3 would 5% greater than flows under Existing Conditions during January, 8% lower during September, and similar in the remaining 5 months of the period.

Kelt

Flows in the San Joaquin River at Vernalis were evaluated for the March and April steelhead kelt downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H3 similar to flows under Existing Conditions in both March and April.

Mokelumne River

Water temperature modeling was not conducted in the Mokelumne River.

Juveniles

Flows in the Mokelumne River at Delta were evaluated for the October through May steelhead juvenile downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H3 would be similar to flows under Existing Conditions during October and March, 8% to 12% lower than flows under Existing Conditions during November, April, and May, and 12% to 14% higher than flows under Existing Conditions during December through February.

Adults

Flows in the Mokelumne River at Delta were evaluated for the September through March steelhead adult upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H3 would be similar to flows under Existing Conditions during October and March, 9% to 27% lower than flows under Existing Conditions during September and November, and 12% to 14% higher than flows under Existing Conditions during December through February.

Kelt

Flows in the Mokelumne River at Delta were evaluated for the March and April steelhead kelt downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H3 would be similar to flows under Existing Conditions during March and 8% lower during April.

H1/LOS

Sacramento River

Juveniles

Flows under H1 in the Sacramento River upstream of Red Bluff during the October through May juvenile steelhead migration period would generally be similar to flows under H3, except during November, in which flows would be up to 12% lower depending on water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*. This reduction would not occur at a high enough frequency to have a meaningful effect on juvenile steelhead migration habitat.

Mean monthly water temperatures in the Sacramento River upstream of Red Bluff were evaluated during the October through May juvenile steelhead migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H1 in all months but October, in which temperatures under H1 would be 5% greater than those under Existing Conditions.

Overall, results for H1 would be similar to those for H3.

Adults

Flows under H1 in the Sacramento River upstream of Red Bluff during the September through March adult steelhead migration period would generally be similar to flows under H3, except during November, in which flows would be up to 12% lower depending on water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). This reduction would not occur at a high enough frequency to have a meaningful effect on juvenile steelhead migration habitat.

Mean monthly water temperatures in the Sacramento River upstream of Red Bluff were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H1 in all months except September and October, in which temperatures under H1 would be 5% greater than those under Existing Conditions.

Overall results for H1 would be similar to those for H3.

Kelts

Flows under H1 in the Sacramento River upstream of Red Bluff during the March through April adult steelhead migration period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River upstream of Red Bluff were evaluated during the March through April steelhead kelt downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H1 in any month or water year type throughout the period.

Overall results for H1 would be similar to those for H3.

Clear Creek

No water temperature modeling was conducted in Clear Creek.

Juveniles

Flows under H1 in Clear Creek at Whiskeytown during the October through May juvenile migration period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Overall results for H1 would be similar to those for H3.

Adults

Flows under H1 in Clear Creek at Whiskeytown during the September through March adult migration period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Overall results for H1 would be similar to those for H3.

Kelts

Flows under H1 in Clear Creek at Whiskeytown during the March through April kelt migration period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Overall results for H1 would be similar to those for H3.

Feather River

Juveniles

Flows under H1 in the Feather River at Thermalito Afterbay and the confluence with the Sacramento River during the October through May juvenile migration period would generally be similar to or greater than flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were evaluated during the October through May juvenile steelhead migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H1 in all months except December, in which temperatures under H1 would be 5% greater than temperatures under Existing Conditions.

Overall results for H1 would be similar to those for H3.

Adults

Flows under H1 in the Feather River at Thermalito Afterbay and the confluence with the Sacramento River during the September through March adult migration period would generally be similar to or greater than flows under H3, except during September, in which flows would be up to 83% lower depending on water year type and location (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Although large, these flow reductions would not have biologically meaningful effects because they occur in only one of seven months.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H1 in all months except September and December, in which temperatures under H1 would be 5% greater than temperatures under Existing Conditions.

Overall results for H1 would be similar to those for H3.

Kelts

Flows under H1 in the Feather River at Thermalito Afterbay and the confluence with the Sacramento River during the March through April kelt migration period would generally be similar to or greater than flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were evaluated during the March through April steelhead kelt downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H1 in any month or water year type throughout the period.

Overall results for H1 would be similar to those for H3.

American River

Juveniles

Flows under H1 in the American River at the confluence with the Sacramento River during the October through May juvenile migration period would generally be similar to flows under H3 with few exceptions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were evaluated during the October through May juvenile steelhead migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H1would be 5% to 10% lower than those under Existing Conditions in all months during the period except April, in which there would be no difference in water temperatures between Existing Conditions and H1.

Overall results for H1 would be similar to those for H3.

Adults

Flows under H1 in the American River at the confluence with the Sacramento River during the September through March adult migration period would generally be similar to flows under H3 with few exceptions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H1 would be 5% to 10% lower than those under Existing Conditions in all months during the period.

Overall results for H1 would be similar to those for H3.

Kelts

Flows under H1 in the American River at the confluence with the Sacramento River during the March through April kelt migration period would generally be similar to flows under H3 with few exceptions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were evaluated during the March and April steelhead kelt downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H1 would be 5% higher than those under Existing Conditions in March but temperatures would be similar between Existing Conditions and H1 during April.

Overall results for H1 would be similar to those for H3.

Stanislaus River

Juveniles

Flows in the Stanislaus River at the confluence with the San Joaquin River were evaluated for the October through May steelhead juvenile downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H1 would be 6% to 16% lower than flows under Existing Conditions depending on month except during January, in which there would be no difference.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were evaluated during the October through May steelhead juvenile downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H1 would be 6% higher than those under Existing Conditions in all months during the period except October, in which temperature would be similar between Existing Conditions and H1.

Adults

Flows in the Stanislaus River at the confluence with the San Joaquin River were evaluated for the September through March steelhead adult upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H1 would be 6% to 16% lower than flows under Existing Conditions depending on month, except during January, in which there would be no differences.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H1 would be 6% higher than those under Existing Conditions in all months during the period except October, in which temperature would be similar between Existing Conditions and H1.

Kelt

Flows in the Stanislaus River at the confluence with the San Joaquin River were evaluated for the March and April steelhead kelt downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H1 would be 8% to 11% lower than flows under Existing Conditions during March and April, respectively.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were evaluated during the March and April steelhead kelt downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H1 would be 6% higher than those under Existing Conditions during March and April.

San Joaquin River

Water temperature modeling was not conducted in the San Joaquin River.

Juveniles

Flows in the San Joaquin River at Vernalis were evaluated for the October through May steelhead juvenile downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H1 would 5% greater than flows under Existing Conditions during January, 5% lower during October, and similar in the remaining 6 months of the period.

Adults

Flows in the San Joaquin River at Vernalis were evaluated for the September through March steelhead adult upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H1 would 5% greater than flows under Existing Conditions during January, 8% lower during September, and similar in the remaining 5 months of the period.

Kelt

Flows in the San Joaquin River at Vernalis were evaluated for the March and April steelhead kelt downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H1 similar to flows under Existing Conditions in both March and April.

Mokelumne River

Water temperature modeling was not conducted in the Mokelumne River.

Juveniles

Flows in the Mokelumne River at Delta were evaluated for the October through May steelhead juvenile downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H1 would be similar to flows under Existing Conditions during October and March, 8% to 12% lower than flows under Existing Conditions during November, April, and May, and 12% to 14% higher than flows under Existing Conditions during December through February.

Adults

Flows in the Mokelumne River at Delta were evaluated for the September through March steelhead adult upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H1 would be similar to flows under Existing Conditions during October and March, 10% to 27% lower than flows under Existing Conditions during September and November, and 12% to 14% higher than flows under Existing Conditions during December through February.

Kelt

Flows in the Mokelumne River at Delta were evaluated for the March and April steelhead kelt downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H1 would be similar to flows under Existing Conditions during March and 8% lower during April.

H4/HOS

Sacramento River

Juveniles

Flows under H4 in the Sacramento River upstream of Red Bluff during the October through May juvenile steelhead migration period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). \

Mean monthly water temperatures in the Sacramento River upstream of Red Bluff were evaluated during the October through May juvenile steelhead migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H4 in all months but October, in which temperatures under H4 would be 5% greater than those under Existing Conditions.

Overall, results for H4 would be similar to those for H3.

Adults

Flows under H4 in the Sacramento River upstream of Red Bluff during the September through March adult steelhead migration period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River upstream of Red Bluff were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H4 in all months except October, in which temperatures under H4 would be 5% greater than those under Existing Conditions.

Overall results for H4 would be similar to those for H3.

Kelts

Flows under H4 in the Sacramento River upstream of Red Bluff during the March through April adult steelhead migration period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River upstream of Red Bluff were evaluated during the March through April steelhead kelt downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H4 in any month or water year type throughout the period.

Overall results for H4 would be similar to those for H3.

Clear Creek

No water temperature modeling was conducted in Clear Creek.

Juveniles

Flows under H4 in Clear Creek at Whiskeytown during the October through May juvenile migration period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Overall results for H4 would be similar to those for H3.

Adults

Flows under H4 in Clear Creek at Whiskeytown during the September through March adult migration period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Overall results for H4 would be similar to those for H3.

Kelts

Flows under H4 in Clear Creek at Whiskeytown during the March through April kelt migration period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Overall results for H4 would be similar to those for H3.

Feather River

Juveniles

Flows under H4 in the Feather River at Thermalito Afterbay and the confluence with the Sacramento River during the October through May juvenile migration period would generally be similar to or greater than flows under H3, except during October, in which flows would be up to 27% lower depending on water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These flow reductions would not cause biologically meaningful effects on juvenile steelhead migration conditions because they occur during only one of eight months during the period.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were evaluated during the October through May juvenile steelhead migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H4 in all months except October through December, in which temperatures under H4 would be 5% greater than temperatures under Existing Conditions.

Overall results for H4 would be similar to those for H3.

Adults

Flows under H4 in the Feather River at Thermalito Afterbay and the confluence with the Sacramento River during the September through March adult migration period would generally be similar to flows under H3, except during September and October, in which flows would be up to 32% lower depending on water year type and location (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These flow reductions would be high enough and would occur at a high enough frequency to have biologically meaningful effects on adult migration conditions.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H4 in all months except October through December, in which temperatures under H4 would be 5% greater than temperatures under Existing Conditions.

Overall results for H4 would be worse for adult migration conditions than those for H3.

Kelts

Flows under H4 in the Feather River at Thermalito Afterbay and the confluence with the Sacramento River during the March through April kelt migration period would generally be similar to or greater than flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were evaluated during the March through April steelhead kelt downstream migration period

(Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H4 in any month or water year type throughout the period.

Overall results for H4 would be similar to those for H3.

American River

Juveniles

Flows under H4 in the American River at the confluence with the Sacramento River during the October through May juvenile migration period would generally be similar to flows under H3, except during October in which flows would be up to 13% lower under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These reductions would not be large or frequent enough to have biologically meaningful effects on juvenile steelhead migration conditions.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were evaluated during the October through May juvenile steelhead migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H4 would be 5% to 11% lower than those under Existing Conditions in all months during the period except April, in which there would be no difference in water temperatures between Existing Conditions and H4.

Overall results for H4 would be similar to those for H3.

Adults

Flows under H4 in the American River at the confluence with the Sacramento River during the September through March adult migration period would generally be similar to flows under H3, except during October in which flows would be up to 13% lower under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These reductions would not be large or frequent enough to have biologically meaningful effects on adult steelhead migration conditions.

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H4 would be 5% to 11% lower than those under Existing Conditions in all months during the period.

Overall results for H4 would be similar to those for H3.

Kelts

Flows under H4 in the American River at the confluence with the Sacramento River during the March through April kelt migration period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the American River at the confluence with the Sacramento River were evaluated during the March and April steelhead kelt downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H4 would be 5% higher than those under Existing Conditions in March but temperatures would be similar between Existing Conditions and H4 during April.

Overall results for H4 would be similar to those for H3.

Stanislaus River

Juveniles

Flows in the Stanislaus River at the confluence with the San Joaquin River were evaluated for the October through May steelhead juvenile downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H4 would be 6% to 18% lower than flows under Existing Conditions depending on month, except during January, in which there would be no difference.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were evaluated during the October through May steelhead juvenile downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H4 would be 6% higher than those under Existing Conditions in all months during the period except October, in which temperature would be similar between Existing Conditions and H4.

Adults

Flows in the Stanislaus River at the confluence with the San Joaquin River were evaluated for the September through March steelhead adult upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H4 would be 6% to 16% lower than flows under Existing Conditions depending on month, except during January, in which there would be no differences.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were evaluated during the September through March steelhead adult upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H4 would be 6% higher than those under Existing Conditions in all months during the period except October, in which temperature would be similar between Existing Conditions and H4.

Kelt

Flows in the Stanislaus River at the confluence with the San Joaquin River were evaluated for the March and April steelhead kelt downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H4 would be 8% to 11% lower than flows under Existing Conditions during March and April, respectively.

Mean monthly water temperatures in the Stanislaus River at the confluence with the San Joaquin River were evaluated during the March and April steelhead kelt downstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H4 would be 6% higher than those under Existing Conditions during March and April.

San Joaquin River

Water temperature modeling was not conducted in the San Joaquin River.

Juveniles

Flows in the San Joaquin River at Vernalis were evaluated for the October through May steelhead juvenile downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H4 would 6% greater than flows under Existing Conditions during January and similar in the remaining 7 months of the period.

Adults

Flows in the San Joaquin River at Vernalis were evaluated for the September through March steelhead adult upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H4 would 6% greater than flows under Existing Conditions during January, 8% lower during September, and similar in the remaining 5 months of the period.

Kelt

Flows in the San Joaquin River at Vernalis were evaluated for the March and April steelhead kelt downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H4 similar to flows under Existing Conditions in both March and April.

Mokelumne River

Water temperature modeling was not conducted in the Mokelumne River.

Juveniles

Flows in the Mokelumne River at Delta were evaluated for the October through May steelhead juvenile downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H4 would be similar to flows under Existing Conditions during October and March, 8% to 12% lower than flows under Existing Conditions during November, April, and May, and 12% to 14% higher than flows under Existing Conditions during December through February.

Adults

Flows in the Mokelumne River at Delta were evaluated for the September through March steelhead adult upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H4 would be similar to flows under Existing Conditions during October and March, 10% to 27% lower than flows under Existing Conditions during September and November, and 12% to 14% higher than flows under Existing Conditions during December through February.

Kelt

Flows in the Mokelumne River at Delta were evaluated for the March and April steelhead kelt downstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean monthly flows under H4 would be similar to flows under Existing Conditions during March and 8% lower during April.

Through-Delta

Based on DPM results for Chinook salmon, steelhead survival would not be expected to decrease more than 1%. Assuming similar effects on steelhead, Alternative 4 would have a minimal effect on steelhead migration success through the Delta. Therefore the impact to juvenile steelhead migration through the Delta would be negligible.

The proportion of Sacramento River water in the Delta under Alternative 4 Scenario H3 would be similar to NAA (<10% difference) during the entire adult steelhead upstream migration, except in March when the proportion of Sacramento River flows would be reduced by 10%. The reduction in olfactory cues in March may negatively affect adult steelhead migration conditions, however this month falls outside the peak migration season for this species, thus limiting its potential impact. Conditions between all flow scenarios under Alternative 4 (e.g., Scenarios H1 and H3) would be similar; there would only be small changes in olfactory cues for migrating adult salmon. Rio Vista flows under Scenario H3 would also be similar or improved compared to Alternative 1A for all the months of the adult steelhead upstream and kelt downstream migrations, except October. Flows at Rio Vista under Scenarios H1 and H4 are similar to conditions under Scenario H3 in all months of the steelhead migration period, except in September when flows under Scenario H1 would be very substantially reduced. Due to the overall similarity in olfactory cues and Rio Vista flows between Alternative 1A and Alternative 4 during the entire adult and kelt migration periods, effects on migration success would be expected to be similar to Alternative 1A. Olfactory cues and flows in the San Joaquin River basin would be improved or similar to Alternative 1A and Existing Conditions. Overall, the impact to steelhead adult and kelt migration under Alternative 4 is considered negligible.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-96 CEQA analysis indicate the difference between the CEQA baseline and Alternative 4 could be significant because, under the CEQA baseline, the alternative could substantially interfere with the movement of fish, contrary to the NEPA conclusion set forth above. Alternative 4 would have negative effects on juvenile and adult migration conditions in drier water years in the Feather River and the American River, and increased occurrence of multi-year critical temperature exceedances would contribute to negative effects in the Feather River. Reduced migration conditions would delay or eliminate successful migration necessary to complete the steelhead life cycle. Alternative 4 would not affect migration conditions for steelhead in the Sacramento River and in Clear Creek. Water temperatures and exceedances of NMFS thresholds where applicable, would be greater in the Feather, American, and Stanislaus Rivers under Alternative 4 relative to the CEQA baseline. There would be no effects on through-Delta migration conditions because changes in juvenile survival and adult olfactory cues would be negligible.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to H3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in

the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and H3 indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and H3. This indicates that the differences between Existing Conditions and Alternative 4 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 4, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on migration habitat for steelhead. This impact is found to be less than significant and no mitigation is required.

Restoration Measures (CM2, CM4–CM7, and CM10)

Alternative 4 has the same Restoration Measures as Alternative 1A. Because no substantial differences in restoration-related fish effects are anticipated anywhere in the affected environment under Alternative 4 compared to those described in detail for Alternative 1A, the fish effects of restoration measures described for steelhead under Alternative 1A (Impacts AQUA-97 through AQUA-99) also appropriately characterize effects under Alternative 4.

The following impacts are those presented under Alternative 1A that are identical for Alternative 4.

Impact AQUA-97: Effects of Construction of Restoration Measures on Steelhead

Impact AQUA-98: Effects of Contaminants Associated with Restoration Measures on Steelhead

Impact AQUA-99: Effects of Restored Habitat Conditions on Steelhead

NEPA Effects: Detailed discussions regarding the potential effects of these three impact mechanisms on steelhead are the same as those described under Alternative 1A (Impacts AQUA-97 through AQUA-99). The effects would not be adverse, and would generally be beneficial. Specifically for AQUA-98, the effects of contaminants on steelhead with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on steelhead are uncertain.

CEQA Conclusion: All of the impact mechanisms listed above would be at least slightly beneficial, or less than significant, and no mitigation is required.

Other Conservation Measures (CM12–CM19 and CM21)

Alternative 4 has the same other conservation measures as Alternative 1A. Because no substantial differences in other conservation-related fish effects are anticipated anywhere in the affected environment under Alternative 4 compared to those described in detail for Alternative 1A, the fish effects of other conservation measures described for steelhead under Alternative 1A (Impacts AQUA-100 through AQUA-108) also appropriately characterize effects under Alternative 4.

The following impacts are those presented under Alternative 1A that are identical for Alternative 4.

Impact AQUA-100: Effects of Methylmercury Management on Steelhead (CM12)

Impact AQUA-101: Effects of Invasive Aquatic Vegetation Management on Steelhead (CM13)

Impact AQUA-102: Effects of Dissolved Oxygen Level Management on Steelhead (CM14)

Impact AQUA-103: Effects of Localized Reduction of Predatory Fish on Steelhead (CM15)

Impact AQUA-104: Effects of Nonphysical Fish Barriers on Steelhead (CM16)

Impact AQUA-105: Effects of Illegal Harvest Reduction on Steelhead (CM17)

Impact AQUA-106: Effects of Conservation Hatcheries on Steelhead (CM18)

Impact AQUA-107: Effects of Urban Stormwater Treatment on Steelhead (CM19)

Impact AQUA-108: Effects of Removal/Relocation of Nonproject Diversions on Steelhead (CM21)

NEPA Effects: Detailed discussions regarding the potential effects of these nine impact mechanisms on steelhead are the same as those described under Alternative 1A (Impacts AQUA-100 through AQUA-108). The effects range from no effect, to not adverse, to beneficial.

CEQA Conclusion: The effects of the nine impact mechanisms listed above range from no impact, to less than significant, to beneficial, and no mitigation is required.

Sacramento Splittail

Construction and Maintenance of CM1

Impact AQUA-109: Effects of Construction of Water Conveyance Facilities on Sacramento Splittail

NEPA Effects: The potential effects of construction of the water conveyance facilities on Sacramento splittail would be similar to those described for Alternative 1A, Impact AQUA-109, except Alternative 4 would include three intakes compared to five intakes under Alternative 1A, so the effects would be proportionally less under this alternative. This would convert about 6,360 lineal feet of existing shoreline habitat into intake facility structures and would require about 17.1 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would 27.3 acres of dredging. As concluded for Alternative 1A, Impact AQUA-109, environmental commitments and mitigation measures would be available to avoid and minimize potential effects, and the effect would not be adverse for Sacramento splittail.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-109, the impact of the construction of the water conveyance facilities on splittail would not be significant except for construction noise associated with pile driving. Potential pile driving impacts would be less than Alternative 1A because only three intakes would be constructed rather than five. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in the discussion of Alternative 1A.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in the discussion of Alternative 1A.

Impact AQUA-110: Effects of Maintenance of Water Conveyance Facilities on Sacramento Splittail

NEPA Effects: The potential effects of the maintenance of water conveyance facilities under Alternative 4 would be the same as those described for Alternative 1A, Impact AQUA-110, except that only three intakes would need to be maintained under Alternative 4 rather than five under Alternative 1A. As concluded in Alternative 1A, Impact AQUA-110, the impact would not be adverse for Sacramento splittail.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-110, the impact of the maintenance of water conveyance facilities on Sacramento splittail would be less than significant and no mitigation is required.

Water Operations of CM1

Impact AQUA-111: Effects of Water Operations on Entrainment of Sacramento Splittail

Water Exports from SWP/CVP South Delta Facilities

The salvage of splittail is considered an indicator of reproductive success more than of relative impact (Sommer et al. 1997); thus splittail salvage across EIR/EIS alternatives was predicted using a historical relationship between Yolo Bypass inundation and salvage density at CVP and SWP (*BDCP Effects Analysis, Appendix 5B – Entrainment; Section 5B.5.4.5.2*). When averaged across all WY types, estimated entrainment of juvenile splittail at the south Delta facilities would be 385% greater under Scenario H3 compared to NAA (Table 11-4-90). The greatest increase in total entrainment occurred in above normal water years (1,881%). These increases in predicted salvage are caused by the expected increase in overall juvenile splittail abundance resulting from additional floodplain inundation in the wetter year types. The amount of Yolo Bypass inundation was explicitly modeled only for Scenario H3 because Sacramento River flows at the Fremont Weir under the other scenarios (H1,H2, and H4), were similar to or greater than those under Scenario H3. The per capita rate of splittail entrainment, which is an index of entrainment risk of an individual splittail and is directly related to the amount of water exported, averaged across all years would be reduced 38% for juveniles (Table 11-4-91) and 52% for adults (Tables 11-4-92) compared to NAA. Adult entrainment and juvenile per capita entrainment are anticipated to be reduced in all water year types due to lower South Delta exports. Because Sacramento River and OMR flows are higher under the H4 flow scenario for Alternative 4 compared to NAA, this scenario is expected to decrease total and per capita entrainment loss at the south Delta more so than the other flow scenarios (i.e., Scenarios H1-H3).

Table 11-4-90. Juvenile Sacramento Splittail Entrainment Index[a] (Yolo Bypass days of inundation method) at the SWP and CVP Salvage Facilities and Differences between Model Scenarios for Alternative 4 (Scenario H3) (See *BDCP Effects Analysis, Appendix 5B – Entrainment, Section 5B.6.1.7.1)*

	Absolute Difference (Percent Difference)	
Water Year Type	EXISTING CONDITIONS vs. A4 (H3)	NAA vs. A4 (H3)
Wet	4,348,574 (453%)	4,161,915 (363%)
Above Normal	690,530 (1,509%)	699,135 (1,881%)
Below Normal	11,906 (348%)	12,338 (413%)
Dry	1,429 (50%)	1,774 (70%)
Critical	-448 (-29%)	3 (0%)
All Years	1,482,150 (474%)	1,424,440 (385%)
	Shading indicates entrainment increased 10% or more.	

[a] Estimated annual number of fish lost, based on normalized data. Average (December–March).

Table 11-4-91. Juvenile Sacramento Splittail Entrainment Index[a] (Per Capita Method) at the SWP and CVP Salvage Facilities and Differences between Model Scenarios for Alternative 4 (Scenario H3) (See *BDCP Effects Analysis, Appendix 5B – Entrainment, Section 5B.6.1.7.1)*

	Absolute Difference (Percent Difference)	
Water Year Type	EXISTING CONDITIONS vs. A4 (H3)	NAA vs. A4 (H3)
Wet	-1,098,765 (-55%)	-774,445 (-46%)
Above Normal	-61,019 (-46%)	-43,187 (-38%)
Below Normal	-2,484 (-25%)	-2,166 (-22%)
Dry	-892 (-44%)	-401 (-26%)
Critical	-627 (-47%)	-369 (-34%)
All Years	-270,487 (-49%)	-168,940 (-38%)
	Shading indicates entrainment increased 10% or more.	

[a] Estimated annual number of fish lost, based on normalized data. Average (December–March).

Table 11-4-92. Adult Sacramento Splittail Entrainment Index[a] (salvage density method) at the SWP and CVP Salvage Facilities and Differences between Model Scenarios for Alternative 4 (Scenario H3) (See *BDCP Effects Analysis, Appendix 5B – Entrainment, Section 5B.6.1.7.1)*

	Absolute Difference (Percent Difference)	
Water Year Type	EXISTING CONDITIONS vs. A4 (H3)	NAA vs. A4 (H3)
Wet	-2,722 (-69%)	-2,857 (-70%)
Above Normal	-3,009 (-62%)	-3,024 (-63%)
Below Normal	-1,276 (-38%)	-1,011 (-32%)
Dry	-790 (-32%)	-625 (-27%)
Critical	-735 (-22%)	-512 (-16%)
All Years	-1,843 (-53%)	-1,765 (-52%)
	Shading indicates entrainment increased 10% or more.	

[a] Estimated annual number of fish lost, based on normalized data. Average (December–March).

Water Exports from SWP/CVP North Delta Intake Facilities

The north Delta intakes would be screened, and all splittail except larvae less than 10 mm long would be excluded from entrainment (*BDCP Effects Analysis – Appendix 5B Entrainment, Section B.6.2.4, hereby incorporated by reference*). The impact of Alternative 4 (3 intakes) is estimated to be lower compared to Alternative 1A (5 intakes), based on number of intakes. Potential impacts would be minimized by project's adaptive management plan, including monitoring of the new screens effectiveness and corrective measures if needed.

Water Export with a Dual Conveyance for the SWP North Bay Aqueduct

The effect of implementing dual conveyance for the NBA with an alternative Sacramento River intake would be the same as described under Alternative 1A (Impact AQUA-111). There would be potential for increased predation and impingement risk associated with the alternative intake. Screens on the Barker Slough pumping plant currently exclude fish greater than 25 mm, and the alternate intake on the Sacramento River would be screened to effectively exclude splittail greater than 10 mm in length (*BDCP Effects Analysis – Appendix 5B Entrainment, Section B.6.2.4, hereby incorporated by reference*). Therefore, for splittail it is concluded that the effect of dual North Bay Aqueduct conveyance would not be adverse.

Predation Associated with Entrainment

Per-capita entrainment-related predation loss of splittail at the south Delta facilities is not expected to be greater under Alternative 4 than the NAA because predicted per capita entrainment is lower due to lower south Delta exports. The predation loss would be lowest under Scenario H4 and highest under Scenarios H1 and H3. However, because predation of entrained splittail is not currently considered to be an important driver of splittail population dynamics, this variation in the predicted impact across Alternative 4 subscenarios, is not considered to be adverse in any of them.

Predation at the north Delta would be increased due to the installation of the proposed water export facilities on the Sacramento River, with three intakes for Alternative 4. These losses would be offset by the reduction in entrainment and predation loss at the SWP/CVP south Delta intakes, and the increased production of juvenile splittail resulting from CM2 (Yolo Bypass Fisheries Enhancement). Further, as described for Alternative 1A, the fishery agencies concluded that the predation was not a factor currently limiting splittail abundance.

NEPA Effects: In conclusion, the effect from entrainment and predation loss under Alternative 4 would not be adverse, because while predation loss of splittail would be potentially increased at the north Delta facilities, it would be offset by substantial reductions in per capita entrainment and associated predation at the south Delta facilities compared to the NAA, and increased production of juvenile splittail from the Yolo Bypass by CM2 (Yolo Bypass Fisheries Enhancement) actions.

CEQA Conclusion: Under Scenario H3 (described above as a conservative scenario relative to entrainment and entrainment-associated predation) total juvenile entrainment (based on Yolo Bypass inundation) would be 474% greater averaged across all years compared to Existing Conditions due to the expected substantially higher juvenile production under Alternative 4 from more floodplain inundation. Operational activities associated with reduced south Delta water exports would result in an overall decrease in the proportion of splittail population entrained for all water year types. For example, under Scenario H3, estimated juvenile entrainment (Per Capita method) and hence pre-screen predation losses would be 49% lower and adult entrainment and pre-screen predation losses would be 53% lower than Existing Conditions. Conditions under Scenario H1 would be similar to Scenario H3. Per capita entrainment and related predation loss at the south Delta would be further reduced under Scenarios H2 and H4 compared to Existing Conditions. Entrainment of splittail would also be reduced at the NBA. The impact and conclusion for predation associated with entrainment would be the same as described above.

In conclusion, the impact of Alternative 4 from entrainment and predation loss would be beneficial because of improvements in overall proportional entrainment, and no mitigation is required.

Impact AQUA-112: Effects of Water Operations on Spawning and Egg Incubation Habitat for Sacramento Splittail

Sacramento splittail spawn in floodplains and channel margins and in side-channel habitat upstream of the Delta, primarily in the Sacramento River and Feather River. Floodplain spawning overwhelmingly dominates production in wet years. During low-flow years when floodplains are not inundated, spawning in side channels and channel margins would be much more critical.

In general, Alternative 4 would have beneficial effects on splittail spawning habitat relative to the NAA by increasing the quantity and quality of spawning habitat in the Yolo Bypass. There would be negligible effects on channel margin and side-channel habitats in the Sacramento River at Wilkins Slough and the Feather River, with beneficial effects from moderate to substantial increases in mean monthly flow for some months and water year types for each location. There would be negligible negative effects on water temperatures in the Feather River and a beneficial effect from a decrease in exposure to critical high water temperatures.

H3/ESO

Floodplain Habitat

Effects of H3 on floodplain spawning habitat were evaluated for Yolo Bypass. Effects in Yolo Bypass were evaluated using a habitat suitability approach based on water depth (2 m threshold) and inundation duration (minimum of 30 days). Effects of flow velocity were ignored because flow velocity was generally very low throughout the modeled area for most conditions, with generally 80 to 90% of the total available area having flow velocities of 0.5 foot per second or less (a reasonable critical velocity for early life stages of splittail; Young and Cech 1996), and because habitat heterogeneity in the flooded Yolo Bypass is high (Sommer et al. 2004; 2005).

There would be three fewer 30–49 day events and one fewer in above normal years under H3 than under NAA, but four more events under H3 in below normal years, and one more event in dry and critical years categories (Table 11-4-93). There would be five fewer 50–69 day events under H3 than under NAA in wet years, one more event in above normal and below normal water years, and no difference in dry and critical years. And there would be seven, one, and one more >70 day inundation events under H3 relative to NAA in wet, above normal, and below normal water years, respectively, and no difference in dry and critical water years. These results indicate that overall project-related effects on occurrence of duration inundation events would benefit splittail spawning by increasing the occurrence of longer duration inundation events. The reduction in the frequency of 50-69 day events in wet years is misleading because it is due to the extension of duration of inundation, which results in the increased frequency of >70 day inundation events. In some cases, two 50-69 day events were combined into one >70 day event as a result of their extended durations. The >70 day inundation events likely contribute disproportionately to splittail production.

In terms of acreage of suitable splittail habitat in Yolo Bypass, there would be substantial increases in suitable spawning habitat acreages for H3 compared to NAA for all water year types (Table 11-4-94). Increases range from 5 to 832 acres. For wet, above normal, and below normal water years there would be project-related increases of 49%, 56%, and 192%, respectively. The increases in dry and critical years (7 and 5 acres, respectively) would establish small areas of suitable spawning habitat during these water year types compared to no suitable habitat under NAA. These results indicate that increases in inundated acreage in each water year type would result in increased habitat and have a beneficial effect on splittail spawning.

Table 11-4-93. Differences in Frequencies of Inundation Events (for 82-Year Simulations) of Different Durations on the Yolo Bypass under Different Scenarios and Water Year Types, February through June, from 15 2-D and Daily CALSIM II Modeling Runs

Number of Days of Continuous Inundation	Change in Number of Inundation Events for Each Scenario	
	EXISTING CONDITIONS vs. H3	NAA vs. H3
30–49 Days		
Wet	-5	-3
Above Normal	-1	-1
Below Normal	4	4
Dry	1	1
Critical	1	1
50–69 Days		
Wet	-5	-5
Above Normal	1	1
Below Normal	1	1
Dry	0	0
Critical	0	0
≥70 Days		
Wet	8	7
Above Normal	1	1
Below Normal	1	1
Dry	0	0
Critical	0	0

Table 11-4-94. Increase in Splittail Weighted Habitat Area (acres and percent) in Yolo Bypass from Existing Biological Conditions to Alternative 4 by Water Year Type from 15 2-D and Daily CALSIM II Modeling Runs

Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
Wet	979 (64%)	832 (49%)
Above Normal	690 (62%)	644 (56%)
Below Normal	244 (193%)	244 (193%)
Dry	7 (NA[a])	7 (NA[a])
Critical	5 (NA[a])	5 (NA[a])

[a] NA percent differences could not be computed because no splittail weighted habitat occurred in the bypass for NAA and Existing Conditions in those years (dividing by 0).

A potential effect of Alternative 4 is changes in inundation of the Sutter Bypass as a result of increased flow diversion at the Fremont Weir. The Fremont Weir notch with gates opened would increase the amount Sacramento River flow diverted from the river into the bypass when the river's flow is greater than about 14,600 cfs (Munévar pers. comm.). As much as about 6,000 cfs more flow would be diverted from the river with the opened notch than without the notch, resulting in a 6,000 cfs decrease in Sacramento River flow at the weir. A decrease of 6,000 cfs in the river, according to rating curves developed for the river at the Fremont Weir, could result in as much as 3 feet of reduction in river stage (Munévar pers. comm.), although understanding of how notch flows would affect river stage is incomplete (Kirkland pers. comm.). In any case, an analysis was conducted to determine whether there would be effects to the Sutter Bypass. Daily average inundated surface in the lower Sutter Bypass during December through June was estimated area for all scenarios. The analysis predicts that there would be very little differences between NAA and H3 in daily average inundation (Table 11-4-95). Therefore, H3 would not affect splittail spawning and rearing habitat in the Sutter Bypass.

Table 11-4-95. Differences (and Percent Change) in Daily Average (December–June) Lower Sutter Bypass Inundation (acres)

Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
Wet	-83 (-3.5)	13 (0.6)
Above Normal	49 (3.7)	42 (3.1)
Below Normal	-37 (-11.0)	6 (2.0)
Dry	-12 (-8.7)	-3 (-2.5)
Critical	1 (5.3)	0 (0.8)
All	1 (0.1)	0 (0)

Channel Margin and Side-Channel Habitat

Splittail spawning and larval and juvenile rearing also occur in channel margin and side-channel habitat upstream of the Delta. These habitats are likely to be especially important during dry years, when flows are too low to inundate the floodplains (Sommer et al. 2007). Side-channel habitats are affected by changes in flow because greater flows cause more flooding, thereby increasing availability of such habitat, and because rapid reductions in flow dewater the habitats, potentially stranding splittail eggs and rearing larvae. Effects of the BDCP on flows in years with low-flows are expected to be most important to the splittail population because in years of high-flows, when most production comes from floodplain habitats, the upstream side-channel habitats contribute relatively little production.

Effects on channel margin and side-channel habitat were evaluated by comparing flow conditions for the Sacramento River at Wilkins Slough and the Feather River at the confluence with the Sacramento River for the time-frame February through June. These are the most important months for splittail spawning and larval rearing (Sommer pers. comm.), and juveniles likely emigrate from the side-channel habitats during May and June if conditions become unfavorable.

Differences between model scenarios for monthly average flows during February through June by water-year type were determined for the Sacramento River at Wilkins Slough and for the Feather River at the confluence.

Flow comparisons of H3 to Existing Conditions in the Sacramento River at Wilkins Slough (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for February through June, indicate that H3 would have primarily negligible effects (<5%) or increases in monthly flow (to 39%), with the exception of a decrease in flow (-6%) during March in below normal years and a large decrease (-16%) during May in wet years when effects of flow reductions on rearing conditions would be less critical. These decreases in flow may reduce spawning success of splittail in wet water years. Flows during May and June would be up to 23% greater than flows under NAA depending on water year type. These increased flows would have beneficial effects on splittail. Modeling results also show that Sacramento splittail spawning temperature tolerances would not be exceeded in the Sacramento River under Alternative 4.

Flows in the Feather River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) during February through June would follow similar patterns to those of the Sacramento River at Wilkins Slough. Flows under H3 would generally be similar to or greater than flows under NAA. Flows under H3 during April, May, and June would be up to 65% greater than flows under NAA, which is a beneficial effect to splittail.

Simulated daily and monthly water temperatures in Sacramento River at Hamilton City and Feather River at the confluence with the Sacramento River, respectively, were used to investigate the potential effects of H3 on the suitability of water temperatures for splittail spawning and egg incubation. A range of 45°F to 75°F was selected as the suitable range for splittail spawning and egg incubation.

There would be no biologically meaningful difference (>5% absolute scale) between NAA and H3 in the frequency of water temperatures in the Sacramento River being within the suitable 45°F to 75°F regardless of water year type (Table 11-4-96). In the Feather River, there would be differences between NAA and H3 in temperatures below 45°F. There would be a 7% and 6% reduction in the exceedance above the 75°F threshold for above and below normal water years, respectively, but no other differences.

Table 11-4-96. Difference (Percent Difference) in Percent of Days or Months[a] during February to June in Which Temperature Would Be below 45°F or above 75°F in the Sacramento River at Hamilton City and Feather River at the Confluence with the Sacramento River[b]

	EXISTING CONDITIONS vs. H3	NAA vs. H3
Sacramento River at Hamilton City		
Temperatures below 45°F		
Wet	-3.5 (-75%)	0 (0%)
Above Normal	-3.9 (-84%)	0.2 (33%)
Below Normal	-4.3 (-85%)	0 (0%)
Dry	-2 (-68%)	0 (0%)
Critical	-1.5 (-73%)	0.2 (45%)
All	-3.1 (-78%)	0.1 (12%)
Temperatures above 75°F		
Wet	0 (NA)	0 (NA)
Above Normal	0 (NA)	0 (NA)
Below Normal	0 (NA)	0 (NA)
Dry	0 (NA)	0 (NA)
Critical	0 (NA)	0 (NA)
All	0 (NA)	0 (NA)
Feather River at Sacramento River Confluence		
Temperatures below 45°F		
Wet	0 (NA)	0 (NA)
Above Normal	0 (NA)	0 (NA)
Below Normal	0 (NA)	0 (NA)
Dry	0 (NA)	0 (NA)
Critical	0 (NA)	0 (NA)
All	0 (NA)	0 (NA)
Temperatures above 75°F		
Wet	14.6 (475%)	0 (0%)
Above Normal	10.9 (NA)	-7.3 (-40%)
Below Normal	20 (NA)	-5.7 (-22%)
Dry	27.8 (626%)	-1.1 (-3%)
Critical	25 (250%)	0 (0%)
All	19.5 (564%)	-2.2 (-9%)

NA = could not be calculated because the denominator was 0.

[a] Days were used in the Sacramento River and months were used in the Feather River.

[b] Based on the modeling period of 1922 to 2003.

These results indicate that H3 would cause negligible effects on splittail spawning conditions in channel margin and side-channel habitats resulting from changes in flow and water temperatures. Effects of H3 on mean monthly flow would consist of negligible effects or increases in flow (increases up to 23% in the Sacramento River and to 65% in the Feather River) for some months and water year types in the spawning period that would have beneficial effects on rearing conditions. There would be negligible or beneficial project-related effects on exceedance of critical water temperatures, and a beneficial effect from a decrease (-60%) in exposure to critical high water temperatures in the Feather River.

Stranding Potential

As indicated above, rapid reductions in flow can dewater channel margin and side-channel habitats, potentially stranding splittail eggs and rearing larvae. Due to a lack of quantitative tools and historical data to evaluate possible stranding effects, the following provides a narrative summary of potential effects. The Yolo Bypass is exceptionally well-drained because of grading for agriculture, which likely helps limit stranding mortality of splittail. Moreover, water stage decreases on the bypass are relatively gradual (Sommer et al. 2001). Stranding of Sacramento splittail in perennial ponds on the Yolo Bypass does not appear to be a problem under Existing Conditions (Feyrer et al. 2004). Yolo Bypass improvements would be designed, in part, to further reduce the risk of stranding by allowing water to inundate certain areas of the bypass to maximize biological benefits, while keeping water away from other areas to reduce stranding in isolated ponds. Actions under H3 to increase the frequency of Yolo Bypass inundation would increase the frequency of potential stranding events. For splittail, an increase in inundation frequency would also increase the production of Sacramento splittail in the bypass. While total stranding losses may be greater under H3 than under NAA, the total number of splittail would be expected to be greater under H3.

In the Yolo Bypass, Sommer et al. (2005) found these potential losses are offset by the improvement in rearing conditions. Henning et al. (2006) also noted the potential for stranding risk as wetlands desiccate and oxygen concentrations decline, but the seasonal timing of use by juveniles may decrease these risks. Sommer et al. (2005) addressed the question of stranding and concluded the potential improvements in habitat capacity outweighed the potential stranding problems that may exist in some years.

H1/LOS

Floodplain Habitat

Flows in the Sacramento River at Fremont Weir under H1 would generally be similar to or greater than flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). As a result, no inundation analyses in the Yolo Bypass were conducted for H1. Overall, floodplain habitat conditions for splittail under H1 would be similar to or better than conditions under H3.

Channel Margin and Side-Channel Habitat

Flows under H1 in the Sacramento River at Wilkins Slough during February through June would be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

There would be no biologically meaningful difference (>5% absolute scale) between NAA and H1 in the frequency of water temperatures in the Sacramento River being within the suitable 45°F to 75°F regardless of water year type (Table 11-4-97). In the Feather River, there would be differences between NAA and H1 in temperatures below 45°F. There would be a 7% increase in the exceedance above the 75°F threshold for wet and above normal water years under H1 relative to NAA, but no other differences.

Table 11-4-97. Difference (Percent Difference) in Percent of Days or Months[a] during February to June in Which Temperature Would Be below 45°F or above 75°F in the Sacramento River at Hamilton City and Feather River at the Confluence with the Sacramento River[b]

	EXISTING CONDITIONS vs. H1	NAA vs. H1	EXISTING CONDITIONS vs. H4	NAA vs. H4
Sacramento River at Hamilton City				
Temperatures below 45°F				
Wet	-3.5 (-75%)	0 (0%)	-3.5 (-75%)	0 (0%)
Above Normal	-4.1 (-88%)	0 (0%)	-4 (-86%)	0.1 (16%)
Below Normal	-4.3 (-85%)	0 (0%)	-4.3 (-85%)	0 (0%)
Dry	-2 (-68%)	0 (0%)	-2 (-68%)	0 (0%)
Critical	-1.5 (-73%)	0.2 (45%)	-1.6 (-78%)	0.1 (23%)
All	-3.1 (-78%)	0.1 (12%)	-3.1 (-78%)	0.1 (12%)
Temperatures above 75°F				
Wet	0 (NA)	0 (NA)	0 (NA)	0 (NA)
Above Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
Below Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
Dry	0 (NA)	0 (NA)	0 (NA)	0 (NA)
Critical	0 (NA)	0 (NA)	0 (NA)	0 (NA)
All	0 (NA)	0 (NA)	0 (NA)	0 (NA)
Feather River at Sacramento River Confluence				
Temperatures below 45°F				
Wet	0 (NA)	0 (NA)	0 (NA)	0 (NA)
Above Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
Below Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
Dry	0 (NA)	0 (NA)	0 (NA)	0 (NA)
Critical	0 (NA)	0 (NA)	0 (NA)	0 (NA)
All	0 (NA)	0 (NA)	0 (NA)	0 (NA)
Temperatures above 75°F				
Wet	22.3 (725%)	7.7 (44%)	15.4 (501%)	0.8 (5%)
Above Normal	25.5 (NA)	7.3 (40%)	10.9 (NA)	-7.3 (-40%)
Below Normal	22.9 (NA)	-2.8 (-11%)	20 (NA)	-5.7 (-22%)
Dry	28.9 (650%)	0 (0%)	31.2 (702%)	2.3 (7%)
Critical	25 (250%)	0 (0%)	25 (250%)	0 (0%)
All	24.6 (712%)	2.9 (12%)	20.5 (593%)	-1.2 (-5%)

NA = could not be calculated because the denominator was 0.

[a] Days were used in the Sacramento River and months were used in the Feather River.

[b] Based on the modeling period of 1922 to 2003.

Overall, channel margin and side-channel habitat conditions for splittail under H1 would be similar to or marginally worse than conditions under H3.

Stranding Potential

Because flows in the Yolo Bypass under H1 would generally be similar to flows under H3, stranding potential would not differ between H1 and H3. Therefore, the results for H1 would be the same as those for H3.

H4/HOS

Floodplain Habitat

Flows in the Sacramento River at Fremont Weir under H4 would generally be similar to or greater than flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). As a result, no inundation analyses in the Yolo Bypass were conducted for H4. Overall, floodplain habitat conditions for splittail under H4 would be similar to or marginally better than conditions under H3.

Channel Margin and Side-Channel Habitat

Flows under H4 in the Sacramento River at Wilkins Slough during February through June would be similar to flows under H3, except during June, in which modeled flows would be up to 21% lower than under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These reductions are not expected to affect splittail habitat in a biologically meaningful way because they occur in only one of five months of splittail presence.

There would be no biologically meaningful difference (>5% absolute scale) between NAA and H1 in the frequency of water temperatures in the Sacramento River being within the suitable 45°F to 75°F regardless of water year type (Table 11-4-97). In the Feather River, there would be differences between NAA and H1 in temperatures below 45°F. There would be a 7% and 6% reduction in the exceedance above the 75°F threshold for above and below normal water years under H4 relative to NAA, but no other differences.

Overall, channel margin and side-channel habitat conditions for splittail under H4 would be similar to or marginally better than conditions under H3.

Stranding Potential

Because flows in the Yolo Bypass under H4 would generally be similar to flows under H3, stranding potential would not differ between H4 and H3. Therefore, the results for H4 would be the same as those for H3.

NEPA Effects: Collectively, these results indicate that the effect is not adverse because it would not substantially reduce suitable spawning habitat or substantially reduce the number of fish as a result of egg mortality. The effects of H3 on splittail spawning habitat are largely beneficial due to increased inundation in the Yolo Bypass, negligible effects and beneficial effects in some months on channel margin and side-channel habitats in the Sacramento River at Wilkins Slough (increases in mean monthly flow to 23%) and the Feather River (increases in mean monthly flow to 65%), and negligible or beneficial effects on water temperatures in the Sacramento and Feather Rivers).

CEQA Conclusion: In general, Alternative 4 would have beneficial effects on splittail spawning habitat relative to Existing Conditions by increasing the quantity of spawning habitat in the Yolo Bypass. There would be negligible effects on channel margin and side-channel habitats in the Sacramento River at Wilkins Slough and the Feather River. There would be negative effects on water temperatures in the Feather River relative to Existing Conditions, but the benefits due to increased inundation in the Yolo Bypass would outweigh the detrimental effects of increased water temperatures in the Feather River because the Yolo Bypass is a more important spawning habitat to splittail than channel margin habitat in the Feather River as evidenced by the large amount of spawning activity when inundated.

H3/ESO

Floodplain Habitat

Comparisons of splittail weighted habitat area for H3 and Existing Conditions show relatively little difference between the two scenarios, with no change or relatively small increases or decreases in longer-duration inundation events for H3 compared to Existing Conditions, except for somewhat larger increases or decreases in wet water year types (Table 11-4-93). However, H3 would result in increased acreage of suitable spawning habitat compared to Existing Conditions (Table 11-4-94), with increases of between 5 and 979 acres of suitable spawning habitat depending on water year type. Increased areas for wet, above normal, and below normal water years are predicted to be 63%, 62%, and 193%, respectively for H3. Comparisons for dry and critical water years indicate project-related increases of 7 and 5 acres of suitable spawning habitat, respectively, compared to 0 acres for Existing Conditions. There would generally be no or small effects (9% to 11% lower in below normal and dry years) of H3 on splittail spawning and rearing habitat in the Sutter Bypass relative to Existing Conditions (Table 11-4-95). These results indicate that H3 would have beneficial effects on splittail habitat through increasing the acreage of suitable spawning habitats by up to 193%.

Channel Margin and Side-Channel Habitat

Flow comparisons of H3 to Existing Conditions for the Sacramento River at Wilkins Slough (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for February through June indicate that H3 would have primarily negligible effects (<5%) or increases in mean monthly flow (to 39%), with the exception of a small decrease in flow (-6%) during March in below normal years and a moderate decrease (-16%) during May in wet years when effects of flow reductions on rearing conditions would be less critical. These decreases in flow would have little or no biologically meaningful negative effects and the increases in flow during May and June would have a beneficial effect on channel margin and side-channel habitats. Modeling results also show that Sacramento splittail spawning temperature tolerances would not be exceeded in the Sacramento River.

Results for the Feather River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) show variable effects of H3 depending on month and water year type. Results for February through April include mostly negligible effects (<5%) and small to moderate increases in mean monthly flow (to 20%), with the exception of a small decrease (-11%) during February, and a moderate decrease (-20%) during March, in below normal years. Effects of H3 during May and June consist of negligible (<5%) effects, and both flow increases (to 59%) and decreases (to -26%), depending on water year type. Decreases in drier water years when effects of flow reductions would be more critical for rearing conditions are limited to a small reduction (-10%) during June in critical years (late in the rearing period). Based on a prevalence of negligible (<5%) or beneficial effects on flow (increases to 59%), and isolated decreases that would be of small magnitude and/or not occur at the more critical times for rearing success, these results indicate that effects of Alternative 4 on flow would not have biologically meaningful negative effects on splittail spawning conditions in channel margin and side-channel habitats in the Feather River.

Simulated daily and monthly water temperatures in Sacramento River at Hamilton City and Feather River at the confluence with the Sacramento River, respectively, were used to investigate the potential effects of H3 on the suitability of water temperatures for splittail spawning and egg incubation. A range of 45°F to 75°F was selected as the suitable range for splittail spawning and egg incubation.

There would be no biologically meaningful difference (>5% absolute scale) between Existing Conditions and H3 in the frequency of water temperatures in the Sacramento River being within the suitable 45°F to 75°F regardless of water year type (Table 11-4-96). In the Feather River, there would be differences between Existing Conditions and H3 in temperatures below 45°F. There would be a 11% to 28% increases in the exceedance above the 75°F threshold under H3 relative to Existing Conditions, respectively, but no other differences.

Stranding Potential

Because there would be little difference in flow conditions between H3 and Existing Conditions in Yolo Bypass, the project will not affect stranding potential.

H1/LOS

Because flows and water temperatures under H1 would be similar to those under H3, conclusions for H1 are similar to those under H3.

H4/HOS

Because flows and water temperatures under H4 would be similar to those under H3, conclusions for H4 are similar to those under H3.

Summary of CEQA Conclusion

Collectively, these results indicate that the impact is not significant because it would not substantially reduce suitable spawning habitat or substantially reduce the number of fish as a result of egg mortality. The effects of H3 on splittail spawning habitat are largely beneficial. Benefits due to increased inundation in the Yolo Bypass would outweigh increases in exceedance of critical high water temperatures in the Feather River because the Yolo Bypass is a more important spawning habitat to splittail than channel margin habitat in the Feather River as evidenced by the large amount of spawning activity when inundated.

Impact AQUA-113: Effects of Water Operations on Rearing Habitat for Sacramento Splittail

H3/ESO

In general, Alternative 4 would have beneficial effects on splittail rearing habitat relative to the NAA by increasing the quantity and quality of rearing habitat in the Yolo Bypass. There would be beneficial effects on rearing conditions in channel margin and side-channel habitats from moderate to substantial increases in mean monthly flow during most of the rearing period in the Sacramento River and the Feather River. There would be a beneficial effect from reduced exposure to critical water temperatures in the Feather River.

Floodplains are important rearing habitats for juvenile splittail during periods of high flows when areas like the Yolo Bypass are inundated. During low flows when floodplains are not inundated, splittail rear in side-channel and channel margin habitat. Therefore, the previous impact discussion applies to rearing as well as spawning habitat for splittail for H3.

H1/LOS

Because flows and water temperatures under H1 would be similar to those under H3, conclusions for H1 are similar to those under H3.

H4/HOS

Because flows and water temperatures under H4 would be similar to those under H3, conclusions for H4 are similar to those under H3.

NEPA Effects: Based on the analyses above, the effect of Alternative 4 on splittail rearing habitat is not adverse because it would not substantially reduce rearing habitat or substantially reduce the number of fish as a result of mortality.

CEQA Conclusion: In general, Alternative 4 would have beneficial effects on splittail rearing habitat relative to Existing Conditions by increasing the quantity of rearing habitat in the Yolo Bypass through increased acreage subjected to periodic inundation. There would be negligible effects on channel margin and side-channel habitats in the Sacramento River at Wilkins Slough and the Feather River**,** with beneficial effect due to moderate to substantial increases in mean monthly flow for some months and water year types during the rearing period. There would be negative effects on water temperatures in the Feather River relative to Existing Conditions, but the benefits due to increased inundation in the Yolo Bypass would outweigh the detrimental effects of increased water temperatures in the Feather River because the Yolo Bypass is a more important rearing habitat to splittail than channel margin habitat in the Feather River as evidenced by the large amount of rearing activity when inundated.

H3/ESO

As described above, floodplains are important rearing habitats for juvenile splittail during periods of high flows when areas like the Yolo Bypass are inundated. During low flows when floodplains are not inundated, splittail rear in side-channel and channel margin habitat. Therefore, the previous impact discussion applies to rearing as well as spawning habitat for splittail for H3.

H1/LOS

Because flows and water temperatures under H1 would be similar to those under H3, conclusions for H1 are similar to those under H3.

H4/HOS

Because flows and water temperatures under H4 would be similar to those under H3, conclusions for H4 are similar to those under H3.

Summary of CEQA Conclusion

Based on the analyses above, the impact of Alternative 4 on splittail rearing habitat is not significant because it would not substantially reduce rearing habitat or substantially reduce the number of fish as a result of mortality, and no mitigation is necessary.

Impact AQUA-114: Effects of Water Operations on Migration Conditions for Sacramento Splittail

Upstream of the Delta

In general, Alternative 4 would not affect migration conditions for juvenile or adult splittail in the Sacramento River or the Feather River relative to the NAA based on negligible or beneficial effects on mean monthly flow during the migration period and negligible effects on exposure to critical water temperatures in the Feather River. Adults migrate upstream primarily in December through March and juvenile migrate primarily in April through July (Moyle et al. 2004).

H3/ESO

The effects of H3 on splittail migration conditions would be the same as described for channel margin and side-channel habitats in the Sacramento River and Feather River for Impact AQUA-112 above. There would be benefits to channel margin and side-channel habitat in both locations from increases in mean monthly flow, and from decreased exposure to critical high water temperatures compared to NAA.

H1/LOS

The effects of H1 on splittail migration conditions would be the same as described for channel margin and side-channel habitats in the Sacramento River and Feather River for Impact AQUA-112 above. These effects would be similar to those for H3.

H4/HOS

The effects of H4 on splittail migration conditions would be the same as described for channel margin and side-channel habitats in the Sacramento River and Feather River for Impact AQUA-112 above. These effects would be similar to those for H3.

Through-Delta

Alternative 4 would generally reduce OMR reverse flows during the period of juvenile splittail migration through the Delta under all flow scenarios. Modeled OMR flows under Alternative 4 would be reduced slightly in May under all flow scenarios (i.e., Scenarios H1-H4), but flows would still be less negative. Modeled OMR flows would be increased in June and July under Alternative 4 flow scenarios compared to baseline conditions (NAA). Based on the modeling overall negative OMR flows decrease during the splittail migration period, the effect on the species under Alternative 4 would not be adverse and may provide a benefit to the species.

NEPA Effects: Therefore, the effect of Alternative 4 is not adverse because it would not substantially reduce or degrade migration habitat or substantially reduce the number of fish as a result of mortality.

CEQA Conclusion:

Upstream of the Delta

In general, effects of Alternative 4 would have beneficial effects on splittail migration conditions relative to Existing Conditions based on moderate to substantial increases in mean monthly flow in the Sacramento River and the Feather River. There would be a negative effect based on substantial increases in exposure to critical water temperatures in the Feather River but this would be offset by the more substantial beneficial effects from increases in mean monthly flow for much of the migration period, and lack of negative effects on water temperature in the Sacramento River, which is the migration route to the main spawning and rearing area, the Yolo Bypass.

H3/ESO

Effects of H3 on splittail migration conditions are the same as described for channel margin and side-channel habitats in Impact AQUA-112.

H1/LOS

The effects of H1 on splittail migration conditions would be the same as described for channel margin and side-channel habitats in the Sacramento River and Feather River for Impact AQUA-112 above. These effects would be similar to those for H3.

H4/HOS

The effects of H4 on splittail migration conditions would be the same as described for channel margin and side-channel habitats in the Sacramento River and Feather River for Impact AQUA-112 above. These effects would be similar to those for H3.

Through-Delta

Average modeled OMR flows would be greater under Scenario H3 than the CEQA baseline during the majority of the juvenile splittail migration through the Delta. Conditions would be similar between Scenarios H1 and H3. OMR flow conditions under Scenario H4 would further improve migration conditions for juvenile splittail. Therefore the impact on splittail migration survival would be less than significant and may provide a benefit to the species.

Summary of CEQA Conclusion

The impact is less than significant because it would not substantially reduce suitable migration habitat or substantially reduce the number of fish as a result of mortality and no mitigation is necessary. Effects of Alternative 4 on flow would not have negative effects on the availability of channel margin and main-channel habitat, and would have a beneficial effect through increases in mean monthly flow for some months and water year types during the migration period. Benefits to flow conditions in both rivers, and lack of negative effects on water temperatures in the Sacramento River, outweigh the negative effects of substantial increases in exposure to critical water temperatures in the Feather River. This is because the Sacramento River serves as the migration route to the primary splittail spawning and rearing area, the Yolo Bypass, and migration conditions in the Feather River are less critical for regional splittail survival.

Restoration Measures (CM2, CM4–CM7, and CM10)

Alternative 4 has the same Restoration Measures as Alternative 1A. Because no substantial differences in restoration-related fish effects are anticipated anywhere in the affected environment under Alternative 4 compared to those described in detail for Alternative 1A, the fish effects of restoration measures described for Sacramento splittail under Alternative 1A (Impacts AQUA-115 through AQUA-117) also appropriately characterize effects under Alternative 4.

The following impacts are those presented under Alternative 1A that are identical for Alternative 4.

Impact AQUA-115: Effects of Construction of Restoration Measures on Sacramento Splittail

Impact AQUA-116: Effects of Contaminants Associated with Restoration Measures on Sacramento Splittail

Impact AQUA-117: Effects of Restored Habitat Conditions on Sacramento Splittail

NEPA Effects: Detailed discussions regarding the potential effects of these three impact mechanisms on splittail are the same for Alternative 4, as those described under Alternative 1A (Impacts AQUA 115-through AQUA-117). The effects would not be adverse, and generally beneficial. Specifically for AQUA-116, the effects of contaminants on Sacramento splittail with respect to selenium, copper, ammonia and pesticides would not be adverse. The effects of methylmercury on Sacramento splittail are uncertain.

CEQA Conclusion: All of the impact mechanisms listed above would be at least slightly beneficial, or less than significant, and no mitigation is required.

Other Conservation Measures (CM12–CM19 and CM21)

Alternative 4 has the same other conservation measures as Alternative 1A. Because no substantial differences in other conservation-related fish effects are anticipated anywhere in the affected environment under Alternative 4 compared to those described in detail for Alternative 1A, the fish effects of other conservation measures described for Sacramento splittail under Alternative 1A (Impacts AQUA-118 through AQUA-126) also appropriately characterize effects under Alternative 4.

The following impacts are those presented under Alternative 1A that are identical for Alternative 4.

Impact AQUA-118: Effects of Methylmercury Management on Sacramento Splittail (CM12)

Impact AQUA-119: Effects of Invasive Aquatic Vegetation Management on Sacramento Splittail (CM13)

Impact AQUA-120: Effects of Dissolved Oxygen Level Management on Sacramento Splittail (CM14)

Impact AQUA-121: Effects of Localized Reduction of Predatory Fish on Sacramento Splittail (CM15)

Impact AQUA-122: Effects of Nonphysical Fish Barriers on Sacramento Splittail (CM16)

Impact AQUA-123: Effects of Illegal Harvest Reduction on Sacramento Splittail (CM17)

Impact AQUA-124: Effects of Conservation Hatcheries on Sacramento Splittail (CM18)

Impact AQUA-125: Effects of Urban Stormwater Treatment on Sacramento Splittail (CM19)

Impact AQUA-126: Effects of Removal/Relocation of Nonproject Diversions on Sacramento Splittail (CM21)

NEPA Effects: Detailed discussions regarding the potential effects of these nine impact mechanisms on splittail are the same as those described under Alternative 1A (Impact s AQUA-118 through AQUA-126). The effects range from no effect, to not adverse, to beneficial.

CEQA Conclusion: The effects of the nine impact mechanisms listed above range from no impact, to less than significant, to beneficial, and no mitigation is required.

Green Sturgeon

Construction and Maintenance of CM1

Impact AQUA-127: Effects of Construction of Water Conveyance Facilities on Green Sturgeon

The potential effects of construction of the water conveyance facilities on green sturgeon would be similar to those described for Alternative 1A, Impact AQUA-127, except that Alternative 4 would include three intakes compared to five intakes under Alternative 1A, so the effects would be proportionally less under this alternative. This would convert about 6,360 lineal feet of existing shoreline habitat into intake facility structures and would require about 17.1 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. Alternative 4 would use five barge locations rather than six as under Alternative 1A so those effects would also be proportionally less. Additionally, construction and excavation at Clifton Court Forebay would be done in the dry via installation of cofferdams for isolation and dewatering of work areas. Implementation of Appendix 3B, *Environmental Commitments*, including construction BMPs and 3B.8–*Fish Rescue and Salvage Plan*, would minimize adverse effects as described for Alternative 1A. Mitigation measures would also be available to avoid and minimize potential effects.

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-127, the effect would not be adverse for green sturgeon.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-127, the impact of the construction of the water conveyance facilities on green sturgeon would not be significant except for construction noise associated with pile driving. Potential pile driving impacts would be less than Alternative 1A because only three intakes would be constructed rather than five. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in the discussion of Alternative 1A.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in the discussion of Alternative 1A.

Impact AQUA-128: Effects of Maintenance of Water Conveyance Facilities on Green Sturgeon

NEPA Effects: The potential effects of the maintenance of water conveyance facilities under Alternative 4 would be the same as those described for Alternative 1A, Impact AQUA-128, except that only three intakes would need to be maintained under Alternative 4 rather than five under Alternative 1A. As concluded in Alternative 1A, Impact AQUA-128, the impact would not be adverse for green sturgeon.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-128, the impact of the maintenance of water conveyance facilities on green sturgeon would be less than significant and no mitigation is required.

Water Operations of CM1

Impact AQUA-129: Effects of Water Operations on Entrainment of Green Sturgeon

Water Exports

The potential entrainment effects under Alternative 4 would be the same as those under Alternative 1A. Operating new north Delta intakes and dual conveyance for SWP NBA have the potential to avoid or reduce entrainment as described for Alternative 1A; there would be no adverse effect.

Scenario H3 would substantially reduce entrainment of juvenile green sturgeon at the south Delta export facilities by about 51% relative to NAA (Table 11-4-98). Entrainment loss would be reduced 57% in wetter years and by 37% in drier years under Scenario H3 compared to NAA. Compared to the Scenario H3, entrainment losses of green sturgeon would be greater under Scenario H1 and reduced under the HOS. Under all flow scenarios, however, entrainment at the south Delta facilities would be substantially reduced compared to the NAA.

Table 11-4-98. Juvenile Green Sturgeon Entrainment Index at the SWP and CVP Salvage Facilities—Differences (Absolute and Percentage) between Model Scenarios for Alternative 4 (Scenario H3)

	Absolute Difference (Percent Difference)	
Water Year Type[b]	EXISTING CONDITIONS vs. A4 (H3)	NAA vs. A4 (H3)
Wet and Above Normal	-72 (-62%)	-59 (-57%)
Below Normal, Dry, and Critical	-23 (-47%)	-15 (-37%)
All Years	-95 (-57%)	-75 (-51%)

[a] Estimated annual number of fish lost, based on non-normalized data.
[b] Sacramento Valley water year-types.

Predation Associated with Entrainment

Entrainment-related predation loss of juvenile green sturgeon would not be greater under this Alternative and may be lower relative to baseline due to a reduction in entrainment loss. Conditions under Scenario H4 would likely reduce predation loss relative to Scenario H3, while conditions under Scenario H1 would likely increase predation loss slightly relative to Scenario H1. The impact and conclusion for predation risk associated with NPB structures and the north Delta intakes would be the same as described for Alternative 1A (Impact AQUA-129).

NEPA Effects: In conclusion, the effect of Alternative 4 on entrainment and associated predation of green sturgeon would not be adverse and may provide modest benefit due to reduced losses at the south Delta facilities.

CEQA Conclusion: As described above, the impact of the water operations on green sturgeon would be less than significant and no mitigation would be required.

Impact AQUA-130: Effects of Water Operations on Spawning and Egg Incubation Habitat for Green Sturgeon

In general, Alternative 4 would not affect spawning and egg incubation habitat for green sturgeon relative to the NAA.

H3/ESO

Sacramento River

Mean monthly flows were examined in the Sacramento River between Keswick and upstream of Red Bluff during the March to July spawning and egg incubation period for green sturgeon (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Lower flows can reduce the instream area available for spawning and egg incubation. Flows under H3 would always be similar to or greater than flows under NAA except for lower flows in dry years during July upstream of Red Bluff and Keswick (7% lower). Also, flows can be lower or higher in individual months of individual years These results indicate that flows in the Sacramento River would increase overall under H3.

Mean monthly water temperatures in the Sacramento River at Bend Bridge were examined during the March through July green sturgeon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

The number of days on which temperature exceeded 63°F by >0.5°F to >5°F in 0.5°F increments was determined for each month (May through September) and year of the 82-year modeling period (Table 11-4-13). The combination of number of days and degrees above the 63°F threshold were further assigned a "level of concern", as defined in Table 11-4-14. Differences between baselines and H3 in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4-99. There would be no substantial differences between NAA and H3 in the number of years with each "level of concern".

Table 11-4-99. Differences between Baseline and H3 Scenarios in the Number of Years in Which Water Temperature Exceedances above 63°F Are within Each Level of Concern, Sacramento River at Bend Bridge, May through September

Level of Concern	EXISTING CONDITIONS vs. H3	NAA vs. H3
Red	10 (250%)	1 (8%)
Orange	1 (100%)	1 (100%)
Yellow	3 (150%)	0 (0%)
None	-14 (-19%)	-2 (-3%)

Total degree-days exceeding 63°F at Bend Bridge were summed by month and water year type during May through September (Table 11-4-100). Total degree-days under H3 would be 5% to 11% higher than under NAA during July through September and 10% to 11% lower during May and June.

Table 11-4-100. Differences between Baseline and H3 Scenarios in Total Degree-Days (°F-Days) by Month and Water Year Type for Water Temperature Exceedances above 63°F in the Sacramento River at Bend Bridge, May through September

Month	Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
May	Wet	1,065 (282%)	-137 (-9%)
	Above Normal	228 (107%)	-127 (-22%)
	Below Normal	434 (198%)	-29 (-4%)
	Dry	246 (132%)	-168 (-28%)
	Critical	454 (205%)	44 (7%)
	All	2,427 (200%)	-417 (-10%)
June	Wet	500 (130%)	-211 (-19%)
	Above Normal	66 (45%)	-163 (-43%)
	Below Normal	276 (199%)	-76 (-15%)
	Dry	514 (273%)	-20 (-3%)
	Critical	623 (155%)	73 (8%)
	All	1,979 (157%)	-397 (-11%)
July	Wet	653 (126%)	47 (4%)
	Above Normal	347 (428%)	77 (22%)
	Below Normal	591 (402%)	135 (22%)
	Dry	1,313 (466%)	385 (32%)
	Critical	1,776 (216%)	-10 (-0.4%)
	All	4,680 (253%)	634 (11%)
August	Wet	2,091 (300%)	128 (5%)
	Above Normal	830 (203%)	171 (16%)
	Below Normal	1,246 (470%)	211 (16%)
	Dry	2,063 (308%)	453 (20%)
	Critical	2,732 (184%)	113 (3%)
	All	8,962 (254%)	1,076 (9%)
September	Wet	806 (109%)	97 (7%)
	Above Normal	586 (82%)	186 (17%)
	Below Normal	1,570 (210%)	424 (22%)
	Dry	2,425 (190%)	-171 (-4%)
	Critical	1,938 (93%)	47 (1%)
	All	7,325 (132%)	583 (5%)

Feather River

Flows were examined in the Feather River between Thermalito Afterbay and the confluence with the Sacramento River during the February through June green sturgeon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would be similar to or greater than flows under NAA in both locations except in below normal years during March (6% to 19% lower, depending on location). These results indicate that flows in the Feather River would increase overall under H3 independent of climate change.

Mean monthly water temperatures in the Feather River at Gridley were examined during the February through June green sturgeon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H3 would be 6% greater than those under NAA during February but there would be no differences (<5%) between NAA and H3 in any other month during the period.

Water temperature-related effects of H3 on green sturgeon spawning, egg incubation, and rearing habitat in the Feather River were evaluated by determining the percent of months during May through September in which water temperatures exceed a 64°F temperature threshold at Gridley (Table 11-4-101). Effects on spawning and egg incubation are evaluated here for May and June; effects on rearing are evaluated under Impact AQUA-131. The percent of months exceeding the threshold during May and June under H3 would be similar to or up to 27% lower than that under NAA, representing a small to moderate benefit of H3.

Table 11-4-101. Differences between Baselines and H3 in Percent of Months during the 82-Year CALSIM Modeling Period during Which Water Temperatures in the Feather River at Gridley Exceed the 64°F Threshold, May through September

	Degrees Above Threshold				
Month	>1.0	>2.0	>3.0	>4.0	>5.0
EXISTING CONDITIONS vs. H3					
May	35 (108%)	28 (153%)	21 (213%)	15 (400%)	9 (350%)
June	5 (5%)	0 (0%)	4 (5%)	9 (13%)	12 (26%)
July	0 (0%)	0 (0%)	0 (0%)	10 (11%)	28 (41%)
August	0 (0%)	0 (0%)	9 (9%)	20 (25%)	35 (56%)
September	17 (25%)	16 (30%)	30 (104%)	36 (483%)	31 (1,250%)
NAA vs. H3					
May	-5 (-7%)	-10 (-17%)	-1 (-4%)	0 (0%)	-1 (-10%)
June	-1 (-1%)	-9 (-9%)	-12 (-13%)	-20 (-21%)	-27 (-31%)
July	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
August	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
September	19 (27%)	11 (19%)	9 (18%)	0 (0%)	5 (17%)

Water temperature-related effects of H3 on green sturgeon spawning, egg incubation, and rearing habitat in the Feather River were also evaluated by determining the total degree-months exceeding the 64°F temperature threshold at Gridley (Table 11-4-102). Effects on spawning and egg incubation are evaluated here for May and June; effects on rearing are evaluated under Impact AQUA-131. Combining water years, total degree-months exceeding the threshold during May and June under H3 would be 8% to 21% lower relative to NAA. Within months, total degree-months under H3 would be similar or up to 26% lower than that under NAA depending on water year type. These results indicate that there would be a small to moderate benefit of H3 to green sturgeon spawning and egg incubation temperature-related conditions in the Feather River.

Table 11-4-102. Differences between Baselines and H3 in Total Degree-Months (°F-Months) by Month and Water Year Type for Water Temperature Exceedances above 64°F in the Feather River at Gridley, May through September

Month	Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
May	Wet	19 (317%)	-5 (-17%)
	Above Normal	12 (109%)	-2 (-8%)
	Below Normal	19 (238%)	-5 (-16%)
	Dry	28 (200%)	-1 (-2%)
	Critical	20 (118%)	0 (0%)
	All	98 (175%)	-13 (-8%)
June	Wet	18 (24%)	-49 (-35%)
	Above Normal	0 (0%)	-29 (-36%)
	Below Normal	0 (0%)	-32 (-33%)
	Dry	46 (49%)	-7 (-5%)
	Critical	36 (64%)	-3 (-3%)
	All	100 (29%)	-120 (-21%)
July	Wet	33 (20%)	17 (9%)
	Above Normal	17 (32%)	0 (0%)
	Below Normal	42 (62%)	10 (10%)
	Dry	87 (101%)	43 (33%)
	Critical	83 (105%)	29 (22%)
	All	262 (58%)	99 (16%)
August	Wet	46 (26%)	29 (15%)
	Above Normal	37 (82%)	15 (22%)
	Below Normal	50 (71%)	18 (18%)
	Dry	99 (146%)	21 (14%)
	Critical	49 (58%)	-1 (-1%)
	All	281 (63%)	82 (13%)
September	Wet	-4 (-10%)	23 (192%)
	Above Normal	11 (69%)	20 (286%)
	Below Normal	34 (121%)	-6 (-9%)
	Dry	48 (171%)	-4 (-5%)
	Critical	52 (260%)	-2 (-3%)
	All	141 (108%)	31 (13%)

San Joaquin River

Flows in the San Joaquin River under H3 would be the same as those under NAA throughout the March through June period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

H1/LOS

Sacramento River

Mean monthly flows in the Sacramento River at Keswick and upstream of Red Bluff during the March through July spawning and egg incubation period for green sturgeon would be similar between H1 and H3 although flows can be lower or higher in individual months of individual years (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Bend Bridge were examined during the March through July green sturgeon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period.

There would be no differences between NAA and H1 in the number of years with each level of concern in the Sacramento River at Bend Bridge (Table 11-4-103).

Table 11-4-103. Differences between Baseline Scenarios and H1 and H4 Scenarios in the Number of Years in Which Water Temperature Exceedances above 63°F Are within Each Level of Concern, Sacramento River at Bend Bridge, May through September

Level of Concern	EXISTING CONDITIONS vs. H1	NAA vs. H1	EXISTING CONDITIONS vs. H4	NAA vs. H4
Red	8 (200%)	-1 (-8%)	9 (225%)	0 (0%)
Orange	1 (100%)	1 (100%)	-1 (-100%)	-1 (-100%)
Yellow	0 (0%)	-3 (-60%)	-1 (-50%)	-4 (-80%)
None	-9 (-12%)	3 (5%)	-7 (-9%)	5 (8%)

Total degree-days exceeding the 63°F NMFS threshold in the Sacramento River at Bend Bridge under H1 would be 8% to 16% higher than under NAA during July through September and 11% to 12% lower during May and June (Table 11-4-104).

Table 11-4-104. Differences between Baseline Scenarios and H1 and H4 Scenarios in Total Degree-Days (°F-Days) by Month and Water Year Type for Water Temperature Exceedances above 63°F in the Sacramento River at Bend Bridge, May through September

Month	Water Year Type	EXISTING CONDITIONS vs. H1	NAA vs. H1	EXISTING CONDITIONS vs. H4	NAA vs. H4
May	Wet	1,050 (279%)	-152 (-10%)	1,109 (294%)	-93 (-6%)
	Above Normal	273 (128%)	-82 (-14%)	290 (136%)	-65 (-11%)
	Below Normal	429 (196%)	-34 (-5%)	493 (225%)	30 (4%)
	Dry	216 (116%)	-198 (-33%)	392 (211%)	-22 (-4%)
	Critical	428 (194%)	18 (3%)	392 (177%)	-18 (-3%)
	All	2,396 (197%)	-448 (-11%)	2,676 (220%)	-168 (-4%)
June	Wet	468 (122%)	-243 (-22%)	645 (168%)	-66 (-6%)
	Above Normal	91 (61%)	-138 (-37%)	247 (167%)	18 (5%)
	Below Normal	245 (176%)	-107 (-22%)	374 (269%)	22 (4%)
	Dry	458 (244%)	-76 (-11%)	576 (306%)	42 (6%)
	Critical	671 (167%)	121 (13%)	607 (151%)	57 (6%)
	All	1,933 (153%)	-443 (-12%)	2,449 (194%)	73 (2%)
July	Wet	658 (127%)	52 (5%)	633 (122%)	27 (2%)
	Above Normal	352 (435%)	82 (23%)	299 (369%)	29 (8%)
	Below Normal	621 (422%)	165 (27%)	506 (344%)	50 (8%)
	Dry	1,162 (412%)	234 (19%)	1,033 (366%)	105 (9%)
	Critical	1,731 (210%)	-55 (-2%)	1,438 (174.5%)	-348 (-13%)
	All	4,524 (244%)	478 (8%)	3,909 (211%)	-137 (-2%)
August	Wet	2,153 (309%)	190 (7%)	1,861 (267%)	-102 (-4%)
	Above Normal	816 (200%)	157 (15%)	593 (145%)	-66 (-6%)
	Below Normal	1,302 (491%)	267 (21%)	1,010 (381%)	-25 (-2%)
	Dry	2,003 (299%)	393 (17%)	1,577 (235%)	-33 (-1%)
	Critical	2,605 (175%)	-14 (-0.3%)	2,284 (154%)	-335 (-8%)
	All	8,879 (252%)	993 (9%)	7,325 (208%)	-561 (-5%)
September	Wet	2,321 (314%)	1,612 (111%)	681 (92%)	-28 (-2%)
	Above Normal	1,025 (144%)	625 (56%)	406 (57%)	6 (1%)
	Below Normal	1,278 (171%)	132 (7%)	1,289 (173%)	143 (8%)
	Dry	2,206 (173%)	-390 (-10%)	2,178 (171%)	-418 (-11%)
	Critical	1,843 (89%)	-48 (-1%)	1,691 (81%)	-200 (-5%)
	All	8,673 (156%)	1,931 (16%)	6,245 (112%)	-497 (-4%)

Feather River

Flows under H1 in the Feather River between Thermalito Afterbay and the confluence with the Sacramento River during the February through June period would generally be similar to or greater than flows under H3 except in critical years during February at Thermalito (5% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*.

Mean monthly water temperatures in the Feather River at Gridley were examined during the February through June green sturgeon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) between NAA and H1 in any month during the period.

The percent of months exceeding the 64°F NMFS threshold during May and June under H1 would be similar to or up to 27% lower than that under NAA, representing a small to moderate benefit of H1 (Table 11-4-105).

Table 11-4-105. Differences between Baselines and H1 and H4 Scenarios in Percent of Months during the 82-Year CALSIM Modeling Period during Which Water Temperatures in the Feather River at Gridley Exceed the 64°F Threshold, May through September

	Degrees Above Threshold				
Month	>1.0	>2.0	>3.0	>4.0	>5.0
EXISITING CONDITIONS vs. H1					
May	30 (92%)	21 (113%)	12 (125%)	12 (333%)	7 (300%)
June	4 (4%)	1 (1%)	0 (0%)	4 (6%)	12 (26%)
July	0 (0%)	0 (0%)	0 (0%)	9 (10%)	23 (34%)
August	0 (0%)	0 (0%)	9 (9%)	16 (20%)	32 (52%)
September	26 (38%)	32 (59%)	44 (157%)	52 (700%)	37 (1,500%)
NAA vs. H1					
May	-10 (-14%)	-17 (-30%)	-10 (-31%)	-2 (-13%)	-2 (-20%)
June	-2 (-3%)	-7 (-8%)	-16 (-17%)	-25 (-27%)	-27 (-31%)
July	0 (0%)	0 (0%)	0 (0%)	-1 (-1%)	-5 (-5%)
August	0 (0%)	0 (0%)	0 (0%)	-4 (-4%)	-2 (-3%)
September	27 (40%)	27 (46%)	23 (48%)	16 (37%)	11 (39%)
EXISITING CONDITIONS vs. H4					
May	21 (65%)	16 (87%)	9 (88%)	7 (200%)	6 (250%)
June	2 (3%)	4 (4%)	5 (6%)	10 (15%)	21 (44%)
July	0 (0%)	0 (0%)	0 (0%)	10 (11%)	28 (41%)
August	0 (0%)	0 (0%)	9 (9%)	20 (25%)	38 (62%)
September	11 (16%)	15 (27%)	33 (117%)	41 (550%)	35 (1,400%)
NAA vs. H4					
May	-19 (-26%)	-22 (-39%)	-14 (-42%)	-7 (-40%)	-4 (-30%)
June	-4 (-4%)	-5 (-5%)	-11 (-12%)	-19 (-20%)	-19 (-21%)
July	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
August	0 (0%)	0 (0%)	0 (0%)	0 (0%)	4 (4%)
September	12 (18%)	10 (17%)	12 (25%)	5 (11%)	9 (30%)

Combining water years, total degree-months exceeding the 64°F NMFS threshold during May and June under H1 would be 7% to 21% lower relative to NAA. Within months, total degree-months under H1 would be similar or up to 36% lower than that under NAA depending on water year type. These results indicate that there would be a small to moderate benefit of H1 to green sturgeon spawning and egg incubation temperature-related conditions in the Feather River (Table 11-4-106).

Table 11-4-106. Differences between Baselines and H1 and H4 Scenarios in Total Degree-Months (°F-Months) by Month and Water Year Type for Water Temperature Exceedances above 64°F in the Feather River at Gridley, May through September

Month	Water Year Type	EXISITING CONDITIONS vs. H1	NAA vs. H1	EXISTING CONDITIONS vs. H4	NAA vs. H4
May	Wet	20 (333%)	-4 (-13%)	15 (250%)	-9 (-30%)
	Above Normal	11 (100%)	-3 (-12%)	1 (9%)	-13 (-52%)
	Below Normal	21 (263%)	-3 (-9%)	16 (200%)	-8 (-25%)
	Dry	26 (186%)	-3 (-7%)	23 (164%)	-6 (-14%)
	Critical	21 (124%)	1 (3%)	21 (124%)	1 (3%)
	All	99 (177%)	-12 (-7%)	76 (136%)	-35 (-21%)
June	Wet	27 (36%)	-40 (-28%)	61 (81%)	-6 (-4%)
	Above Normal	0 (0%)	-29 (-36%)	25 (49%)	-4 (-5%)
	Below Normal	-2 (-3%)	-34 (-35%)	10 (15%)	-22 (-23%)
	Dry	41 (44%)	-12 (-8%)	46 (49%)	-7 (-5%)
	Critical	36 (64%)	-3 (-3%)	37 (66%)	-2 (-2%)
	All	103 (30%)	-117 (-21%)	179 (52%)	-41 (-7%)
July	Wet	35 (21%)	19 (10%)	64 (38%)	48 (26%)
	Above Normal	18 (34%)	1 (1%)	43 (81%)	26 (37%)
	Below Normal	43 (63%)	11 (11%)	54 (79%)	22 (22%)
	Dry	80 (93%)	36 (28%)	94 (109%)	50 (38%)
	Critical	78 (99%)	24 (18%)	72 (91%)	18 (14%)
	All	255 (56%)	92 (15%)	328 (72%)	165 (27%)
August	Wet	45 (25%)	28 (14%)	77 (43%)	60 (31%)
	Above Normal	36 (80%)	14 (21%)	51 (113%)	29 (43%)
	Below Normal	46 (66%)	14 (14%)	67 (96%)	35 (34%)
	Dry	92 (135%)	14 (10%)	98 (144%)	20 (14%)
	Critical	47 (55%)	-3 (-2%)	50 (59%)	0 (0%)
	All	267 (60%)	68 (11%)	344 (77%)	145 (22%)
September	Wet	60 (154%)	87 (725%)	24 (62%)	51 (425%)
	Above Normal	18 (113%)	27 (386%)	21 (131%)	30 (429%)
	Below Normal	35 (125%)	-5 (-7%)	48 (171%)	8 (12%)
	Dry	46 (164%)	-6 (-8%)	48 (171%)	-4 (-5%)
	Critical	50 (250%)	-4 (-5%)	47 (235%)	-7 (-9%)
	All	209 (160%)	99 (41%)	187 (143%)	77 (32%)

San Joaquin River

Flows under H1 in the San Joaquin River during the March through June period would be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*. No water temperature modeling was in the San Joaquin River.

H4/HOS

Sacramento River

Mean monthly flows in the Sacramento River at Keswick and upstream of Red Bluff during the March through July spawning and egg incubation period for green sturgeon would generally be similar between H4 and H3, except during June in which flows would be up to 13% lower under H4 depending on water year type and 5% and 7% lower during July in dry years (Keswick and upstream of Red Bluff, respectively) although flows can be lower or higher in individual months of individual years (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These reductions would not be large or frequent enough to have a biologically meaningful effect on green sturgeon spawning habitat.

Mean monthly water temperatures in the Sacramento River at Bend Bridge were examined during the March through July green sturgeon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

There would be no differences between NAA and H4 in the number of years with each level of concern in the Sacramento River at Bend Bridge (Table 11-4-103).

Total degree-days exceeding the 63°F NMFS threshold in the Sacramento River at Bend Bridge under H4 would be similar to those under NAA in all months during the period except August, in which there would be a 5% reduction in exceedances (Table 11-4-104).

Feather River

Flows under H4 in the Feather River between Thermalito Afterbay and the confluence with the Sacramento River during the February through June period would generally be similar to or greater than flows under H3, except during June, in which flows would be up to 38% lower under H4 depending on water year type and during July in dry years at Thermalito when the flows would be 7% lower (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*. These reductions would not be large or frequent enough to have a biologically meaningful effect on green sturgeon spawning habitat.

Mean monthly water temperatures in the Feather River at Gridley were examined during the February through June green sturgeon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) between NAA and H4 in any other month during the period.

The percent of months exceeding the 64°F NMFS threshold during May and June under H4 would be similar to or up to 22% lower than that under NAA, representing a small to moderate benefit of H4 (Table 11-4-105).

Combining water years, total degree-months exceeding the 64°F NMFS threshold during May and June under H4 would be 7% to 21% lower relative to NAA. Within months, total degree-months under H4 would be similar or up to 52% lower than that under NAA depending on water year type. These results indicate that there would be a small to moderate benefit of H4 to green sturgeon spawning and egg incubation temperature-related conditions in the Feather River (Table 11-4-106).

San Joaquin River

Flows under H4 in the San Joaquin River during the period would be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*.

No water temperature modeling was in the San Joaquin River.

NEPA Effects: Collectively, these results indicate that this effect is not adverse because it does not have the potential to substantially reduce the amount of suitable habitat. There would generally be higher flows in the Sacramento and Feather rivers that would benefit spawning and egg incubation conditions for green sturgeon. Water temperatures in the Sacramento River would not differ from those under NAA, and temperature conditions under Alternative 4 would be better than those under NAA in the Sacramento and Feather Rivers. Temperature conditions would slightly improve under H4 relative to H1 and H3 during spring months.

CEQA Conclusion: In general, under all the Alternative 4 water operations scenarios, the quantity and quality of spawning and egg incubation habitat for green sturgeon would not be affected relative to the CEQA baseline.

H3/ESO

Sacramento River

Mean monthly flows were examined in the Sacramento River between Keswick and upstream of Red Bluff during the March to July spawning and egg incubation period for green sturgeon (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*. Flows under H3 would generally be similar to or greater than those under Existing Conditions, except in July during critical years (10% and 9% lower, depending on location), in May during wet years (17% and 21% lower, depending on location), March during below normal years (10% to 18% lower, depending on location), and April during above normal years at Keswick (6% lower)*.* Also, flows can be lower or higher in individual months of individual years These results indicate that there would be few reductions and multiple increases in flows in the Sacramento River under H3 relative to Existing Conditions.

Mean monthly water temperatures in the Sacramento River at Bend Bridge were examined during the March through July green sturgeon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H3 in any month or water year type throughout the period.

There would be 10 more years with a "red" NMFS level of concern in the Sacramento River at Bend Bridge under H3 than under Existing Conditions (Table 11-4-99).

Total degree-days exceeding the 63°F NMFS threshold in the Sacramento River at Bend Bridge under H3 would be 132% to 254% higher than under Existing Conditions during the May through September period (Table 11-4-100).

Feather River

Flows were examined in the Feather River between Thermalito Afterbay and the confluence with the Sacramento River during the February through June green sturgeon spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*. At Thermalito, flows under H3 would generally be similar to or greater than those under Existing Conditions, except during March in below normal years and May in wet years, in which flows under H3 would be up to 53% lower than under Existing Conditions and except in above normal, below normal, and dry years during February (35%, 46%, and 14%, respectively).). At the confluence with the Sacramento River, flows under H3 would generally be similar to or greater than flows under Existing Conditions, except during March in below normal years, May in wet years, and in June in wet and critical years, in which flows under H3 would be up to 26% lower than under Existing Conditions, and in normal years during February (11% lower). These results indicate that there would generally be greater flows in the Feather River under H3 relative to Existing Conditions with few exceptions.

Water temperature-related effects of H3 on green sturgeon spawning, egg incubation, and rearing habitat in the Feather River were evaluated by determining the percent of months during May through September in which water temperatures exceed a 64°F temperature threshold at Gridley (Table 11-4-101). Effects on spawning and egg incubation are evaluated here for May and June; effects on rearing are evaluated under Impact AQUA-131. The percent of months exceeding the threshold during May and June under H3 would be similar to or up to 35% greater than that under Existing Conditions, representing a small to moderate negative effect of H3. This analysis includes the effect of climate change.

Water temperature-related effects of H3 on green sturgeon spawning, egg incubation, and rearing habitat in the Feather River were also evaluated by determining the total degree-months exceeding the 64°F temperature threshold at Gridley (Table 11-4-102). Effects on spawning and egg incubation are evaluated here for May and June; effects on rearing are evaluated under Impact AQUA-131. Combining water years, total degree-months exceeding the threshold during May and June under H3 would be 29% to 175% greater relative to Existing Conditions. Within months, total degree-months under H3 would be similar or up to 317% lower than that under Existing Conditions depending on water year type. These results indicate that there would be a moderate to large negative effect of H3 on green sturgeon spawning and egg incubation temperature-related conditions in the Feather River. This analysis includes the effect of climate change.

San Joaquin River

Flows in the San Joaquin River under H3 similar to those under Existing Conditions throughout the March through June spawning and egg incubation period for green sturgeon, except during June, in which there would be a 30% flow reduction under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis).*

No water temperatures modeling was conducted in the San Joaquin River.

H1/LOS

Sacramento River

Mean monthly flows in the Sacramento River at Keswick and upstream of Red Bluff during the March through July spawning and egg incubation period for green sturgeon would be similar between H1 and H3 although flows can be lower or higher in individual months of individual years (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) except in critical years during July (16% lower).

Mean monthly water temperatures in the Sacramento River at Bend Bridge were examined during the March through July green sturgeon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the*

Fish Analysis). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H1 in any month or water year type throughout the period.

There would be 8 more years with a "red" NMFS level of concern in the Sacramento River at Bend Bridge under H1 than under Existing Conditions (Table 11-4-103).

Total degree-days exceeding the 63°F NMFS threshold in the Sacramento River at Bend Bridge under H1 would be 156% to 252% higher than under Existing Conditions during the May through September period (Table 11-4-104).

Feather River

Flows under H1 in the Feather River between Thermalito Afterbay and the confluence with the Sacramento River during the February through June period would generally be similar to or greater than flows under H3 except in below normal, dry and critical years (29%, 8%, and 13% lower, respectively) (Thermalito) and in critical years (7% lower) (Sacramento River confluence) during February (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis).*

Mean monthly water temperatures in the Feather River at Gridley were examined during the February through June green sturgeon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H1 would be 6% lower than those under Existing Conditions during February, but there would be no differences (<5%) in any other month during the period.

The percent of months exceeding the 64°F NMFS threshold during May and June under H1 would be similar to or up to 30% greater than that under Existing Conditions, representing a small to moderate negative effect of H1 (Table 11-4-105). This analysis includes climate change.

Combining water years, total degree-months exceeding the threshold during May and June under H1 would be 30% to 177% greater relative to Existing Conditions. Within months, total degree-months under H1 would be similar or up to 333% lower than that under Existing Conditions depending on water year type. These results indicate that there would be a moderate to large negative effect of H1 on green sturgeon spawning and egg incubation temperature-related conditions in the Feather River. This analysis includes the effect of climate change.

San Joaquin River

Flows in the San Joaquin River under H1 similar to those under Existing Conditions throughout the March through June spawning and egg incubation period for green sturgeon, except during June, in which there would be a 30% flow reduction under H1 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis).*

No water temperature modeling was in the San Joaquin River.

H4/HOS

Sacramento River

Mean monthly flows in the Sacramento River at Keswick and upstream of Red Bluff during the March through July spawning and egg incubation period for green sturgeon would generally be similar between H4 and H3, except during June in which flows would be up to 13% lower under H4 depending on water year type and during July in critical years when flows would be 7% or 8% lower although flows can be lower or higher in individual months of individual years (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These reductions would not be large or frequent enough to have a biologically meaningful effect on green sturgeon spawning habitat.

Mean monthly water temperatures in the Sacramento River at Bend Bridge were examined during the March through July green sturgeon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H4 in any month or water year type throughout the period, except in wet years during May (5% higher under H4).

There would be 9 more years with a "red" NMFS level of concern in the Sacramento River at Bend Bridge under H4 than under Existing Conditions (Table 11-4-103).

Total degree-days exceeding the 63°F NMFS threshold in the Sacramento River at Bend Bridge under H4 would be 112% to 220% higher than under Existing Conditions during the May through September period (Table 11-4-104).

Feather River

Flows under H1 in the Feather River between Thermalito Afterbay and the confluence with the Sacramento River during the February through June period would generally be similar to or greater than flows under H3, except during June, in which flows would be up to 38% lower under H4 depending on water year type and during February in below normal, dry and critical years (30%, 15%, and 7% lower, respectively) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*. These reductions would not be large or frequent enough to have a biologically meaningful effect on green sturgeon spawning habitat.

Mean monthly water temperatures in the Feather River at Gridley were examined during the February through June green sturgeon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures under H4 would be 6% lower than those under Existing Conditions during February, but there would be no differences (<5%) in any other month during the period.

The percent of months exceeding the 64°F NMFS threshold during May and June under H4 would be similar to or up to 21% greater than that under Existing Conditions, representing a small to moderate negative effect of H4 (Table 11-4-105). This analysis includes climate change.

Combining water years, total degree-months exceeding the threshold during May and June under H4 would be 52% to 136% greater relative to Existing Conditions. Within months, total degree-months under H4 would be similar or up to 250% lower than that under Existing Conditions depending on water year type. These results indicate that there would be a moderate to large negative effect of H4 on green sturgeon spawning and egg incubation temperature-related conditions in the Feather River. This analysis includes the effect of climate change.

San Joaquin River

Flows in the San Joaquin River under H1 similar to those under Existing Conditions throughout the March through June spawning and egg incubation period for green sturgeon, except during June, in which there would be a 30% flow reduction under H1 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis).*

No water temperature modeling was in the San Joaquin River.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-130 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 4 could be significant because, under the CEQA baseline, the alternative could substantially reduce the amount of suitable spawning and egg incubation habitat for green sturgeon, contrary to the NEPA conclusion set forth above. Flows would generally not differ under Alternative 4 in the Sacramento, Feather, and San Joaquin Rivers and temperatures would not differ in the Sacramento River. However, exceedances above temperature thresholds by NMFS would be higher in the Sacramento and Feather Rivers. Results would generally be consistent among scenarios.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to H3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and H3 indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and H3. This indicates that the differences between Existing Conditions and Alternative 4 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 4, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on spawning habitat for green sturgeon. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-131: Effects of Water Operations on Rearing Habitat for Green Sturgeon

In general, Alternative 4 would not affect the quantity and quality of green sturgeon larval and juvenile rearing habitat relative to the NAA.

H3/ESO

Water temperature was used to determine the potential effects of H3 on green sturgeon larval and juvenile rearing habitat because larvae and juveniles are benthic-oriented and, therefore, their habitat is more likely to be limited by changes in water temperature than flow rates.

Sacramento River

Mean monthly water temperatures in the Sacramento River at Bend Bridge were examined during the May through October green sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

Feather River

Mean monthly water temperatures in the Feather River at Gridley were examined during the April through August green sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

Water temperature-related effects of H3 on green sturgeon rearing habitat in the Feather River were evaluated by determining the percent of months during May through September in which water temperatures exceed a 64°F temperature threshold at Gridley (Table 11-4-101). The percent of months exceeding the threshold under H3 would be similar to or up to 27% lower than that under NAA during May and June, similar to that under NAA during July and August, and similar to or up to 19% greater than that under NAA during September.

Water temperature-related effects of H3 on green sturgeon rearing habitat in the Feather River were also evaluated by determining the total degree-months exceeding the 64°F temperature threshold at Gridley (Table 11-4-102). Combining water years, total degree-months exceeding the threshold under H3 would be 8% to 31% lower relative to NAA during May and June and 13% to 126% higher during July through September. These results indicate that there would be both beneficial and negative temperature-related effects to green sturgeon rearing in the Feather River.

San Joaquin River

Water temperature modeling was not conducted in the San Joaquin River.

H1/LOS

Sacramento River

Mean monthly water temperatures in the Sacramento River at Bend Bridge were examined during the May through October green sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period.

Feather River

Mean monthly water temperatures in the Feather River at Gridley were examined during the April through August green sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period.

The percent of months exceeding the 64°F NMFS threshold under H1 would be similar to or up to 27% lower than that under NAA during May and June, generally similar to that under NAA during July and August, and 11% to 27% greater than that under NAA during September. (Table 11-4-105).

Combining water years, total degree-months exceeding the 64°F NMFS threshold under H1 would be 7% to 21% lower relative to NAA during May and June and 11% to 41% higher during July through September (Table 11-4-106). These results indicate that there would be both beneficial and negative temperature-related effects of H1 on green sturgeon rearing in the Feather River.

Regardless of the results of these analyses, all current applicable regulatory standards for the Feather River in the NMFS BiOp (NMFS 2009) would be met under H1 at the same frequency as are being met currently under the NEPA point of comparison. Therefore, regardless of these results, H1 would be protective of green sturgeon as defined by NMFS (2009).

San Joaquin River

Water temperature modeling was not conducted in the San Joaquin River.

H4/HOS

Sacramento River

Mean monthly water temperatures in the Sacramento River at Bend Bridge were examined during the May through October green sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

Feather River

Mean monthly water temperatures in the Feather River at Gridley were examined during the April through August green sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

The percent of months exceeding the 64°F NMFS threshold under H4 would be similar to or up to 22% lower than that under NAA during May and June, similar to that under NAA during July and August, and 5% to 12% greater than that under NAA during September. (Table 11-4-105).

Combining water years, total degree-months exceeding the 64°F NMFS threshold under H4 would be 7% to 21% lower relative to NAA during May and June and 22% to 32% higher during July through September (Table 11-4-106). These results indicate that there would be both beneficial and negative temperature-related effects of H4 on green sturgeon rearing in the Feather River.

San Joaquin River

Water temperature modeling was not conducted in the San Joaquin River.

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because it does not have the potential to substantially reduce the amount of suitable habitat. Water temperatures in the Sacramento and Feather rivers and exceedances of NMFS temperature thresholds in the Feather

River under Alternative 4 would be similar to those under NAA. These results would be consistent among scenarios.

CEQA Conclusion: In general, under all the Alternative 4 water operations scenarios, the quantity and quality of green sturgeon rearing habitat would not be affected relative to the CEQA baseline.

H3/ESO

Water temperature was used to determine the potential effects of H3 on green sturgeon larval and juvenile rearing habitat because larvae and juveniles are benthic-oriented and, therefore, their habitat is more likely to be limited by changes in water temperature than flow rates.

Sacramento River

Mean monthly water temperatures in the Sacramento River at Bend Bridge were examined during the May through October green sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H3 during May through July and 5% to 6% lower during August through October.

Feather River

Mean monthly water temperatures in the Feather River at Gridley were examined during the April through August green sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H3 in any month throughout the period, except during October (6% higher under H3).

Water temperature-related effects of H3 on green sturgeon rearing habitat in the Feather River were evaluated by determining the percent of months during May through September in which water temperatures exceed a 64°F temperature threshold at Gridley (Table 11-4-101). The percent of months exceeding the threshold under H3 would generally be greater by up to 35% than the percent under Existing Conditions during all months. These results include the effects of climate change.

Water temperature-related effects of H3 on green sturgeon rearing habitat in the Feather River were also evaluated by determining the total degree-months exceeding the 64°F temperature threshold at Gridley (Table 11-4-102). Combining water years, total degree-months exceeding the threshold under H3 would be 29% to 175% higher in all months. These results indicate that there would be negative temperature-related effects of H3 on green sturgeon rearing in the Feather River. These results include the effects of climate change.

San Joaquin River

Water temperature modeling was not conducted in the San Joaquin River.

H1/LOS

Sacramento River

Mean monthly water temperatures in the Sacramento River at Bend Bridge were examined during the May through October green sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H1 during May through July and 5% to 6% lower during August through October.

Feather River

Mean monthly water temperatures in the Feather River at Gridley were examined during the April through August green sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H1 in any month throughout the period, except during October (5% higher under H1).

The percent of months exceeding the 64°F NMFS threshold under H1 would generally be greater by up to 52% than the percent under Existing Conditions during all months (Table 11-4-105). These results include the effects of climate change.

Combining water years, total degree-months exceeding the 64°F NMFS threshold under H1 would be 30% to 177% higher in all months (Table 11-4-106). These results indicate that there would be negative temperature-related effects of H1 on green sturgeon rearing in the Feather River. These results include the effects of climate change.

San Joaquin River

Water temperature modeling was not conducted in the San Joaquin River.

H4/HOS

Sacramento River

Mean monthly water temperatures in the Sacramento River at Bend Bridge were examined during the May through October green sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H4 during May through July and 5% lower during August and October.

Feather River

Mean monthly water temperatures in the Feather River at Gridley were examined during the April through August green sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H4 in any month throughout the period, except during July, August, and October (5% to 7% higher under H4).

The percent of months exceeding the 64°F NMFS threshold under H4 would generally be greater by up to 41% than the percent under Existing Conditions during all months (Table 11-4-105). These results include the effects of climate change.

Combining water years, total degree-months exceeding the 64°F NMFS threshold under H4 would be 52% to 143% higher in all months (Table 11-4-106). These results indicate that there would be negative temperature-related effects of H4 on green sturgeon rearing in the Feather River. These results include the effects of climate change.

San Joaquin River

Water temperature modeling was not conducted in the San Joaquin River.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-131 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 4 could be significant because, under the CEQA baseline, the alternative could substantially reduce suitable rearing habitat, contrary to the NEPA conclusion set forth above. Water temperatures be similar in the Sacramento River, although the exceedance above NMFS temperature thresholds in the Feather River would be higher under Alternative 4 than those under the CEQA baseline, which could increase stress, mortality, and susceptibility to disease for larval and juvenile green sturgeon. These results are consistent among scenarios.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to H3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and H3 indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and H3. This indicates that the differences between Existing Conditions and Alternative 4 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 4, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on rearing habitat for green sturgeon. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-132: Effects of Water Operations on Migration Conditions for Green Sturgeon

In general, effects of Alternative 4 on green sturgeon migration conditions relative to the NAA are uncertain.

Upstream of the Delta

H3/ESO

Analyses for green sturgeon migration conditions focused on flows in the Sacramento River between Keswick and Wilkins Slough and in the Feather River between Thermalito and the confluence with the Sacramento River during the April through October larval migration period, the August through March juvenile migration period, and the November through June adult migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Because these periods encompass the entire year, flows during all months were compared. Reduced flows could slow or inhibit downstream migration of larvae and juveniles and reduce the ability to sense upstream migration cues and pass impediments by adults.

Sacramento River flows at Keswick under H3 would generally be lower than flows under NAA during November, greater during May and June, and similar to flows under NAA in the remaining nine months (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Sacramento River flows at Wilkins Slough under H3 would generally be lower than flows under NAA during November, greater during May and June, and similar to flows under NAA in the remaining nine months (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Feather River flows at Thermalito under H3 would generally be lower than flows under NAA during July through September, greater during March through June and October, and similar to flows under NAA in the remaining four months (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). However, given the benthic nature of green sturgeon and that flows in the Feather River would be consistent with the flow schedule provided by NMFS during the BDCP planning process, these reductions in summer flows are not expected to have a substantial effect on green sturgeon in the Feather River.

Feather River flows at the confluence with the Sacramento River under H3 would generally be lower than flows under NAA during July through September, greater during April through June and October, and similar to flows under NAA in the remaining five months (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). However, given the benthic nature of green sturgeon and that flows in the Feather River would be consistent with the flow schedule provided by NMFS during the BDCP planning process, these reductions in summer flows are not expected to have a substantial effect on green sturgeon in the Feather River.

Larval transport flows were also examined by utilizing the positive correlation between white sturgeon year class strength and Delta outflow during April and May (USFWS 1995) under the assumption that the mechanism responsible for the relationship is that Delta outflow provides improved green sturgeon larval transport that results in improved year class strength. Results for white sturgeon presented in Impact AQUA-150 below suggest that, using the positive correlation between Delta outflow and year class strength, green sturgeon year class strength would be lower under H3 than those under NAA (up to 50% lower).

H1/LOS

Year-round flows under H1 in the Sacramento River at Keswick and Wilkins Slough would generally be similar to flows under H3, except during September and November, during which flows would be up to 46% lower (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These isolated reductions would not have biologically meaningful effects on green sturgeon migration habitat. Year-round flows in the Feather River below Thermalito Afterbay (high-flow channel) and at the confluence with the Sacramento River under H1 would generally be similar to or greater than flows under H3, except during September during which flows would be up to 83% lower. This isolated reduction would not have biologically meaningful effects on green sturgeon migration habitat. Overall, results for H1 would be the same as those for H3.

H4/HOS

Year-round flows in the Sacramento River at Keswick and Wilkins Slough under H4 would generally be similar to flows under H3, except during May and June, during which flows would be up to 21%

lower (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These small and isolated reductions would not have biologically meaningful effects on green sturgeon migration habitat. Flows in the Feather River below Thermalito Afterbay (high-flow channel) under H4 during January through May and November through December would generally be similar to or greater than flows under H3. However, flows during June through October would generally be up to 39% lower under H4. These reductions are expected to cause a biologically meaningful effect on green sturgeon migration habitat.

Through-Delta

The impact of Alternative 4 on in-Delta conditions for green sturgeon would be the same as described for splittail in Impact AQUA-114. The effect on green sturgeon would not be adverse.

NEPA Effects: Upstream flows (above north Delta intakes) are similar between Alternative 4 and NAA. However, due to the removal of water at the North Delta intakes, there are substantial differences in through-Delta flows between Alternative 4 and NAA (see Table 11-4-114 below). Analysis of white sturgeon year-class strength (USFWS 1995), used here as a surrogate for green sturgeon, found a positive correlation between year class strength and Delta outflow during April and May. However, this conclusion was reached in the absence of north Delta intakes and the exact mechanism that causes this correlation is not known at this time. One hypothesis suggests that the correlation is caused by high flows in the upper river resulting in improved migration, spawning, and rearing conditions in the upper river. Another hypothesis suggests that the positive correlation is a result of higher flows through the Delta triggering more adult sturgeon to move up into the river to spawn. It is also possible that some combination of these factors are working together to produce the positive correlation between high flows and sturgeon year-class strength.

The scientific uncertainty regarding which mechanisms are responsible for the positive correlation between year class strength and river/Delta flow will be addressed through targeted research and monitoring to be conducted in the years leading up to the initiation of north Delta facilities operations. If these targeted investigations determine that the primary mechanisms behind the positive correlation between high flows and sturgeon year-class strength are related to upstream conditions, then Alternative 4 would be deemed Not Adverse due to the similarities in upstream flow conditions between Alternative 4 and NAA. However, if the targeted investigations lead to a conclusion that the primary mechanisms behind the positive correlation are related to in-Delta and through-Delta flow conditions, then Alternative 4 would be deemed adverse due to the magnitude of reductions in through-Delta flow conditions in Alternative 4 as compared to NAA.

CEQA Conclusion: In general, under all the Alternative 4 water operations scenarios, migration conditions for green sturgeon would not change relative to the CEQA baseline.

Upstream of the Delta

Analyses for green sturgeon migration conditions focused on flows in the Sacramento River between Keswick and Wilkins Slough and in the Feather River between Thermalito and the confluence with the Sacramento River during the April through October larval migration period, the August through March juvenile migration period, and the November through July adult migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*)*.* Because these periods encompass the entire year, flows during all months were compared. Reduced flows could slow or inhibit downstream migration of larvae and juveniles and reduce the ability to sense upstream migration cues and pass impediments by adults.

Sacramento River flows between Keswick and Wilkins Slough under H3 would generally be lower than flows under Existing Conditions during August, September, and November by up to 29%, greater during February, May, and June, and similar to flows under Existing Conditions in the remaining six months (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

For Delta outflow, the percent of months exceeding outflow thresholds under H3 would consistently be lower than those under Existing Conditions for each flow threshold, water year type, and month (8% to 50% lower on a relative scale) (see Table 11-4-114 below).

Feather River flows between Thermalito and the confluence with the Sacramento River under H3 would generally be lower than flows under Existing Conditions during January, February, July, August and December by up to 64%, greater during April through June, September, and October by up to 209%, and similar to flows under Existing Conditions in March and November (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

H1/LOS

Year-round flows under H1 in the Sacramento River at Keswick and Wilkins Slough would generally be similar to flows under H3, except during September and November, during which flows would be up to 46% lower (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These isolated reductions would not have biologically meaningful effects on green sturgeon migration habitat. Year-round flows in the Feather River below Thermalito Afterbay (high-flow channel) and at the confluence with the Sacramento River under H1 would generally be similar to or greater than flows under H3, except during September during which flows would be up to 83% lower. This isolated reduction would not have biologically meaningful effects on green sturgeon migration habitat. Overall, results for H1 would be the same as those for H3.

H4/HOS

Year-round flows in the Sacramento River at Keswick and Wilkins Slough under H4 would generally be similar to flows under H3, except during May and June, during which flows would be up to 21% lower (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These small and isolated reductions would not have biologically meaningful effects on green sturgeon migration habitat. Flows in the Feather River below Thermalito Afterbay (high-flow channel) under H4 during January through May and November through December would generally be similar to or greater than flows under H3. However, flows during June through October would generally be up to 39% lower under H4. These reductions are expected to cause a biologically meaningful effect on green sturgeon migration habitat.

Through-Delta

As described above, the potential impact of Alternative 4 on in-Delta conditions for green sturgeon is considered less than significant, and no mitigation would be required.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-132 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 4 could be significant because, under the CEQA baseline, the alternative could substantially interfere with the movement of fish, contrary to the NEPA conclusion set forth above. The frequent small to large reductions in flows in the Sacramento and Feather Rivers would reduce the ability of all three life stages of green sturgeon to migrate successfully. Flow reductions during June through October under H4 would further reduce migration conditions for all three life stages. Exceedance of Delta outflow thresholds would be lower under Alternative 4 than under Existing Conditions, although there is high uncertainty that year class strength is due to Delta outflow or if both year class strength and Delta outflows co-vary with another unknown factor.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to H3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and H3 indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and H3. This indicates that the differences between Existing Conditions and Alternative 4 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 4, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on migration conditions for green sturgeon. This impact is found to be less than significant and no mitigation is required.

Restoration Measures (CM2, CM4–CM7, and CM10)

Alternative 4 has the same Restoration Measures as Alternative 1A. Because no substantial differences in restoration-related fish effects are anticipated anywhere in the affected environment under Alternative 4 compared to those described in detail for Alternative 1A, the fish effects of restoration measures described for green sturgeon under Alternative 1A (Impacts AQUA-133 through AQUA-135) also appropriately characterize effects under Alternative 4.

The following impacts are those presented under Alternative 1A that are identical for Alternative 4.

Impact AQUA-133: Effects of Construction of Restoration Measures on Green Sturgeon

Impact AQUA-134: Effects of Contaminants Associated with Restoration Measures on Green Sturgeon

Impact AQUA-135: Effects of Restored Habitat Conditions on Green Sturgeon

NEPA Effects: Detailed discussions regarding the potential effects of these three impact mechanisms on green sturgeon are the same for Alternative 4, as those described under Alternative 1A (Impacts AQUA 133-through AQUA-135). The effects would not be adverse, and would generally be beneficial. Specifically for AQUA-134, the effects of contaminants on green sturgeon with respect to copper, ammonia and pesticides would not be adverse. The effects of methylmercury and selenium on green sturgeon are uncertain.

CEQA Conclusion: All of the impact mechanisms listed above would be at least slightly beneficial, or less than significant, and no mitigation is required.

Other Conservation Measures (CM12–CM19 and CM21)

Alternative 4 has the same other conservation measures as Alternative 1A. Because no substantial differences in other conservation-related fish effects are anticipated anywhere in the affected environment under Alternative 4 compared to those described in detail for Alternative 1A, the fish effects of other conservation measures described for green sturgeon under Alternative 1A (Impacts AQUA-136 through AQUA-144) also appropriately characterize effects under Alternative 4.

The following impacts are those presented under Alternative 1A that are identical for Alternative 4.

Impact AQUA-136: Effects of Methylmercury Management on Green Sturgeon (CM12)

Impact AQUA-137: Effects of Invasive Aquatic Vegetation Management on Green Sturgeon (CM13)

Impact AQUA-138: Effects of Dissolved Oxygen Level Management on Green Sturgeon (CM14)

Impact AQUA-139: Effects of Localized Reduction of Predatory Fish on Green Sturgeon (CM15)

Impact AQUA-140: Effects of Nonphysical Fish Barriers on Green Sturgeon (CM16)

Impact AQUA-141: Effects of Illegal Harvest Reduction on Green Sturgeon (CM17)

Impact AQUA-142: Effects of Conservation Hatcheries on Green Sturgeon (CM18)

Impact AQUA-143: Effects of Urban Stormwater Treatment on Green Sturgeon (CM19)

Impact AQUA-144: Effects of Removal/Relocation of Nonproject Diversions on Green Sturgeon (CM21)

NEPA Effects: Detailed discussions regarding the potential effects of these nine impact mechanisms on green sturgeon are the same as those described under Alternative 1A (Impacts AQUA-136 through AQUA-144). The effects range from no effect, to not adverse, to beneficial.

CEQA Conclusion: The effects of the nine impact mechanisms listed above range from no impact, to less than significant, to beneficial, and no mitigation is required.

White Sturgeon

Construction and Maintenance of CM1

Impact AQUA-145: Effects of Construction of Water Conveyance Facilities on White Sturgeon

The potential effects of construction of the water conveyance facilities on white sturgeon would be similar to those described for Alternative 1A, Impact AQUA-145, except that Alternative 4 would include three intakes compared to five intakes under Alternative 1A, so the effects would be proportionally less under this alternative. This would convert about 6,360 lineal feet of existing shoreline habitat into intake facility structures and would require about 17.1 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. Alternative 4 would use five barge locations rather than six as under Alternative 1A so those effects would also be proportionally less. Additionally, construction and excavation at Clifton Court Forebay would be done in the dry via installation of cofferdams for isolation and dewatering of work areas. Implementation of Appendix 3B, *Environmental Commitments*, including construction BMPs and 3B.8–*Fish Rescue and Salvage Plan*, would minimize adverse effects as described for Alternative 1A. Mitigation measures would also be available to avoid and minimize potential effects.

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-145, the effect would not be adverse for white sturgeon.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-145, the impact of the construction of the water conveyance facilities on white sturgeon would not be significant except for construction noise associated with pile driving. Potential pile driving impacts would be less than Alternative 1A because only three intakes would be constructed rather than five. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in the discussion of Alternative 1A.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in the discussion of Alternative 1A.

Impact AQUA-146: Effects of Maintenance of Water Conveyance Facilities on White Sturgeon

NEPA Effects: The potential effects of the maintenance of water conveyance facilities under Alternative 4 would be the same as those described for Alternative 1A, Impact AQUA-146, except that only three intakes would need to be maintained under Alternative 4, compared to the five intakes under Alternative 1A. As concluded in Alternative 1A, Impact AQUA-146, the impact would not be adverse for white sturgeon.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-146, the impact of the maintenance of water conveyance facilities on white sturgeon would be less than significant and no mitigation is required.

Water Operations of CM1

Impact AQUA-147: Effects of Water Operations on Entrainment of White Sturgeon

Water Exports

The potential effects of the water operations under Alternative 4 would be the same as those described for green sturgeon (see Impact AQUA-129), which is a reduction in entrainment at the south Delta facilities, and avoidance or reduction of entrainment at the proposed north Delta diversion facilities and the NBA alternative intake. As concluded in Impact AQUA-129, the impact of Alternative 4 on white sturgeon would not be adverse.

Predation Associated with Entrainment

The potential effects would be the same as described for green sturgeon in Alternative 4 (see Impact AQUA-129).

NEPA Effects: In conclusion, the effect of Alternative 4 operations on entrainment and associated predation of white sturgeon would not be adverse and may provide modest benefit due to reduced losses at the south Delta facilities.

CEQA Conclusion: As described above for green sturgeon (Impact AQUA-129) the impact of water operations on white sturgeon would be less than significant and no mitigation would be required.

Impact AQUA-148: Effects of Water Operations on Spawning and Egg Incubation Habitat for White Sturgeon

In general, Alternative 4 would not affect spawning and egg incubation habitat for white sturgeon relative to the NAA. Alternative 4 would provide flow-related benefits to green sturgeon spawning in the Feather River.

H3/ESO

Sacramento River

Flows in the Sacramento River at Wilkins Slough and Verona were examined during the February to May spawning and egg incubation period for white sturgeon. Flows at Wilkins Slough and Verona during February through April under H3 would generally be similar to those under NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows during May at both locations would generally be greater than flows under NAA.

Mean monthly water temperatures in the Sacramento River at Hamilton City were examined during the February through May white sturgeon spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

The number of days on which temperature exceeded a 61°F optimal and 68°F lethal threshold by >0.5°F to >5°F in 0.5°F increments were determined for each month (March through June) and year of the 82-year modeling period (Table 11-4-13). The combination of number of days and degrees above each threshold were further assigned a "level of concern", as defined in Table 11-4-14. Differences between baselines and H3 in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4-107. For the 61°F threshold, there would be 11 fewer (19% fewer) "red" years under H3 than under NAA. For the 68°F threshold, there would be negligible differences in the number of years under each level of concern between NAA and H3.

Table 11-4-107. Differences between Baselines and H3 Scenarios in the Number of Years in Which Water Temperature Exceedances above the 61°F and 68°F Thresholds Are Within Each Level of Concern, Sacramento River at Hamilton City, March through June

Level of Concern	EXISTING CONDITIONS vs. H3	NAA vs. H3
61°F threshold		
Red	38 (475%)	-11 (-19%)
Orange	-4 (-27%)	-1 (-8%)
Yellow	-13 (-42%)	8 (80%)
None	-21 (-75%)	4 (133%)
68°F threshold		
Red	0 (NA)	0 (NA)
Orange	0 (NA)	0 (NA)
Yellow	1 (NA)	-2 (-200%)
None	-1 (-1%)	2 (2%)

NA = could not be calculated because the denominator was 0.

Total degree-days exceeding 61°F and 68°F were summed by month and water year type at Hamilton City during March through June (Table 11-4-108, Table 11-4-109). Total degree-days exceeding the 61°F threshold under H3 would be 1 degree-day (6%) greater than those during March, which would not be biologically meaningful. During April through June, total degree days above 61°F would be 41 to 774 (9% to 16%) lower under H3 than under NAA. Total degree-days exceeding the 68°F threshold be similar between NAA and H3, except during May, in which exceedances would be 20 degree-days (30%) fewer under H3.

Table 11-4-108. Differences between Baseline and H3 Scenarios in Total Degree-Days (°F-Days) by Month and Water Year Type for Water Temperature Exceedances above 61°F in the Sacramento River at Hamilton City, March through June

Month	Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
March	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	5 (NA)	1 (25%)
	Dry	11 (NA)	0 (0%)
	Critical	1 (NA)	0 (0%)
	All	17 (NA)	1 (6%)
April	Wet	65 (542%)	-1 (-1%)
	Above Normal	59 (590%)	-9 (-12%)
	Below Normal	62 (1,033%)	0 (0%)
	Dry	113 (222%)	-31 (-16%)
	Critical	14 (1,400%)	0 (0%)
	All	313 (391%)	-41 (-9%)
May	Wet	990 (297%)	-125 (-9%)
	Above Normal	223 (102%)	-128 (-22%)
	Below Normal	380 (207%)	-69 (-11%)
	Dry	247 (122%)	-186 (-29%)
	Critical	368 (182%)	18 (3%)
	All	2,208 (194%)	-490 (-13%)
June	Wet	639 (111%)	-319 (-21%)
	Above Normal	124 (41%)	-242 (-36%)
	Below Normal	364 (173%)	-138 (-19%)
	Dry	578 (173%)	-124 (-12%)
	Critical	595 (159%)	49 (5%)
	All	2,300 (128%)	-774 (-16%)

NA = could not be calculated because the denominator was 0.

Table 11-4-109. Differences between Baseline and H3 Scenarios in Total Degree-Days (°F-Days) by Month and Water Year Type for Water Temperature Exceedances above 68°F in the Sacramento River at Hamilton City, March through June

Month	Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
Mar	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
Apr	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
May	Wet	35 (500%)	-1 (-2%)
	Above Normal	1 (NA)	-19 (-95%)
	Below Normal	1 (NA)	1 (NA)
	Dry	0 (NA)	-2 (-100%)
	Critical	2 (NA)	1 (100%)
	All	39 (557%)	-20 (-30%)
Jun	Wet	7 (NA)	-1 (-13%)
	Above Normal	1 (100%)	-3 (-60%)
	Below Normal	2 (NA)	0 (0%)
	Dry	0 (NA)	0 (NA)
	Critical	13 (NA)	-14 (-52%)
	All	23 (2,300%)	0 (NA)

NA = could not be calculated because the denominator was 0.

Feather River

Flows in the Feather River between Thermalito Afterbay and the confluence with the Sacramento River were examined during the February to May spawning and egg incubation period for white sturgeon (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows at Thermalito Afterbay under H3 would generally be greater by up to 59% than those under NAA, with some exceptions. Flows at the confluence with the Sacramento River under H3 would be similar to or greater than flows under NAA, with some exceptions.

Mean monthly water temperatures in the Feather River below Thermalito Afterbay and at the confluence with the Sacramento River were examined during the February through May white sturgeon spawning and egg incubation period. Mean monthly water temperatures would not differ between NAA and H3 at either location throughout the period.

San Joaquin River

Flows in the San Joaquin River at Vernalis under H3 during February through May would not be different from flows under NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*.

Water temperature modeling was not conducted for the San Joaquin River.

H1/LOS

Sacramento River

Flows under H1 in the Sacramento River at Wilkins Slough and Verona during February to May would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Hamilton City were examined during the February through May white sturgeon spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1in any month or water year type throughout the period.

The number of days on which temperature exceeded a 61°F optimal and 68°F lethal threshold by >0.5°F to >5°F in 0.5°F increments were determined for each month (March through June) and year of the 82-year modeling period (Table 11-4-13). The combination of number of days and degrees above each threshold were further assigned a "level of concern", as defined in Table 11-4-14. Differences between baselines and H1 in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4-110. For the 61°F threshold, there would be 11 fewer (19% fewer) "red" years under H1 than under NAA. For the 68°F threshold, there would be negligible differences in the number of years under each level of concern between NAA and H1.

Table 11-4-110. Differences between Baselines and H1 and H4 Scenarios in the Number of Years in Which Water Temperature Exceedances above the 61°F and 68°F Thresholds Are within Each Level of Concern, Sacramento River at Hamilton City, March through June

Level of Concern	EXISTING CONDITIONS vs. H1	NAA vs. H1	EXISTING CONDITIONS vs. H4	NAA vs. H4
61°F threshold				
Red	38 (475%)	-11 (-19%)	51 (638%)	2 (4%)
Orange	-3 (-20%)	0 (0%)	-4 (-27%)	-1 (-8%)
Yellow	-16 (-52%)	5 (50%)	-23 (-74%)	-2 (-20%)
None	-19 (-68%)	6 (200%)	-24 (-86%)	1 (33%)
68°F threshold				
Red	0 (NA)	0 (NA)	0 (NA)	0 (NA)
Orange	0 (NA)	0 (NA)	0 (NA)	0 (NA)
Yellow	1 (NA)	-2 (-67%)	2 (NA)	-1 (-33%)
None	-1 (-1%)	2 (3%)	-2 (-2%)	1 (1%)

NA = could not be calculated because the denominator was 0.

Total degree-days exceeding 61°F and 68°F were summed by month and water year type at Hamilton City during March through June (Table 11-4-111, Table 11-4-112). Total degree-days exceeding the 61°F threshold under H1 would be 5 degree-days (31%) greater than those during March, which would not be biologically meaningful. During April, degree-days would be similar between NAA and H1. During May through June, total degree-days above 61°F would be 533 to 801 (14% to 16%) lower under H1 than under NAA. Total degree-days exceeding the 68°F threshold be similar between NAA and H3, except during May and June, in which exceedances would be 21 and 18 degree-days (32% and 43%, respectively) fewer under H1.

Table 11-4-111. Differences between Baselines and H1 and H4 Scenarios in Total Degree-Days (°F-days) by Month and Water Year Type for Water Temperature Exceedances above 61°F in the Sacramento River at Hamilton City, March through June

Month	Water Year Type	EXISTING CONDITIONS vs. H1	NAA vs. H1	EXISTING CONDITIONS vs. H4	NAA vs. H4
March	Wet	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Below Normal	9 (NA)	5 (125%)	8 (NA)	4 (100%)
	Dry	11 (NA)	0 (0%)	12 (NA)	1 (9%)
	Critical	1 (NA)	0 (0%)	1 (NA)	0 (0%)
	All	21 (NA)	5 (31%)	21 (NA)	5 (31%)
April	Wet	65 (542%)	-1 (-1%)	67 (558%)	1 (1%)
	Above Normal	62 (620%)	-6 (-8%)	59 (590%)	-9 (-12%)
	Below Normal	62 (1,033%)	0 (0%)	63 (1,050%)	1 (1%)
	Dry	137 (269%)	-7 (-4%)	150 (294%)	6 (3%)
	Critical	13 (1,300%)	-1 (-7%)	14 (1,400%)	0 (0%)
	All	339 (424%)	-15 (-3%)	353 (441%)	-1 (-0.2%)
May	Wet	961 (289%)	-154 (-11%)	1,042 (313%)	-73 (-5%)
	Above Normal	253 (116%)	-98 (-17%)	287 (132%)	-64 (-11%)
	Below Normal	374 (203%)	-75 (-12%)	466 (253%)	17 (3%)
	Dry	219 (108%)	-214 (-34%)	407 (201%)	-26 (-4%)
	Critical	358 (177%)	8 (1%)	341 (168.8%)	-9 (-2%)
	All	2,165 (190%)	-533 (-14%)	2,543 (223%)	-155 (-4%)
June	Wet	595 (103%)	-363 (-24%)	872 (151%)	-86 (-6%)
	Above Normal	144 (47%)	-222 (-33%)	404 (132%)	38 (6%)
	Below Normal	334 (158%)	-168 (-24%)	536 (254%)	34 (5%)
	Dry	547 (163%)	-155 (-15%)	733 (219%)	31 (3%)
	Critical	653 (175%)	107 (11.6%)	620 (166%)	74 (8%)
	All	2,273 (126%)	-801 (-16%)	3,165 (176%)	91 (2%)

NA = could not be calculated because the denominator was 0.

Table 11-4-112. Differences between Baselines and H1 and H4 Scenarios in Total Degree-Days (°F-Days) by Month and Water Year Type for Water Temperature Exceedances above 68°F in the Sacramento River at Hamilton City, March through June

Month	Water Year Type	EXISTING CONDITIONS vs. H1	NAA vs. H1	EXISTING CONDITIONS vs. H4	NAA vs. H4
March	Wet	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)	0 (NA)	0 (NA)
April	Wet	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)	0 (NA)	0 (NA)
May	Wet	33 (471%)	-3 (-7%)	33 (471%)	-3 (-7%)
	Above Normal	2 (NA)	-18 (-90%)	20 (NA)	0 (0%)
	Below Normal	1 (NA)	1 (NA)	0 (NA)	0 (NA)
	Dry	0 (NA)	-2 (-100%)	3 (NA)	1 (50%)
	Critical	2 (NA)	1 (100%)	2 (NA)	1 (100%)
	All	38 (543%)	-21 (-32%)	58 (829%)	-1 (-2%)
June	Wet	7 (NA)	-1 (-13%)	8 (NA)	0 (0%)
	Above Normal	2 (200%)	-2 (-40%)	4 (400%)	0 (0%)
	Below Normal	1 (NA)	-1 (-50%)	3 (NA)	1 (50%)
	Dry	0 (NA)	0 (NA)	0 (NA)	0 (NA)
	Critical	13 (NA)	-14 (-52%)	7 (NA)	-20 (-74%)
	All	23 (2,300%)	-18 (-43%)	22 (2,200%)	-19 (-45%)

NA = could not be calculated because the denominator was 0.

Feather River

Flows under H1 in the Feather River between Thermalito Afterbay and the confluence with the Sacramento River during the February to May would generally be similar to flows under H3 with few exceptions.

Mean monthly water temperatures in the Feather River below Thermalito Afterbay and at the confluence with the Sacramento River were examined during the February through May white sturgeon spawning and egg incubation period. Mean monthly water temperatures would not differ between NAA and H1 at either location throughout the period.

San Joaquin River

Flows under H1 in the San Joaquin River would be the same as those under H3.

Water temperature modeling was not conducted for the San Joaquin River.

H4/HOS

Sacramento River

Flows under H4 in the Sacramento River at Wilkins Slough and Verona during February to May would generally be similar to or greater than flows under H3 with few exceptions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Hamilton City were examined during the February through May white sturgeon spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

The number of days on which temperature exceeded a 61°F optimal and 68°F lethal threshold by >0.5°F to >5°F in 0.5°F increments were determined for each month (March through June) and year of the 82-year modeling period (Table 11-4-13). The combination of number of days and degrees above each threshold were further assigned a "level of concern", as defined in Table 11-4-14. Differences between baselines and H4 in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4-110. For the 61°F threshold, there would be 2 more (4%) "red" years under H4 than under NAA, which would not be biologically meaningful. For the 68°F threshold, there would be negligible differences in the number of years under each level of concern between NAA and H4.

Total degree-days exceeding 61°F and 68°F were summed by month and water year type at Hamilton City during March through June (Table 11-4-111, Table 11-4-112). Total degree-days exceeding the 61°F threshold under H4 would be 5 degree-days (31%) greater than those during March, which would not be biologically meaningful. During the remaining months, there would be no differences between NAA and H4 in total degree-days exceeding the 61°F threshold. Total degree-days exceeding the 68°F threshold be similar between NAA and H4, except during June, in which exceedances would be 19 degree-days (45%) fewer under H4.

Feather River

Flows under H4 in the Feather River between Thermalito Afterbay and the confluence with the Sacramento River during the February to May would generally be similar to or greater than flows under H3 with few exceptions.

Mean monthly water temperatures in the Feather River below Thermalito Afterbay and at the confluence with the Sacramento River were examined during the February through May white sturgeon spawning and egg incubation period. Mean monthly water temperatures would not differ between NAA and H4 at either location throughout the period.

San Joaquin River

Mean monthly flows in the San Joaquin River at Vernalis under H4 during February through May would be similar to those under NAA (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*.

Water temperature modeling was not conducted for the San Joaquin River.

NEPA Effects: Collectively, these results indicate that the effect is not adverse because it does not have the potential to substantially reduce the amount of suitable habitat. Flows under Alternative 4 would generally be higher in the Feather River under Alternative 4 relative to the NAA and generally similar to flows under the NAA in the Sacramento and San Joaquin Rivers. Alternative 4 would not affect temperatures in any river during the white sturgeon spawning and egg incubation period. Results would generally be similar among model scenarios

CEQA Conclusion: In general, Alternative 4 would not reduce spawning and egg incubation habitat for white sturgeon relative to Existing Conditions.

Sacramento River

Flows in the Sacramento River at Wilkins Slough and Verona were examined during the February to May spawning and egg incubation period for white sturgeon (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). At Wilkins Slough, flows under H3 during February through April would be similar to those under Existing Conditions with few exceptions, and greater by up to 28% than flows under Existing Conditions during May with few exceptions. At Verona, flows under H3 during February would be generally lower by up to 9% than flows under Existing Conditions with few exceptions. Flows under H3 during March and April would generally be similar to flows under Existing Conditions with few exceptions. Flows under H3 during May would generally be greater by up to 18% than flows under Existing Conditions with few exceptions.

Mean monthly water temperatures in the Sacramento River at Hamilton City were examined during the February through May white sturgeon spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H3 in any month or water year type throughout the period, except for a 5% increase in wet years during May.

The number of days on which temperature exceeded a 61°F optimal and 68°F lethal threshold by >0.5°F to >5°F in 0.5°F increments were determined for each month (March through June) and year of the 82-year modeling period (Table 11-4-13). The combination of number of days and degrees above each threshold were further assigned a "level of concern", as defined in Table 11-4-14. Differences between baselines and H3 in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4-107. For the 61°F threshold, there would be 38 more (475% increase) "red" years under H3 than under Existing Conditions. For the 68°F threshold, there would be negligible differences in the number of years under each level of concern between Existing Conditions and H3.

Total degree-days exceeding 61°F and 68°F were summed by month and water year type at Hamilton City during March through June (Table 11-4-108, Table 11-4-109). Total degree-days exceeding the 61°F threshold under H3 would be 17 degree-days (percent change unable to be calculated due to division by 0) to 2,300 degree-days (128%) higher depending on month. Total degree-days exceeding the 68°F threshold would not differ between Existing Conditions and H3 during March and April. During May and June, total degree-days would be 39 (557%) and 23 (2,300%) degree-days higher under H3, although these small absolute differences would not cause a biologically meaningful effect on white sturgeon.

Feather River

Flows in the Feather River between Thermalito Afterbay and the confluence with the Sacramento River were examined during the February to May spawning and egg incubation period for white sturgeon (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows at Thermalito Afterbay under H3 during February would generally be lower by up to 45% than flows under Existing Conditions with few exceptions, and flows during March through May would generally be greater by up to 131% than those under Existing Conditions, with few exceptions. Flows at the confluence with the Sacramento River under H3 would generally be similar to or greater than flows under Existing Conditions, except in below normal years during February and March (11% and 20% lower, respectively) and wet years during May (26% lower). These results indicate that there would be few reductions in flows in the Feather River under H3 relative to Existing Conditions.

Mean monthly water temperatures in the Feather River below Thermalito Afterbay and at the confluence with the Sacramento River were examined during the February through May white sturgeon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures would not differ between Existing Conditions and H3 at either location throughout the period, except below Thermalito Afterbay during February, in which temperatures under H3 would be 6% higher than temperatures under Existing Conditions.

San Joaquin River

Mean monthly flows in the San Joaquin River at Vernalis under H3 during February through May would be similar to those under Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*.

Water temperature modeling was not conducted for the San Joaquin River.

H1/LOS

Sacramento River

Flows under H1 in the Sacramento River at Wilkins Slough and Verona during the February through May white sturgeon spawning period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*.

Mean monthly water temperatures in the Sacramento River at Hamilton City were examined during the February through May white sturgeon spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H1 in any month or water year type throughout the period, except for a 5% increase in wet years during May.

The number of days on which temperature exceeded a 61°F optimal and 68°F lethal threshold by >0.5°F to >5°F in 0.5°F increments were determined for each month (March through June) and year of the 82-year modeling period (Table 11-4-13). The combination of number of days and degrees above each threshold were further assigned a “level of concern”, as defined in Table 11-4-14. Differences between baselines and H1 in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4-110. For the 61°F threshold, there would be 38 more (475% increase) “red” years under H1 than under Existing Conditions. For the 68°F threshold, there would be negligible differences in the number of years under each level of concern between Existing Conditions and H1.

Total degree-days exceeding 61°F and 68°F were summed by month and water year type at Hamilton City during March through June (Table 11-4-108, Table 11-4-109). Total degree-days exceeding the 61°F threshold under H3 would be 21 degree-days (percent change unable to be calculated due to division by 0) to 2,273 degree-days (126%) higher depending on month. Total degree-days exceeding the 68°F threshold would not differ between Existing Conditions and H1 during March and April. During May and June, total degree-days would be 38 (543%) and 23 (2,300%) degree-days higher under H1, although these small absolute differences would not cause a biologically meaningful effect on white sturgeon.

Feather River

Flows under H1 in the Feather River between Thermalito Afterbay and the confluence with the Sacramento River during the February to May would generally be similar to flows under H3 with few exceptions.

Mean monthly water temperatures in the Feather River below Thermalito Afterbay and at the confluence with the Sacramento River were examined during the February through May white sturgeon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures would not differ between Existing Conditions and H1 at either location throughout the period, except below Thermalito Afterbay during February, in which temperatures under H1 would be 6% higher than temperatures under Existing Conditions.

San Joaquin River

Flows under H1 in the San Joaquin River would be the same as those under H3.

Water temperature modeling was not conducted for the San Joaquin River.

Results of these analyses for H1 would be the same as those for H3. Overall, results for H1 would be similar to those under H3.

H4/HOS

Sacramento River

Flows under H4 in the Sacramento River at Wilkins Slough and Verona during February to May would generally be similar to or greater than flows under H3 with few exceptions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean monthly water temperatures in the Sacramento River at Hamilton City were examined during the February through May white sturgeon spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between Existing Conditions and H1 in any month or water year type throughout the period, except for a 5% increase in wet years during May.

The number of days on which temperature exceeded a 61°F optimal and 68°F lethal threshold by >0.5°F to >5°F in 0.5°F increments were determined for each month (March through June) and year of the 82-year modeling period (Table 11-4-13). The combination of number of days and degrees above each threshold were further assigned a "level of concern", as defined in Table 11-4-14. Differences between baselines and H1 in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4-110. For the 61°F threshold, there would be 38 more (475% increase) "red" years under H1 than under Existing Conditions. For the 68°F threshold, there would be negligible differences in the number of years under each level of concern between Existing Conditions and H1.

Total degree-days exceeding 61°F and 68°F were summed by month and water year type at Hamilton City during March through June (Table 11-4-108, Table 11-4-109). Total degree-days exceeding the 61°F threshold under H3 would be 21 degree-days (percent change unable to be calculated due to division by 0) to 2,273 degree-days (126%) higher depending on month. Total degree-days exceeding the 68°F threshold would not differ between Existing Conditions and H1 during March and April. During May and June, total degree-days would be 38 (543%) and 23 (2,300%) degree-days higher under H1, although these small absolute differences would not cause a biologically meaningful effect on white sturgeon.

Feather River

Flows under H4 in the Feather River between Thermalito Afterbay and the confluence with the Sacramento River during the February to May would generally be similar to or greater than flows under H3 with few exceptions.

Mean monthly water temperatures in the Feather River below Thermalito Afterbay and at the confluence with the Sacramento River were examined during the February through May white sturgeon spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures would not differ between Existing Conditions and H4 at either location throughout the period, except below Thermalito Afterbay during February, in which temperatures under H4 would be 6% higher than temperatures under Existing Conditions.

San Joaquin River

Flows under H4 in the San Joaquin River would be the same as those under H3.

Results of these analyses for H4 would be the same as those for H3. Overall, results for H4 would be similar to those under H3.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-148 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 4 could be significant because, under the CEQA baseline, the alternative could substantially reduce the amount of suitable spawning and egg incubation habitat for white sturgeon, contrary to the NEPA conclusion set forth above. There are small, infrequent reductions in flows in the Sacramento and Feather rivers that would not cause biologically meaningful effects to white sturgeon spawning and egg incubation habitat. However, there would be differences in exceedances of NMFS temperature thresholds in the Sacramento and Feather River that would cause a biologically meaningful effect to white sturgeon spawning and egg incubation. Results would generally be consistent among scenarios.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to H3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and H3 indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and H3. This indicates that the differences between Existing Conditions and Alternative 4 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 4, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on spawning habitat for white sturgeon. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-149: Effects of Water Operations on Rearing Habitat for White Sturgeon

In general, Alternative 4 would not affect quantity and quality of white sturgeon larval and juvenile rearing habitat relative to the NAA.

H3/ESO

Water temperature was used to determine the potential effects of H3 on white sturgeon larval and juvenile rearing habitat because larvae and juveniles are benthic-oriented and, therefore, their habitat is more likely to be limited by changes in water temperature than flow rates.

Mean monthly water temperatures in the Sacramento River at Hamilton City were examined during the year-round white sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period.

Mean monthly water temperatures in the Feather River at Honcut Creek were examined during the year-round white sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H3 in any month or water year type throughout the period

Water temperatures were not modeled in the San Joaquin River.

H1/LOS

Mean monthly water temperatures in the Sacramento River at Hamilton City were examined during the year-round white sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water*

Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis). There would be no differences (<5%) in mean monthly water temperature between NAA and H1 in any month or water year type throughout the period.

Mean monthly water temperatures in the Feather River at Honcut Creek were examined during the year-round white sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H1in any month or water year type throughout the period.

Water temperatures were not modeled in the San Joaquin River.

H4/HOS

Mean monthly water temperatures in the Sacramento River at Hamilton City were examined during the year-round white sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

Mean monthly water temperatures in the Feather River at Honcut Creek were examined during the year-round white sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA and H4 in any month or water year type throughout the period.

Water temperatures were not modeled in the San Joaquin River.

NEPA Effects: These results indicate that the effect is not adverse because it does not have the potential to substantially reduce the amount of suitable habitat. There would be no differences in water temperatures between Alternative 4 and the NEPA point of comparison. Results would be similar among scenarios.

CEQA Conclusion: In general, Alternative 4 would not affect the quantity and quality of white sturgeon larval and juvenile rearing habitat relative to Existing Conditions.

H3/ESO

Water temperature was used to determine the potential effects of H3 on white sturgeon larval and juvenile rearing habitat because larvae and juveniles are benthic-oriented and, therefore, their habitat is more likely to be limited by changes in water temperature than flow rates.

Mean monthly water temperatures in the Sacramento River at Hamilton City were examined during the year-round white sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures would be similar between Existing Conditions and H3 during November through July and September, but 6% and 5% higher under H3 relative to Existing Conditions during August and October, respectively.

Mean monthly water temperatures in the Feather River at Honcut Creek were examined during the year-round white sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures would be similar between Existing Conditions and H3 during March through July and September, but 5% to 8% higher under H3 relative to Existing Conditions during October through February and August.

Water temperatures were not modeled in the San Joaquin River.

H1/LOS

Mean monthly water temperatures in the Sacramento River at Hamilton City were examined during the year-round white sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures would be similar between Existing Conditions and H1 during November through July and September, but 6% and 7% higher under H1 relative to Existing Conditions during August and September, respectively.

Mean monthly water temperatures in the Feather River at Honcut Creek were examined during the year-round white sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures would be similar between Existing Conditions and H1 during March through July and September, but 5% to 8% higher under H1 relative to Existing Conditions during October through February and August.

Water temperatures were not modeled in the San Joaquin River.

H4/HOS

Mean monthly water temperatures in the Sacramento River at Hamilton City were examined during the year-round white sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures would be similar between Existing Conditions and H4 during November through July and September, but 5% higher under H4 relative to Existing Conditions during August and October.

Mean monthly water temperatures in the Feather River at Honcut Creek were examined during the year-round white sturgeon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean monthly water temperatures would be similar between Existing Conditions and H4 during March through June and September, but 6% to 8% higher under H4 relative to Existing Conditions during October through February and July through August.

Water temperatures were not modeled in the San Joaquin River.

Summary of CEQA Conclusion

These results indicate that the effect is less than significant because it does not have the potential to substantially reduce the amount of suitable habitat and no mitigation is required. There would be no differences in water temperatures between Alternative 4 and the CEQA baseline. Results would be similar among scenarios.

Impact AQUA-150: Effects of Water Operations on Migration Conditions for White Sturgeon

In general, effects of Alternative 4 on white sturgeon migration conditions relative to NAA are uncertain.

Upstream of the Delta

H3/ESO

Analyses for white sturgeon focused on the Sacramento River (North Delta to RM 143—i.e., Wilkins Slough and Verona CALSIM nodes). Larval transport flows were represented by the average number of months per year that exceeded thresholds of 17,700 cfs (Wilkins Slough) and 31,000 cfs (Verona) (Table 11-4-113). Exceedances of the 17,700 cfs threshold for Wilkins Slough and the 31,000 cfs threshold at Verona under H3 would generally be similar to those under NAA. Despite some large relative difference (up to 50%), these changes would be negligible on an absolute scale.

Table 11-4-113. Difference and Percent Difference in Number of Months in Which Flow Rates Exceed 17,700 and 5,300 cfs in the Sacramento River at Wilkins Slough and 31,000 cfs at Verona

	EXISTING CONDITIONS vs. H3	NAA vs. H3
Wilkins Slough, 17,700 cfs[a]		
Wet	0 (-2%)	0 (0%)
Above Normal	0.3 (18%)	0.1 (5%)
Below Normal	-0.1 (-25%)	0 (0%)
Dry	0 (0%)	0 (0%)
Critical	0 (0%)	0 (0%)
Wilkins Slough, 5,300 cfs[b]		
Wet	-0.2 (-3%)	0 (0%)
Above Normal	-0.3 (-4%)	0.1 (1%)
Below Normal	0.3 (5%)	0.6 (12%)
Dry	0.4 (9%)	0.2 (3%)
Critical	0.2 (5%)	0.1 (2%)
Verona, 31,000 cfs[a]		
Wet	-0.5 (-21%)	-0.2 (-9%)
Above Normal	-0.2 (-10%)	0 (0%)
Below Normal	-0.2 (-43%)	-0.1 (-33%)
Dry	-0.2 (-60%)	-0.1 (-50%)
Critical	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.
[a] Months analyzed: February through May.
[b] Months analyzed: November through May.

Larval transport flows were also examined by utilizing the positive correlation between year class strength and Delta outflow during April and May (USFWS 1995) under the assumption that the mechanism responsible for the relationship is that Delta outflow provides improved larval transport that results in improved year class strength. The percentage of months exceeding flow thresholds under H3 would generally be lower than those under NAA (up to 50% lower) (Table 11-4-114).

These results indicate that, using the positive correlation between Delta outflow and year class strength, year class strength generally would be lower under H3.

Table 11-4-114. Difference and Percent Difference in Percentage of Months in Which Average Delta Outflow is Predicted to Exceed 15,000, 20,000, and 25,000 Cubic Feet per Second (cfs) in April and May of Wet and Above-Normal Water Years

Flow	Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
April			
15,000 cfs	Wet	-8 (-8%)	-8 (-8%)
	Above Normal	-17 (-18%)	-17 (-18%)
20,000 cfs	Wet	-8 (-9%)	-8 (-9%)
	Above Normal	-25 (-33%)	-17 (-25%)
25,000 cfs	Wet	-15 (-19%)	-12 (-15%)
	Above Normal	-17 (-29%)	-8 (-17%)
May			
15,000 cfs	Wet	-8 (-9%)	0 (0%)
	Above Normal	-17 (-20%)	8 (14%)
20,000 cfs	Wet	-35 (-41%)	-12 (-19%)
	Above Normal	-17 (-40%)	-8 (-25%)
25,000 cfs	Wet	-27 (-39%)	-15 (-27%)
	Above Normal	-17 (-50%)	-8 (-33%)
April/May Average			
15,000 cfs	Wet	-8 (-8%)	0 (0%)
	Above Normal	-25 (-25%)	-17 (-18%)
20,000 cfs	Wet	-19 (-22%)	-15 (-18%)
	Above Normal	-17 (-25%)	0 (0%)
25,000 cfs	Wet	-19 (-24%)	-8 (-11%)
	Above Normal	-25 (-50%)	-25 (-50%)

For juveniles, flows in the Sacramento River at Verona were examined during the year-round migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows at Verona under H3 would be lower by up to 25% relative to NAA during January, July, August, and November, greater by up to 32% greater during May and June, and similar in the remaining six months (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

For adults, the average number of months per year during the November through May adult migration period in which flows in the Sacramento River at Wilkins Slough exceed 5,300 cfs was determined (Table 11-4-113). The average number of months exceeding 5,300 cfs under H3 would be similar to or greater than the number of months under NAA (up to 12% greater).

H1/LOS

Year-round flows under H1 in the Sacramento River at Wilkins Slough and Verona would be similar to those under H3, except during November at Wilkins Slough in which flows would be up to 13% lower under H1 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These reductions would not be frequent or large enough to have biologically meaningful effects on white sturgeon migration in the Sacramento River. Because flows under H1 in the Sacramento River would be similar to those under H3, additional flow threshold analyses were not warranted. Results of these analyses for H1 would be the same as those for H3. Overall, results for H1 would be similar to those for H3.

H4/HOS

Year-round flows under H1 in the Sacramento River at Wilkins Slough and Verona would be similar to those under H3, except during May and June at Wilkins Slough (up to 21% lower) and during June through August at Verona (up to 23% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These reductions would not be frequent or large enough to have biologically meaningful effects on white sturgeon migration in the Sacramento River. Because flows under H4 in the Sacramento River would be similar to those under H3, additional flow threshold analyses were not warranted. Results of these analyses for H4 would be the same as those for H3. Overall, results for H4 would be similar to those for H3.

Through-Delta

The impact of Alternative 4 on in-Delta movement conditions would be the same as described above for splittail (Impact AQUA-114). The effect on white sturgeon would not be adverse.

NEPA Effects: Upstream flows (above north Delta intakes) are similar between Alternative 4 and NAA (Table 11-4-113). However, due to the removal of water at the North Delta intakes, there are substantial differences in through-Delta flows between Alternative 4 and NAA (Table 11-4-114). Analysis of white sturgeon year-class strength (USFWS 1995) found a positive correlation between year class strength and Delta outflow during April and May. However, this conclusion was reached in the absence of north Delta intakes and the exact mechanism that causes this correlation is not known at this time. One hypothesis suggests that the correlation is caused by high flows in the upper river resulting in improved migration, spawning, and rearing conditions in the upper river. Another hypothesis suggests that the positive correlation is a result of higher flows through the Delta triggering more adult sturgeon to move up into the river to spawn. It is also possible that some combination of these factors are working together to produce the positive correlation between high flows and sturgeon year-class strength.

The scientific uncertainty regarding which mechanisms are responsible for the positive correlation between year class strength and river/Delta flow will be addressed through targeted research and monitoring to be conducted in the years leading up to the initiation of north Delta facilities operations. If these targeted investigations determine that the primary mechanisms behind the positive correlation between high flows and sturgeon year-class strength are related to upstream conditions, then Alternative 4 would be deemed Not Adverse due to the similarities in upstream flow conditions between Alternative 4 and NAA. However, if the targeted investigations lead to a conclusion that the primary mechanisms behind the positive correlation are related to in-Delta and through-Delta flow conditions, then Alternative 4 would be deemed adverse due to the magnitude of reductions in through-Delta flow conditions in Alternative 4 as compared to NAA.

CEQA Conclusion: In general, under all the Alternative 4 water operations scenarios, migration conditions for white sturgeon would not be affected relative to the CEQA baseline.

Upstream of the Delta

H3/ESO

The number of months per year with exceedances above the 17,700 cfs threshold for Wilkins Slough under H3 would generally be similar to or greater those under Existing Conditions, except in below normal years (25% lower)(Table 11-4-113). The number of months per year exceeding 31,000 cfs at Verona under H3 would generally be up to 60% lower than those under Existing Conditions except in critical years, in which there would be no change from Existing Conditions.

For Delta outflow, the percent of months exceeding outflow thresholds under H3 would consistently be lower than those under Existing Conditions for each flow threshold, water year type, and month (8% to 50% lower on a relative scale) (Table 11-4-114).

For juveniles, flows in the Sacramento River at Verona were examined during the year-round migration period. In general, flows under H3 would be lower relative to Existing Conditions during January, February, July, August, and November (up to 29% lower), greater during May and June (up to 33% greater), and similar during the remaining five months (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

For adult migration, the average number of months exceeding 5,300 cfs at Wilkins Slough under H3 would generally be greater than the number of months under Existing Conditions (up to 9% greater), except in wet and above normal water years, in which exceedances would be similar between H3 and Existing Conditions (Table 11-4-113).

H1/LOS

Year-round flows under H1 in the Sacramento River at Wilkins Slough and Verona would be similar to those under H3, except during November at Wilkins Slough in which flows would be up to 13% lower under H1 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These reductions would not be frequent or large enough to have biologically meaningful effects on white sturgeon migration in the Sacramento River. Because flows under H1 in the Sacramento River would be similar to those under H3, additional flow threshold analyses were not warranted. Results of these analyses for H1 would be the same as those for H3. Overall, results for H1 would be similar to those for H3.

H4/HOS

Year-round flows under H4 in the Sacramento River at Wilkins Slough and Verona would be similar to those under H3, except during May and June at Wilkins Slough (up to 21% lower) and during June through August at Verona (up to 23% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These reductions would not be frequent or large enough to have biologically meaningful effects on white sturgeon migration in the Sacramento River. Because flows under H4 in the Sacramento River would be similar to those under H3, additional flow threshold analyses were not warranted. Results of these analyses for H4 would be the same as those for H3. Overall, results for H4 would be similar to those for H3.

Through-Delta

As described above in Impact AQUA-150, the potential impact of Alternative 4 on white sturgeon is considered less than significant, and no mitigation would be required.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-150 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 4 could be significant because, under the CEQA baseline, the alternative could substantially reduce migration conditions for green sturgeon, contrary to the NEPA conclusion set forth above. The exceedance of flow thresholds in the Sacramento River and for Delta outflow would be lower under Alternative 4 than under Existing Conditions, although there is high uncertainty that year class strength is due to Delta outflow or if both year class strength and Delta outflows are co-variable with another unknown factor. Juvenile migration flows in the Sacramento River at Verona would be up to 29% lower in five of 12 months relative to Existing Conditions. These reduced flows would have a substantial effect on the ability to migrate downstream, delaying or slowing rates of successful migration downstream and increasing the risk of mortality. There would be no effects of Alternative 4 on through-Delta migration conditions.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alterantive 4 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and Alternative 4 indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and Alternative 4. This indicates that the differences between Existing Conditions and Alternative 4 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 4, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion of not adverse, and therefore would not in itself result in a significant impact on migration conditions for white sturgeon. Additionally, as described above in the NEPA Effects statement, further investigation is needed to better understand the association of Delta outflow to sturgeon recruitment, and if needed, adaptive management would be used to make adjustments to meet the biological goals and objectives. This impact is found to be less than significant and no mitigation is required.

Restoration Measures (CM2, CM4–CM7, and CM10)

Alternative 4 has the same Restoration Measures as Alternative 1A. Because no substantial differences in restoration-related fish effects are anticipated anywhere in the affected environment under Alternative 4 compared to those described in detail for Alternative 1A, the fish effects of restoration measures described for white sturgeon under Alternative 1A (Impacts AQUA-151 through AQUA-153) also appropriately characterize effects under Alternative 4.

The following impacts are those presented under Alternative 1A that are identical for Alternative 4.

Impact AQUA-151: Effects of Construction of Restoration Measures on White Sturgeon

Impact AQUA-152: Effects of Contaminants Associated with Restoration Measures on White Sturgeon

Impact AQUA-153: Effects of Restored Habitat Conditions on White Sturgeon

NEPA Effects: Detailed discussions regarding the potential effects of these three impact mechanisms on white sturgeon are the same for Alternative 4, as those described under Alternative 1A (Impacts AQUA 151-through AQUA-153). The effects would not be adverse, and would generally be beneficial. Specifically for AQUA-152, the effects of contaminants on white sturgeon with respect to copper, ammonia and pesticides would not be adverse. The effects of methylmercury and selenium on white sturgeon are uncertain.

CEQA Conclusion: All of the impact mechanisms listed above would be at least slightly beneficial, or less than significant, and no mitigation is required.

Other Conservation Measures (CM12–CM19 and CM21)

Alternative 4 has the same other conservation measures as Alternative 1A. Because no substantial differences in other conservation-related fish effects are anticipated anywhere in the affected environment under Alternative 4 compared to those described in detail for Alternative 1A, the fish effects of other conservation measures described for white sturgeon under Alternative 1A (Impacts AQUA-154 through AQUA-162) also appropriately characterize effects under Alternative 4.

The following impacts are those presented under Alternative 1A that are identical for Alternative 4.

Impact AQUA-154: Effects of Methylmercury Management on White Sturgeon (CM12)

Impact AQUA-155: Effects of Invasive Aquatic Vegetation Management on White Sturgeon (CM13)

Impact AQUA-156: Effects of Dissolved Oxygen Level Management on White Sturgeon (CM14)

Impact AQUA-157: Effects of Localized Reduction of Predatory Fish on White Sturgeon (CM15)

Impact AQUA-158: Effects of Nonphysical Fish Barriers on White Sturgeon (CM16)

Impact AQUA-159: Effects of Illegal Harvest Reduction on White Sturgeon (CM17)

Impact AQUA-160: Effects of Conservation Hatcheries on White Sturgeon (CM18)

Impact AQUA-161: Effects of Urban Stormwater Treatment on White Sturgeon (CM19)

Impact AQUA-162: Effects of Removal/Relocation of Nonproject Diversions on White Sturgeon (CM21)

NEPA Effects: Detailed discussions regarding the potential effects of these nine impact mechanisms on white sturgeon are the same as those described under Alternative 1A (Impacts AQUA-154 through AQUA-162). The effects range from no effect, to not adverse, to beneficial.

CEQA Conclusion: The effects of the nine impact mechanisms listed above range from no impact, to less than significant, to beneficial, and no mitigation is required.

Pacific Lamprey

Construction and Maintenance of CM1

Impact AQUA-163: Effects of Construction of Water Conveyance Facilities on Pacific Lamprey

The potential effects of construction of the water conveyance facilities on Pacific lamprey would be similar to those described for Alternative 1A, Impact AQUA-163, except that Alternative 4 would include three intakes compared to five intakes under Alternative 1A, so the effects would be proportionally less under this alternative. This would convert about 6,360 lineal feet of existing shoreline habitat into intake facility structures and would require about 17.1 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. Alternative 4 would use five barge locations rather than six as under Alternative 1A so those effects would also be proportionally less. Additionally, construction and excavation at Clifton Court Forebay would be done in the dry via installation of cofferdams for isolation and dewatering of work areas. Implementation of Appendix 3B, *Environmental Commitments*, including construction BMPs and 3B.8–*Fish Rescue and Salvage Plan*, would minimize adverse effects as described for Alternative 1A. Mitigation measures would also be available to avoid and minimize potential effects.

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-163, the effect would not be adverse for Pacific lamprey.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-163, the impact of the construction of the water conveyance facilities on Pacific lamprey would not be significant except for construction noise associated with pile driving. Potential pile driving impacts would be less than Alternative 1A because only three intakes would be constructed rather than five. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in the discussion of Alternative 1A.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in the discussion of Alternative 1A.

Impact AQUA-164: Effects of Maintenance of Water Conveyance Facilities on Pacific Lamprey

NEPA Effects: The potential effects of the maintenance of water conveyance facilities under Alternative 4 would be the same as those described for Alternative 1A, Impact AQUA-164, except that only three intakes would need to be maintained under Alternative 4 rather than five under

Alternative 1A. As concluded in Alternative 1A, Impact AQUA-2, the impact would not be adverse for Pacific lamprey.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-164, the impact of the maintenance of water conveyance facilities on Pacific lamprey would be less than significant and no mitigation is required.

Water Operations of CM1

Impact AQUA-165: Effects of Water Operations on Entrainment of Pacific Lamprey

Water Exports

The potential entrainment impacts of Alternative 4 on Pacific lamprey and river lamprey would be the same as described above for Alternative 1A for operating SWP/CVP south Delta export facilities and the proposed new SWP/CVP North Delta intakes (Impacts AQUA-165), non-physical barriers at the entrances to CCF and the DMC (Impacts AQUA-176), and decommissioning agricultural diversions in ROAs (Impacts AQUA-180). These actions would avoid or reduce potential entrainment and the effect would not be adverse and may be beneficial.

The analysis of Pacific lamprey and river lamprey entrainment at the SWP/CVP south Delta export facilities is combined because the salvage facilities do not distinguish between the two lamprey species. Under Scenario H3, average annual entrainment of lamprey at the south Delta export facilities would be substantially reduced by about 41% (Table 11-4-115) across all year types compared to the NAA. Entrainment losses would be similar between Scenario H3 and the Scenario H1, but would be further reduced under Scenario H4 compared to NAA. Therefore, Alternative 4 would not have adverse effects on lamprey.

Predation Associated with Entrainment

Entrainment-related predation loss of lamprey at the south Delta facilities would not be greater under this Alternative and may be lower due to a reduction in entrainment loss. Conditions under Scenario H4 would decrease predation loss relative to NAA and Scenario H3, while conditions would be similar between Scenario H1 and Scenario H3. Predation at the north Delta would be increased due to the installation of the proposed water export facilities on the Sacramento River. The effect on lamprey from predation loss at the north Delta facilities is unknown because of the lack of knowledge about their distribution and population abundances in the Delta.

NEPA Effects: Overall, it is expected that the effect of predation loss on lamprey under Alternative 4 may be moderate, but would not be adverse.

CEQA Conclusion: Annual entrainment losses of lamprey would be decreased under Scenario H3 by 43% relative to existing biological conditions. Conditions would be similar between Scenario H3 and H1, while entrainment would be further decreased under Scenario H4. Lamprey predation loss at the south Delta facilities would not be increased relative to Existing Conditions and may be decreased due to reduction entrainment losses. Predation at the north Delta would be increased due to the installation of the proposed water export facilities on the Sacramento River. The effect on lamprey from predation loss at the north Delta facilities is unknown because of the lack of knowledge about their distribution and population abundances in the Delta. Overall, it is expected that the effect of predation loss on lamprey under Alternative 4 may be moderate, but would be less than significant.

Table 11-4-115. Lamprey Annual Entrainment Index[a] at the SWP and CVP Salvage Facilities for Alternative 4 (Scenario H3)

	Absolute Difference (Percent Difference)	
Water Year Type	EXISTING CONDITIONS vs. A4_LLT	NAA vs. A4_LLT
All Years	-1,462 (-43%)	-1,356 (-41%)

[a] Estimated annual number of fish lost, based on non-normalized data.

Impact AQUA-166: Effects of Water Operations on Spawning and Egg Incubation Habitat for Pacific Lamprey

In general, Alternative 4 would not affect the quality and quantity of spawning and egg incubation habitat for Pacific lamprey relative to the NAA.

H3/ESO

Flow-related impacts to Pacific lamprey spawning habitat were evaluated by estimating effects of flow alterations on egg exposure, called redd dewatering risk, and effects on water temperature. Rapid reductions in flow can dewater redds leading to mortality. Locations for each river used in the dewatering risk analysis were based on available literature, personal conversations with agency experts, and spatial limitations of the CALSIM II model, and include the Sacramento River at Keswick, Sacramento River at Red Bluff, Trinity River downstream of Lewiston, Feather River at Thermalito Afterbay, and the American River at Nimbus Dam and at the confluence with the Sacramento River. Pacific lamprey spawn in these rivers between January and August so flow reductions during those months have the potential to dewater redds, which could result in incomplete development of the eggs to ammocoetes (the larval stage). Water temperature results from the SRWQM and the Reclamation Temperature Model were used to assess the exceedances of water temperatures under all model scenarios in the upper Sacramento, Trinity, Feather, and American rivers.

Dewatering risk to redd cohorts was characterized by the number of cohorts experiencing a month-over-month reduction in flows (using CALSIM II outputs) of greater than 50%. Small-scale spawning location suitability characteristics (e.g., depth, velocity, and substrate) of river lamprey are not adequately described to employ a more formal analysis such as a weighted usable area analysis. Therefore, there is uncertainty that these values represent actual redd dewatering events, and results should be treated as rough estimates of flow fluctuations under each model scenario. Results were expressed as the number of cohorts exposed to dewatering risk and as a percentage of the total number of cohorts anticipated in the river based on the applicable time-frame, January to August.

There would be negligible differences between H3 and NAA in exposure to flow reductions in all rivers except for a small (6%) increase in the Feather River at Thermalito Afterbay (Table 11-4-116). These results indicate that H3 would not have biologically meaningful effects on Pacific lamprey redd cohorts predicted to experience a month-over-month change in flow of greater than 50% in all locations analyzed.

Table 11-4-116. Differences between Model Scenarios in Dewatering Risk of Pacific Lamprey Redd Cohorts[a]

Location	EXISTING CONDITIONS vs. H3	NAA vs. H3
Sacramento River at Keswick	20 (36%)	-2 (-3%)
Sacramento River at Red Bluff	20 (37%)	2 (3%)
Trinity River downstream of Lewiston	0 (0%)	0 (0%)
Feather River at Thermalito Afterbay	-36 (-24%)	6 (6%)
American River at Nimbus Dam	32 (38%)	-5 (-4%)
American River at Sacramento River Confluence	34 (36%)	-6 (-4%)

[a] Difference and percent difference between model scenarios in the number of Pacific lamprey redd cohorts experiencing a month-over-month reduction in flows of greater than 50%. Positive values indicate a higher value in H3 than in Existing Conditions or NAA.

Significant reduction in survival of eggs and embryos of Pacific lamprey were observed at 22°C (71.6°F; Meeuwig et al. 2005). Therefore, in the Sacramento River, this analysis predicted the number of consecutive 49 day periods for the entire 82-year CALSIM period during which at least one day exceeds 22°C (71.6°F) using daily data from SRWQM. For other rivers, the analysis predicted the number of consecutive 2 month periods during which at least one month exceeds 22°C (71.6°F) using monthly averaged data from the Reclamation temperature model. Each individual day or month starts a new "egg cohort" such that there are 19,928 cohorts for the Sacramento River, corresponding to 82 years of eggs being laid every day each year from January 1 through August 31, and 648 cohorts for the other rivers using monthly data over the same period. The incubation periods used in this analysis are conservative and represent the extreme long end of the egg incubation period (Brumo 2006). Also, the utility of the monthly average time step is limited because the extreme temperatures are masked; however, no better analytical tools are currently available for this analysis. Exact spawning locations of Pacific lamprey are not well defined. Therefore, this analysis uses the widest range in which the species is thought to spawn in each river.

In most locations, egg cohort exposure would not differ between NAA and H3 (Table 11-4-117). However, the number of cohorts exposed under H3 would be 100% and 93% lower than those under NAA in the Sacramento River at Keswick and Trinity River at Lewiston, respectively. Also, the number of cohorts exposed under H3 would be 11% and 53% greater than those under NAA in the Sacramento River at Hamilton City. The increases and decreases in egg cohort exposure under NAA would not have a biologically meaningful effect due to their small absolute values relative to total egg cohort sizes.

Table 11-4-117. Differences (Percent Differences) between Model Scenarios in Pacific Lamprey Egg Cohort Temperature Exposure[a]

Location	EXISTING CONDITIONS vs. H3	NAA vs. H3
Sacramento River at Keswick	0 (NA)	-51 (-100%)
Sacramento River at Hamilton City	1,186 (NA)	118 (11%)
Trinity River at Lewiston	4 (200%)	-83 (-93%)
Trinity River at North Fork	14 (NA)	-3 (-18%)
Feather River at Fish Barrier Dam	0 (NA)	-1 (-100%)
Feather River below Thermalito Afterbay	117 (488%)	49 (53%)
American River at Nimbus	74 (673%)	0 (0%)
American River at Sacramento River Confluence	158 (282%)	-2 (-1%)
Stanislaus River at Knights Ferry	2 (NA)	0 (0%)
Stanislaus River at Riverbank	87 (4,350%)	0 (0%)

NA = could not be calculated because the denominator was 0.

[a] Difference and percent difference between model scenarios in the number of Pacific lamprey egg cohorts experiencing water temperatures above 71.6°F during January to August on at least one day during a 49-day incubation period in the Sacramento River or for at least one month during a 2-month incubation period for in other rivers each model scenario. Positive values indicate a higher value in H3 than in EXISTING CONDITIONS or NAA.

H1/LOS

Flows during January through August under H1 would generally be similar to or greater than flows under H3 in all rivers except the Feather River. As a result, the redd dewatering risk analysis was not conducted for H1 in these rivers and results for H1 would be the same as those for H3.

In the Feather River at Thermalito Afterbay, there would be 41 more cohorts (38%) exposed to a 50% month over month drop in flow rate under H1 relative to NAA (Table 11-4-118). Although relatively large, this value represents 6% of the population of ammocoetes. Therefore, it is not expected that this increase in exposure would have a biologically meaningful effect to the population.

Table 11-4-118. Differences between Model Scenarios in Dewatering Risk of Pacific Lamprey Redd Cohorts in the Feather River at Thermalito Afterbay[a]

Measurement	EXISTING CONDITIONS vs. H1	NAA vs. H1	EXISTING CONDITIONS vs. H4	NAA vs. H4
Difference (Percent Difference)	-1 (-1%)	41 (38%)	-30 (-20%)	12 (11%)

[a] Difference and percent difference between model scenarios in the number of Pacific lamprey redd cohorts experiencing a month-over-month reduction in flows of greater than 50%. Positive values indicate a higher value in H1 or H4 than in Existing Conditions or NAA.

Water temperatures would not differ between H1 and H3 and, therefore, no egg cohort temperature analyses were conducted. Overall, results for H1 would be similar to those for H3.

H4/HOS

Flows during January through August under H4 would generally be similar to or greater than flows under H3 in all rivers except the Feather River. As a result, the redd dewatering risk analysis was not conducted for H4 in these rivers and results for H4 would be the same as those for H3.

In the Feather River at Thermalito Afterbay, there would be 12 more cohorts (11%) exposed to a 50% month over month drop in flow rate under H4 relative to NAA (Table 11-4-118). Although relatively large, this value represents <2% of the population of ammocoetes. Therefore, it is not expected that this increase in exposure would have a biologically meaningful effect to the population.

Water temperatures would not differ between H4 and H3 and, therefore, no egg cohort temperature analyses were conducted. Overall, results for H4 would be similar to those for H3.

NEPA Effects: Collectively, these results indicate that the effect is not adverse because Alternative 4 would not have substantial effects on spawning and egg incubation habitat for Pacific lamprey. Flows reductions that increase redd dewatering risk would not differ between the NEPA point of comparison and H3 in all locations except the in Feather River at Thermalito Afterbay. This result in the Feather River would be similar for H4 but dewatering risk would be higher under H1. There would be increases and decreases in exposure risk of eggs to elevated temperatures but would not have a biologically meaningful effect due to their small absolute values relative to total egg cohort sizes.

CEQA Conclusion: In general, under all the Alternative 4 water operations scenarios, the quantity and quality of spawning and egg incubation habitat for Pacific lamprey would not be affected relative to the CEQA baseline.

H3/ESO

Effects of H3 on month-over-month flow reduction compared to Existing Conditions consist of negligible effects (<5% difference) in the Trinity River, a decrease in egg cohorts exposed to flow reductions (-20%) in the Feather River, and moderate to substantial increases in exposures in the Sacramento River and American River (Table 11-4-116). Changes would be most substantial for the American River (increased risk of dewatering exposure to 40 cohorts or 48% at Nimbus Dam, and 44 cohorts or 46% at the confluence). For the Sacramento River, there would be increased exposure to flow reductions for 12 cohorts or 22% at Keswick, and to 8 cohorts or 15% at Red Bluff. These results indicate that effects of Alternative 4 on flow would not affect Pacific lamprey redd dewatering risk in the Feather River and Trinity River; Alternative 4 would affect dewatering risk in the Sacramento River (increases to 22%) and the American River (increase of 48% at Nimbus Dam and 46% at the confluence).

The number of egg cohorts exposed to 22°C (71.6°F) under H3 would be greater than that under Existing Conditions in all the river locations, except the Trinity River (Table 11-4-117).

H1/LOS

Flows during January through August under H1 would generally be similar to or greater than flows under H3 in all rivers except the Feather River. As a result, the redd dewatering risk analysis was not conducted for H1 in these rivers and results for H1 would be the same as those for H3.

In the Feather River at Thermalito Afterbay, there would be no difference between H1 and Existing Conditions in the number of cohorts exposed to a 50% month over month drop in flow rate (Table 11-4-118).

Water temperatures under H1 would be similar to those under H3 for all rivers examined. Therefore, no additional cohort temperature exposure analyses were conducted for H1. Overall, results for H1 would be similar to those for H3 except for redd dewatering risk in the Feather River.

H4/HOS

Flows during January through August under H4 would generally be similar to or greater than flows under H3 in all rivers except the Feather River. As a result, the redd dewatering risk analysis was not conducted for H4 in these rivers and results for H4 would be the same as those for H3.

In the Feather River at Thermalito Afterbay, there would be 30 fewer cohorts (20%) exposed to a 50% month over month drop in flow rate under H1 relative to NAA (Table 11-4-118). Although relatively large, this value represents <5% of the population of ammocoetes. Therefore, it is not expected that this decrease in exposure would have a biologically meaningful effect to the population.

Water temperatures under H4 would be similar to those under H3 for all rivers examined. Therefore, no additional cohort temperature exposure analyses were conducted for H4. Overall, results for H4 would be similar to those for H3.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-166 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 4 could be significant because, under the CEQA baseline, the alternative could substantially reduce suitable spawning habitat and substantially reduce the number of fish as a result of egg mortality, contrary to the NEPA conclusion set forth above. There would be moderate increases in redd dewatering in the Sacramento River (up to 22%) and substantial increases in the American River (up to 48%) that would increase the risk of desiccation of eggs. There would be a substantial increase (up to 4,350%) in exposure of egg cohorts to elevated water temperatures in all rivers except the Trinity River that would increase stress and the risk of mortality.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to H3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and H3 indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and H3. This indicates that the differences between Existing Conditions and Alternative 4 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 4, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on spawning habitat for Pacific lamprey. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-167: Effects of Water Operations on Rearing Habitat for Pacific Lamprey

In general, the effect of Alternative 4 on Pacific lamprey rearing habitat would be negligible relative to the NAA.

H3/ESO

Flow-related impacts to Pacific lamprey rearing habitat were evaluated by estimating of the frequency of rapid flow reductions in ammocoete rearing areas. Rapid reductions in flow can strand ammocoetes, leading to mortality. Comparisons of effects were made for ammocoete cohorts in the Sacramento River at Keswick and Red Bluff, the Trinity River, Feather River, and the American River at Nimbus Dam and at the confluence with the Sacramento River. An ammocoete remains relatively immobile in the sediment in the same location for 5 to 7 years, after which it migrates downstream. During the upstream rearing period there is potential for ammocoete stranding from rapid reductions in flow.

The analysis of ammocoete stranding was conducted by analyzing a range of month-over-month flow reductions from CALSIM II outputs, using the range of 50%–90% in 5% increments. A cohort of ammocoetes was assumed to be born every month during their spawning period (January through August) and spend 7 years rearing upstream. Therefore, a cohort was considered stranded if at least one month-over-month flow reduction was greater than a given flow reduction (50%–90% in 5% increments)at any time during the seven-year period.

Comparisons of month-over-month flow reductions for the Sacramento River at Keswick (Table 11-4-119) indicate that H3 would have either no effect (0%) or negligible effects (<5%) on cohort exposures to all flow reductions. These results indicate that there would be no difference in Pacific lamprey stranding risk between H3 and NAA in the Sacramento River at Keswick.

Table 11-4-119. Percent Difference between Model Scenarios in the Number of Pacific Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Sacramento River at Keswick

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. H3	NAA vs. H3
-50%	0	0
-55%	0	0
-60%	4	0
-65%	3	3
-70%	-2	-2
-75%	-3	0
-80%	7	0
-85%	47	0
-90%	NA	NA

NA = could not be calculated because the denominator was 0.
[a] Negative values indicate reduced cohort exposure, a benefit of H3.

Results of comparisons for the Sacramento River at Red Bluff (Table 11-4-120) indicate that there would be no or negligible changes in most flow reductions and a moderate decrease (-16%) in exposure at the 80% flow reduction, which would be a beneficial effect on rearing conditions. These results indicate that there would generally be no or beneficial effects of H3 on Pacific lamprey ammocoete in the Sacramento River at Red Bluff.

Table 11-4-120. Percent Difference between Model Scenarios in the Number of Pacific Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Sacramento River at Red Bluff

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. H3	NAA vs. H3
-50%	0	0
-55%	4	0
-60%	6	4
-65%	-2	-3
-70%	9	-2
-75%	0	-9
-80%	6	-16
-85%	100	0
-90%	NA	NA

NA = could not be calculated because the denominator was 0.
[a] Negative values indicate reduced cohort exposure, a benefit of H3.

Comparisons for the Trinity River indicate that there would be no differences in cohort exposure between NAA and H3 at any flow reduction (Table 11-4-121). These results indicate that there would be no effects of H3 on Pacific lamprey stranding risk in the Trinity River.

Table 11-4-121. Percent Difference between Model Scenarios in the Number of Pacific Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Trinity River at Lewiston

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. H3	NAA vs. H3
-50%	0	0
-55%	0	0
-60%	0	0
-65%	0	0
-70%	0	0
-75%	21	-3
-80%	27	0
-85%	18	0
-90%	41	3

[a] Negative values indicate reduced cohort exposure, a benefit of H3.

In the Feather River at Thermalito Afterbay, there would be no difference in ammocoete cohort exposure at the 50% through 75% flow reductions (Table 11-4-122). For the 80% through 90% flow reductions, ammocoete exposure would be 6% to 35% lower, which would have a beneficial effect on ammocoete rearing. These results indicate that there will be beneficial effects of H3 on Pacific lamprey ammocoete rearing in the Feather River.

Table 11-4-122. Percent Difference between Model Scenarios in the Number of Pacific Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Feather River at Thermalito Afterbay

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. H3	NAA vs. H3
-50%	0	0
-55%	0	0
-60%	0	0
-65%	0	0
-70%	0	0
-75%	0	0
-80%	-12	-10
-85%	-15	-35
-90%	-53	-6

[a] Negative values indicate reduced cohort exposure, a benefit of H3.

Comparisons for the American River at Nimbus Dam (Table 11-4-123) and at the confluence with the Sacramento River (Table 11-4-124) have similar results. There would be no or negligible differences in cohort exposure between NAA and H3 for the 50% to 70% flow reductions range, There would be higher cohort exposure under H3 relative to NAA at Nimbus Dam at the 75% flow reduction (7% higher) and at the confluence with the Sacramento River at the 75% (7% higher) and 80% (17% higher) flow reductions. There would be up to 25% lower cohort exposures under H3 relative to NAA at the remaining flow reductions at both locations. These results indicate that there would generally be no effect of H3 on stranding risk in the American River with few small exceptions that would not be common enough to have biologically meaningful effects.

Table 11-4-123. Percent Difference between Model Scenarios in the Number of Pacific Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, American River at Nimbus Dam

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. H3	NAA vs. H3
-50%	0	0
-55%	0	0
-60%	1	0
-65%	1	-1
-70%	39	-1
-75%	104	7
-80%	200	-21
-85%	352	-11
-90%	125	-25

[a] Negative values indicate reduced cohort exposure, a benefit of H3.

Table 11-4-124. Percent Difference between Model Scenarios in the Number of Pacific Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, American River at the Confluence with the Sacramento River

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. H3	NAA vs. H3
-50%	0	0
-55%	0	0
-60%	1	0
-65%	1	0
-70%	7	-1
-75%	45	7
-80%	246	17
-85%	186	-18
-90%	268	-12

[a] Negative values indicate reduced cohort exposure, a benefit of H3.

To evaluate water temperature-related effects of H3 on Pacific lamprey ammocoetes, we examined the predicted number of ammocoete "cohorts" that experience water temperatures greater than 71.6°F for at least one day in the Sacramento River (because daily water temperature data are available) or for at least one month in the Feather, American, Stanislaus, and Trinity rivers over a 7 year period, the maximum likely duration of the ammocoete life stage (Moyle 2002). Each individual day or month starts a new "cohort" such that there are 18,244 cohorts for the Sacramento River, corresponding to 82 years of ammocoetes being "born" every day each year from January 1 through August 31, and 593 cohorts for the other rivers using monthly data over the same period.

There would be differences in the number of ammocoete cohorts exposed to temperatures greater than 71.6°F in most of the rivers (Table 11-1A-125). However, each river with an increase in exposure would also have a site with a decrease in exposure. Overall, the increases and decreases are expected to balance out within rivers such that there would be no overall effect on Pacific lamprey ammocoetes.

Table 11-4-125. Differences (Percent Differences) between Model Scenarios in Pacific Lamprey Ammocoete Cohorts Exposed to Temperatures Greater than 71.6°F in at Least One Day or Month

Location	EXISTING CONDITIONS vs. H3	NAA vs. H3
Sacramento River at Keswick[b]	0 (NA)	-1,705 (-100%)
Sacramento River at Hamilton City[b]	13,236 (NA)	1,981 (18%)
Trinity River at Lewiston	136 (NA)	23 (20%)
Trinity River at North Fork	283 (NA)	-22 (-7%)
Feather River at Fish Barrier Dam	0 (NA)	-56 (-100%)
Feather River below Thermalito Afterbay	211 (55%)	72 (14%)
American River at Nimbus	359 (185%)	-8 (-1%)
American River at Sacramento River Confluence	159 (37%)	0 (0%)
Stanislaus River at Knights Ferry	56 (NA)	0 (0%)
Stanislaus River at Riverbank	530 (946%)	0 (0%)

NA = could not be calculated because the denominator was 0.

[a] Positive values indicate a higher value in H3 than in EXISTING CONDITIONS or NAA.

[b] Based on daily data; all other locations use monthly data; 1922–2003.

H1/LOS

There would be generally no differences in mean flows year-round between H1 and H3 in the Sacramento, Trinity, and American rivers. Therefore, ammocoete stranding risk analysis was conducted only for the Feather River.

In the Feather River at Thermalito Afterbay, there would be no or a negligible difference in ammocoete cohort exposure between NAA and H1at the 50% through 80% flow reductions (Table 11-4-126). For the 85% and 90% flow reductions, ammocoete exposure under H1 would be 6% and 5% lower, respectively, than that under NAA. These results indicate that there will be very small beneficial effects of H1 on Pacific lamprey ammocoete rearing in the Feather River.

Table 11-4-126. Percent Difference between Baselines and H1 and H4 Model Scenarios in the Number of Pacific Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Feather River at Thermalito Afterbay

Percent Flow Reduction	Percent Difference[a] EXISTING CONDITIONS vs. H1	NAA vs. H1	EXISTING CONDITIONS vs. H4	NAA vs. H4
-50%	0	0	0	0
-55%	0	0	0	0
-60%	0	0	0	0
-65%	0	0	0	0
-70%	0	0	0	0
-75%	0	0	0	0
-80%	0	2	-2	0.2
-85%	23	-6	14	-13
-90%	-53	-5	7	114

[a] Negative values indicate reduced cohort exposure under H1 or H4.

There would generally be no differences in mean water temperatures year-round between H1 and H3 in any river examined. As a result, no additional ammocoete temperature cohort exposure analyses were conducted for H1. Results of these analyses for H1 would be the same as those for H3.

Overall, these results indicate that results for H1 would generally be similar to those under H3.

H4/HOS

There would be generally no differences in mean flows year-round between H4 and H3 in the Sacramento, Trinity, and American rivers. Therefore, ammocoete stranding risk analysis was conducted only for the Feather River.

In the Feather River at Thermalito Afterbay, there would be no or a negligible difference in ammocoete cohort exposure between NAA and H4 at the 50% through 80% flow reductions (Table 11-4-126). For the 85% and 90% flow reductions, ammocoete exposure under H4 would be 13% lower and 114% higher, respectively.

There would generally be no differences in mean water temperatures year-round between H4 and H3 in any river examined. As a result, no additional ammocoete cohort exposure analyses were conducted for H4. Results of these analyses for H4 would be the same as those for H3.

Overall, these results indicate that results for H4 would generally be similar to those under H3 except for an increase in ammocoete stranding risk exposure in the Feather River at 90% flow reduction under H4 if water operations were to move to this end of the operational range.

NEPA Effects: Collectively, these results indicate that the effect is not adverse because it would not substantially reduce rearing habitat or substantially reduce the number of fish as a result of ammocoete mortality. There would generally be negligible effects or beneficial effects of H3 on Pacific lamprey ammocoete stranding risk in all rivers evaluated. Stranding risk under both H1 and H4 in the Feather River at Thermalito Afterbay would be higher than those under H3, such that benefits to stranding risk predicted for H3 would not be as large under these limits of the operational range. There would be increase and decreases in exposure risk of ammocoetes to elevated temperatures within each river evaluated that would balance out such that there would be no net effect on Pacific lamprey ammocoetes.

CEQA Conclusion: In general, under all the Alternative 4 water operations scenarios, the quantity and quality of rearing habitat for Pacific lamprey would not be affected relative to the CEQA baseline.

H3/ESO

Comparisons of H3 to Existing Conditions for the Sacramento River at Keswick indicate negligible changes (<5%) in occurrence of flow reductions for all flow reduction categories, with the exception of a small increase (7%) in occurrence of month-over-month flow reductions of 80% and a more substantial increase (161 to 236 cohorts or 47%) for 85% flow reductions (Table 11-4-119). Comparisons for the Sacramento River at Red Bluff indicate no effect (0%) or negligible effects (<5%) for all flow reduction categories with the exception of a small increase in exposure (6%) for 80% flow reduction events and a more substantial increase in exposure (56 to 112 cohorts or a 100% increase for 85% flow reduction events) (Table 11-4-120). Based on the fact that increases in exposure would only be substantial for a single flow reduction category, H3 would not be expected to have biologically meaningful negative effects on spawning success in the Sacramento River but would contribute incrementally to regional effects.

Increases of 18–41% are predicted for flow reductions from 75% to 90% for the Trinity River (Table 11-4-121); the percentages correspond generally to increased occurrences from approximately 400 events for Existing Conditions to approximately 500 events for H3. Despite the prevalence of increased exposure risk to the higher flow reduction events, the percentage of cohorts exposed to stranding risk is relatively small compared to the total number of cohorts and therefore effects on spawning success in the Trinity River would not be biologically meaningful but would contribute incrementally to regional effects.

Comparisons for the American River at Nimbus Dam (Table 11-4-123) and at the confluence with the Sacramento River (Table 11-4-124) indicate increased chance of occurrence of flow reductions between 65% or 70% and 90% for H3 compared to Existing Conditions; predicted increases ranged from 39 to 352% for Nimbus Dam and from 7 to 268% for the confluence. These persistent and substantial increases in exposures to larger flow reduction events would have biologically meaningful effects on Pacific lamprey ammocoete cohort stranding and therefore spawning success in the American River.

The number of ammocoete cohorts exposed to 71.6°F under H3 would be higher than those under Existing Conditions in most locations examined, except in the Sacramento River at Keswick and in the Feather River at the Fish Barrier Dam (Table 11-4-125).

H1/LOS

There would be generally no differences in mean flows year-round between H1 and H3 in the Sacramento, Trinity, and American rivers. Therefore, ammocoete stranding risk analysis was conducted only for the Feather River.

In the Feather River at Thermalito Afterbay, there would be no or a negligible difference in ammocoete cohort exposure between Existing Conditions and H1at the 50% through 80% flow reductions (Table 11-4-126). For the 85% and 90% flow reductions, ammocoete exposure under H1 would be 23% higher and 53% lower, respectively.

There would generally be no differences in mean water temperatures year-round between H1 and H3 in any river examined. As a result, no additional ammocoete cohort exposure analyses were conducted for H1. Results of these analyses for H1 would be the same as those for H3.

Overall, these results indicate that results for H1 would generally be similar to those under H3 except for an increase in ammocoete stranding risk exposure in the Feather River at Thermalito Afterbay for the 80% flow reduction under H1 if water operations were to move to this end of the operational range.

H4/HOS

There would be generally no differences in mean flows year-round between H4 and H3 in the Sacramento, Trinity, and American rivers. Therefore, ammocoete stranding risk analysis was conducted only for the Feather River.

In the Feather River at Thermalito Afterbay, there would be no or a negligible difference in ammocoete cohort exposure between Existing Conditions and H4 at the 50% through 80% flow reductions (Table 11-4-126). For the 85% and 90% flow reductions, ammocoete exposure under H4 would be 14% and 7% higher, respectively.

There would generally be no differences in mean water temperatures year-round between H4 and H3 in any river examined. As a result, no additional ammocoete cohort exposure analyses were conducted for H4. Results of these analyses for H4 would be the same as those for H3.

Overall, these results indicate that results for H4 would generally be similar to those under H3.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-167 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 4 could be significant because, under the CEQA baseline, the alternative could substantially reduce rearing habitat and substantially reduce the number of fish as a result of ammocoete mortality, contrary to the NEPA conclusion set forth above. Risk of redd dewatering would increase to some degree under higher flow reductions in the Sacramento River at Red Bluff (56 to 112 cohorts or a 100% increase for 85% flow reduction events) and the Trinity River (increases of 18–41% for flow reductions from 75% to 90%), and substantially in the American River at Nimbus Dam (increases from 39% to 352%) and at the confluence with the Sacramento (39% to 356%). Flow reductions would increase the risk of ammocoete stranding and desiccation in these rivers. There would be a beneficial effect from decreased occurrence of flow reduction events (=reduced ammocoete stranding risk) in the Feather River (-12% to -53% for the three largest flow reduction categories) but this effect would not offset the more substantial reductions in the other locations. Stranding risk under both H1 and H4 in the Feather River would be higher than those under H3, such that benefits under H3 would not occur under these limits of the operational range. There would be an increase in exposure to critical water temperatures in all locations examined except the Sacramento River at Keswick, and the Feather River at the Fish Barrier Dam. Increased exposure to higher water temperatures would increase stress and mortality of ammocoetes.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to H3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and H3 indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and H3. This indicates that the differences between Existing Conditions and Alternative 4 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 4, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on rearing habitat for Pacific lamprey. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-168: Effects of Water Operations on Migration Conditions for Pacific Lamprey

In general, the effect of Alternative 4 on Pacific lamprey migration conditions would be negligible relative to the NAA.

H3/ESO

After 5 to7 years, Pacific lamprey ammocoetes migrate downstream and become macropthalmia (juveniles) once they reach the Delta. Migration generally is associated with large flow pulses in winter months (December through March) (USFWS unpublished data) meaning alterations in flow have the potential to affect downstream migration conditions. The effects of H3 water operations on seasonal migration flows for Pacific lamprey macropthalmia were assessed using CALSIM II flow output. Flow rates along the likely migration pathways of Pacific lamprey during the likely macropthalmia migration period (December through May) were examined for the Sacramento River at Rio Vista and Red Bluff, the Feather River at the confluence with the Sacramento River, and the American River at the confluence with the Sacramento River.

The adult Pacific lamprey upstream migration period occurs between January and June. CALSIM II flow outputs were examined during these periods for each model scenario.

Sacramento River

Macropthalmia

Flows the Sacramento River at Rio Vista (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) were examined during the December to May macropthalmia migration period. Flows under H3 would generally be lower by up to 25% under H3 relative to NAA. Based on the prevalence of moderate decreases in flow in drier water years for much of migration period, H3 would affect

Pacific lamprey macropthalmia migration conditions at this location. In the Sacramento River upstream of Red Bluff (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*), flows under H3 during December through May would be similar to or greater than flows under NAA.

Adults

Flows in the Sacramento River at Red Bluff (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) were examined during the January to June adult migration period. Flows under H3 would be similar to flows under NAA during January through April and slightly greater (by up to 12%) during May and June. These results indicate that H3 would generally not affect adult migration conditions in the Sacramento River.

Feather River

Juveniles

Flows in the Feather River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) were examined during the December to May macropthalmia migration period. Flows under H3 during would generally be similar to or greater (up to 23% greater) than flows under NAA. These results indicate that effects of H3 on macropthalmia migration flows in the Feather River would generally be negligible.

Adults

Flows in the Feather River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) were examined during the January through June adult migration period. Flows under H3 would generally be similar to flows under NAA during January through April and greater by up to 65% during May and June. Increases in flow would have a beneficial effect on migration conditions. These results indicate that H3 would not have negative effects on adult migration conditions in the Feather River.

American River

Juveniles

Flows in the American River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) were examined during the December through March macropthalmia migration period. Flows under H3 would generally be similar to flows under NAA with few small exceptions. These results indicate that H3 would not have negative effects on macropthalmia migration conditions in the American River.

Adults

Flows in the American River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) were examined during the January to June adult migration period. Flows under H3 during January through April would generally be similar to flows under NAA with few small exceptions. Flows under H3 during May and June would generally be greater by up to 25% than flows under NAA. Increases in flow would have a beneficial effect on migration conditions. These results indicate that H3 would not have negative effects on adult migration conditions in the American River.

H1/LOS

Flows in the Sacramento River at Rio Vista and upstream of Red Bluff under H1 during the December through May macropthalmia migration period would generally be similar to or greater than flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in the Sacramento River at Red Bluff under H1 during the January through June migration period would generally be similar to or greater than flows under H3.

Flows in the Feather River at the confluence with the Sacramento River under H1 during the December through May macropthalmia migration period and the January through June adult migration period would generally be similar to or greater than flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flows in the American River at the confluence with the Sacramento River under H1 during the December through May macropthalmia migration period and the January through June adult migration period would generally be similar to or greater than flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

These results indicate that the effects of H1 on Pacific lamprey migration conditions would generally be the same as those under H3.

H4/HOS

Flows in the Sacramento River at Rio Vista and upstream of Red Bluff under H4 during the December through May macropthalmia migration period would generally be similar to or greater than (up to 35% greater) flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*), indicating that migration conditions for macropthalmia would be improved under H4 relative to H3. Flows in the Sacramento River at Red Bluff under H4 during the January through June migration period would generally be similar to or greater than (up to 35% greater) flows under H3, except during June in which flows under H4 would be up to 21% lower. Overall, due to infrequent differences, flows would not be different under H4 than those under H3.

Flows in the Feather River at the confluence with the Sacramento River under H4 during the December through May macropthalmia migration period would generally be similar to or greater than (up to 100% greater) flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*), indicating that migration conditions for macropthalmia would be improved under H4 relative to H3. Flows in the Feather River at the confluence with the Sacramento River under H4 during the January through June migration period would generally be similar to or greater than (up to 100% greater) flows under H3, except during June in which flows under H4 would be up to 29% lower. Overall, due to infrequent differences, flows would not be different under H4 than those under H3.

Flows in the American River at the confluence with the Sacramento River under H4 during the December through May macropthalmia migration period and the January through June adult migration period would generally be similar to or greater than flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

These results indicate that the effects of H4 on Pacific lamprey migration conditions would generally be the same as those under H3.

NEPA Effects: Collectively, these results indicate that the effect is not adverse because it would not substantially reduce or degrade migration habitat or substantially reduce the number of fish as a result of mortality. Effects of Alternative 4 on mean monthly flow for the macropthalmia and adult migration periods consist primarily of negligible effects (<5%) in all locations analyzed, with infrequent and small decreases in flow for some months/water years that would not have biologically meaningful effects on migration conditions, with the exception of small to moderate flow reductions (to -29%) for some months and water year types during the migration periods in the Sacramento River at Rio Vista. The degree to which this reduction would affect lamprey is unknown, but given the predominance of negligible effects in other locations, it is not likely that reduced flows at this location would affect the Pacific lamprey population.

CEQA Conclusion: In general, under all the Alternative 4 water operations scenarios, the quantity and quality of migration habitat for Pacific lamprey would not be reduced relative to the CEQA baseline.

H3/ESO

Sacramento River

Macropthalmia

Comparisons of mean monthly flow rates for H3 to Existing Conditions in the Sacramento River at Rio Vista (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for December to May indicate negligible effects (<5% difference) from H3 or reductions in flow ranging from -5% to -47% in most water years for each of these months, with only a single occurrence of a small increase in flow during May in dry years (11%). There would be negligible effects or small (to approximately -11%) to moderate (to -26%) reductions in flow during drier water years under H3, when flow reductions would be more critical for migration conditions.

Comparisons for the Sacramento River at Red Bluff (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for December to May indicate negligible effects (<5%) or small increases or decreases in flow (to 12%) under H3 that would not have biologically meaningful effects on migration conditions. Exceptions include a decrease in flow of -17% during May in wet years under H3 when flow reductions would not be as critical for migration conditions. Overall, the effects of H3 would primarily consist of negligible effects (<5%), and small increases or decreases that would not have biologically meaningful effects on macropthalmia migration conditions.

Adults

Comparisons of mean monthly flow for the Sacramento River at Red Bluff (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for January through June for H3 relative to Existing Conditions indicate that for most months and water year types, flows under H3 would be similar to (<5% difference) or greater than flows under Existing Conditions, with increases in mean monthly flow to 20% that would have a beneficial effect on migration conditions, and a small decrease in flow during March in below normal years (-10%) and a moderate decrease (-17%) during May in wet years when flow reductions would be less critical for migration conditions. Increases in mean monthly flow, particularly those that would occur in drier water years during January, March, May and June, would have beneficial effects on migration conditions. These results indicate that the effects of H3 on flow consist predominantly of negligible effects (<5%) or increases in flow (to 20%)

that would be beneficial for migration, and infrequent and small reductions in flow that would not have biologically meaningful negative effects on migration conditions.

Feather River

Juveniles

Comparisons for the Feather River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for December to May indicate variable effects of H3 relative to Existing Conditions by month and water year type, with negligible effects (<5%), moderate increases in flow (to 20%) that would be beneficial for migration conditions, with occasional occurrences of moderate decreases in flow to -26%. Decreases in flow would occur in below normal years during January (-15%), February (-11%) and March (-20%), but otherwise effects of H3 in drier water years consist of negligible effects or increases in flow that would have beneficial effects. These results indicate that the effects of H3 on flows would not have negative effects on macropthalmia migration in the Feather River.

Adults

Comparisons of mean monthly flow for the Feather River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for January to June indicate variable effects of H3 relative to Existing Conditions depending on the month and water year type, with primarily negligible effects (<5%), small to substantial increases in flow (to 59%) that would have a beneficial effect on migration conditions, and occasional small to moderate decreases in flow, including during January through March in below normal years (to -20%), during May in wet years (-26%) when effects on migration conditions would be less critical, and during June in wet (-8%) and critical (-10%) years. Based on the prevalence of negligible effects and increases in flow which would have a beneficial effect on migration conditions, and only occasional reductions in flow of small to moderate magnitude, these results indicate that effects of H3 on flow would not have biologically meaningful negative effects on adult migration conditions in the Feather River.

American River

Juveniles

Comparisons for the American River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for December to May indicate variable effects of H3 relative to Existing Conditions, with negligible effects (<5%) or decreases in flow during December, increases in flow during January through March for some wetter water year types (to 27%) and decreases for some drier water year types (to -19%), negligible effects or small increases or decreases (to 9%) during April, and decreases to -31% during May in all water year types except dry (increase of 12%). Decreases in drier water years for December and January, and in critical years during February and March encompass much of the migration period and would affect macropthalmia migration conditions for that time-frame, particularly in critical years. These results indicate that there would be moderate to substantial decreases in mean monthly flow for much of the migration period (to -31%), including in drier water years, that would affect Pacific lamprey migration conditions.

Adults

Comparisons of mean monthly flow for the American River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for January to June indicate variable effects of H3 relative to Existing Conditions depending on the month and water year type, with primarily increases in mean monthly flow (to 27%) during January through March in wetter years, and decreases (to -19%) in drier years. There would be primarily negligible effects (<5%) or small increases or decreases (to 9%) during April. There would be decreases (to -31%) in all but critical years (increase of 12%) during May, and decreases during June in wet (-29%) and critical (-39%) years with increases (to 23%) in the remaining water years. Effects during dry and critical years when changes in flow would be more important for migration include negligible effects and increases and decreases in mean monthly flows throughout the migration period. The largest flow reductions in drier water years would not occur until late in the migration period (May and June). These results indicate that effects of H3 consist of variable effects on flow and flow reductions in some months would be offset by increases in other months and would not have biologically meaningful effects on adult migration conditions.

H1/LOS

Flows in the Sacramento River at Rio Vista and upstream of Red Bluff under H1 during the December through May macropthalmia migration period would generally be similar to or greater than flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in the Sacramento River at Red Bluff under H1 during the January through June migration period would generally be similar to or greater than flows under H3.

Flows in the Feather River at the confluence with the Sacramento River under H1 during the December through May macropthalmia migration period and the January through June adult migration period would generally be similar to or greater than flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flows in the American River at the confluence with the Sacramento River under H1 during the December through May macropthalmia migration period and the January through June adult migration period would generally be similar to or greater than flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

These results indicate that the effects of H1 on Pacific lamprey migration conditions would generally be the same as those under H3.

H4/HOS

Flows in the Sacramento River at Rio Vista and upstream of Red Bluff under H4 during the December through May macropthalmia migration period would generally be similar to or greater than (up to 35% greater) flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*), indicating that migration conditions for macropthalmia would be improved under H4 relative to H3. Flows in the Sacramento River at Red Bluff under H4 during the January through June migration period would generally be similar to or greater than (up to 35% greater) flows under H3, except during June in which flows under H4 would be up to 21% lower. Overall, due to infrequent differences, flows would not be different under H4 than those under H3.

Flows in the Feather River at the confluence with the Sacramento River under H4 during the December through May macropthalmia migration period would generally be similar to or greater than (up to 100% greater) flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*), indicating that migration conditions for macropthalmia would be improved under H4 relative to H3. Flows in the Feather River at the confluence with the Sacramento River under H4 during the January through June migration period would generally be similar to or greater than (up to 100% greater) flows under H3, except during June in which flows under H4 would be up to 29% lower. Overall, due to infrequent differences, flows would not be different under H4 than those under H3.

Flows in the American River at the confluence with the Sacramento River under H4 during the December through May macropthalmia migration period and the January through June adult migration period would generally be similar to or greater than flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

These results indicate that the effects of H4 on Pacific lamprey migration conditions would generally be the same as those under H3.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-168 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 4 could be significant because, under the CEQA baseline, the alternative could substantially reduce the amount of suitable habitat and substantially interfere with the movement of fish. Alternative 4 would cause decreases in mean monthly flow to -31% in the American River during a substantial portion of the macropthalmia migration period, including in drier water year types. A prevalence of flow reductions in the Sacramento River at Rio Vista (to -47%, including moderate reductions, to -26%, in drier water year types) would contribute incrementally to negative effects. Flow reductions during the macropthalmia life stage would increase migration delays to the ocean life stage and straying and increase the risk of mortality. Effects of Alternative 4 in the other locations analyzed would consist of negligible effects and/or increases or decreases in mean monthly flow that would generally balance out throughout the macropthalmia and adult migration periods, with the exception of greater magnitude and occurrence of beneficial increases in flow in the Feather River that would enhance migration conditions at that location. These results are consistent among scenarios.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to H3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and H3 indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and H3. This indicates that the differences between Existing Conditions and Alternative 4 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 4, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on migration conditions for Pacific lamprey. This impact is found to be less than significant and no mitigation is required.

Restoration Measures (CM2, CM4–CM7, and CM10)

Alternative 4 has the same Restoration Measures as Alternative 1A. Because no substantial differences in restoration-related fish effects are anticipated anywhere in the affected environment under Alternative 4 compared to those described in detail for Alternative 1A, the fish effects of restoration measures described for Pacific lamprey under Alternative 1A (Impacts AQUA-169 through AQUA-171) also appropriately characterize effects under Alternative 4.

The following impacts are those presented under Alternative 1A that are identical for Alternative 4.

Impact AQUA-169: Effects of Construction of Restoration Measures on Pacific Lamprey

Impact AQUA-170: Effects of Contaminants Associated with Restoration Measures on Pacific Lamprey

Impact AQUA-171: Effects of Restored Habitat Conditions on Pacific Lamprey

NEPA Effects: Detailed discussions regarding the potential effects of these three impact mechanisms on Pacific lamprey are the same for Alternative 4, as those described under Alternative 1A (Impacts AQUA 169-through AQUA-171). The effects would not be adverse, and would generally be beneficial.

CEQA Conclusion: All of the impact mechanisms listed above would be at least slightly beneficial, or less than significant, and no mitigation is required.

Other Conservation Measures (CM12–CM19 and CM21)

Alternative 4 has the same other conservation measures as Alternative 1A. Because no substantial differences in other conservation-related fish effects are anticipated anywhere in the affected environment under Alternative 4 compared to those described in detail for Alternative 1A, the fish effects of other conservation measures described for Pacific lamprey under Alternative 1A (Impacts AQUA-172 through AQUA-180) also appropriately characterize effects under Alternative 4.

The following impacts are those presented under Alternative 1A that are identical for Alternative 4.

Impact AQUA-172: Effects of Methylmercury Management on Pacific Lamprey (CM12)

Impact AQUA-173: Effects of Invasive Aquatic Vegetation Management on Pacific Lamprey (CM13)

Impact AQUA-174: Effects of Dissolved Oxygen Level Management on Pacific Lamprey (CM14)

Impact AQUA-175: Effects of Localized Reduction of Predatory Fish on Pacific Lamprey (CM15)

Impact AQUA-176: Effects of Nonphysical Fish Barriers on Pacific Lamprey (CM16)

Impact AQUA-177: Effects of Illegal Harvest Reduction on Pacific Lamprey (CM17)

Impact AQUA-178: Effects of Conservation Hatcheries on Pacific Lamprey (CM18)

Impact AQUA-179: Effects of Urban Stormwater Treatment on Pacific Lamprey (CM19)

Impact AQUA-180: Effects of Removal/Relocation of Nonproject Diversions on Pacific Lamprey (CM21)

NEPA Effects: Detailed discussions regarding the potential effects of these nine impact mechanisms on Pacific lamprey are the same as those described under Alternative 1A (Impacts AQUA-172 through AQUA-180). The effects range from no effect, to not adverse, to beneficial.

CEQA Conclusion: The effects of the nine impact mechanisms listed above range from no impact, to less than significant, to beneficial, and no mitigation is required.

River Lamprey

Construction and Maintenance of CM1

Impact AQUA-181: Effects of Construction of Water Conveyance Facilities on River Lamprey

The potential effects of construction of water conveyance facilities on river lamprey would be similar to those described for Alternative 1A, Impact AQUA-181, except that Alternative 4 would include three intakes compared to five intakes under Alternative 1A, so the effects would be proportionally less under this alternative. This would convert about 6,360 lineal feet of existing shoreline habitat into intake facility structures and would require about 17.1 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. Alternative 4 would use five barge locations rather than six as under Alternative 1A so those effects would also be proportionally less. Additionally, construction and excavation at Clifton Court Forebay would be done in the dry via installation of cofferdams for isolation and dewatering of work areas. Implementation of Appendix 3B, *Environmental Commitments*, including construction BMPs and 3B.8–*Fish Rescue and Salvage Plan*, would minimize adverse effects as described for Alternative 1A. Mitigation measures would also be available to avoid and minimize potential effects.

NEPA Effects: As concluded for Alternative 1A, Impact AQUA-181, the effect would not be adverse for river lamprey.

CEQA Conclusion: As described in Alternative 1A, Impact AQUA-181, the impact of the construction of water conveyance facilities on river lamprey would not be significant except for construction noise associated with pile driving. Potential pile driving impacts would be less than Alternative 1A because only three intakes would be constructed rather than five. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in the discussion of Alternative 1A.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in the discussion of Alternative 1A.

Impact AQUA-182: Effects of Maintenance of Water Conveyance Facilities on River Lamprey

The potential effects of the maintenance of water conveyance facilities under Alternative 4 would be the same as those described for Alternative 1A (see Impact AQUA-182) except that only three intakes would need to be maintained under Alternative 4 rather than five under Alternative 1A. As concluded in Alternative 1A, Impact AQUA-182, the impact would not be adverse for river lamprey.

CEQA Conclusion: As described in Alternative 1A,Impact AQUA-182, the impact of the maintenance of water conveyance facilities on river lamprey would be less than significant and no mitigation is required.

Water Operations of CM1

Impact AQUA-183: Effects of Water Operations on Entrainment of River Lamprey

Water Exports

The impact on entrainment of river lamprey at water operations facilities in the south and north Delta is expected to be the same as described for Pacific lamprey (see Impact AQUA-165). Entrainment losses at the south Delta facilities would be reduced for all flow scenarios under Alternative 4 compared to NAA. The potential impacts at the proposed new north Delta intakes are unknown since little is known about the river lamprey life history in the Delta.

Predation Associated with Entrainment

Entrainment-related predation loss of lamprey at the south Delta facilities would not be greater under this Alternative and may be lower due to a reduction in entrainment loss. Conditions under Scenario H4 would decrease predation loss relative to NAA and Scenario H3, while conditions would be similar between Scenario H1 and Scenario H3. Predation at the north Delta would be increased due to the installation of the proposed water export facilities on the Sacramento River. The effect on lamprey from predation loss at the north Delta facilities is unknown because of the lack of knowledge about their distribution and population abundances in the Delta.

NEPA Effects: Overall, it is expected that the effect of predation loss on lamprey under Alternative 4 may be moderate, but would not be adverse.

CEQA Conclusion: As described above, annual entrainment losses of lamprey would be substantially reduced under all flow scenarios for Alternative 4 relative to existing biological conditions. The impact of predation loss at the north Delta is unknown, since there is little available knowledge on the distribution and abundance in the Delta, especially in the vicinity of the proposed new north Delta intakes. Overall the impact on River lamprey from water operations is expected to be less than significant. No mitigation would be required.

Impact AQUA-184: Effects of Water Operations on Spawning and Egg Incubation Habitat for River Lamprey

In general, the effect of Alternative 4 would be negligible relative to the NAA.

H3/ESO

Flow-related impacts to river lamprey spawning habitat were evaluated by estimating effects of flow alterations on redd dewatering risk as described for Pacific lamprey with appropriate time-frames for river lamprey incorporated into the analysis. The same locations were analyzed as for Pacific lamprey: the Sacramento River at Keswick and Red Bluff, Trinity River downstream of Lewiston, Feather River at Thermalito Afterbay, and the American River at Nimbus Dam and at the confluence with the Sacramento River. River lamprey spawn in these rivers between February and June so flow reductions during those months have the potential to dewater redds, which could result in incomplete development of the eggs to ammocoetes (the larval stage).

Dewatering risk to redd cohorts was characterized by the number of cohorts experiencing a month-over-month reduction in flows (using CALSIM II outputs) of greater than 50%. Small-scale spawning location suitability characteristics (e.g., depth, velocity, and substrate) of river lamprey are not adequately described to employ a more formal analysis such as a weighted usable area analysis. Therefore, as described for Pacific lamprey, there is uncertainty that these values represent actual redd dewatering events, and results should be treated as rough estimates of flow fluctuations under each model scenario. Results were expressed as the number of cohorts exposed to dewatering risk and as a percentage of the total number of cohorts anticipated in the river based on the applicable time-frame, February to June.

There would be negligible differences between H3 and NAA in exposure to flow reductions in all rivers except for a small decrease (8% lower) in the Trinity River at Lewiston Dam and a small (6% greater) increase in the American River at Nimbus Dam (Table 11-4-127). These results indicate that H3 would not have biologically meaningful effects on river lamprey redd cohorts predicted to experience a month-over-month change in flow of greater than 50% in all locations analyzed.

Table 11-4-127. Differences between Model Scenarios in Dewatering Risk of River Lamprey Redd Cohorts[a]

Location	EXISTING CONDITIONS vs. H3	NAA vs. H3
Sacramento River at Keswick	3 (9%)	0 (0%)
Sacramento River at Red Bluff	-1 (-3%)	-3 (-8%)
Trinity River downstream of Lewiston	-4 (-6%)	-2 (-3%)
Feather River below Thermalito Afterbay	-8 (-12%)	2 (3%)
American River at Nimbus	13 (24%)	4 (6%)
American River at Sacramento River confluence	19 (32%)	2 (3%)

[a] Difference and percent difference between model scenarios in the number of river lamprey redd cohorts experiencing a month-over-month reduction in flows of greater than 50%. Positive values indicate a higher value in H3 than in Existing Conditions or NAA.

River lamprey generally spawn between February and June (Beamish 1980; Moyle 2002). Using Pacific lamprey as a surrogate, eggs are assumed to hatch in 18-49 days depending on water temperature (Brumo 2006) and are, therefore, assumed to be present during roughly the same period and locations as spawners. Moyle et al. (1995) indicate that river lamprey "adults need… temperatures [that] do not exceed 25°C," although there is no mention of thermal requirements for eggs in this or any existing literature. Meeuwig et al. (2005) reported that, for Pacific lamprey eggs, significant reductions in survival were observed at 22°C (71.6°F). Therefore, for this analysis, both temperatures, 22°C (71.6°F) and 25°C (77°F), were used as upper thresholds of river lamprey eggs. The analysis predicted the number of consecutive 49 day periods for the entire 82-year CALSIM period during which at least one day exceeds 22°C (71.6°F) or 25°C (77°F) using daily data from USRWQM. For other rivers, the analysis predicted the number of consecutive two-month periods during which at least one month exceeds 22°C (71.6°F) or 25°C (77°F) using monthly averaged data from the Bureau's temperature model. Each individual day or month starts a new "egg cohort" such that there are 12.320 cohorts for the Sacramento River, corresponding to 82 years of eggs being laid every day each year from February 1 through June 30, and 405 cohorts for the other rivers using monthly data over the same period. The incubation periods used in this analysis are conservative and represent the extreme long end of the egg incubation period (Brumo 2006). Also, the utility of the monthly average time step is limited because the extreme temperatures are masked; however, no better analytical tools are currently available for this analysis. Spawning locations of river lamprey are not well defined. Therefore, this analysis uses the widest range in which the species is thought to spawn in each river.

For both thresholds, there would be few differences in egg cohort exposure between NAA and H3 among all sites (Table 11-4-128). In all cases, absolute differences account for <5% of the total number of cohorts; thus, none of these differences would have biologically meaningful effects.

Table 11-4-128. Differences (Percent Differences) between Model Scenarios in River Lamprey Egg Cohort Temperature Exposure[a]

Location	EXISTING CONDITIONS vs. H3	NAA vs. H3
Temperatures above 71.6°F		
Sacramento River at Keswick	0 (NA)	0 (NA)
Sacramento River at Hamilton City	291 (NA)	-32 (-10%)
Trinity River at Lewiston	0 (NA)	-1 (-100%)
Trinity River at North Fork	4 (NA)	-1 (-20%)
Feather River at Fish Barrier Dam	0 (NA)	0 (NA)
Feather River below Thermalito Afterbay	39 (433%)	10 (26%)
American River at Nimbus	23 (460%)	-2 (-7%)
American River at Sacramento River Confluence	43 (154%)	-11 (-13%)
Stanislaus River at Knights Ferry	0 (NA)	0 (NA)
Stanislaus River at Riverbank	34 (3,400%)	0 (0%)
Temperatures above 77°F		
Sacramento River at Keswick	0 (NA)	0 (NA)
Sacramento River at Hamilton City	39 (NA)	3 (8%)
Trinity River at Lewiston	0 (NA)	0 (NA)
Trinity River at North Fork	0 (NA)	0 (NA)
Feather River at Fish Barrier Dam	0 (NA)	0 (NA)
Feather River below Thermalito Afterbay	3 (NA)	1 (50%)
American River at Nimbus	4 (NA)	0 (0%)
American River at Sacramento River Confluence	8 (NA)	2 (33%)
Stanislaus River at Knights Ferry	0 (NA)	0 (NA)
Stanislaus River at Riverbank	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.

[a] Difference and percent difference between model scenarios in the number of river lamprey egg cohorts experiencing water temperatures above 71.6°F and 77°F during February through June on at least one day during a 49-day incubation period in the Sacramento River or for at least one month during a 2-month incubation period in other rivers for each model scenario. Positive values indicate a higher value in H3 than in EXISTING CONDITIONS or NAA.

H1/LOS

Flows during February through June under H1 would generally be similar to or greater than flows under H3 in all rivers except the Feather River. As a result, the redd dewatering risk analysis was not conducted for H1 in these rivers and results for H1 would be the same as those for H3.

In the Feather River at Thermalito Afterbay, there would be 5 more cohorts (9%) exposed to a 50% month over month drop in flow rate under H1 relative to NAA (Table 11-4-129). This change of 5 cohorts out of 410 cohorts would be negligible to the population.

Table 11-4-129. Differences between Model Scenarios in Dewatering Risk of River Lamprey Redd Cohorts[a]

Location	EXISTING CONDITIONS vs. H1	NAA vs. H1	EXISTING CONDITIONS vs. H4	NAA vs. H4
Feather River at Thermalito Afterbay	-5 (-7%)	5 (9%)	4 (6%)	14 (24%)

[a] Difference and percent difference between model scenarios in the number of river lamprey redd cohorts experiencing a month-over-month reduction in flows of greater than 50%. Positive values indicate a higher value in H1 or H4 than in Existing Conditions or NAA.

Water temperatures would not differ between H1 and H3 and, therefore, no egg cohort temperature analyses were conducted. Overall, results for H1 would be similar to those for H3.

H4/HOS

Flows during January through August under H4 would generally be similar to or greater than flows under H3 in all rivers except the Feather River. As a result, the redd dewatering risk analysis was not conducted for H4 in these rivers and results for H4 would be the same as those for H3.

In the Feather River at Thermalito Afterbay, there would be 14 more cohorts (24%) exposed to a 50% month over month drop in flow rate under H4 relative to NAA (Table 11-4-129). This change of 14 cohorts out of 410 cohorts would be negligible to the population.

Water temperatures would not differ between H4 and H3 and, therefore, no egg cohort temperature analyses were conducted. Overall, results for H4 would be similar to those for H3.

NEPA Effects: Collectively, these results indicate that the effect is not adverse because it would not substantially reduce suitable spawning habitat or substantially reduce the number of fish as a result of egg mortality. Effects of Alternative 4 on river lamprey redd dewatering risk would be negligible for all locations analyzed. Exposure risk of eggs to elevated water temperatures under Alternative 4 would be similar to or lower than that of NAA at all locations. These results are consistent among scenarios.

CEQA Conclusion: In general, under all the Alternative 4 water operations scenarios, the quantity and quality of spawning and egg incubation habitat for river lamprey would not be affected relative to the CEQA baseline.

H3/ESO

Effects of H3 relative to Existing Conditions on flow reductions during the river lamprey spawning period from February to June in the Sacramento River and American River consist of small to substantial increases in dewatering risk in the Sacramento River at Keswick (9%) and the American River (to 32%), and negligible effects (<5%) or small decreases in redd cohort dewatering risk in the Sacramento River at Red Bluff <5%), the Trinity River (-6%) and the Feather River (-12%) (Table 11-4-127). Effects of Alternative 4 on river lamprey redd dewatering in the American River consist of a substantial increase in risk that would affect river lamprey spawning success in that location (increases of 24% at Nimbus Dam and 32% at the confluence with the Sacramento River).

Egg cohort temperature exposure results are reported in Table 11-4-128. There would be increased exposure of egg cohorts (23 to 43 cohorts, or 154% to 3,400%) under H3 relative to Existing

Conditions to temperatures above 71.6°F in the Feather River, American River, and Stanislaus River. There would be 39 more cohorts exposed to temperatures above 77°F under H3 relative to Existing Conditions, although this absolute value, would not be biologically meaningful because it is a small proportion of the 12,320 total cohorts, There would be no differences in the number of cohorts exposed to the 77°F threshold.

H1/LOS

Flows during February through June under H1 would generally be similar to or greater than flows under H3 in all rivers except the Feather River. As a result, the redd dewatering risk analysis was not conducted for H1 in these rivers and results for H1 would be the same as those for H3.

In the Feather River at Thermalito Afterbay, there would be 5 fewer cohorts (7%) under H1 that would be exposed to a 50% flow reduction than under Existing Conditions (Table 11-4-129). This increase would be too small to have a biologically meaningful effect on river lamprey.

Water temperatures under H1 would be similar to those under H3 for all rivers examined. Therefore, no additional cohort temperature exposure analyses were conducted for H1.

Overall, results for H1 would be similar to those for H3.

H4/HOS

Flows during February through June under H4 would generally be similar to or greater than flows under H3 in all rivers except the Feather River. As a result, the redd dewatering risk analysis was not conducted for H4 in these rivers and results for H4 would be the same as those for H3.

In the Feather River at Thermalito Afterbay, there would be 4 more cohorts (236 under H4 that would be exposed to a 50% flow reduction than under H3 (Table 11-4-129). This increase would be too small to have a biologically meaningful effect on river lamprey.

Water temperatures under H4 would be similar to those under H3 for all rivers examined. Therefore, no additional cohort temperature exposure analyses were conducted for H1.

Overall, results for H4 would be similar to those for H3.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-184 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 4 could be significant because, under the CEQA baseline, the alternative could substantially reduce suitable spawning habitat and substantially reduce the number of fish as a result of egg mortality. Increased risk of redd dewatering in the American River (to 32%) would increase the risk of desiccation and mortality of eggs, contrary to the NEPA conclusion set forth above. The increase in exposure of egg cohorts to critical water temperatures in the Feather River would increase stress and egg mortality. Flow reductions in the Sacramento, Feather, American, and Stanislaus Rivers would cause increased risk of redd dewatering for river lamprey under H4 if operations were changed to this limit.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to H3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and H3 indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and H3. This indicates that the differences between Existing Conditions and Alternative 4 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 4, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on spawning habitat for river lamprey. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-185: Effects of Water Operations on Rearing Habitat for River Lamprey

In general, the effect of Alternative 4 would be negligible relative to the NAA.

H3/ESO

Flow-related impacts to river lamprey rearing habitat were evaluated by estimating of the frequency of rapid flow reductions in ammocoete rearing areas. Rapid reductions in flow can strand ammocoetes, leading to mortality. Comparisons of effects were made for ammocoete cohorts, as described for Pacific lamprey, in the Sacramento River at Keswick and Red Bluff, the Trinity River, Feather River, and the American River at Nimbus Dam and at the confluence with the Sacramento River.

As for Pacific lamprey, the analysis of river lamprey ammocoete stranding was conducted by analyzing a range of month-over-month flow reductions from CALSIM II outputs, using the range of 50%–90% in 5% increments. A cohort of ammocoetes was assumed to be born every month during their spawning period (February through June) and spend 5 years rearing upstream. Therefore, a cohort was considered stranded if at least one month-over-month flow reduction was greater than the flow reduction at any time during the period.

Comparisons of H3 to NAA for the Sacramento River at Keswick (Table 11-4-130) indicate that there would be no effect (0%) or negligible effects (<5%) attributable to H3 in all flow reduction categories.

Table 11-4-130. Percent Difference between Model Scenarios in the Number of River Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Sacramento River at Keswick

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. H3	NAA vs. H3
-50%	0	0
-55%	2	0
-60%	6	2
-65%	3	3
-70%	-2	-2
-75%	-6	0
-80%	11	0
-85%	44	0
-90%	NA	NA

NA = could not be calculated because the denominator was 0.
[a] Negative values indicate reduced cohort exposure, a benefit of H3.

Results of comparisons for the Sacramento River at Red Bluff indicates that H3 would have negligible effects (<5%) or small to moderate decreases in cohort exposure (to -16%) that would have a beneficial effect, attributable to the project for different flow reduction categories (Table 11-4-131).

Table 11-4-131. Percent Difference between Model Scenarios in the Number of River Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Sacramento River at Red Bluff

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. H3	NAA vs. H3
-50%	0	0
-55%	6	3
-60%	12	5
-65%	-2	-3
-70%	10	1
-75%	10	-10
-80%	8	-16
-85%	100	0
-90%	NA	NA

NA = could not be calculated because the denominator was 0.
[a] Negative values indicate reduced cohort exposure, a benefit of H3.

Comparisons for the Trinity River indicate that there would be no or negligible differences in ammocoete cohorts exposed flow reductions between H3 and NAA (Table 11-4-132).

Table 11-4-132. Percent Difference between Model Scenarios in the Number of River Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Trinity River at Lewiston

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. H3	NAA vs. H3
-50%	0	0
-55%	0	0
-60%	0	0
-65%	0	0
-70%	0	0
-75%	26	-5
-80%	39	0
-85%	31	0
-90%	59	4

[a] Negative values indicate reduced cohort exposure, a benefit of H3.

In the Feather River at Thermalito Afterbay, there would be no difference in ammocoete cohort exposure at the 50% through 75% flow reductions (Table 11-4-133). For the 80% through 90% flow reductions, ammocoete exposure would be 7% to 41% lower, which would have a beneficial effect on ammocoete rearing. These results indicate that there will be beneficial effects of H3 on river lamprey ammocoete rearing in the Feather River.

Table 11-4-133. Percent Difference between Model Scenarios in the Number of River Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Feather River at Thermalito Afterbay

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. H3	NAA vs. H3
-50%	0	0
-55%	0	0
-60%	0	0
-65%	0	0
-70%	0	0
-75%	-1	-1
-80%	-17	-11
-85%	-23	-41
-90%	-48	-7

[a] Negative values indicate reduced cohort exposure, a benefit of H3.

Comparisons for the American River at Nimbus Dam (Table 11-4-134) and at the confluence with the Sacramento River (Table 11-4-135) have similar results. There would be no or negligible differences in cohort exposure between NAA and H3 for the 50% to 70% flow reductions range, There would be higher cohort exposure under H3 relative to NAA at Nimbus Dam at the 75% flow reduction (9% higher) and at the confluence with the Sacramento River at the 75% (11% higher) and 80% (25% higher) flow reductions. There would be up to 24% lower cohort exposures under

H3 relative to NAA at the remaining flow reductions at both locations. These results indicate that there would generally be no effect of H3 on stranding risk in the American River with few small exceptions that would not be common enough to have biologically meaningful effects.

Table 11-4-134. Percent Difference between Model Scenarios in the Number of River Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, American River at Nimbus Dam

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. H3	NAA vs. H3
-50%	0	0
-55%	0	0
-60%	4	0
-65%	5	-3
-70%	59	0
-75%	146	9
-80%	262	-24
-85%	416	-8
-90%	136	-21

[a] Negative values indicate reduced cohort exposure, a benefit of H3.

Table 11-4-135. Relative Difference between Model Scenarios in the Number of River Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, American River at the Confluence with the Sacramento River

	Percent Difference[a]	
Percent Flow Reduction	EXISTING CONDITIONS vs. H3	NAA vs. H3
-50%	0	0
-55%	0	0
-60%	4	0
-65%	5	0
-70%	20	-3
-75%	71	11
-80%	323	25
-85%	240	-21
-90%	300	-14

[a] Negative values indicate reduced cohort exposure, a benefit of H3.

Because the thermal tolerance of river lamprey ammocoetes is unknown, the thermal tolerance of Pacific lamprey ammocoetes of 22°C (71.6°F) and of river lamprey adults of 25°C (77°F) (Moyle et al. 1995) was used. River lamprey ammocoetes rear upstream for 3–5 years (Moyle 2002). To be conservative, this analysis assumed a maximum ammocoete duration of 5 years. Each individual day or month starts a new "cohort" such that there are 18,730 cohorts for the Sacramento River, corresponding to 82 years of ammocoetes being "born" every day each year from January 1 through August 31, and 380 cohorts for the other rivers using monthly data over the same period.

There would be differences in the number of ammocoete cohorts exposed to temperatures greater than the thresholds in most of the rivers, particularly for the 77°F threshold (Table 11-4-136). However, each river with an increase in exposure would also have a site with a decrease in exposure of similar magnitude, except in the Feather River for the 77°F threshold. Overall, the increases and decreases are expected to balance out within rivers such that there would be no overall effect on river lamprey ammocoetes.

Table 11-4-136. Differences (Percent Differences) between Model Scenarios in River Lamprey Ammocoete Cohorts Exposed to Temperatures in the Feather River Greater than 71.6°F and 77°F in at Least One Month

Location	EXISTING CONDITIONS vs. H3	NAA vs. H3
71.6°F Threshold		
Sacramento River at Keswick[b]	0 (NA)	-1,218 (-100%)
Sacramento River at Hamilton City[b]	10,951 (NA)	1,456 (15%)
Trinity River at Lewiston	65 (NA)	15 (30%)
Trinity River at North Fork	135 (NA)	-25 (-16%)
Feather River at Fish Barrier Dam	0 (NA)	-25 (-100%)
Feather River below Thermalito Afterbay	180 (95%)	50 (16%)
American River at Nimbus	240 (267%)	-5 (-1%)
American River at Sacramento River Confluence	135 (55%)	0 (0%)
Stanislaus River at Knights Ferry	25 (NA)	0 (0%)
Stanislaus River at Riverbank	335 (1,340%)	0 (0%)
77°F Threshold		
Sacramento River at Keswick[b]	0 (NA)	0 (NA)
Sacramento River at Hamilton City[b]	0 (NA)	0 (NA)
Trinity River at Lewiston	0 (NA)	0 (NA)
Trinity River at North Fork	25 (NA)	25 (NA)
Feather River at Fish Barrier Dam	0 (NA)	0 (NA)
Feather River below Thermalito Afterbay	65 (NA)	25 (63%)
American River at Nimbus	200 (NA)	-20 (-9%)
American River at Sacramento River Confluence	265 (530%)	35 (15%)
Stanislaus River at Knights Ferry	0 (NA)	0 (NA)
Stanislaus River at Riverbank	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.
[a] Positive values indicate a higher value in H3 than in EXISTING CONDITIONS or NAA.
[b] Based on daily data; all other locations use monthly data; 1922–2003.

H1/LOS

There would be generally no differences in mean flows year-round between H1 and H3 in the Sacramento, Trinity, and American rivers. Therefore, ammocoete stranding risk analysis was conducted only for the Feather River.

In the Feather River at Thermalito Afterbay, there would be no or a negligible difference in ammocoete cohort exposure between NAA and H1 at the 50% through 75% flow reductions (Table

11-4-137). For the 85% flow reductions, ammocoete exposure under H1 would be 9% higher than that under NAA, respectively. For the 90% and 95% flow reductions, ammocoete exposure under H1 would be7% lower than that under NAA. Overall, these results indicate that there would generally be no biologically meaningful effect of H1 on river lamprey ammocoete rearing in the Feather River.

Table 11-4-137. Percent Difference between Baselines and H1 and H4 Model Scenarios in the Number of River Lamprey Ammocoete Cohorts Exposed to Month-over-Month Flow Reductions, Feather River at Thermalito Afterbay

	Percent Difference[a]			
Percent Flow Reduction	EXISTING CONDITIONS vs. H1	NAA vs. H1	EXISTING CONDITIONS vs. H4	NAA vs. H4
-50%	0	0	0	0
-55%	0	0	0	0
-60%	0	0	0	0
-65%	0	0	0	0
-70%	0	0	0	0
-75%	0	0	0	0
-80%	2	9	-2	4
-85%	23	-7	17	-11
-90%	-48	-7	15	103

[a] Negative values indicate reduced cohort exposure under H1 or H4.

There would generally be no differences in mean water temperatures year-round between H1 and H3 in any river examined. As a result, no additional ammocoete temperature cohort exposure analyses were conducted for H1. Results of these analyses for H1 would be the same as those for H3.

Overall, these results indicate that results for H1 would generally be similar to those under H3.

H4/HOS

There would be generally no differences in mean flows year-round between H4 and H3 in the Sacramento, Trinity, and American rivers. Therefore, ammocoete stranding risk analysis was conducted only for the Feather River.

In the Feather River at Thermalito Afterbay, there would be no or a negligible difference in ammocoete cohort exposure between NAA and H4 at the 50% through 80% flow reductions (Table 11-4-137). For the 85% and 90% flow reductions, ammocoete exposure under H4 would be 11% lower and 103% higher, respectively.

There would generally be no differences in mean water temperatures year-round between H4 and H3 in any river examined. As a result, no additional ammocoete cohort exposure analyses were conducted for H4. Results of these analyses for H4 would be the same as those for H3.

Overall, these results indicate that results for H4 would generally be similar to those under H3 except for an increase in ammocoete stranding risk exposure in the Feather River at 90% flow reduction under H4 if water operations were to move to this end of the operational range.

NEPA Effects: These results indicate the effect would not be adverse because it would not substantially reduce rearing habitat or substantially reduce the number of fish through ammocoete mortality. Project-related effects on flow reductions and effects on water temperatures in all locations analyzed would be negligible and would not affect river lamprey ammocoete stranding risk and rearing success. There would be small to substantial beneficial effects from decreased stranding risk in the Sacramento River at Red Bluff (to -16%), the Feather River (to -41%), and the American River at Nimbus Dam (to -24%). However, stranding risk under both H1 and H4 in the Feather River would be higher than those under H3, such that benefits under H3 would not occur under these limits of the operational range.

There would be increases and decreases in ammocoete exposure to elevated temperatures that are expected to balance out within rivers such that there would be no overall effect.

CEQA Conclusion: In general, under all the Alternative 4 water operations scenarios, the quantity and quality of rearing habitat for river lamprey would not be affected relative to the CEQA baseline.

H3/ESO

Comparisons of H3 to Existing Conditions for the Sacramento River at Keswick indicate negligible effects (<5%) or small increases (to 11%) for ammocoete cohort exposures to flow reductions from 50% to 80%, and a more substantial increase in exposure (44%) to 85% flow reduction events (Table 11-4-130). Comparisons for the Sacramento River at Red Bluff indicate similar results with negligible effects (<5%) or small increases in exposure (to 12%) for 50% to 80% flow reduction categories, and a more substantial increases in exposure (from 25 to 50 cohorts or 100%) in the 85% flow reduction category (Table 11-4-131). Based on the prevalence of negligible effects (<5%), or relatively small increased occurrence of flow reductions for most of the flow reduction categories, the effects of a more substantial increase in flow reductions in a single flow reduction category would not be considered biologically meaningful to river lamprey in the Sacramento River.

Comparisons for the Trinity River between H3 and Existing Conditions indicated no effect (0%) for the lower flow reduction categories, up to 70%, and increases in occurrence ranging from 26% to 59% for the 75% through 90% flow reduction categories (Table 11-4-132). The prevalence of increased occurrence of higher-magnitude flow reductions would affect river lamprey ammocoete stranding in the Trinity River.

Comparisons for the Feather River between H3 and Existing Conditions indicated no effect (0%) or reductions in frequency of occurrence for all flow reduction categories, with 17% to 48% reductions in cohorts exposed to80% to 90% flow reduction events (Table 11-4-133). Decreased occurrences of flow reductions would have a beneficial effect.

Comparisons for the American River at Nimbus Dam (Table 11-4-134) and at the confluence with the Sacramento River (Table 11-4-135) between H3 and Existing Conditions indicate increased chance of occurrence of flow reductions between 70 and 90% for Alternative 4 compared to NAA; meaningful (>5%) predicted increases are from 59 to 416% (increase in cohorts exposed from 25 to 129) for Nimbus Dam and from 20 to 300% (increase in cohorts exposed from 25 to 100) for the confluence. The prevalence of increased occurrence of higher-magnitude flow reductions would constitute a biologically meaningful effect on river lamprey ammocoete stranding in the American River.

The number of ammocoete cohorts exposed to 71.6°F under H3 would be higher than those under Existing Conditions in most locations examined, except in the Sacramento River at Keswick and in the Feather River at the Fish Barrier Dam (Table 11-A1-132). The number of ammocoete cohorts exposed to 77°F would be similar between Existing Conditions and H3 in the Sacramento, Trinity, and Stanislaus Rivers, but higher in the Feather and American Rivers.

H1/LOS

There would be generally no differences in mean flows year-round between H1 and H3 in the Sacramento, Trinity, and American rivers. Therefore, ammocoete stranding risk analysis was conducted only for the Feather River.

In the Feather River at Thermalito Afterbay, there would be no or a negligible difference in ammocoete cohort exposure between Existing Conditions and H1 at the 50% through 80% flow reductions (Table 11-4-137). There would be 23% more and 48% fewer cohorts exposed to 85% and 90% flow reductions, respectively, under H3 relative to Existing Conditions.

There would generally be no differences in mean water temperatures year-round between H1 and H3 in any river examined. As a result, no additional ammocoete temperature cohort exposure analyses were conducted for H1. Results of these analyses for H1 would be the same as those for H3.

Overall, these results indicate that results for H1 would generally be similar to those under H3.

H4/HOS

There would be generally no differences in mean flows year-round between H4 and H3 in the Sacramento, Trinity, and American rivers. Therefore, ammocoete stranding risk analysis was conducted only for the Feather River.

In the Feather River at Thermalito Afterbay, there would be no or a negligible difference in ammocoete cohort exposure between Existing Conditions and H4 at the 50% through 80% flow reductions (Table 11-4-137). There would be 17% and 15% more cohorts exposed to 85% and 90% flow reductions, respectively, under H3 relative to Existing Conditions.

There would generally be no differences in mean water temperatures year-round between H4 and H3 in any river examined. As a result, no additional ammocoete temperature cohort exposure analyses were conducted for H4. Results of these analyses for H4 would be the same as those for H3.

Overall, these results indicate that results for H4 would generally be similar to those under H3.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-185 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 4 could be significant because, under the CEQA baseline, the alternative could substantially reduce rearing habitat and substantially reduce the number of fish as a result of ammocoete mortality, contrary to the NEPA conclusion set forth above. There would be moderate to substantial increases in occurrence of flow reduction events for Alternative 4 with respect to Existing Conditions for the Trinity River (26% to 59%) and the American River at Nimbus Dam (59% to 416%) and at the confluence with the Sacramento River (20% to 300%) that would affect river lamprey ammocoete stranding risk and therefore rearing success for these locations. There would be a beneficial effect from reduced occurrence of flow reductions in the Feather River (-17% to 48%) but this effect would not be sufficient to offset the negative effects from increased occurrence of flow reductions at the other locations. Further, stranding risk under both H1 and H4 in the Feather River would be higher than those under H3, such that benefits under H3 would not occur under these limits of the operational range. There would also be increases under Alternative 4 in ammocoete cohort exposure to critical water temperatures in all rivers evaluated that would have biologically meaningful effects on rearing success through ammocoete mortality. These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to H3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and H3 indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and H3. This indicates that the differences between Existing Conditions and Alternative 4 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 4, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on rearing habitat for river lamprey. This impact is found to be less than significant and no mitigation is required.

Impact AQUA-186: Effects of Water Operations on Migration Conditions for River Lamprey

In general, the effect of Alternative 4 on river lamprey migration conditions would be negligible relative to the NAA.

H3/ESO

After 3 to 5 years, river lamprey ammocoetes migrate downstream and become macropthalmia once they reach the Delta. River lamprey migration generally occurs September through November (USFWS unpublished data). The effects of H3 on seasonal migration flows for river lamprey macropthalmia were assessed using CALSIM II flow output. Flow rates along the likely migration pathways of river lamprey during the likely migration period (September through November) were examined to predict how H3 may affect migration flows for outmigrating macropthalmia. Analyses were conducted for the Sacramento River at Red Bluff, Feather River at the confluence with the Sacramento River, and the American River at the confluence with the Sacramento River.

The adult river lamprey upstream migration period also occurs between September and June. Therefore, results presented below represent effects to the migration of both macropthalmia and adult river lamprey. CALSIM II flow outputs were examined during these periods for each model scenario.

Sacramento River

Mean monthly flow rates for the Sacramento River at Red Bluff (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) were examined during the September to November river lamprey macropthalmia and adult migration periods. Flows under H3 would generally be similar to flows under NAA during September and October, but up to 18% lower during November depending on water year type. Because of the relatively small magnitude, reduced flows during November are not likely to cause biologically meaningful effects on river lamprey migration.

Feather River

Flows in the Feather River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) were examined during the September to November river lamprey macropthalmia and adult migration periods. Flows under H3 would generally be lower than flows under NAA during September, higher than flows under NAA during October, and similar to flows under NAA during November. Based on occurrence of negligible effects or increases in flow that would have a beneficial effect on migration conditions, with decreases predicted for wetter water years when effects on migration conditions would not be as critical, these results indicate that effects of NAA on flows would not have biologically meaningful negative effects on migration conditions in the Feather River.

American River

Flows in the American River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) were examined during the September through November macropthalmia and adult migration periods. Flows under H3 would be lower than flows under NAA during September and November and similar to flows during October. However, flows during September would only be negative during wetter water years, when reduced flows are less critical to lamprey migration. Further, flows during November would be only marginally lower (6% to 8%). Overall, these results indicate that project-related effects would include small decreases in flow for some months and water year types, but that overall effects throughout the migration period would not have biologically meaningful effects on river lamprey migration.

H1/LOS

Flows under H1 in the Sacramento River at Red Bluff would be lower than flows under H3 (up to 44% lower) during September and November and similar during October (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H1 in the Feather River at the confluence with the Sacramento River would generally be similar to flows under H3, except in wet and above normal water years during September, in which flows would be 65% and 40% lower, respectively. Flows under H1 in the American River at the confluence with the Sacramento River would generally be similar to flows under H3, except in wet and above normal water years during September, in which flows would be 65% and 40% lower, respectively. Overall, migration conditions for river lamprey under H1 would be less favorable than conditions under H3.

H4/HOS

Flows under H4 in the Sacramento River at Red Bluff would be similar to or greater than flows under H3 during September through November (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 in the Feather River at the confluence with the Sacramento River would generally be up to 24% lower than flows under H3 in September and October but similar during November. Flows under H4 in the American River at the confluence with the Sacramento River would generally be up to 20% greater than flows under H3 during September, up to 13%

lower than flows under H3 during October, and similar to flows under H3 during November. Overall, migration conditions for river lamprey under H4 would be less favorable than conditions under H3.

NEPA Effects: Collectively, these results indicate that the effect is not adverse because it would not substantially reduce the amount of suitable habitat or substantially interfere with the movement of fish. H3 would primarily have negligible effects (<5%), small increases or decreases in flow, or decreases in wetter water year types and/or during a limited portion of the migration period that would not have negative effects on migration conditions. There would be beneficial effects from moderate increases in flow for some months and water year types in all locations, including the Sacramento River (to 18%), the Feather River (to 22%) and the American River (to 16%); however, the beneficial effect would be partially offset by flow reductions during other months of the migration periods. Flows under H1 and H4 would be less favorable than those under H3 if water operations, although neither would cause adverse impacts.

CEQA Conclusion: In general, under all the Alternative 4 water operations scenarios, the quantity and quality of migration habitat for river lamprey would not be reduced relative to the CEQA baseline.

H3/ESO

For the Sacramento River at Red Bluff, comparisons of mean monthly flow rate for H3 to Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) indicate variable effects of H3 during September, with increases in mean monthly flow for wetter water year types (39 to 55%) and decreases for drier water year types (-11 and -14% for below normal and dry years, respectively). H3 would have negligible effects (<5%) for October in all water years, and would have negligible effects (<5%) or cause small decreases in mean monthly flows for all water year types in November (-7 to -14%). Based on small decreases in drier water year types during September and November, these results indicate that H3 would not have biologically meaningful negative effects on macropthalmia migration conditions in the Sacramento River.

Comparisons for the Feather River at the confluence with the Sacramento River indicate (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) indicate variable effects of H3 relative to Existing Conditions based on month and water year type. There would be substantial increases for wetter years (to 108%) and decreases in drier years (to -28%) during September, variable results during October with increases to 30% in above normal, dry, and critical years and small decreases (to -9%) in wet and below normal years, and negligible effects (<5%) or decreases (-20% in wet years, -8% in below normal years) during November. There would be small to moderate decreases during all three months in below normal years, however, effects during dry and critical years are more variable. These results indicate that despite variable effects by month and water year type, effects of H3 on flow would not have biologically meaningful negative effects on macropthalmia migration in the Feather River.

Comparisons for the American River at the confluence with the Sacramento River (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) for September through November indicate reductions in flow for most months and most water year types, ranging from -16 to -51%, with the exception of increases in mean monthly flow during October in below normal (26%) and critical (13%) water years, and negligible decreases (<5%) in above normal and dry years. The predominance of decreased flows for H3 compared to Existing Conditions would have adverse effects on migration, with substantial decreases for dry and critical years in September (-39 and -51%, respectively) and November (-33 and -28%, respectively).

H1/LOS

Flows under H1 in the Sacramento River at Red Bluff would be lower than flows under H3 (up to 44% lower) during September and November and similar during October (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H1 in the Feather River at the confluence with the Sacramento River would generally be similar to flows under H3, except in wet and above normal water years during September, in which flows would be 65% and 40% lower, respectively. Flows under H1 in the American River at the confluence with the Sacramento River would generally be similar to flows under H3, except in wet and above normal water years during September, in which flows would be 65% and 40% lower, respectively. Overall, migration conditions for river lamprey under H1 would be less favorable than conditions under H3.

H4/HOS

Flows under H4 in the Sacramento River at Red Bluff would be similar to or greater than flows under H3 during September through November (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 in the Feather River at the confluence with the Sacramento River would generally be up to 24% lower than flows under H3 in September and October but similar during November. Flows under H4 in the American River at the confluence with the Sacramento River would generally be up to 20% greater than flows under H3 during September, up to 13% lower than flows under H3 during October, and similar to flows under H3 during November. Overall, migration conditions for river lamprey under H4 would be less favorable than conditions under H3.

Summary of CEQA Conclusion

Collectively, the results of the Impact AQUA-186 CEQA analysis indicate that the difference between the CEQA baseline and Alternative 4 could be significant because, under the CEQA baseline, the alternative could substantially reduce the amount of suitable habitat and substantially interfere with the movement of fish, contrary to the NEPA conclusion set forth above. There would be moderate and persistent flow reductions for substantial portions of the river lamprey macropthalmia migration period in the American River, and less persistent and smaller magnitude flow reductions in the Sacramento River and Feather River. These flow reductions would affect juvenile migration success, increase straying, and delay access to the ocean. These flow reductions would also affect adult migration success, including a reduction in the ability for adults to sense olfactory cues if they use these cues to find natal spawning grounds. There would be beneficial effects from increases in flow for some months and water year types in each location including in the Sacramento River (to 55% in wetter water years), the Feather River (to 108% in wetter water years and to 30% for drier water years in October), and the American River (to 26% in October). However, this effect would not be sufficient to offset the negative effects of flow reductions for the remainder of the migration period and/or in other water year types, particularly drier water year types when effects of flow reductions would be more critical. Flows under H1 and H4 would be less favorable than those under H3.

These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to H3 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. In addition, CALSIM modeling has been conducted for Existing Conditions in the LLT implementation period, which does include future sea level rise, climate change, and water demands. Therefore, the comparison of results between the alternative and Existing Conditions in the LLT, both of which include sea level rise, climate change, and future water demands, isolates the effect of the alternative from those of sea level rise, climate change, and water demands.

The additional comparison of CALSIM flow outputs between Existing Conditions in the late long-term implementation period and H3 indicates that flows in the locations and during the months analyzed above would generally be similar between Existing Conditions during the LLT and H3. This indicates that the differences between Existing Conditions and Alternative 4 found above would generally be due to climate change, sea level rise, and future demand, and not the alternative. As a result, the CEQA conclusion regarding Alternative 4, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on migration conditions for river lamprey. This impact is found to be less than significant and no mitigation is required.

Restoration Measures (CM2, CM4–CM7, and CM10)

Alternative 4 has the same Restoration Measures as Alternative 1A. Because no substantial differences in restoration-related fish effects are anticipated anywhere in the affected environment under Alternative 4 compared to those described in detail for Alternative 1A, the fish effects of restoration measures described for river lamprey under Alternative 1A (Impacts AQUA-187 through AQUA-189) also appropriately characterize effects under Alternative 4.

The following impacts are those presented under Alternative 1A that are identical for Alternative 4.

Impact AQUA-187: Effects of Construction of Restoration Measures on River Lamprey

Impact AQUA-188: Effects of Contaminants Associated with Restoration Measures on River Lamprey

Impact AQUA-189: Effects of Restored Habitat Conditions on River Lamprey

NEPA Effects: Detailed discussions regarding the potential effects of these three impact mechanisms on river lamprey are the same for Alternative 4, as those described under Alternative 1A (Impacts AQUA 187-through AQUA-189). The effects would not be adverse, and would generally be beneficial.

CEQA Conclusion: All of the impact mechanisms listed above would be at least slightly beneficial, or less than significant, and no mitigation is required.

Other Conservation Measures (CM12–CM19 and CM21)

Alternative 4 has the same other conservation measures as Alternative 1A. Because no substantial differences in other conservation-related fish effects are anticipated anywhere in the affected environment under Alternative 4 compared to those described in detail for Alternative 1A, the fish effects of other conservation measures described for river lamprey under Alternative 1A (Impacts AQUA-190 through AQUA-198) also appropriately characterize effects under Alternative 4.

The following impacts are those presented under Alternative 1A that are identical for Alternative 4.

Impact AQUA-190: Effects of Methylmercury Management on River Lamprey (CM12)

Impact AQUA-191: Effects of Invasive Aquatic Vegetation Management on River Lamprey (CM13)

Impact AQUA-192: Effects of Dissolved Oxygen Level Management on River Lamprey (CM14)

Impact AQUA-193: Effects of Localized Reduction of Predatory Fish on River Lamprey (CM15)

Impact AQUA-194: Effects of Nonphysical Fish Barriers on River Lamprey (CM16)

Impact AQUA-195: Effects of Illegal Harvest Reduction on River Lamprey (CM17)

Impact AQUA-196: Effects of Conservation Hatcheries on River Lamprey (CM18)

Impact AQUA-197: Effects of Urban Stormwater Treatment on River Lamprey (CM19)

Impact AQUA-198: Effects of Removal/Relocation of Nonproject Diversions on River Lamprey (CM21)

NEPA Effects: Detailed discussions regarding the potential effects of these nine impact mechanisms on river lamprey are the same as those described under Alternative 1A, Impacts AQUA-190 through AQUA-198). The effects would not be adverse, and would generally be beneficial.

CEQA Conclusion: All nine of the impact mechanisms listed above would be at least slightly beneficial, or less than significant, and no mitigation is required.

Non-Covered Aquatic Species of Primary Management Concern

Construction and Maintenance of CM1

The effects of construction and maintenance of CM1 under Alternative 4 would be similar for all non-covered species; therefore, the analysis below is combined for all non-covered species instead of analyzed by individual species.

Impact AQUA-199: Effects of Construction of Water Conveyance Facilities on Non-Covered Aquatic Species of Primary Management Concern

NEPA Effects: Refer to Impact AQUA-1 under delta smelt for a discussion of the effects of construction of water conveyance facilities on non-covered species of primary management concern. That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. The potential effects of the construction of water conveyance facilities under Alternative 4 would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-1) except that Alternative 4 would include three intakes compared to five intakes under Alternative 1A, so the effects would be proportionally less under this alternative. This would convert about 6,360 lineal feet of existing shoreline habitat into intake facility structures and would require about 17.1 acres of dredge and channel reshaping. In contrast, Alternative 1A would convert 11,900 lineal feet of shoreline and would require 27.3 acres of dredging. Additionally, California bay shrimp would not be affected because they do not occur in the vicinity and Sacramento-San Joaquin roach and hardhead are unlikely to be affected because their primary distributions are upstream.

Similar to the conclusion for Alternative 1A, Impact AQUA-1, environmental commitments and mitigation measures would be available to avoid and minimize potential effects, and the effect would not be adverse for non-covered aquatic species of primary management concern.

CEQA Conclusion: Similar to the conclusion for Alternative 1A, Impact AQUA-1, the impact of the construction of the water conveyance facilities on non-covered aquatic species of primary management concern would not be significant except for construction noise associated with pile driving. Potential pile driving impacts would be less than Alternative 1A because only three intakes would be constructed rather than five. Implementation of Mitigation Measure AQUA-1a and Mitigation Measure AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1a under Impact AQUA-1 in the discussion of Alternative 1A.

Mitigation Measure AQUA-1b: Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Please refer to Mitigation Measure AQUA-1b under Impact AQUA-1 in the discussion of Alternative 1A.

Impact AQUA-200: Effects of Maintenance of Water Conveyance Facilities on Non-Covered Aquatic Species of Primary Management Concern

NEPA Effects: Refer to Impact AQUA-2 under delta smelt for a discussion of the effects of maintenance of water conveyance facilities on non-covered species of primary management concern. That discussion under delta smelt addresses the type, magnitude and range of impact mechanisms that are relevant to the aquatic environment and aquatic species. The potential effects of the construction of water conveyance facilities under Alternative 4 would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-2). California bay shrimp would not be affected because they do not occur in the vicinity and Sacramento-San Joaquin roach and hardhead are unlikely to be affected because their primary distributions are upstream. Consequently, the effects would not be adverse.

CEQA Conclusion: Similar to the conclusion for Alternative 1A, Impact AQUA-2, the impact of the maintenance of water conveyance facilities on non-covered species of primary management concern would be less than significant and no mitigation is required.

Water Operations of CM1

The effects of water operations of CM1 under Alternative 4 include a detailed analysis of the following species:

- Striped Bass
- American Shad
- Threadfin Shad
- Largemouth Bass

- Sacramento tule perch
- Sacramento-San Joaquin roach – California species of special concern
- Hardhead – California species of special concern

Impact AQUA-201: Effects of Water Operations on Entrainment of Non-Covered Aquatic Species of Primary Management Concern

Striped Bass

NEPA Effects: Under Existing Conditions, striped bass are observed in salvage operations of the south Delta facilities throughout the year, with the majority of juvenile striped bass entrainment occurring during the summer (May through July). Entrainment losses under Scenario H3 to the SWP/CVP south Delta intakes would be reduced moderately compared to baseline conditions (NAA) since exports from the south Delta facilities would be reduced in the summer. Entrainment loss at the south Delta facilities under Scenario H1 would be similar to conditions under Scenario H3, while entrainment would be further reduced under Scenario H4. Entrainment of juvenile and adult striped bass would be limited at the proposed north Delta intakes and the alternate NBA intake by screens designed to exclude fish larger than 15 mm. Eggs and larvae would be vulnerable as they are passively transported downstream from spawning areas on the Sacramento River. Agricultural diversions are potential sources of entrainment for small fish such as larval and juvenile striped bass. Reduction or consolidation of up to 12% of agricultural diversions in ROAs would not increase entrainment and may provide a minor benefit for the species. Also larval entrainment is not thought to have population consequences due to the large fecundity of individual females and the fact that population levels do not correspond to numbers of larvae (Moyle 2002). In addition, restoration activities as part of the conservation measures should increase the amount of habitat for young striped bass (e.g. inshore rearing habitat), and increase their food supply. The expectation is that these habitat changes would result in at least a minor improvement in production of juvenile striped bass. Overall, the effect of Alternative 4 on striped bass entrainment would not be adverse and may benefit the species due to reductions in south Delta entrainment and increases in habitat and food supply.

CEQA Conclusion: The impact of water operations on entrainment of striped bass would be the same as described immediately above. The changes in entrainment under Alternative 4 would not substantially reduce the striped bass population when other conservation measures are taken into consideration. The impact would be less than significant and no mitigation would be required.

American Shad

American shad eggs and larvae would be vulnerable to entrainment at the proposed north SWP/CVP Delta intakes and the alternate NBA intake as these life stages are passively transported downstream to the north Delta. Most American shad spawning though takes place well upstream of the Delta. State-of-the-art fish screens on these north Delta intakes though would exclude juvenile and adult American shad.

NEPA Effects: American shad entrainment losses would be reduced at the SWP/CVP south Delta facilities under the flow scenarios for Alternative 4 compared to baseline conditions due to moderately reduced south delta exports in the summer. Entrainment losses would be further reduced under Scenario H4 compared to the other flow scenarios. Reduction or consolidation of up to 12% of agricultural diversions in ROAs would not increase entrainment and may provide a modest benefit to the species. Overall, the effect on American shad would not be adverse, and would be slightly beneficial.

CEQA Conclusion: The impact of water operations on entrainment of American shad would be the same as described immediately above. The changes in entrainment under Alternative 4 would not substantially reduce the American shad population. The impact would be less than significant and no mitigation would be required.

Threadfin Shad

NEPA Effects: The impact and conclusion would be the same as discussed for Alternative 1A (Impact AQUA-201 for Threadfin Shad). Entrainment at the south delta would be reduced due to overall decreased exports from the SWP/CVP south Delta facilities. Entrainment losses would be further reduced under Scenario H4 compared to the other flow scenarios for Alternative 4. There would be potential entrainment of threadfin shad eggs and larvae to the north Delta intakes, although this risk is minimal because threadfin shad are most abundant in the south Delta (Baxter et al. 2010). Decommissioning or consolidation of agricultural diversions in Delta ROAs would potentially reduce threadfin shad entrainment loss. Overall, threadfin shad entrainment would be reduced because they are most abundant in the southern Delta and would particularly benefit from reduced south Delta exports. The effect would not be adverse.

CEQA Conclusion: The impact of water operations on entrainment of threadfin shad would be the same as described immediately above. The changes in entrainment under Alternative 4 would not substantially reduce and may benefit the threadfin shad population. The impact would be less than significant and no mitigation would be required.

Largemouth Bass

NEPA Effects: Since largemouth bass are predominantly found in the south and central portions of the Delta, largemouth bass would be most vulnerable to entrainment to south Delta facilities. Entrainment to the south Delta would be reduced under all flow scenarios for Alternative 4 because of reductions in south Delta exports in the summer. Entrainment loss would be further reduced under Scenario H4 compared to other Alternative 4 flow scenarios, because of lower south Delta exports. As discussed for Alternative 1A (Impact AQUA-201for Largemouth Bass) few larval largemouth bass would be vulnerable to entrainment to north Delta and alternative NBA intake since they are not expected to readily occur in the vicinity. Largemouth bass are nest builders and typically build their nests in quiet, low flow backwaters. Decommissioning or consolidation of up to 12% of Delta agricultural diversions would potentially reduce entrainment of largemouth bass. Overall entrainment would be reduced under Alternative 4.

CEQA Conclusion: The impact of water operation on largemouth bass would be as described immediately above. The changes in entrainment under Alternative 4 could benefit the largemouth bass population. The impact would be less than significant and no mitigation would be required.

Sacramento Tule Perch

NEPA Effects: The effects and conclusion for this impact would be the same as Alternative 1A (Impact AQUA-201 for Sacramento tule perch). Entrainment of Sacramento tule perch is documented in small numbers at the SWP/CVP south Delta. Entrainment at the south Delta intakes would be further minimized under all flow scenarios for Alternative 4, especially Scenario H4. Under Alternative 4, entrainment would be reduced because north Delta intakes would be screened and south Delta exports would be reduced compared to baseline conditions (NAA). Because Sacramento tule perch are viviparous, newly born Sacramento tule perch would be large enough to be effectively screened at the proposed north delta facilities. Reduction or consolidation of agricultural diversions under the Plan would potentially reduce entrainment of Sacramento tule perch. Overall the reduction in entrainment of Sacramento tule perch under Alternative 4 would not be adverse.

CEQA Conclusion: The impact of water operations on entrainment of Sacramento tule perch would be the same as described immediately above. The changes in entrainment under Alternative 4 would not substantially reduce the Sacramento tule perch population. The impact would be less than significant and no mitigation would be required.

Sacramento-San Joaquin Roach

NEPA Effects: The effect of water operations on entrainment of Sacramento-San Joaquin roach under Alternative 4 would be similar to that described for Alternative 1A (see Alternative 1A, Impact AQUA-201). Also, Sacramento-San Joaquin roach distribution is primarily upstream of the intakes and south Delta facilities. For a detailed discussion, please see Alternative 1A, Impact AQUA-201. The effects would not be adverse.

CEQA Conclusion: The impact of water operations on entrainment of Sacramento-San Joaquin roach would be the same as described immediately above and would be less than significant and no mitigation would be required.

Hardhead

NEPA Effects: The effect of water operations on entrainment of hardhead under Alternative 4 would be similar to that described for Alternative 1A (see Alternative 1A, Impact AQUA-201). Also, hardhead distribution is primarily upstream of the intakes and south Delta facilities. For a detailed discussion, please see Alternative 1A, Impact AQUA-201. The effects would not be adverse.

CEQA Conclusion: The impact of water operations on entrainment of hardhead would be the same as described immediately above and would be less than significant and no mitigation would be required.

California Bay Shrimp

NEPA Effects: California bay shrimp do not occur in the vicinity of the intakes so there would be no entrainment effect on them.

CEQA Conclusion: California bay shrimp do not occur in the vicinity of the intakes so there would no entrainment impact on them.

Impact AQUA-202: Effects of Water Operations on Spawning and Egg Incubation Habitat for Non-Covered Aquatic Species of Primary Management Concern

Also, see Alternative 1A, Impact AQUA-202 for additional background information relevant to non-covered species of primary management concern.

Striped Bass

In general, Alternative 4 would slightly improve the quality and quantity of upstream habitat conditions for striped bass relative to the NAA.

H3/ESO

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the April through June striped bass spawning, embryo incubation, and initial rearing period. Lower flows could reduce the quantity and quality of instream habitat available for spawning, egg incubation, and rearing.

In the Sacramento River upstream of Red Bluff, flows under H3 would generally be similar to or greater than flows under NAA during April through June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under H3 would generally be similar to or greater than flows under NAA during April through June except in above normal years during April (11% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under H3 would be similar to flows under NAA during April through June except in critical years during June (8% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under H3 would generally be moderately to substantially greater than flows under NAA during April through June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under H3 would be similar to or greater than flows under NAA during April through June regardless of water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).Flow rates in the San Joaquin and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months outside of the 59°F to 68°F suitable water temperature range for striped bass spawning, embryo incubation, and initial rearing during April through June was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced spawning success and increased egg and larval stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature related effects in these rivers during the April through June period.

In the Feather River below Thermalito Afterbay, the percentage of months under H3 outside the range would be similar to or lower than the percentage under NAA in all water year types (Table 11-4-138).

Table 11-4-138. Difference and Percent Difference in the Percentage of Months during April–June in Which Water Temperatures in the Feather River below Thermalito Afterbay Are outside the 59°F to 68°F Water Temperature Range for Striped Bass Spawning, Embryo Incubation, and Initial Rearing[a]

Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
Wet	-3 (-7%)	-8 (-16%)
Above Normal	-18 (-40%)	-15 (-36%)
Below Normal	-17 (-40%)	-19 (-42%)
Dry	-2 (-4%)	1 (2%)
Critical	11 (28%)	-3 (-6%)
All	-5 (-11%)	-8 (-17%)

[a] A negative value indicates a benefit (reduction in percentage of months outside suitable range) of the alternative.

H1/LOS

Flows under H1 in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek during the April through June striped bass spawning, embryo incubation, and initial rearing period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*. The percentage of months under H1 with mean water temperatures outside the 59°F to 68°F suitable water temperature range in the Feather River below Thermalito Afterbay would be similar to or lower than the percentage under H3 in all water year types (Table 11-4-139).

Table 11-4-139. Difference and Percent Difference between the H3 Model Scenario and H1 and H4 Model Scenarios in the Percentage of Months during April–June in Which Water Temperatures in the Feather River below Thermalito Afterbay Are outside the 59°F to 68°F Water Temperature Range for Striped Bass Spawning, Embryo Incubation, and Initial Rearing[a]

Water Year Type	H3 vs. H1	H3 vs. H4
Wet	0 (0%)	10 (24%)
Above Normal	-3 (-11%)	18 (67%)
Below Normal	0 (0%)	17 (65%)
Dry	-3 (-7%)	-5 (-11%)
Critical	0 (0%)	-3 (-6%)
All	-2 (-5%)	7 (18%)

[a] A negative value indicates a reduction in percentage of months outside suitable range for H1 or H4.

H4/HOS

Flows under H4 in the Sacramento River upstream of Red Bluff during the April through June striped bass spawning, embryo incubation, and initial rearing period would generally be similar to flows under H3 except during June, in which flows would be up to 12% lower under H4 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 in the Feather River at Thermalito Afterbay would generally be up to 330% greater than flows under H3 during April and May and generally up to 20% lower than flows under H3 during June. Flows under H4 in the

American River below Nimbus Dam would generally be similar to flows under H3 during April and May and generally up to 39% lower than flows under H3 during June. Flows under H4 in the Trinity, San Joaquin, and Stanislaus rivers and in Clear Creek would be similar to flows under H3 throughout the period. The percentage of months under H4 with mean water temperatures outside the 59°F to 68°F suitable water temperature range in the Feather River below Thermalito Afterbay would be 10% to 18% higher than the percentage under H3 in wet, above normal, and below normal water years and 3% to 5% lower in dry and critical water years (Table 11-4-139).

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because Alternative 4 would not cause a substantial reduction in striped bass spawning, incubation, or initial rearing habitat. Flows in all rivers examined during the April through June spawning, incubation, and initial rearing period under Alternative 4 would generally be similar to or greater than flows under the NAA. The percentage of months outside the 59°F to 68°F water temperature range would generally be lower under Alternative 4 than under the NAA. Flow and water temperature conditions under H4 would be less favorable than those under H3 if water operations were to shift towards this end of the adaptive range.

CEQA Conclusion: In general, Alternative 4 would not affect the quality and quantity of upstream habitat conditions for striped bass relative to Existing Conditions.

H3/ESO

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the April through June striped bass spawning, embryo incubation, and initial rearing period. Lower flows could reduce the quantity and quality of instream habitat available for spawning, egg incubation, and rearing.

In the Sacramento River upstream of Red Bluff, flows under H3 would generally be similar to or greater than flows under Existing Conditions during April through June, except in wet years during May (17% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under H3 would generally be similar to or greater than flows under Existing Conditions during April through June, except in critical years during May (6% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under H3 would be similar to or greater than flows under Existing Conditions during April through June regardless of water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under H3 would be greater than flows under Existing Conditions during April through June, except in wet years during May (33% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under H3 would generally be similar to or greater than flows under Existing Conditions during April and June, except in above normal and below normal years during April (7% and 6% lower, respectively) and wet and critical years during June (27% and 33% lower, respectively), but generally lower, by up to 29%, during May (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). The most persistent flow reductions in drier water year types, when effects would be most critical for habitat conditions, consist of reductions in critical years during May (15% lower) and June (33% lower).

Flow rates in the San Joaquin and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months outside of the 59°F to 68°F suitable water temperature range for striped bass spawning, embryo incubation, and initial rearing during April through June was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced spawning success and increased egg and larval stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature related effects in these rivers during the April through June period.

In the Feather River below Thermalito Afterbay, the percentage of months under H3 outside of the 59°F to 68°F suitable water temperature range for striped bass spawning, embryo incubation, and initial rearing during April through June would be lower than the percentage under Existing Conditions in all water years except critical years (28% higher) (Table 11-4-138). This is a relatively small effect that would not have biologically meaningful negative effects on the striped bass population.

H1/LOS

Flows under H1 in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek during the April through June striped bass spawning, embryo incubation, and initial rearing period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*. The percentage of months under H1 with mean water temperatures outside the 59°F to 68°F suitable water temperature range in the Feather River below Thermalito Afterbay would be similar to or lower than the percentage under H3 in all water year types (Table 11-4-139).

H4/HOS

Flows under H4 in the Sacramento River upstream of Red Bluff during the April through June striped bass spawning, embryo incubation, and initial rearing period would generally be similar to flows under H3 except during June, in which flows would be up to 12% lower under H4 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*. Flows under H4 in the Feather River at Thermalito Afterbay would generally be up to 330% greater than flows under H3 during April and May and generally up to 20% lower than flows under H3 during June. Flows under H4 in the American River below Nimbus Dam would generally be similar to flows under H3 during April and May and generally up to 39% lower than flows under H3 during June. Flows under H4 in the Trinity, San Joaquin, and Stanislaus rivers and in Clear Creek would be similar to flows under H3 throughout the period. The percentage of months under H4 with mean water temperatures outside the 59°F to 68°F suitable water temperature range in the Feather River below Thermalito Afterbay would be 10% to 18% higher than the percentage under H3 in wet, above normal, and below normal water years and 3% to 5% lower in dry and critical water years (Table 11-4-139).

Collectively, these results indicate that the impact would not be significant because Alternative 4 would not cause a substantial reduction in spawning, incubation, and initial rearing habitat of striped bass. Therefore, no mitigation is necessary. Flows in all rivers except the San Joaquin and Stanislaus rivers during the April through June spawning, incubation, or initial rearing period under Alternative 4 would generally be similar to or greater than flows under Existing Conditions. There would be isolated and/or small-magnitude flow reductions for some months and water year types that would not have biologically meaningful negative effects. The most persistent flow reductions would be small to moderate reductions for two of the three months in the spawning period in the American River, which would not have biologically meaningful negative effects on the striped bass population. Flows in the San Joaquin and Stanislaus rivers would be lower under Alternative 4, although this effect would not be biologically meaningful to striped bass. The percentage of months outside the 59°F to 68°F water temperature range would generally be lower under Alternative 4 than under Existing Conditions. Flow and water temperature conditions under H4 would be less favorable than those under H3 if water operations were to shift towards this end of the adaptive range.

American Shad

In general, Alternative 4 would slightly improve the quality and quantity of upstream habitat conditions for American shad relative to the NAA.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the April through June American shad adult migration and spawning period. Lower flows could reduce migration ability and instream habitat quantity and quality for spawning.

In the Sacramento River upstream of Red Bluff, flows under H3 would generally be similar to or greater than flows under NAA during April through June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under H3 would generally be similar to or greater than flows under NAA during April through June except in above normal years during April (11% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under H3 would be similar to flows under NAA during April through June except in critical years during June (8% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under H3 would generally be moderately to substantially greater than flows under NAA during April through June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under H3 would be similar to or greater than flows under NAA during April through June regardless of water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flow rates in the San Joaquin and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months outside of the 60°F to 70°F water temperature range for American shad adult migration and spawning during April through June was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced spawning success and increased adult migrant stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under H3 be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature related effects in these rivers during the April through June period.

In the Feather River below Thermalito Afterbay, the percentage of months under H3 outside the 60°F to 70°F water temperature range would generally be lower than the percentage under NAA depending on water year type (Table 11-4-140).

Table 11-4-140. Difference and Percent Difference in the Percentage of Months during April–June in Which Water Temperatures in the Feather River below Thermalito Afterbay Are outside the 60°F to 70°F Water Temperature Range for American Shad Adult Migration and Spawning[a]

Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
Wet	-6 (-13%)	-1 (-2%)
Above Normal	-6 (-17%)	-15 (-33%)
Below Normal	0 (0%)	-7 (-18%)
Dry	0 (0%)	-5 (-11%)
Critical	3 (8%)	-3 (-7%)
All	-2 (-5%)	-5 (-12%)

[a] A negative value indicates a benefit (reduction in percentage of months outside suitable range) of the alternative.

H1/LOS

Flows under H1 in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek during the April through June American Shad migration and spawning period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*. The percentage of months under H1 with mean water temperatures outside the 60°F to 70°F suitable water temperature range in the Feather River below Thermalito Afterbay would be similar to or lower than the percentage under H3 in all water year types (Table 11-4-141).

Table 11-4-141. Difference and Percent Difference between the H3 Model Scenario and H1 and H4 Model Scenarios in the Percentage of Months during April–June in Which Water Temperatures in the Feather River below Thermalito Afterbay Are outside the 60°F to 70°F Water Temperature Range for American Shad Adult Migration and Spawning[a]

Water Year Type	H3 vs. H1	H3 vs. H4
Wet	0 (0%)	11 (28%)
Above Normal	-3 (-10%)	18 (60%)
Below Normal	0 (0%)	14 (45%)
Dry	-6 (-15%)	-6 (-15%)
Critical	0 (0%)	0 (0%)
All	-2 (-5%)	7 (19%)

[a] A negative value indicates a reduction in percentage of months outside suitable range for H1 or H4.

H4/HOS

Flows under H4 in the Sacramento River upstream of Red Bluff during the April through June American Shad migration and spawning period would generally be similar to flows under H3 except during June, in which flows would be up to 12% lower under H4 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 in the Feather River at Thermalito Afterbay would generally be up to 330% greater than flows under H3 during April and May and generally up to 20% lower than flows under H3 during June. Flows under H4 in the American River below Nimbus Dam would generally be similar to flows under H3 during April and May and generally up to 39% lower than flows under H3 during June. Flows under H4 in the Trinity, San Joaquin, and Stanislaus rivers and in Clear Creek would be similar to flows under H3 throughout the period. The percentage of months under H4 with mean water temperatures outside the 60°F to 70°F suitable water temperature range in the Feather River below Thermalito Afterbay would be 11% to 18% higher than the percentage under H3 in wet, above normal, and below normal water years, 6% lower in dry water years, and identical in critical water years (Table 11-4-141).

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because Alternative 4 would not cause a substantial reduction in American shad spawning or adult migration. Flows in all rivers examined during the April through June adult migration and spawning period under Alternative 4 would generally be similar to or greater than flows under the NAA. The percentage of months outside the 60°F to 70°F water temperature range would generally be lower under Alternative 4 than under the NAA. Flow and water temperature conditions under H4 would be less favorable than those under H3 if water operations were to shift towards this end of the adaptive range.

CEQA Conclusion: In general, Alternative 4 would not affect the quality and quantity of upstream habitat conditions for American shad relative to Existing Conditions.

H3/ESO

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the April through June American shad adult migration and spawning period. Lower flows could reduce migration ability and instream habitat quantity and quality for spawning.

In the Sacramento River upstream of Red Bluff, flows under H3 would generally be similar to or greater than flows under Existing Conditions during April through June, except in wet years during May (17% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under H3 would generally be similar to or greater than flows under Existing Conditions during April through June, except in critical years during May (6% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under H3 would be similar to or greater than flows under Existing Conditions during April through June regardless of water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under H3 would be greater than flows under Existing Conditions during April through June, except in wet years during May (33% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under H3 would generally be similar to or greater than flows under Existing Conditions during April and June, except in above normal and below normal years during April (7% and 6% lower, respectively) and wet and critical years during June (27% and 33% lower, respectively), but generally lower, by up to 29%, during May (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). The most persistent flow reductions in drier water year types, when effects would be most critical for habitat conditions, consist of reductions in critical years during May (15% lower) and June (33% lower).

Flow rates in the San Joaquin and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months outside of the 60°F to 70°F water temperature range for American shad adult migration and spawning during April through June was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced spawning success and increased adult migrant stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature related effects in these rivers during the April through June period.

In the Feather River below Thermalito Afterbay, the percentage of months under H3 outside of the 60°F to 70°F water temperature range would be similar to or lower than the percentage under Existing Conditions in all water years except critical years (8% higher) (Table 11-4-140).

H1/LOS

Flows under H1 in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek during the April through June American Shad migration and spawning period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the*

Fish Analysis). The percentage of months under H1 with mean water temperatures outside the 60°F to 70°F suitable water temperature range in the Feather River below Thermalito Afterbay would be similar to or lower than the percentage under H3 in all water year types (Table 11-4-141).

H4/HOS

Flows under H4 in the Sacramento River upstream of Red Bluff during the April through June American Shad migration and spawning period would generally be similar to flows under H3 except during June, in which flows would be up to 12% lower under H4 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*. Flows under H4 in the Trinity River below Lewiston Reservoir and in Clear Creek at Whiskeytown Dam would be similar to flows under H3 throughout the period. Flows under H4 in the Feather River at Thermalito Afterbay would generally be up to 330% greater than flows under H3 during April and May and generally up to 20% lower than flows under H3 during June. Flows under H4 in the American River below Nimbus Dam would generally be similar to flows under H3 during April and May and generally up to 39% lower than flows under H3 during June. Flows under H4 in the Trinity, San Joaquin, and Stanislaus rivers and in Clear Creek would be similar to flows under H3 throughout the period. The percentage of months under H4 with mean water temperatures outside the 60°F to 70°F suitable water temperature range in the Feather River below Thermalito Afterbay would be 11% to 18% higher than the percentage under H3 in wet, above normal, and below normal water years, 6% lower in dry water years, and identical in critical water years (Table 11-4-141).

Collectively, these results indicate that the impact would not be significant because Alternative 4 would not cause a substantial reduction in American shad adult migration and spawning habitat, and no mitigation is necessary. Flows in all rivers examined except the San Joaquin and Stanislaus rivers during the April through June adult migration and spawning period under Alternative 4 would generally be similar to or greater than flows under Existing Conditions. Flows in the San Joaquin and Stanislaus rivers would be lower under Alternative 4, although this effect would be biologically meaningful to American shad. The percentage of months outside the 60°F to 70°F water temperature range would generally be similar to or lower under Alternative 4 than under Existing Conditions. Flow and water temperature conditions under H4 would be less favorable than those under H3 if water operations were to shift towards this end of the adaptive range.

Threadfin Shad

In general, Alternative 4 would not affect the quality and quantity of upstream habitat conditions for threadfin shad relative to the NAA.

H3/ESO

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during April through August threadfin shad spawning period. Lower flows could reduce the quantity and quality of instream habitat available for spawning.

In the Sacramento River upstream of Red Bluff, flows under H3 would generally be similar to or greater than flows under NAA during April through August except in dry years during July (7% lower) and in dry and critical years during August (to 14% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under H3 would generally be similar to or greater than flows under NAA during April through August except in above normal years during April and in critical years during August (both 11% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under H3 would be similar to flows under NAA during April through August except in critical years during June (8% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under H3 would be moderately to substantially greater than flows under NAA during April through June, and lower than flows under NAA during July and August (to 50% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Based on occurrence late in the spawning period, and the fact that they would be partially offset by flow increases in the prior months, these flow reductions are not expected to have biologically meaningful effects.

In the American River below Nimbus Dam, flows under H3 would be similar to or greater than flows under NAA during April through August regardless of water year type except in dry years during July (12% lower) and in drier water year types during August (to 24%) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These flow reductions are small to moderate magnitude and limited to late in the spawning period and, therefore, would not have biologically meaningful negative effects.

Flow rates in the San Joaquin and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months below 68°F water temperature threshold for the April through August adult threadfin shad spawning period was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures below this threshold could delay or prevent successful spawning in these areas. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers throughout the year.

In the Feather River below Thermalito Afterbay, the percentage of months under H3 below 68°F would be greater than those under NAA (11% to 22% greater) in all but dry and critical years (Table 11-4-142). These are relatively small increases that would not have biologically meaningful effects.

Table 11-4-142. Difference and Percent Difference in the Percentage of Months during April–August in Which Water Temperatures in the Feather River below Thermalito Afterbay fall below the 68°F Water Temperature Threshold for Threadfin Shad Spawning[a]

Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
Wet	-8 (-12%)	5 (11%)
Above Normal	-20 (-26%)	9 (19%)
Below Normal	-14 (-20%)	10 (22%)
Dry	-36 (-48%)	-6 (-12%)
Critical	-28 (-44%)	0 (0%)
All	-20 (-29%)	3 (7%)

[a] A negative value indicates a benefit (reduction in percentage of months outside suitable range) of the alternative.

H1/LOS

Flows under H1 in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek during the April through August threadfin shad spawning period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*. The percentage of months under H1 with mean water temperatures outside the 59°F to 68°F suitable water temperature range in the Feather River below Thermalito Afterbay would be similar to the percentage under H3 in all water year types (Table 11-4-143).

Table 11-4-143. Difference and Percent Difference between the H3 Model Scenario and H1 and H4 Model Scenarios in the Percentage of Months during April–June in Which Water Temperatures in the Feather River below Thermalito Afterbay fall below the 68°F Water Temperature Threshold for Threadfin Shad Spawning[a]

Water Year Type	H3 vs. H1	H3 vs. H4
Wet	0 (0%)	-6 (-11%)
Above Normal	-2 (-3%)	-9 (-16%)
Below Normal	-1 (-3%)	-4 (-8%)
Dry	1 (3%)	2 (6%)
Critical	0 (0%)	0 (0%)
All	0 (0%)	-3 (-7%)

[a] A negative value indicates a reduction in percentage of months outside suitable range for H1 or H4.

H4/HOS

Flows under H4 in the Sacramento River upstream of Red Bluff during the April through August threadfin shad spawning period would generally be similar to flows under H3 except during June, in which flows would be up to 12% lower under H4, and during August, in which flows would be up to 13% greater under H4 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*. Flows under H4 in the Feather River at Thermalito Afterbay would generally be up to 330% greater than flows under H3 during April and May and generally up to 39% lower than flows under H3 during June through August. Flows under H4 in the American River below Nimbus Dam would generally be similar to flows under H3 except during June in which flows would be up to 39% lower than flows under H3, and during August, in which flows would be up to 32% greater than flows under H3. Flows under H4 in the Trinity, San Joaquin, and Stanislaus rivers and in Clear Creek would be similar to flows under H3 throughout the period. The percentage of months under H4 with mean water temperatures below the 68°F temperature threshold in the Feather River below Thermalito Afterbay would be similar to or lower than the percentage under H3 in all water years (Table 11-4-143).

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because Alternative 4 would not cause a substantial reduction in threadfin shad spawning habitat. Flows in all rivers examined during the April through August spawning period under Alternative 4 would generally be similar to or greater than flows under the NAA. Small to substantial flow reductions would occur in the Feather River during July and August, but would be offset by increases in flows during the preceding months. In all other locations the occurrence of flow reductions would not be of sufficient magnitude or frequency to have a biologically meaningful effect on threadfin shad. The percentage of years below the spawning temperature threshold would be moderately higher under Alternative 4 relative to the NAA, but this increase is not expected to have a biologically meaningful effect on the threadfin shad population because there are no temperature-related effects in any other rivers. Flow conditions in the Feather River under H4 would be less favorable than those under H3 if water operations were to shift towards this end of the adaptive range.

CEQA Conclusion: In general, Alternative 4 would not affect the quality and quantity of upstream habitat conditions for threadfin shad relative to Existing Conditions.

H3/ESO

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during April through August spawning period. Lower flows could reduce the quantity and quality of instream habitat available for spawning.

In the Sacramento River upstream of Red Bluff, flows under H3 would generally be similar to or greater than flows under Existing Conditions during April through August, except in wet years during May (17% lower), in critical years during July (8% lower), and in wet, dry and critical years during August (5%, 11%, and 26% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These are relatively small-magnitude and infrequent flow reductions and would not have biologically meaningful effects.

In the Trinity River below Lewiston Reservoir, flows under H3 would generally be similar to or greater than flows under Existing Conditions during April through August, except in critical years during May and August (6% and 33% lower, respectively) and in wet years during July (14% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under H3 would be similar to or greater than flows under Existing Conditions during April through August regardless of water year type except in critical years during August (25% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under H3 would be greater than flows under Existing Conditions during April through June, except in wet years during May (33% lower), and in wetter years during July and August, and would be lower than flows under Existing Conditions in drier water years during July (to 61% lower) and August (to 47% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under H3 would generally be similar to or greater than flows under Existing Conditions during April and June, except in above normal and below normal years during April (7% and 6% lower, respectively) and wet and critical years during June (27% and 33% lower, respectively), but generally lower, by up to 48%, during May, July, and August (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). The most persistent flow reductions in drier water year types, when effects would be most critical for habitat conditions, would be inconsistent and of relatively small magnitude, and/or would occur for two months in a row during July and August at the end of the spawning period, and therefore would not have biologically meaningful negative effects.

Flow rates in the San Joaquin and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months below 68°F water temperature threshold for the April through August adult threadfin shad spawning period was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures below this threshold could delay or prevent successful spawning in these areas. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the April through November period.

In the Feather River below Thermalito Afterbay, the percentage of months below the 68°F water temperature threshold for threadfin shad spawning under H3 would be 12% to 48% lower than the percentage under Existing Conditions, depending on water year type (Table 11-4-142).

H1/LOS

Flows under H1 in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek during the April through August threadfin shad spawning period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis)*. The percentage of months under H1 with mean water temperatures outside the 59°F to 68°F suitable water temperature range in the Feather River below Thermalito Afterbay would be similar to the percentage under H3 in all water year types (Table 11-4-143).

H4/HOS

Flows under H4 in the Sacramento River upstream of Red Bluff during the April through August threadfin shad spawning period would generally be similar to flows under H3 except during June, in which flows would be up to 12% lower under H4, and during August, in which flows would be up to 13% greater under H4 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 in the Feather River at Thermalito Afterbay would generally be up to 330% greater than flows under H3 during April and May and generally up to 39% lower than flows under H3 during June through August. Flows under H4 in the American River below Nimbus Dam would generally be similar to flows under H3 except during June in which flows would be up to 39% lower than flows under H3, and during August, in which flows would be up to 32% greater than flows under H3. Flows under H4 in the Trinity, San Joaquin, and Stanislaus rivers and in Clear Creek would be similar to flows under H3 throughout the period. The percentage of months under H4 with mean water temperatures below the 68°F temperature threshold in the Feather River below Thermalito Afterbay would be similar to or lower than the percentage under H3 in all water years (Table 11-4-143). Collectively, these results indicate that the impact would not be significant because Alternative 4 would not cause a substantial reduction in threadfin shad spawning habitat, and no mitigation is necessary. Flows in most rivers examined during the April through August spawning period under Alternative 4 would generally be similar to or greater than flows under Existing Conditions. There would be substantial flow reductions during July and August in drier water years in the Feather River that would have a localized effect late in the spawning season. There would be flow reductions for some months and some of the drier water year types from May through August in the American River, but the flow reductions would be offset by increases in adjoining months and/or would not be of sufficient magnitude or frequency to cause a biologically meaningful effect on threadfin shad. Flows in the San Joaquin and Stanislaus rivers would be lower under Alternative 4, although these reductions would not have population-level effects on American shad. The percentage of months outside all temperature thresholds are lower under Alternative 4 than under Existing Conditions, indicating that there would be a net temperature-related benefit of Alternative 4 to threadfin shad. Flow conditions in the Feather River under H4 would be less favorable than those under H3 if water operations were to shift towards this end of the adaptive range.

Largemouth Bass

In general, Alternative 4 would not affect the quality and quantity of upstream habitat conditions for largemouth bass relative to the NAA.

H3/ESO

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the March through June largemouth bass spawning period. Lower flows could reduce the quantity and quality of instream spawning habitat.

In the Sacramento River upstream of Red Bluff, flows under H3 would generally be similar to or greater than flows under NAA during March through June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under H3 would generally be similar to or greater than flows under NAA during March through June except in above normal years during April (11% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under H3 would be similar to flows under NAA during March through June except in critical years during June (8% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under H3 would generally be moderately to substantially greater than flows under NAA during March through June except in below normal years during March (20% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under H3 would be similar to or greater than flows under NAA during March through June regardless of water year type except in dry and critical years during March (5% and 7% lower, respectively) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months outside of the 59°F to 75°F suitable water temperature range for largemouth bass spawning during March through June was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced spawning success. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the March through June period.

In the Feather River below Thermalito Afterbay, the percentage of months under H3 outside the 59°F to 75°F water temperature range would be similar to or lower than the percentage under NAA in all water years except dry years (7% higher) (Table 11-4-144).

Table 11-4-144. Difference and Percent Difference in the Percentage of Months during March–June in Which Water Temperatures in the Feather River below Thermalito Afterbay Would Be outside the 59°F to 75°F Water Temperature Range for Largemouth Bass Spawning[a]

Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
Wet	-9 (-16%)	0 (0%)
Above Normal	-16 (-32%)	-2 (-6%)
Below Normal	-11 (-24%)	0 (0%)
Dry	-16 (-34%)	2 (7%)
Critical	-15 (-34%)	-4 (-12%)
All	-13 (-27%)	-1 (-3%)

[a] A negative value indicates a benefit (reduction in percentage of months outside suitable range) of the alternative.

H1/LOS

Flows under H1 in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek during the March through June largemouth bass spawning period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). The percentage of months under H1 outside the 59°F to 75°F water temperature range in the Feather River below Thermalito Afterbay would be similar to the percentage under H3 in all water year types (Table 11-4-145).

Table 11-4-145. Difference and Percent Difference between the H3 Model Scenario and H1 and H4 Model Scenarios in the Percentage of Months during April–June in Which Water Temperatures in the Feather River below Thermalito Afterbay Would Be outside the 59°F to 75°F Water Temperature Range for Largemouth Bass Spawning[a]

Water Year Type	H3 vs. H1	H3 vs. H4
Wet	0 (0%)	4 (9%)
Above Normal	-2 (-6%)	9 (26%)
Below Normal	-2 (-6%)	5 (15%)
Dry	-2 (-6%)	-3 (-10%)
Critical	0 (0%)	-4 (-14%)
All	-1 (-3%)	3 (8%)

[a] A negative value indicates a reduction in percentage of months outside suitable range for H1 or H4.

H4/HOS

Flows under H4 in the Sacramento River upstream of Red Bluff during the March through June largemouth bass spawning period would generally be similar to flows under H3 except during June, in which flows would be up to 12% lower under H4 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 in the Feather River at Thermalito Afterbay would generally be similar to flows under H3 during March, up to 330% greater than flows under H3 during April and May, and generally up to 39% lower than flows under H3 during June. Flows under H4 in the American River below Nimbus Dam would generally be similar to flows under H3 except during June in which flows would be up to 39% lower than flows under H3. Flows under H4 in the Trinity, San Joaquin, and Stanislaus rivers and in Clear Creek would be similar to flows under H3 throughout the period. The percentage of months under H4 with mean water temperatures below outside the 59°F to 75°F water temperature range in the Feather River below Thermalito Afterbay would be similar to the percentage under H3 in all water years except above and below normal water years in which the percentages under H4 would be 9% and 5% higher than those under H3 (Table 11-4-143). These small increases would not cause biologically meaningful effects to largemouth bass spawning habitat conditions.

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because Alternative 4 would not cause a substantial reduction in largemouth bass spawning habitat. Flows in all rivers examined during the March through June spawning period under Alternative 4 would generally be similar to or greater than flows under the NAA. The occurrence of flow reductions would not be of sufficient magnitude or frequency to have a biologically meaningful effect on largemouth bass. The percentage of years outside the suitable spawning temperature range under Alternative 4 would be similar to the NAA and there are no differences in water temperatures between the NAA and Alternative 4 in all other rivers and creeks examined.

CEQA Conclusion: In general, Alternative 4 would not reduce the quality and quantity of upstream habitat conditions for largemouth bass relative to Existing Conditions.

H3/ESO

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the March through June largemouth bass spawning period. Lower flows could reduce the quantity and quality of instream spawning habitat.

In the Sacramento River upstream of Red Bluff, flows under H3 would generally be similar to or greater than flows under Existing Conditions during March through June, except in below normal years during March (10% lower) and in wet years during May (17% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under H3 would generally be similar to or greater than flows under Existing Conditions during March through June, except in below normal years during March (6% lower) and in critical years during May (6% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under H3 would be similar to or greater than flows under Existing Conditions during March through June regardless of water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under H3 would be greater than flows under Existing Conditions during March through June, except in below normal years during March (53% lower) and in wet years during May (33% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under H3 would generally be similar to or greater than flows under Existing Conditions during March, April and June, except in critical years during March (7% lower), above and below normal years during April (7% and 6% lower, respectively), and in wet and critical years during June (27% and 33% lower, respectively) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would generally be similar to or lower than flows under Existing Conditions during May (to 29% lower) except in dry years (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flow reductions in drier water year types, when effects on habitat conditions would be more critical, would be inconsistent and/or of small magnitude throughout the spawning period and would not have biologically meaningful negative effects.

Flow rates in the San Joaquin and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months outside of the 59°F to 75°F suitable water temperature range for largemouth bass spawning during March through June was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced spawning success. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the March through June period.

In the Feather River below Thermalito Afterbay, the percentage of months under H3 outside of the 59°F to 75°F water temperature range for largemouth bass spawning would be lower than the percentage under Existing Conditions in all water years (Table 11-4-144).

H1/LOS

Flows under H1 in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek during the March through June largemouth bass spawning period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). The percentage of months under H1 outside the 59°F to 75°F water temperature range in the Feather River below Thermalito Afterbay would be similar to the percentage under H3 in all water year types (Table 11-4-145).

H4/HOS

Flows under H4 in the Sacramento River upstream of Red Bluff during the March through June largemouth bass spawning period would generally be similar to flows under H3 except during June, in which flows would be up to 12% lower under H4 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 in the Feather River at Thermalito Afterbay would generally be similar to flows under H3 during March, up to 330% greater than flows under H3 during April and May, and generally up to 39% lower than flows under H3 during June. Flows under H4 in the American River below Nimbus Dam would generally be similar to flows under H3 except during June in which flows would be up to 39% lower than flows under H3. Flows under H4 in the Trinity, San Joaquin, and Stanislaus rivers and in Clear Creek would be similar to flows under H3 throughout the period. The percentage of months under H4 with mean water temperatures below outside the 59°F to 75°F water temperature range in the Feather River below Thermalito Afterbay would be similar to the percentage under H3 in all water years except above and below normal water years in which the percentages under H4 would be 9% and 5% higher than those under H3 (Table 11-4-143). These small increases would not cause biologically meaningful effects to largemouth bass spawning habitat conditions.

Collectively, these results indicate that the impact would not be significant because Alternative 4 would not cause a substantial reduction in largemouth bass spawning habitat, and no mitigation is necessary. Flows in all rivers examined except the San Joaquin and Stanislaus rivers during the March through June spawning period under Alternative 4 would generally be similar to or greater than flows under Existing Conditions. Flows in the San Joaquin and Stanislaus rivers would be lower under Alternative 4, although these reductions would not have population-level effects on largemouth bass. The percentage of months outside the 59°F to 75°F water temperature range would generally be lower under Alternative 4 than under Existing Conditions.

Sacramento Tule Perch

NEPA Effects: The effects of water operations on spawning habitat for Sacramento tule perch under Alternative 4 would be similar to that described for Alternative 1A. For a detailed discussion, please see Alternative 1A, Impact AQUA-202. The effects would not be adverse.

CEQA Conclusion: As described under Alternative 1A, Impact AQUA-202 the impacts on Sacramento tule perch spawning would be not be significant and no mitigation is required.

Sacramento-San Joaquin Roach – California species of special concern

In general, Alternative 4 would not affect the quality and quantity of upstream habitat conditions for Sacramento-San Joaquin roach relative to the NAA.

H3/ESO

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the March through June Sacramento-San Joaquin roach spawning period. Lower flows could reduce the quantity and quality of instream habitat available for spawning.

In the Sacramento River upstream of Red Bluff, flows under H3 would generally be similar to or greater than flows under NAA during March through June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under H3 would generally be similar to or greater than flows under NAA during March through June except in above normal years during April (11% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under H3 would be similar to flows under NAA during March through June except in critical years during June (8% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under H3 would generally be moderately to substantially greater than flows under NAA during March through June except in below normal years during March (20% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under H3 would be similar to or greater than flows under NAA during March through June regardless of water year type except in dry and critical years during March (5% and 7% lower, respectively) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of months below the 60.8°F water temperature threshold for Sacramento-San Joaquin roach spawning initiation during March through June was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures below this threshold could delay or prevent spawning initiation. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the March through June period.

In the Feather River below Thermalito Afterbay, the percentage of months in which temperatures would be below the 60.8°F water temperature threshold for roach spawning initiation under H3 would be similar to or lower than the percentage under NAA in all water years (Table 11-4-146).

Table 11-4-146. Difference and Percent Difference in the Percentage of Months during March–June in Which Water Temperatures in the Feather River below Thermalito Afterbay Fall below the 60.8°F Water Temperature Threshold for the Initiation of Sacramento-San Joaquin Roach Spawning[a]

Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
Wet	-13 (-19%)	0 (0%)
Above Normal	-7 (-12%)	0 (0%)
Below Normal	-4 (-7%)	2 (4%)
Dry	-11 (-20%)	0 (0%)
Critical	-17 (-30%)	-2 (-5%)
All	-11 (-18%)	0 (0%)

[a] A negative value indicates a benefit (reduction in percentage of months outside suitable range) of the alternative.

H1/LOS

Flows under H1 in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek during the March through June Sacramento-San Joaquin roach spawning period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). The percentage of months under H1 below the 60.8°F water temperature threshold in the Feather River below Thermalito Afterbay would be similar to the percentage under H3 in all water year types (Table 11-4-147).

Table 11-4-147. Difference and Percent Difference between the H3 Model Scenario and H1 and H4 Model Scenarios in the Percentage of Months during April–June in Which Water Temperatures in the Feather River below Thermalito Afterbay Would Fall below the 60.8°F Water Temperature Threshold for Sacramento-San Joaquin Roach Spawning[a]

Water Year Type	H3 vs. H1	H3 vs. H4
Wet	0 (0%)	4 (7%)
Above Normal	0 (0%)	2 (5%)
Below Normal	0 (0%)	2 (4%)
Dry	-1 (-3%)	0 (0%)
Critical	0 (0%)	0 (0%)
All	0 (-1%)	2 (4%)

[a] A negative value indicates a reduction in percentage of months outside suitable range for H1 or H4.

H4/HOS

Flows under H4 in the Sacramento River upstream of Red Bluff during the March through June Sacramento-San Joaquin roach spawning period would generally be similar to flows under H3 except during June, in which flows would be up to 12% lower under H4 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 in the Feather River at Thermalito Afterbay would generally be similar to flows under H3 during March, up to 330% greater than flows under H3 during April and May, and generally up to 39% lower than flows under H3 during June. Flows under H4 in the American River below Nimbus Dam would generally be similar to flows under H3 except during June in which flows would be up to 39% lower than flows under H3. Flows under H4 in the Trinity, San Joaquin, and Stanislaus rivers and in Clear Creek would be similar to flows under H3 throughout the period. The percentage of months under H4 with mean water temperatures below the 60.8°F water temperature range in the Feather River below Thermalito Afterbay would be similar to the percentage under H3 in all water years (Table 11-4-147).

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because Alternative 4 would not cause a substantial reduction in roach spawning habitat. Flows in all rivers examined during the March through June spawning period under Alternative 4 would generally be similar to or greater than flows under the NAA. The occurrence of flow reductions would not be of sufficient magnitude or frequency to have a biologically meaningful effect on roach. The percentage of years below the spawning temperature threshold under Alternative 4 would be similar to the NAA and there are no differences in water temperatures between the NAA and Alternative 4 in all other rivers and creeks examined.

CEQA Conclusion: In general, Alternative 4 would not affect the quality and quantity of upstream habitat conditions for Sacramento-San Joaquin Roach relative to Existing Conditions.

H3/ESO

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the March through June Sacramento-San Joaquin roach spawning period. Lower flows could reduce the quantity and quality of instream habitat available for spawning.

In the Sacramento River upstream of Red Bluff, flows under H3 would generally be similar to or greater than flows under Existing Conditions during March through June, except in below normal years during March (10% lower) and in wet years during May (17% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under H3 would generally be similar to or greater than flows under Existing Conditions during March through June, except in below normal years during March (6% lower) and in critical years during May (6% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under H3 would be similar to or greater than flows under Existing Conditions during March through June regardless of water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under H3 would be greater than flows under Existing Conditions during March through June, except in below normal years during March (53% lower) and in wet years during May (33% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under H3 would generally be similar to or greater than flows under Existing Conditions during March, April and June, except in critical years during March (7% lower), above and below normal years during April (7% and 6% lower, respectively), and in wet and critical years during June (27% and 33% lower, respectively) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would generally be similar to or lower than flows under Existing Conditions during May (to 29% lower) except in dry years (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flow reductions in drier water year types, when effects on habitat conditions would be more critical, would be inconsistent and/or of small magnitude throughout the spawning period and would not have biologically meaningful negative effects.

Flow rates in the San Joaquin and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months below the 60.8°F water temperature threshold for Sacramento-San Joaquin roach spawning initiation during March through June was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures below this threshold could delay or prevent spawning initiation. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the March through June period.

In the Feather River below Thermalito Afterbay, the percentage of months under H3 in which temperatures would be below the 60.8°F water temperature threshold for roach spawning initiation would be lower than the percentage under Existing Conditions in all water years (Table 11-4-146).

H1/LOS

Flows under H1 in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek during the March through June Sacramento-San Joaquin roach spawning period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). The percentage of months under H1 below the 60.8°F water temperature threshold in the Feather River below Thermalito Afterbay would be similar to the percentage under H3 in all water year types (Table 11-4-147).

H4/HOS

Flows under H4 in the Sacramento River upstream of Red Bluff during the March through June Sacramento-San Joaquin roach spawning period would generally be similar to flows under H3 except during June, in which flows would be up to 12% lower under H4 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 in the Feather River at Thermalito

Afterbay would generally be similar to flows under H3 during March, up to 330% greater than flows under H3 during April and May, and generally up to 39% lower than flows under H3 during June. Flows under H4 in the American River below Nimbus Dam would generally be similar to flows under H3 except during June in which flows would be up to 39% lower than flows under H3. Flows under H4 in the Trinity, San Joaquin, and Stanislaus rivers and in Clear Creek would be similar to flows under H3 throughout the period. The percentage of months under H4 with mean water temperatures below the 60.8°F water temperature range in the Feather River below Thermalito Afterbay would be similar to the percentage under H3 in all water years (Table 11-4-147).

Collectively, these results indicate that the impact would not be significant because Alternative 4 would not cause a substantial reduction in Sacramento-San Joaquin roach spawning habitat, and no mitigation is necessary. Flows in all rivers examined except the San Joaquin and Stanislaus rivers during the March through June spawning period under Alternative 4 would generally be similar to or greater than flows under Existing Conditions. Flows in the San Joaquin and Stanislaus rivers would be lower under Alternative 4, although these reductions would not have population-level effects on roach. The percentage of months below the 60.8°F water temperature threshold would generally be lower under Alternative 4 than under Existing Conditions.

Hardhead – California species of special concern

In general, Alternative 4 would not affect the quality and quantity of upstream habitat conditions for hardhead relative to the NAA.

H3/ESO

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the April through May hardhead spawning period. Lower flows could reduce the quantity and quality of instream habitat available for spawning.

In the Sacramento River upstream of Red Bluff, flows under H3 would generally be similar to or greater than flows under NAA during April and May) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under H3 would generally be similar to or greater than flows under NAA during April and May except during April compared to NAA (11% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under H3 would be similar to flows under NAA during April and May (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under H3 would generally be moderately to substantially greater than flows under NAA during April and May (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under H3 would be similar to or greater than flows under NAA during April and May regardless of water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Flow rates in the San Joaquin and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows relative to the NAA.

Water Temperature

The percentage of years outside of the 59°F to 64°F suitable water temperature range for hardhead spawning during April through May was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced spawning success and increased egg and larval stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers throughout the year.

In the Feather River below Thermalito Afterbay, the percentage of years under H3 outside the 59°F to 64°F suitable water temperature range would be similar to or lower than the percentage under NAA in all water year types (Table 11-4-148).

Table 11-4-148. Difference and Percent Difference in the Percentage of Months during April–May in Which Water Temperatures in the Feather River below Thermalito Afterbay Would Be outside the 59°F to 64°F Water Temperature Range for Hardhead Spawning[a]

Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
Wet	-2 (-3%)	-3 (-5%)
Above Normal	-19 (-30%)	-10 (-18%)
Below Normal	18 (42%)	-3 (-5%)
Dry	-9 (-16%)	-3 (-6%)
Critical	-4 (-7%)	-4 (-7%)
All	-2 (-4%)	-4 (-7%)

[a] A negative value indicates a benefit (reduction in percentage of months outside suitable range) of the alternative.

H1/LOS

Flows under H1 in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek during the April through May hardhead spawning period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). The percentage of months under H1 outside the 59°F to 64°F suitable water temperature range in the Feather River below Thermalito Afterbay would be similar to the percentage under H3 in all water year types (Table 11-4-149).

Table 11-4-149. Difference and Percent Difference between the H3 Model Scenario and H1 and H4 Model Scenarios in the Percentage of Months during April–May in Which Water Temperatures in the Feather River below Thermalito Afterbay Would Fall outside the 59°F to 64°F Water Temperature Range for Hardhead Spawning[a]

Water Year Type	H3 vs. H1	H3 vs. H4
Wet	0 (0%)	5 (8%)
Above Normal	-4 (-9%)	10 (22%)
Below Normal	0 (0%)	0 (0%)
Dry	-3 (-6%)	-3 (-6%)
Critical	4 (8%)	0 (0%)
All	-1 (-2%)	2 (4%)

[a] A negative value indicates a reduction in percentage of months outside suitable range for H1 or H4.

H4/HOS

Flows under H4 in the Sacramento River upstream of Red Bluff during the April through May period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 in the Feather River at Thermalito Afterbay would up to 330% greater than flows under H3 during April and May. Flows under H4 in the Trinity, American, San Joaquin, and Stanislaus rivers and in Clear Creek would be similar to flows under H3 throughout the period. The percentage of months under H4 with mean water temperatures outside the 59°F to 64°F suitable water temperature range in the Feather River below Thermalito Afterbay would be similar to the percentage under H3 in all water years (Table 11-4-149).

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because Alternative 4 would not cause a substantial reduction in roach spawning habitat. Flows in all rivers examined during the April through May spawning period under Alternative 4 would generally be similar to or greater than flows under the NAA. The percentage of years below the spawning temperature threshold under Alternative 4 would be similar to the NAA and there are no differences in water temperatures between the NAA and Alternative 4 in all other rivers and creeks examined.

CEQA Conclusion: In general, Alternative 4 would not affect the quality and quantity of upstream habitat conditions for hardhead relative to Existing Conditions.

H3/ESO

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the April through May hardhead spawning period. Lower flows could reduce the quantity and quality of instream habitat available for spawning.

In the Sacramento River upstream of Red Bluff, flows under H3 would generally be similar to or greater than flows under Existing Conditions during April through May, except in wet years during May (17% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Trinity River below Lewiston Reservoir, flows under H3 would generally be similar to or greater than flows under Existing Conditions during April through May, except in critical years during May (6% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under H3 would be similar to or greater than flows under Existing Conditions during April through May regardless of water year type (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under H3 would be greater than flows under Existing Conditions during April through May, except in wet years during May (33% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under H3 would generally be similar to or greater than flows under Existing Conditions during April except in above normal and below normal years (7% and 6% lower, respectively), but generally lower, by up to 29%, during May (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flow reductions in drier water year types, when effects would be most critical for habitat conditions, consist of reductions in below normal years in both months (6% and 19% lower, respectively) and in critical years during May (15% lower, following a 10% increase in flows during April), which are relatively small-magnitude flow reductions that would not have biologically meaningful negative effects.

Flow rates in the San Joaquin and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months outside of the 59°F to 64°F suitable water temperature range for hardhead spawning during April through May was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced spawning success and increased egg and larval stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under H3 would be the same as those under Alternative 1A. For a discussion of the topic see the analysis for Alternative 1A.

In the Feather River below Thermalito Afterbay, the percentage of months under H3 outside of the 59°F to 64°F water temperature range for hardhead spawning would be lower than the percentage under Existing Conditions in all water years except below normal years (18% higher) (Table 11-4-148).

H1/LOS

Flows under H1 in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek during the April through May hardhead spawning period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). The percentage of months under H1 outside the 59°F to 64°F suitable water temperature range in the Feather River below Thermalito Afterbay would be similar to the percentage under H3 in all water year types (Table 11-4-149).

H4/HOS

Flows under H4 in the Sacramento River upstream of Red Bluff during the April through May period would generally be similar to flows under H3 (Appendix 11C, *CALSIM II Model Results utilized in the*

Fish Analysis). Flows under H4 in the Feather River at Thermalito Afterbay would up to 330% greater than flows under H3 during April and May. Flows under H4 in the Trinity, American, San Joaquin, and Stanislaus rivers and in Clear Creek would be similar to flows under H3 throughout the period. The percentage of months under H4 with mean water temperatures outside the 59°F to 64°F suitable water temperature range in the Feather River below Thermalito Afterbay would be similar to the percentage under H3 in all water years (Table 11-4-149).

Collectively, these results indicate that the effect would not be adverse because Alternative 4 would not cause a substantial reduction in roach spawning habitat, and no mitigation is necessary. Flows in most rivers examined during the April through May spawning period under Alternative 4 would generally be similar to or greater than flows under Existing Conditions. Flows in the San Joaquin and Stanislaus rivers would be lower under Alternative 4, although these reductions would not have population-level effects on hardhead. The percentage of years below the spawning temperature threshold under Alternative 4 would be similar to Existing Conditions and there are no differences in water temperatures between Existing Conditions and Alternative 4 in all other rivers and creeks examined.

California Bay Shrimp

NEPA Effects: The effect of water operations on spawning habitat of California bay shrimp under Alternative 4 would be similar to that described for Alternative 1A (see Alternative 1A, Impact AQUA-202). For a detailed discussion, please see Alternative 1A, Impact AQUA-202. The effects would not be adverse.

CEQA Conclusion: The impact of water operations on spawning habitat of California bay shrimp would be the same as described immediately above. The impacts would be less than significant and no mitigation would be required.

Impact AQUA-203: Effects of Water Operations on Rearing Habitat for Non-Covered Aquatic Species of Primary Management Concern

Also, see Alternative 1A, Impact AQUA-203 for additional background information relevant to non-covered species of primary management concern.

Striped Bass

NEPA Effects: The discussion under Alternative 4, Impact AQUA-202 for striped bass also addressed the embryo incubation and initial rearing period. That analysis indicates that there is no adverse effect on striped bass rearing during that period. Other effects of water operations on rearing habitat for striped bass under Alternative 4 would be similar to that described for Alternative 1A (see Alternative 1A, Impact AQUA-203). For a detailed discussion, please see Alternative 1A, Impact AQUA-203. The effects would not be adverse.

CEQA Conclusion: As described above the impacts on striped bass rearing habitat would be less than significant and no mitigation would be required.

American Shad

The effects of water operations on rearing habitat for American shad under Alternative 4 would be similar to that described for Alternative 1A (see Alternative 1A, Impact AQUA-203). For a detailed discussion, please see Alternative 1A, Impact AQUA-203. The effects would not be adverse.

CEQA Conclusion: As described above the impacts on American shad rearing habitat would be less than significant and no mitigation would be required.

Threadfin Shad

NEPA Effects: The effects of water operations on rearing habitat for threadfin shad under Alternative 4 would be similar to that described for Alternative 1A (see Alternative 1A, Impact AQUA-203). For a detailed discussion, please see Alternative 1A, Impact AQUA-203. The effects would not be adverse.

CEQA Conclusion: As described above the impacts on threadfin shad rearing habitat would be less than significant and no mitigation would be required.

Largemouth Bass

H3/ESO

Juveniles

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the April through November juvenile largemouth bass rearing period. Lower flows could reduce the quantity and quality of instream habitat available for juvenile rearing.

In the Sacramento River upstream of Red Bluff, flows under H3 would generally be similar to or greater than flows under NAA during April through October with some exceptions (to 14% lower), and would be lower in all water year types during November (to 18% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flow reductions in drier water years, when effects on habitat conditions would be more critical, would be inconsistent and/or of small magnitude for all months during the rearing period and would not have biologically meaningful negative effects.

In the Trinity River below Lewiston Reservoir, flows under H3 would generally be similar to flows under NAA with isolated exceptions, including small flow reductions in critical years during August through October (to 11%) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under H3 would be similar to flows under NAA during April through November except in critical years during June (8% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under H3 would generally be greater than flows under NAA during April through June, drier water years during September, in all water years during October, and in dry years during November; flows would be lower (to 50% lower) during July, August, wetter water years during September, and above normal years during November (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flow reductions in drier water years, when effects would be more critical for habitat conditions, range from moderate to substantial in drier water years during July, August, and below normal years during September. These would be partially offset by increases in flow in the adjoining months (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the American River at Nimbus Dam, flows under H3 would be similar to or greater than flows under NAA during April through July except in dry years during July (12% lower), and would be similar to or lower than flows under NAA (to 40% lower) during August through November with a few exceptions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flow reductions in drier water years when effects would be more critical for habitat conditions consist of small to moderate reductions for some months and water year types from July through November, which would be offset by increases in some months and/or not persistent within a single water year type. Effects would not be biologically meaningful.

Flow rates in the San Joaquin and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows between H3 and NAA.

Water Temperature

The percentage of months above the 88°F water temperature threshold for juvenile largemouth bass rearing during April through November was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Elevated water temperatures could lead to reduced quantity and quality of instream habitat available for juvenile rearing and increased stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the April through November period.

In the Feather River below Thermalito Afterbay, water temperatures would not exceed 88°F under NAA or H3. As a result, there would be no difference between NAA and H3 in the percentage of months in which the 88°F water temperature threshold is exceeded (Table 11-4-150).

Table 11-4-150. Difference and Percent Difference in the Percentage of Months during April–November in Which Water Temperatures in the Feather River below Thermalito Afterbay Exceed the 88°F Water Temperature Threshold for Juvenile Largemouth Bass Rearing[a]

Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
Wet	0 (NA)	0 (NA)
Above Normal	0 (NA)	0 (NA)
Below Normal	0 (NA)	0 (NA)
Dry	0 (NA)	0 (NA)
Critical	0 (NA)	0 (NA)
All	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.

[a] A negative value indicates a benefit (reduction in percentage of months outside suitable range) of the alternative.

Adults

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during year-round adult largemouth bass rearing period. Lower flows could reduce the quantity and quality of instream habitat available for adult rearing.

In the Sacramento River upstream of Red Bluff, flows under H3 would generally be similar to or greater than flows under NAA throughout the year with some exceptions (up to 14% lower), and would be lower in all water year types during November (up to 18% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flow reductions in drier water years, when effects on habitat conditions would be more critical, would be inconsistent and/or of small magnitude for all months during the rearing period and, therefore, would not have biologically meaningful negative effects.

In the Trinity River below Lewiston Reservoir, flows under H3 would generally be similar to flows under NAA during the period with isolated exceptions (up to 11% lower), including small flow reductions in critical years during August through October (up to 12% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under H3 would be similar to flows under NAA throughout the year except in critical years during June (8% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under H3 would generally be similar to or greater than flows under NAA during January through June with a few isolated exceptions in drier water years during September, and during October through December with a few relatively isolated, small-magnitude reductions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows would be more persistently lower under H3 relative to NAA (up to 50% lower) during July, August, and in wetter water years during September (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flow reductions in drier water years, when effects would be more critical for habitat conditions, range from moderate to substantial in drier water years during July, August, and below normal years during September. These would be partially offset by increases in flow in the adjoining months.

In the American River at Nimbus Dam, flows under H3 would be similar to or greater than flows under NAA during January through July and December, with a few isolated, small-magnitude exceptions (up to 12% lower), and would be similar to or lower than flows under NAA (up to 40% lower) during August through November with a few exceptions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flow reductions in drier water years when effects would be more critical for habitat conditions consist of small to moderate reductions for some months and water year types from July through November, which would be offset by increases in some months and/or not persistent within a single water year type. Effects would not be biologically meaningful.

Flow rates in the San Joaquin and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows between H3 and NAA.

Water Temperature

The percentage of months above the 86°F water temperature threshold for year-round adult largemouth bass rearing period was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Elevated water temperatures could lead to reduced quantity and quality of adult rearing habitat and increased stress and mortality of rearing adults. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the year-round period.

In the Feather River below Thermalito Afterbay, water temperatures would not exceed 86°F under NAA and H3 (Table 11-4-151). As a result, there would be no difference in the percentage of months in which the 86°F water temperature threshold is exceeded between NAA and H3.

Table 11-4-151. Difference and Percent Difference in the Percentage of Months Year-Round in Which Water Temperatures in the Feather River below Thermalito Afterbay Exceed the 86°F Water Temperature Threshold for Adult Largemouth Bass Survival[a]

Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
Wet	0 (NA)	0 (NA)
Above Normal	0 (NA)	0 (NA)
Below Normal	0 (NA)	0 (NA)
Dry	0 (NA)	0 (NA)
Critical	0 (NA)	0 (NA)
All	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.

[a] A negative value indicates a benefit (reduction in percentage of months outside suitable range) of the alternative.

H1/LOS

Juveniles

Flows under H1 in the Sacramento River upstream of Red Bluff during the April through November juvenile largemouth bass rearing period would generally be similar to flows under H3 except in wetter water years during September, in which flows would be up to 45% lower (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H1 in the Trinity, San Joaquin, and Stanislaus rivers, and Clear Creek would generally be similar to flows under H3 throughout the period. Flows under H1 in the Feather River at Thermalito Afterbay would generally be similar to those under H3 except in wetter years during September, in which flows would be up to 83% lower. Flows under H1 in the American River below Nimbus Dam would generally be similar to those under H3 except in wetter years during September, in which flows would be up to 35% lower. Flow reductions in wetter water years are less critical to largemouth bass than in drier water years and, therefore, these flow reductions would not have biologically meaningful effects on largemouth bass rearing habitat.

Water temperatures in the Feather River below Thermalito Afterbay during the April through November juvenile largemouth bass rearing period would not exceed the 88°F water temperature threshold in H1 or H3. As a result, there would be no difference between H1 and H3 in the percentage of months in which the 88°F water temperature threshold is exceeded (Table 11-4-152).

Table 11-4-152. Difference and Percent Difference between the H3 Model Scenario and H1 and H4 Model Scenarios in the Percentage of Months during April–November in Which Water Temperatures in the Feather River below Thermalito Afterbay Exceed the 88°F Water Temperature Threshold for Juvenile Largemouth Bass Rearing[a]

Water Year Type	H3 vs. H1	H3 vs. H4
Wet	0 (NA)	0 (NA)
Above Normal	0 (NA)	0 (NA)
Below Normal	0 (NA)	0 (NA)
Dry	0 (NA)	0 (NA)
Critical	0 (NA)	0 (NA)
All	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.

[a] A negative value indicates a reduction in percentage of months outside suitable range for H1 or H4.

Adults

Flows under H1 in the Sacramento River upstream of Red Bluff during the year-round adult largemouth bass rearing period would generally be similar to flows under H3 except in wetter water years during September and December, in which flows would be up to 45% lower (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Year-round flows under H1 in the Trinity, San Joaquin, and Stanislaus rivers and in Clear Creek would be similar to flows under H3 with few exceptions. Flows under H1 in the Feather River at Thermalito Afterbay would be up to 29% greater than flows under H3 during January and December, up to 83% lower during September, and generally similar during the remainder of months. Flows under H1 in the American River at Nimbus Dam would be up to 8% greater than flows under H3 during December, up to 35% lower during September, and generally similar during the remainder of months. Flow reductions would not be frequent enough to have biologically meaningful effects on adult largemouth bass rearing habitat.

Water temperatures in the Feather River below Thermalito Afterbay during the year-round adult largemouth bass rearing period would not exceed the 86°F water temperature threshold in H1 or H3. As a result, there would be no difference between H1 and H3 in the percentage of months in which the 86°F water temperature threshold is exceeded (Table 11-4-153).

Table 11-4-153. Difference and Percent Difference between the H3 Model Scenario and H1 and H4 Model Scenarios in the Percentage of Months Year-Round in Which Water Temperatures in the Feather River below Thermalito Afterbay Exceed the 86°F Water Temperature Threshold for Adult Largemouth Bass Survival[a]

Water Year Type	H3 vs. H1	H3 vs. H4
Wet	0 (NA)	0 (NA)
Above Normal	0 (NA)	0 (NA)
Below Normal	0 (NA)	0 (NA)
Dry	0 (NA)	0 (NA)
Critical	0 (NA)	0 (NA)
All	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.

[a] A negative value indicates a reduction in percentage of months outside suitable range for H1 or H4.

H4/HOS

Juveniles

Flows under H4 in the Sacramento River upstream of Red Bluff during the April through November juvenile largemouth bass rearing period would generally be similar to flows under H3 except during June, in which flows would be up to 12% lower, and during September, in which flows would be up to 13% greater (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 in the Trinity, San Joaquin, and Stanislaus rivers, and Clear Creek would generally be similar to flows under H3 throughout the period. Flows under H4 in the Feather River at Thermalito Afterbay would generally be up to 330% greater than flows under H3 during April and May, up to 39% lower during June through October, and similar to flows under H3 during November. Based on these flow reductions, adult rearing habitat conditions would generally be less favorable under H4 relative to H3 in the Feather River. Flows under H4 in the American River below Nimbus Dam would generally be up to 32% greater than flows under H3 during August and September, up to 20% lower during June and October, and similar to flows under H3 during April, May, July, and November.

Water temperatures in the Feather River below Thermalito Afterbay during the April through November juvenile largemouth bass rearing period would not exceed the 88°F water temperature threshold in H4 or H3. As a result, there would be no difference between H4 and H3 in the percentage of months in which the 88°F water temperature threshold is exceeded (Table 11-4-152).

Adults

Flows under H4 in the Sacramento River upstream of Red Bluff during the year-round adult largemouth bass rearing period would generally be similar to flows under H3 except during June, in which flows would be up to 12% lower, and during September, in which flows would be up to 13% greater (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Year-round flows under H4 in the Trinity, San Joaquin, and Stanislaus rivers and in Clear Creek would be similar to flows under H3 with few exceptions. Flows under H4 in the Feather River at Thermalito Afterbay would generally be up to 330% greater than flows under H3 during January, April, and May, up to 39% lower during June through October, and similar to flows under H3 during February, March, November, and December. Based on these flow reductions, adult rearing habitat conditions would generally be less favorable under H4 relative to H3 in the Feather River. Flows under H4 in the American River below Nimbus Dam would generally be up to 32% greater than flows under H3 during August and September, up to 20% lower during June and October, and similar to flows under H3 during the remaining eight months.

Water temperatures in the Feather River below Thermalito Afterbay during the year-round adult largemouth bass rearing period would not exceed the 86°F water temperature threshold in H4 or H3. As a result, there would be no difference between H4 and H3 in the percentage of months in which the 86°F water temperature threshold is exceeded (Table 11-4-153).

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because Alternative 4 would not cause a substantial reduction in juvenile and adult rearing or spawning habitat. Flows in all rivers examined during the year under Alternative 4 are generally similar to or greater than flows under the NAA in most months. Flows in July or August through November are more likely to be lower for some water year types in some of the locations analyzed, however they are generally of small magnitude, not consistent from month to month within a specific water year type, and/or would be offset by increases in flow in the adjoining months. Therefore, the flow reductions are not expected to have biologically meaningful negative effects on the largemouth bass population. Flow-related habitat conditions in the Feather River for both juvenile and adult largemouth bass under H4 would be less favorable than those under H3 if water operations were to shift to this end of the adaptive limits. The percentage of months outside all temperature thresholds examined in the Feather River under Alternative 4 are the same as those under the NAA. Also, there are no temperature-related effects in any other rivers examined.

CEQA Conclusion: In general, Alternative 4 would reduce the quality and quantity of upstream habitat conditions for largemouth bass relative to Existing Conditions.

Juveniles

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the April through November juvenile largemouth bass rearing period. Lower flows could reduce the quantity and quality of instream habitat available for juvenile rearing.

In the Sacramento River upstream of Red Bluff, flows under H3 would generally be similar to or greater than flows under Existing Conditions during April through July and October, except in wet years during May (17% lower) and in critical years during July (9% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows would generally be similar to or lower than flows under Existing Conditions during August, September, and November (to 26% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). There would be primarily small flow reductions in some drier water year types for some months, but not persistent enough and of a magnitude that would not be expected to have biologically meaningful negative effects.

In the Trinity River below Lewiston Reservoir, flows under H3 would generally be similar to or greater than flows under Existing Conditions during April through November, except in critical years during May (6% lower), in wet years during July (14% lower), in critical years during August through November (to 45% lower), and in most of the remaining water year types during October and November (to 25% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). The persistent, small to moderate flow reductions in critical years during August through November would have a localized effect on rearing conditions in that water year type. Flow reductions in the other drier water year types are inconsistent and of small magnitude and would not have biologically meaningful negative effects.

In Clear Creek at Whiskeytown Dam, flows under H3 would be similar to or greater than flows under Existing Conditions during April through November regardless of water year type except in critical years during August through October (6% to 28% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). This flow reduction is a relatively small, isolated effect limited to a single water year type and would not be expected to have biologically meaningful negative effects.

In the Feather River at Thermalito Afterbay, flows under H3 would be greater than flows under Existing Conditions during April through June and October, with a few isolated exceptions (to 33% lower), and in wetter water year types during July, August, and September (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would generally be moderately to substantially lower than flows under Existing Conditions in drier water years during July through September (to 61% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). However, these would be offset by substantial increases in flow that would occur in drier water year types during April through June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) and therefore are not expected to have biologically meaningful negative effects.

In the American River at Nimbus Dam, flows under H3 would generally be similar to or greater than flows under Existing Conditions during April and June, except in above normal and below normal years during April (7% and 6% lower, respectively) and wet and critical years during June (27% and 33% lower, respectively), but generally lower, by up to 48%, during May and July through November (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). There would be moderate flow reductions in drier water year types, when effects would be most critical for habitat conditions, for some months/water year types from May through November that would affect rearing conditions at this location (to 42% lower in below normal, to 48% lower in dry and to 43% lower in critical water years).

Flow rates in the San Joaquin and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months above the 88°F water temperature threshold for juvenile largemouth bass rearing during April through November was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Elevated water temperatures could lead to reduced quantity and quality of instream habitat available for juvenile rearing and increased stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the April through November period.

In the Feather River below Thermalito Afterbay, water temperatures would not exceed the 88°F water temperature threshold for year-round juvenile largemouth bass occurrence under Existing Conditions or H3 (Table 11-4-150). As a result, there would be no difference in the percentage of months in which the 88°F water temperature threshold is exceeded between H3 and Existing Conditions.

Adults

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the year-round adult largemouth bass rearing period. Lower flows could reduce the quantity and quality of instream habitat available for adult rearing.

In the Sacramento River upstream of Red Bluff, flows under H3 would generally be similar to or greater than flows under Existing Conditions during January through July, October, and December, except in below normal years during March (10% lower), in wet years during May (17% lower), in critical years during July (9% lower), and in wet years during December (7% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows would generally be similar to or lower than flows under Existing Conditions during August, September, and November (to 26% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). There would be primarily small flow reductions in some drier water year types for some months, but not persistent enough and of a magnitude that would not be expected to have biologically meaningful negative effects.

In the Trinity River below Lewiston Reservoir, flows under H3 would generally be similar to or greater than flows under Existing Conditions throughout the year, except in below normal and critical years during January (16% and 8% lower, respectively), in below normal years during March (6% lower), in critical years during May (6% lower), in wet years during July (14% lower), in critical years during August through December (to 45% lower), and in most of the remaining water year types during October and November (to 25% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). The persistent, small to moderate flow reductions in critical years during August through December would have a localized effect on rearing conditions in that water year type. Flow reductions in the other drier water year types are inconsistent and of small magnitude and would not have biologically meaningful negative effects.

In Clear Creek at Whiskeytown Dam, flows under H3 would be similar to or greater than flows under Existing Conditions throughout the year regardless of water year type except in critical years during August through October (6% to 28% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). This flow reduction is a relatively small, isolated effect limited to a single water year type and would not be expected to have biologically meaningful negative effects.

In the Feather River at Thermalito Afterbay, flows under H3 would be greater than flows under Existing Conditions during March through June and October, with a few isolated exceptions (to 53% lower), and in wetter water year types during July, August, and September (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would generally be moderately to substantially lower than flows under Existing Conditions in drier water years during July through September (to 61% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). However, these would be offset by substantial increases in flow that would occur in drier water year types during April through June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) and therefore are not expected to have biologically meaningful negative effects.

In the American River at Nimbus Dam, flows under H3 would generally be similar to or greater than flows under Existing Conditions in wetter years during January, and most water years during February through April, with isolated exceptions of relatively small flow reductions (to 13% lower), but generally lower, by up to 48%, in drier years during January, most water years during May, wet and critical years during June, and in most water years during July through December (Appendix

11C, *CALSIM II Model Results utilized in the Fish Analysis*). There would be small to substantial flow reductions in drier water year types, when effects would be most critical for habitat conditions, for some months/water year types during each month of the year, with the most consistent flow reductions in critical water years and the greatest magnitude of flow reductions occurring during June through December. These persistent flow reductions would affect rearing conditions at this location (to 42% lower in below normal, to 48% lower in dry and to 43% lower in critical water years).

Flow rates in the San Joaquin and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months above the 86°F water temperature threshold for year-round adult largemouth bass rearing period was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Elevated water temperatures could lead to reduced quantity and quality of adult rearing habitat and increased stress and mortality of rearing adults. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the April through November period.

In the Feather River below Thermalito Afterbay, water temperatures would not exceed the 86°F water temperature range for year-round adult largemouth bass occurrence under Existing Conditions or H3 (Table 11-4-151). As a result, there would be no difference in the percentage of months in which the 86°F water temperature threshold is exceeded between H3 and Existing Conditions.

H1/LOS

Juveniles

Flows under H1 in the Sacramento River upstream of Red Bluff during the April through November juvenile largemouth bass rearing period would generally be similar to flows under H3 except in wetter water years during September, in which flows would be up to 45% lower (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H1 in the Trinity, San Joaquin, and Stanislaus rivers, and Clear Creek would generally be similar to flows under H3 throughout the period. Flows under H1 in the Feather River at Thermalito Afterbay would generally be similar to those under H3 except in wetter years during September, in which flows would be up to 83% lower. Flows under H1 in the American River below Nimbus Dam would generally be similar to those under H3 except in wetter years during September, in which flows would be up to 35% lower. Flow reductions in wetter water years are less critical to largemouth bass than in drier water years and, therefore, these flow reductions would not have biologically meaningful effects on largemouth bass rearing habitat.

Water temperatures in the Feather River below Thermalito Afterbay during the April through November juvenile largemouth bass rearing period would not exceed the 88°F water temperature threshold in H1 or H3. As a result, there would be no difference between H1 and H3 in the percentage of months in which the 88°F water temperature threshold is exceeded (Table 11-4-152).

Adults

Flows under H1 in the Sacramento River upstream of Red Bluff during the year-round adult largemouth bass rearing period would generally be similar to flows under H3 except in wetter water years during September and December, in which flows would be up to 45% lower (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Year-round flows under H1 in the Trinity, San Joaquin, and Stanislaus rivers and in Clear Creek would be similar to flows under H3 with few exceptions. Flows under H1 in the Feather River at Thermalito Afterbay would be up to 29% greater than flows under H3 during January and December, up to 83% lower during September, and generally similar during the remainder of months. Flows under H1 in the American River at Nimbus Dam would be up to 8% greater than flows under H3 during December, up to 35% lower during September, and generally similar during the remainder of months. Flow reductions would not be frequent enough to have biologically meaningful effects on adult largemouth bass rearing habitat.

Water temperatures in the Feather River below Thermalito Afterbay during the year-round adult largemouth bass rearing period would not exceed the 86°F water temperature threshold in H1 or H3. As a result, there would be no difference between H1 and H3 in the percentage of months in which the 86°F water temperature threshold is exceeded (Table 11-4-153).

H4/HOS

Juveniles

Flows under H4 in the Sacramento River upstream of Red Bluff during the April through November juvenile largemouth bass rearing period would generally be similar to flows under H3 except during June, in which flows would be up to 12% lower, and during September, in which flows would be up to 13% greater (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H4 in the Trinity, San Joaquin, and Stanislaus rivers, and Clear Creek would generally be similar to flows under H3 throughout the period. Flows under H4 in the Feather River at Thermalito Afterbay would generally be up to 330% greater than flows under H3 during April and May, up to 39% lower during June through October, and similar to flows under H3 during November. Based on these flow reductions, adult rearing habitat conditions would generally be less favorable under H4 relative to H3 in the Feather River. Flows under H4 in the American River below Nimbus Dam would generally be up to 32% greater than flows under H3 during August and September, up to 20% lower during June and October, and similar to flows under H3 during April, May, July, and November.

Water temperatures in the Feather River below Thermalito Afterbay during the April through November juvenile largemouth bass rearing period would not exceed the 88°F water temperature threshold in H4 or H3. As a result, there would be no difference between H4 and H3 in the percentage of months in which the 88°F water temperature threshold is exceeded (Table 11-4-152).

Adults

Flows under H4 in the Sacramento River upstream of Red Bluff during the year-round adult largemouth bass rearing period would generally be similar to flows under H3 except during June, in which flows would be up to 12% lower, and during September, in which flows would be up to 13% greater (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Year-round flows under H4 in the Trinity, San Joaquin, and Stanislaus rivers and in Clear Creek would be similar to flows under H3 with few exceptions. Flows under H4 in the Feather River at Thermalito Afterbay would generally be up to 330% greater than flows under H3 during January, April, and May, up to 39%

lower during June through October, and similar to flows under H3 during February, March, November, and December. Based on these flow reductions, adult rearing habitat conditions would generally be less favorable under H4 relative to H3 in the Feather River. Flows under H4 in the American River below Nimbus Dam would generally be up to 32% greater than flows under H3 during August and September, up to 20% lower during June and October, and similar to flows under H3 during the remaining eight months.

Water temperatures in the Feather River below Thermalito Afterbay during the year-round adult largemouth bass rearing period would not exceed the 86°F water temperature threshold in H4 or H3. As a result, there would be no difference between H4 and H3 in the percentage of months in which the 86°F water temperature threshold is exceeded (Table 11-4-153).

Collectively, these results indicate that the impact is not significant because Alternative 4 would not cause a substantial reduction in largemouth bass habitat and no mitigation is necessary. Flows would be substantially lower during the majority of the year-round adult rearing period in the American River, but based on the fact that this persistent effect occurs at only one location, it would not be expected to have biologically meaningful negative effects on the largemouth bass population. Flow reductions would occur throughout roughly half of the rearing period in the Feather River, but would be partially offset by substantial increases in flow during the preceding months. There would also be small to moderate flow reductions in the Trinity River in critical water years for roughly half the year that would have a localized effect juvenile and adult rearing in that water year type. Reduced flows in other rivers including the San Joaquin and Stanislaus rivers would not have biologically meaningful effects on largemouth bass. Flow-related habitat conditions in the Feather River for both juvenile and adult largemouth bass under H4 would be less favorable than those under H3 if water operations were to shift to this end of the adaptive limits. The percentages of months outside all temperature thresholds under Alternative 4 are the same as those under Existing Conditions. Also, there are no temperature-related effects in any other rivers examined.

Sacramento Tule Perch

In general, Alternative 4 would not affect the quality and quantity of upstream habitat conditions for Sacramento tule perch relative to the NAA.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during year-round Sacramento tule perch presence. Lower flows could reduce the quantity and quality of instream habitat available for rearing.

In the Sacramento River upstream of Red Bluff, flows under H3 would generally be similar to or greater than flows under NAA throughout the year with some exceptions (up to 14% lower), and would be lower in all water year types during November (up to 18% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flow reductions in drier water years, when effects on habitat conditions would be more critical, would be inconsistent and/or of small magnitude for all months during the rearing period and, therefore, would not have biologically meaningful negative effects.

In the Trinity River below Lewiston Reservoir, flows under H3 would generally be similar to flows under NAA during the period with isolated exceptions (up to 11% lower), including small flow reductions in critical years during August through October (up to 12% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under H3 would be similar to flows under NAA throughout the year except in critical years during June (8% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under H3 would generally be similar to or greater than flows under NAA during January through June with a few isolated exceptions, in drier water years during September, and during October through December with a few relatively isolated, small-magnitude reductions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows would be more persistently lower under H3 relative to NAA (up to 50% lower) during July, August, and in wetter water years during September (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flow reductions in drier water years, when effects would be more critical for habitat conditions, range from moderate to substantial in drier water years during July, August, and below normal years during September. These would be partially offset by increases in flow in the adjoining months.

In the American River at Nimbus Dam, flows under H3 would be similar to or greater than flows under NAA during January through July and December, with a few isolated, small-magnitude exceptions (up to 12% lower), and would be similar to or lower than flows under NAA (up to 40% lower) during August through November with a few exceptions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flow reductions in drier water years when effects would be more critical for habitat conditions consist of small to moderate reductions for some months and water year types from July through November, which would be offset by increases in some months and/or not persistent within a single water year type. Effects would not be biologically meaningful.

Flow rates in the San Joaquin and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows between H3 and NAA.

Water Temperature

The percentage of months exceeding water temperature thresholds of 72°F and 75°F for the year-round occurrence of all life stages of Sacramento tule perch was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures exceeding these thresholds could lead to reduced rearing habitat quantity and quality and increased stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers throughout the year.

In the Feather River below Thermalito Afterbay, the percentage of years under H3 exceeding the 72°F threshold would be higher than the percentage under NAA by 16% to 65% depending on water year type (Table 11-4-154). Although relative differences in above normal, below normal, and critical years are large due to small values, the absolute differenced in percent exceedance are only 2% to 6%, and do not represent biologically meaningful effects to Sacramento tule perch.

The percentage of months under H3 exceeding the 75°F threshold would be similar to or slightly greater than the percentage under NAA (up to 9% greater) (Table 11-4-154). The maximum increase corresponds to an absolute increase of 1%, which would not represent a biologically meaningful effect to Sacramento tule perch.

Table 11-4-154. Difference and Percent Difference in the Percentage of Months Year-Round in Which Water Temperatures in the Feather River below Thermalito Afterbay Exceed 72°F and 75°F Water Temperature Thresholds for Sacramento Tule Perch Occurrence[a]

Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
72°F Threshold		
Wet	3 (145%)	4 (184%)
Above Normal	2 (NA)	2 (188%)
Below Normal	7 (NA)	4 (137%)
Dry	11 (NA)	6 (118%)
Critical	13 (314%)	3 (19%)
All	7 (538%)	4 (84%)
75°F Threshold		
Wet	0.3 (NA)	0.3 (NA)
Above Normal	0 (NA)	0 (NA)
Below Normal	0 (NA)	0 (NA)
Dry	1 (NA)	0 (0%)
Critical	6 (986%)	1 (10%)
All	1 (1,300%)	0.2 (17%)

NA = could not be calculated because the denominator was 0.

[a] A negative value indicates a benefit (reduction in percentage of months outside suitable range) of the alternative.

H1/LOS

Flows under H1 in the Sacramento River upstream of Red Bluff during the year-round adult Sacramento tule perch rearing period would generally be similar to flows under H3 except in wetter water years during September and December, in which flows would be up to 45% lower (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Year-round flows under H1 in the Trinity, San Joaquin, and Stanislaus rivers and in Clear Creek would be similar to flows under H3 with few exceptions. Flows under H1 in the Feather River at Thermalito Afterbay would be up to 29% greater than flows under H3 during January and December, up to 83% lower during September, and generally similar during the remainder of months. Flows under H1 in the American River at Nimbus Dam would be up to 8% greater than flows under H3 during December, up to 35% lower during September, and generally similar during the remainder of months. Flow reductions would not be frequent enough to have biologically meaningful effects on Sacramento tule perch upstream rearing habitat.

The percentage of months under H1 exceeding the 72°F and 75°F water temperature thresholds in the Feather River below Thermalito Afterbay during the year-round Sacramento tule perch rearing period would be similar to the percentage under H3 in all water year types (Table 11-4-155).

Table 11-4-155. Difference and Percent Difference between the H3 Model Scenario and H1 and H4 Model Scenarios in the Percentage of Months Year-Round in Which Water Temperatures in the Feather River below Thermalito Afterbay Exceed 72°F and 75°F Water Temperature Thresholds for Sacramento Tule Perch Occurrence[a]

Water Year Type	H3 vs. H1	H3 vs. H4
72°F Threshold		
Wet	0 (0%)	3 (54%)
Above Normal	0 (0%)	6 (261%)
Below Normal	-1 (-8%)	2 (25%)
Dry	-1 (-8%)	0 (0%)
Critical	-1 (-8%)	0 (0%)
All	-1 (-6%)	2 (25%)
75°F Threshold		
Wet	0 (0%)	1 (433%)
Above Normal	0 (NA)	1 (NA)
Below Normal	0 (NA)	3 (NA)
Dry	0 (0%)	1 (156%)
Critical	0 (0%)	0 (0%)
All	0 (0%)	1 (100%)

NA = could not be calculated because the denominator was 0.

[a] A negative value indicates a reduction in percentage of months outside suitable range under H1 or H4.

H4/HOS

Flows under H4 in the Sacramento River upstream of Red Bluff during the year-round Sacramento tule perch rearing period would generally be similar to flows under H3 except during June, in which flows would be up to 12% lower, and during September, in which flows would be up to 13% greater (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Year-round flows under H4 in the Trinity, San Joaquin, and Stanislaus rivers and in Clear Creek would be similar to flows under H3 with few exceptions. Flows under H4 in the Feather River at Thermalito Afterbay would generally be up to 330% greater than flows under H3 during January, April, and May, up to 39% lower during June through October, and similar to flows under H3 during February, March, November, and December. Based on these flow reductions, rearing habitat conditions would generally be less favorable under H4 relative to H3 in the Feather River. Flows under H4 in the American River below Nimbus Dam would generally be up to 32% greater than flows under H3 during August and September, up to 20% lower during June and October, and similar to flows under H3 during the remaining eight months.

The percentage of months under H4 exceeding the 72°F and 75°F water temperature thresholds in the Feather River below Thermalito Afterbay during the year-round Sacramento tule perch rearing period would generally be similar to the percentage under H3, except in above normal water years under the 72°F threshold (6% higher)(Table 11-4-155).

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because Alternative 4 would not cause a substantial reduction in Sacramento tule perch habitat. Flows in all rivers examined during the year under Alternative 4 are generally similar to or greater than flows under the NAA in most months. Flows in July or August through November are more likely to be lower for some water year types in some of the locations analyzed, however they are generally of small magnitude, not consistent from month to month within a specific water year type, and/or would be offset by increases in flow in the adjoining months. Therefore, the flow reductions are not expected to have biologically meaningful negative effects on the Sacramento tule perch population. The percentages of months outside all temperature thresholds under Alternative 4 are generally similar to or only slightly greater than the percentages under the NAA.

CEQA Conclusion: In general, Alternative 4 would not affect the quality and quantity of upstream habitat conditions for Sacramento tule perch relative to Existing Conditions.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during year-round Sacramento tule perch presence. Lower flows could reduce the quantity and quality of instream habitat available for rearing.

In the Sacramento River upstream of Red Bluff, flows under H3 would generally be similar to or greater than flows under Existing Conditions during January through July, October, and December, except in below normal years during March (10% lower), in wet years during May (17% lower), in critical years during July (9% lower), and in wet years during December (7% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows would generally be similar to or lower than flows under Existing Conditions during August, September, and November (to 26% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). There would be primarily small flow reductions in some drier water year types for some months, but not persistent enough and of a magnitude that would not be expected to have biologically meaningful negative effects.

In the Trinity River below Lewiston Reservoir, flows under H3 would generally be similar to or greater than flows under Existing Conditions throughout the year, except in below normal and critical years during January (16% and 8% lower, respectively), in below normal years during March (6% lower), in critical years during May (6% lower), in wet years during July (14% lower), in critical years during August through December (to 45% lower), and in most of the remaining water year types during October and November (to 25% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). The persistent, small to moderate flow reductions in critical years during August through December would have a localized effect on rearing conditions in that water year type. Flow reductions in the other drier water year types are inconsistent and of small magnitude and would not have biologically meaningful negative effects.

In Clear Creek at Whiskeytown Dam, flows under H3 would be similar to or greater than flows under Existing Conditions throughout the year regardless of water year type except in critical years during August through October (6% to 28% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). This flow reduction is a relatively small, isolated effect limited to a single water year type and would not be expected to have biologically meaningful negative effects.

In the Feather River at Thermalito Afterbay, flows under H3 would be greater than flows under Existing Conditions during March through June and October, with a few isolated exceptions (to 53% lower), and in wetter water year types during July, August, and September (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would generally be moderately to substantially lower than flows under Existing Conditions in drier water years during July through September (to 61% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

However, these would be offset by substantial increases in flow that would occur in drier water year types during April through June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) and therefore are not expected to have biologically meaningful negative effects.

In the American River at Nimbus Dam, flows under H3 would generally be similar to or greater than flows under Existing Conditions in wetter years during January, and most water years during February through April, with isolated exceptions of relatively small flow reductions (to 13% lower), but generally lower, by up to 48%, in drier years during January, most water years during May, wet and critical years during June, and in most water years during July through December (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). There would be small to substantial flow reductions in drier water year types, when effects would be most critical for habitat conditions, for some months/water year types during each month of the year, with the most consistent flow reductions in critical water years and the greatest magnitude of flow reductions occurring during June through December. These persistent flow reductions would affect rearing conditions at this location (to 42% lower in below normal, to 48% lower in dry and to 43% lower in critical water years).

Flow rates in the San Joaquin and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months exceeding water temperatures of 72°F and 75°F for the year-round occurrence of all life stages of Sacramento tule perch was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures exceeding these thresholds could lead to reduced rearing habitat quality and increased stress and mortality. Water temperatures were not modeled in Clear Creek or the San Joaquin River.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the year.

In the Feather River below Thermalito Afterbay, the percentage of months under H3 exceeding 72°F relative to the percentage under Existing Conditions would be similar to or higher, by up to 314% (Table 11-4-154). The increases correspond to relatively small absolute increases, up to 13%, and are not expected to have biologically meaningful negative effects.

The percentage of years under H3 exceeding 75°F would be similar to the percentage under Existing Conditions in all water years except critical years (986% higher) (Table 11-4-154). The increase corresponds to a small absolute increase (6%) and would not have biologically meaningful negative effects.

H1/LOS

Flows under H1 in the Sacramento River upstream of Red Bluff during the year-round adult Sacramento tule perch rearing period would generally be similar to flows under H3 except in wetter water years during September and December, in which flows would be up to 45% lower (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Year-round flows under H1 in the Trinity, San Joaquin, and Stanislaus rivers and in Clear Creek would be similar to flows under H3 with few exceptions. Flows under H1 in the Feather River at Thermalito Afterbay would be up to 29% greater than flows under H3 during January and December, up to 83% lower during September, and generally similar during the remainder of months. Flows under H1 in the American River at Nimbus Dam would be up to 8% greater than flows under H3 during December, up to 35% lower during September, and generally similar during the remainder of months. Flow reductions would not be frequent enough to have biologically meaningful effects on Sacramento tule perch upstream rearing habitat.

The percentage of months under H1 exceeding the 72°F and 75°F water temperature thresholds in the Feather River below Thermalito Afterbay during the year-round Sacramento tule perch rearing period would be similar to the percentage under H3 in all water year types (Table 11-4-155).

H4/HOS

Flows under H4 in the Sacramento River upstream of Red Bluff during the year-round Sacramento tule perch rearing period would generally be similar to flows under H3 except during June, in which flows would be up to 12% lower, and during September, in which flows would be up to 13% greater (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Year-round flows under H4 in the Trinity, San Joaquin, and Stanislaus rivers and in Clear Creek would be similar to flows under H3 with few exceptions. Flows under H4 in the Feather River at Thermalito Afterbay would generally be up to 330% greater than flows under H3 during January, April, and May, up to 39% lower during June through October, and similar to flows under H3 during February, March, November, and December. Based on these flow reductions, rearing habitat conditions would generally be less favorable under H4 relative to H3 in the Feather River. Flows under H4 in the American River below Nimbus Dam would generally be up to 32% greater than flows under H3 during August and September, up to 20% lower during June and October, and similar to flows under H3 during the remaining eight months.

The percentage of months under H4 exceeding the 72°F and 75°F water temperature thresholds in the Feather River below Thermalito Afterbay during the year-round Sacramento tule perch rearing period would generally be similar to the percentage under H3, except in above normal water years under the 72°F threshold (6% higher)(Table 11-4-155).

Collectively, these results indicate that the impact is not significant because Alternative 4 would not cause a substantial reduction in Sacramento tule perch habitat, and no mitigation is necessary. Flows would be substantially lower during the majority of the year-round adult rearing period in the American River, but based on the fact that this persistent effect occurs at only one location, it would not be expected to have biologically meaningful negative effects on the Sacramento tule perch population. Flow reductions would occur throughout roughly half of the rearing period in the Feather River, but would be partially offset by substantial increases in flow during the preceding months. There would also be small to moderate flow reductions in the Trinity River in critical water years for roughly half the year that would have a localized effect juvenile and adult rearing in that water year type. Reduced flows in other rivers including the San Joaquin and Stanislaus rivers would not have biologically meaningful effects. The percentages of months outside both temperature thresholds are generally lower under Alternative 4 than under Existing Conditions.

Sacramento-San Joaquin Roach

In general, Alternative 4 would not affect the quality and quantity of upstream habitat conditions for Sacramento-San Joaquin roach relative to the NAA.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the year-round juvenile and adult Sacramento-San Joaquin roach rearing period. Lower flows could reduce the quantity and quality of instream habitat available for rearing.

In the Sacramento River upstream of Red Bluff, flows under H3 would generally be similar to or greater than flows under NAA throughout the year with some exceptions (up to 14% lower), and would be lower in all water year types during November (up to 18% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flow reductions in drier water years, when effects on habitat conditions would be more critical, would be inconsistent and/or of small magnitude for all months during the rearing period and, therefore, would not have biologically meaningful negative effects.

In the Trinity River below Lewiston Reservoir, flows under H3 would generally be similar to flows under NAA during the period with isolated exceptions (up to 11% lower), including small flow reductions in critical years during August through October (up to 12% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under H3 would be similar to flows under NAA throughout the year except in critical years during June (8% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under H3 would generally be similar to or greater than flows under NAA during January through June with a few isolated exceptions, in drier water years during September, and during October through December with a few relatively isolated, small-magnitude reductions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows would be more persistently lower under H3 relative to NAA (up to 50% lower) during July, August, and in wetter water years during September (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flow reductions in drier water years, when effects would be more critical for habitat conditions, range from moderate to substantial in drier water years during July, August, and below normal years during September. These would be partially offset by increases in flow in the adjoining months.

In the American River at Nimbus Dam, flows under H3 would be similar to or greater than flows under NAA during January through July and December, with a few isolated, small-magnitude exceptions (up to 12% lower), and would be similar to or lower than flows under NAA (up to 40% lower) during August through November with a few exceptions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flow reductions in drier water years when effects would be more critical for habitat conditions consist of small to moderate reductions for some months and water year types from July through November, which would be offset by increases in some months and/or not persistent within a single water year type. Effects would not be biologically meaningful.

Flow rates in the San Joaquin and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows between H3 and NAA.

Water Temperature

The percentage of months above the 86°F water temperature threshold for year-round juvenile and adult Sacramento-San Joaquin roach rearing period was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Elevated water temperatures could lead to reduced rearing habitat quality and increased stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers throughout the year.

In the Feather River below Thermalito Afterbay, water temperatures would not exceed 86°F under NAA or H3(Table 11-4-156). As a result, there would be no difference in the percentage of months in which the 86°F water temperature threshold is exceeded between NAA and H3.

Table 11-4-156. Difference and Percent Difference in the Percentage of Months Year-Round in Which Water Temperatures in the Feather River below Thermalito Afterbay Exceed the 86°F Water Temperature Threshold for Sacramento-San Joaquin Roach Survival[a]

Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
Wet	0 (NA)	0 (NA)
Above Normal	0 (NA)	0 (NA)
Below Normal	0 (NA)	0 (NA)
Dry	0 (NA)	0 (NA)
Critical	0 (NA)	0 (NA)
All	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.

[a] A negative value indicates a benefit (reduction in percentage of months outside suitable range) of the alternative.

H1/LOS

Flows under H1 in the Sacramento River upstream of Red Bluff during the year-round Sacramento-San Joaquin roach rearing period would generally be similar to flows under H3 except in wetter water years during September and December, in which flows would be up to 45% lower (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Year-round flows under H1 in the Trinity, San Joaquin, and Stanislaus rivers and in Clear Creek would be similar to flows under H3 with few exceptions. Flows under H1 in the Feather River at Thermalito Afterbay would be up to 29% greater than flows under H3 during January and December, up to 83% lower during September, and generally similar during the remainder of months. Flows under H1 in the American River at Nimbus Dam would be up to 8% greater than flows under H3 during December, up to 35% lower during September, and generally similar during the remainder of months. Flow reductions would not be frequent enough to have biologically meaningful effects on roach upstream rearing habitat.

Water temperatures in the Feather River below Thermalito Afterbay during the year-round adult largemouth bass rearing period would not exceed the 86°F water temperature threshold in H1 or H3. As a result, there would be no difference between H1 and H3 in the percentage of months in which the 86°F water temperature threshold is exceeded (Table 11-4-157).

Table 11-4-157. Difference and Percent Difference between the H3 Model Scenario and H1 and H4 Model Scenarios in the Percentage of Months Year-Round in Which Water Temperatures in the Feather River below Thermalito Afterbay Exceed the 86°F Water Temperature Threshold for Sacramento-San Joaquin Roach Survival[a]

Water Year Type	H3 vs. H1	H3 vs. H4
Wet	0 (NA)	0 (NA)
Above Normal	0 (NA)	0 (NA)
Below Normal	0 (NA)	0 (NA)
Dry	0 (NA)	0 (NA)
Critical	0 (NA)	0 (NA)
All	0 (NA)	0 (NA)

NA = could not be calculated because the denominator was 0.
[a] A negative value indicates a reduction in percentage of months outside suitable range for H1 or H4.

H4/HOS

Flows under H4 in the Sacramento River upstream of Red Bluff during the year-round Sacramento-San Joaquin roach rearing period would generally be similar to flows under H3 except during June, in which flows would be up to 12% lower, and during September, in which flows would be up to 13% greater (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Year-round flows under H4 in the Trinity, San Joaquin, and Stanislaus rivers and in Clear Creek would be similar to flows under H3 with few exceptions. Flows under H4 in the Feather River at Thermalito Afterbay would generally be up to 330% greater than flows under H3 during January, April, and May, up to 39% lower during June through October, and similar to flows under H3 during February, March, November, and December. Based on these flow reductions, rearing habitat conditions would generally be less favorable under H4 relative to H3 in the Feather River. Flows under H4 in the American River below Nimbus Dam would generally be up to 32% greater than flows under H3 during August and September, up to 20% lower during June and October, and similar to flows under H3 during the remaining eight months.

Water temperatures in the Feather River below Thermalito Afterbay during the year-round adult largemouth bass rearing period would not exceed the 86°F water temperature threshold in H4 or H3. As a result, there would be no difference between H4 and H3 in the percentage of months in which the 86°F water temperature threshold is exceeded (Table 11-4-157).

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because Alternative 4 would not cause a substantial reduction in spawning and juvenile and adult Sacramento-San Joaquin roach rearing habitat. Flows in all rivers examined during the year under Alternative 4 are generally similar to or greater than flows under the NAA in most months. Flows in July or August through November are more likely to be lower for some water year types in some of the locations analyzed, however they are generally of small magnitude, not consistent from month to month within a specific water year type, and/or would be offset by increases in flow in the adjoining months. Therefore, the flow reductions are not expected to have biologically meaningful negative effects on the largemouth bass population. The percentage of months outside temperature thresholds are generally similar to or lower under Alternative 4 than under the NAA.

CEQA Conclusion: In general, Alternative 4 would not affect the quality and quantity of upstream habitat conditions for Sacramento-San Joaquin roach relative to Existing Conditions.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the year-round juvenile and adult Sacramento-San Joaquin roach rearing period. Lower flows could reduce the quantity and quality of instream habitat available for rearing.

In the Sacramento River upstream of Red Bluff, flows under H3 would generally be similar to or greater than flows under Existing Conditions during January through July, October, and December, except in below normal years during March (10% lower), in wet years during May (17% lower), in critical years during July (9% lower), and in wet years during December (7% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows would generally be similar to or lower than flows under Existing Conditions during August, September, and November (to 26% lower). There would be primarily small flow reductions in some drier water year types for some months, but not persistent enough and of a magnitude that would not be expected to have biologically meaningful negative effects.

In the Trinity River below Lewiston Reservoir, flows under H3 would generally be similar to or greater than flows under Existing Conditions throughout the year, except in below normal and critical years during January (16% and 8% lower, respectively), in below normal years during March (6% lower), in critical years during May (6% lower), in wet years during July (14% lower), in critical years during August through December (to 45% lower), and in most of the remaining water year types during October and November (to 25% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). The persistent, small to moderate flow reductions in critical years during August through December would have a localized effect on rearing conditions in that water year type. Flow reductions in the other drier water year types are inconsistent and of small magnitude and would not have biologically meaningful negative effects.

In Clear Creek at Whiskeytown Dam, flows under H3 would be similar to or greater than flows under Existing Conditions throughout the year regardless of water year type except in critical years during August through October (6% to 28% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). This flow reduction is a relatively small, isolated effect limited to a single water year type and would not be expected to have biologically meaningful negative effects.

In the Feather River at Thermalito Afterbay, flows under H3 would be greater than flows under Existing Conditions during March through June and October, with a few isolated exceptions (to 53% lower), and in wetter water year types during July, August, and September (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would generally be moderately to substantially lower than flows under Existing Conditions in drier water years during July through September (to 61% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). However, these would be offset by substantial increases in flow that would occur in drier water year types during April through June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) and therefore are not expected to have biologically meaningful negative effects.

In the American River at Nimbus Dam, flows under H3 would generally be similar to or greater than flows under Existing Conditions in wetter years during January, and most water years during February through April, with isolated exceptions of relatively small flow reductions (to 13% lower), but generally lower, by up to 48%, in drier years during January, most water years during May, wet and critical years during June, and in most water years during July through December (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). There would be small to substantial flow reductions in drier water year types, when effects would be most critical for habitat conditions, for some months/water year types during each month of the year, with the most consistent flow reductions in critical water years and the greatest magnitude of flow reductions occurring during June through December. These persistent flow reductions would affect rearing conditions at this location (to 42% lower in below normal, to 48% lower in dry and to 43% lower in critical water years).

Flow rates in the San Joaquin and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months above the 86°F water temperature threshold for year-round juvenile and adult Sacramento-San Joaquin roach rearing period was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Elevated water temperatures could lead to reduced quantity and quality of adult rearing habitat and increased stress and mortality of rearing adults. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the April through November period.

In the Feather River below Thermalito Afterbay, water temperatures would not exceed 86°F water temperature threshold for Sacramento-San Joaquin roach occurrence under Existing Conditions or H3 (Table 11-4-156). As a result, there would be no difference in the percentage of months in which the 86°F water temperature threshold is exceeded between H3 and Existing Conditions.

H1/LOS

Flows under H1 in the Sacramento River upstream of Red Bluff during the year-round Sacramento-San Joaquin roach rearing period would generally be similar to flows under H3 except in wetter water years during September and December, in which flows would be up to 45% lower (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Year-round flows under H1 in the Trinity, San Joaquin, and Stanislaus rivers and in Clear Creek would be similar to flows under H3 with few exceptions. Flows under H1 in the Feather River at Thermalito Afterbay would be up to 29% greater than flows under H3 during January and December, up to 83% lower during September, and generally similar during the remainder of months. Flows under H1 in the American River at Nimbus Dam would be up to 8% greater than flows under H3 during December, up to 35% lower during September, and generally similar during the remainder of months. Flow reductions would not be frequent enough to have biologically meaningful effects on roach upstream rearing habitat.

Water temperatures in the Feather River below Thermalito Afterbay during the year-round adult largemouth bass rearing period would not exceed the 86°F water temperature threshold in H1 or H3. As a result, there would be no difference between H1 and H3 in the percentage of months in which the 86°F water temperature threshold is exceeded (Table 11-4-157).

H4/HOS

Flows under H4 in the Sacramento River upstream of Red Bluff during the year-round Sacramento-San Joaquin roach rearing period would generally be similar to flows under H3 except during June, in which flows would be up to 12% lower, and during September, in which flows would be up to 13% greater (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Year-round flows under H4 in the Trinity, San Joaquin, and Stanislaus rivers and in Clear Creek would be similar to flows under H3 with few exceptions. Flows under H4 in the Feather River at Thermalito Afterbay would generally be up to 330% greater than flows under H3 during January, April, and May, up to 39% lower during June through October, and similar to flows under H3 during February, March, November, and December. Based on these flow reductions, rearing habitat conditions would generally be less favorable under H4 relative to H3 in the Feather River. Flows under H4 in the American River below Nimbus Dam would generally be up to 32% greater than flows under H3 during August and September, up to 20% lower during June and October, and similar to flows under H3 during the remaining eight months.

Water temperatures in the Feather River below Thermalito Afterbay during the year-round adult largemouth bass rearing period would not exceed the 86°F water temperature threshold in H4 or H3. As a result, there would be no difference between H4 and H3 in the percentage of months in which the 86°F water temperature threshold is exceeded (Table 11-4-157).

Collectively, these results indicate that the impact would not be significant because Alternative 4 would not cause a substantial reduction in Sacramento-San Joaquin roach habitat, and no mitigation is necessary. Flows would be substantially lower during the majority of the year-round adult rearing period in the American River, but based on the fact that this persistent effect occurs at only one location, it would not be expected to have biologically meaningful negative effects on the largemouth bass population. Flow reductions would occur throughout roughly half of the rearing period in the Feather River, but would be partially offset by substantial increases in flow during the preceding months. There would also be small to moderate flow reductions in the Trinity River in critical water years for roughly half the year that would have a localized effect juvenile and adult rearing in that water year type. Reduced flows in other rivers including the San Joaquin and Stanislaus rivers would not have biologically meaningful effects on largemouth bass. The percentages of months outside both temperature thresholds would generally be lower under Alternative 4 than under Existing Conditions.

Hardhead

In general, H4 would not affect the quality and quantity of upstream habitat conditions for hardhead relative to the NAA.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the year-round juvenile and adult hardhead rearing period. Lower flows could reduce the quantity and quality of instream habitat available for juvenile and adult rearing.

In the Sacramento River upstream of Red Bluff, flows under H3 would generally be similar to or greater than flows under NAA throughout the year with some exceptions (up to 14% lower), and would be lower in all water year types during November (up to 18% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flow reductions in drier water years, when effects on habitat conditions would be more critical, would be inconsistent and/or of small magnitude for all months during the rearing period and, therefore, would not have biologically meaningful negative effects.

In the Trinity River below Lewiston Reservoir, flows under H3 would generally be similar to flows under NAA during the period with isolated exceptions (up to 11% lower), including small flow reductions in critical years during August through October (up to 12% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In Clear Creek at Whiskeytown Dam, flows under H3 would be similar to flows under NAA throughout the year except in critical years during June (8% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

In the Feather River at Thermalito Afterbay, flows under H3 would generally be similar to or greater than flows under NAA during January through June with a few isolated exceptions, in drier water years during September, and during October through December with a few relatively isolated, small-magnitude reductions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows would be more persistently lower under H3 relative to NAA (up to 50% lower) during July, August, and in wetter water years during September (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flow reductions in drier water years, when effects would be more critical for habitat conditions, range from moderate to substantial in drier water years during July, August, and below normal years during September. These would be partially offset by increases in flow in the adjoining months.

In the American River at Nimbus Dam, flows under H3 would be similar to or greater than flows under NAA during January through July and December, with a few isolated, small-magnitude exceptions (up to 12% lower), and would be similar to or lower than flows under NAA (up to 40% lower) during August through November with a few exceptions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flow reductions in drier water years when effects would be more critical for habitat conditions consist of small to moderate reductions for some months and water year types from July through November, which would be offset by increases in some months and/or not persistent within a single water year type. Effects would not be biologically meaningful.

Flow rates in the San Joaquin and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be no differences in flows between H3 and NAA.

Water Temperature

The percentage of months outside of the 65°F to 82.4°F suitable water temperature range for juvenile and adult hardhead rearing was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced rearing habitat quality and increased stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers throughout the year.

In the Feather River below Thermalito Afterbay, the percentage of months under H3 outside the range would be similar to or lower than the percentage under NAA in all water year except below normal years (5% higher) (Table 11-4-158).

Table 11-4-158. Difference and Percent Difference in the Percentage of Months Year-Round in Which Water Temperatures in the Feather River below Thermalito Afterbay Are outside the 65°F to 82.4°F Water Temperature Range for Juvenile and Adult Hardhead Occurrence[a]

Water Year Type	EXISTING CONDITIONS vs. H3	NAA vs. H3
Wet	-2 (-3%)	2 (3%)
Above Normal	-9 (-12%)	-4 (-6%)
Below Normal	-5 (-7%)	5 (8%)
Dry	-7 (-10%)	0 (0%)
Critical	-7 (-10%)	-1 (-2%)
All	-5 (-7%)	1 (2%)

[a] A negative value indicates a benefit (reduction in percentage of months outside suitable range) of the alternative.

H1/LOS

Flows under H1 in the Sacramento River upstream of Red Bluff during the year-round hardhead rearing period would generally be similar to flows under H3 except in wetter water years during September and December, in which flows would be up to 45% lower (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Year-round flows under H1 in the Trinity, San Joaquin, and Stanislaus rivers and in Clear Creek would be similar to flows under H3 with few exceptions. Flows under H1 in the Feather River at Thermalito Afterbay would be up to 29% greater than flows under H3 during January and December, up to 83% lower during September, and generally similar during the remainder of months. Flows under H1 in the American River at Nimbus Dam would be up to 8% greater than flows under H3 during December, up to 35% lower during September, and generally similar during the remainder of months. Flow reductions would not be frequent enough to have biologically meaningful effects on hardhead upstream rearing habitat.

The percentage of months under H1 outside the 65°F to 82.4°F water temperature range in the Feather River below Thermalito Afterbay during the year-round hardhead rearing period would be similar to the percentage under H3 in all water year types (Table 11-4-159).

Table 11-4-159. Difference and Percent Difference between the H3 Model Scenario and H1 and H4 Model Scenarios in the Percentage of Months Year-Round in Which Water Temperatures in the Feather River below Thermalito Afterbay Are outside the 65°F to 82.4°F Water Temperature Range for Juvenile and Adult Hardhead Occurrence[a]

Water Year Type	H3 vs. H1	H3 vs. H4
Wet	-4 (-5%)	-4 (-5%)
Above Normal	2 (3%)	0 (0%)
Below Normal	-2 (-3%)	-1 (-2%)
Dry	0 (0%)	0 (0%)
Critical	0 (0%)	1 (2%)
All	-1 (-1%)	-1 (-1%)

[a] A negative value indicates a reduction in percentage of months outside suitable range for H1 or H4.

H4/HOS

Flows under H4 in the Sacramento River upstream of Red Bluff during the year-round juvenile and adult hardhead rearing period would generally be similar to flows under H3 except during June, in which flows would be up to 12% lower, and during September, in which flows would be up to 13% greater (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Year-round flows under H4 in the Trinity, San Joaquin, and Stanislaus rivers and in Clear Creek would be similar to flows under H3 with few exceptions. Flows under H4 in the Feather River at Thermalito Afterbay would generally be up to 330% greater than flows under H3 during January, April, and May, up to 39% lower during June through October, and similar to flows under H3 during February, March, November, and December. Based on these flow reductions, rearing habitat conditions would generally be less favorable under H4 relative to H3 in the Feather River. Flows under H4 in the American River below Nimbus Dam would generally be up to 32% greater than flows under H3 during August and September, up to 20% lower during June and October, and similar to flows under H3 during the remaining eight months.

The percentage of months under H4 outside the 65°F to 82.4°F water temperature range in the Feather River below Thermalito Afterbay during the year-round hardhead rearing period would be similar to the percentage under H3 in all water year types (Table 11-4-159).

NEPA Effects: Collectively, these results indicate that the effect would not be adverse because Alternative 4 would not cause a substantial reduction in spawning and juvenile and adult hardhead rearing. Flows in all rivers examined during the year under Alternative 4 are generally similar to or greater than flows under the NAA in most months. Flows in July or August through November are more likely to be lower for some water year types in some of the locations analyzed, however they are generally of small magnitude, not consistent from month to month within a specific water year type, and/or would be offset by increases in flow in the adjoining months. Therefore, the flow reductions are not expected to have biologically meaningful negative effects on hardhead. The percentages of months outside all temperature thresholds are generally lower under Alternative 4 than under the NAA.

CEQA Conclusion: In general, Alternative 4 would not affect the quality and quantity of upstream habitat conditions for hardhead relative to Existing Conditions.

Flows

Flow rates in the Sacramento, Trinity, Feather, American, San Joaquin, and Stanislaus rivers and in Clear Creek were examined during the year-round juvenile and adult hardhead rearing period. Lower flows could reduce the quantity and quality of instream habitat available for juvenile and adult rearing.

In the Sacramento River upstream of Red Bluff, flows under H3 would generally be similar to or greater than flows under Existing Conditions during January through July, October, and December, except in below normal years during March (10% lower), in wet years during May (17% lower), in critical years during July (9% lower), and in wet years during December (7% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows would generally be similar to or lower than flows under Existing Conditions during August, September, and November (to 26% lower). There would be primarily small flow reductions in some drier water year types for some months, but not persistent enough and of a magnitude that would not be expected to have biologically meaningful negative effects.

In the Trinity River below Lewiston Reservoir, flows under H3 would generally be similar to or greater than flows under Existing Conditions throughout the year, except in below normal and critical years during January (16% and 8% lower, respectively), in below normal years during March (6% lower), in critical years during May (6% lower), in wet years during July (14% lower), in critical years during August through December (to 45% lower), and in most of the remaining water year types during October and November (to 25% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). The persistent, small to moderate flow reductions in critical years during August through December would have a localized effect on rearing conditions in that water year type. Flow reductions in the other drier water year types are inconsistent and of small magnitude and would not have biologically meaningful negative effects.

In Clear Creek at Whiskeytown Dam, flows under H3 would be similar to or greater than flows under Existing Conditions throughout the year regardless of water year type except in critical years during August through October (6% to 28% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). This flow reduction is a relatively small, isolated effect limited to a single water year type and would not be expected to have biologically meaningful negative effects.

In the Feather River at Thermalito Afterbay, flows under H3 would be greater than flows under Existing Conditions during March through June and October, with a few isolated exceptions (to 53% lower), and in wetter water year types during July, August, and September (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows under H3 would generally be moderately to substantially lower than flows under Existing Conditions in drier water years during July through September (to 61% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). However, these would be offset by substantial increases in flow that would occur in drier water year types during April through June (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) and therefore are not expected to have biologically meaningful negative effects.

In the American River at Nimbus Dam, flows under H3 would generally be similar to or greater than flows under Existing Conditions in wetter years during January, and most water years during February through April, with isolated exceptions of relatively small flow reductions (to 13% lower), but generally lower, by up to 48%, in drier years during January, most water years during May, wet and critical years during June, and in most water years during July through December (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). There would be small to substantial flow reductions in drier water year types, when effects would be most critical for habitat conditions, for some months/water year types during each month of the year, with the most consistent flow reductions in critical water years and the greatest magnitude of flow reductions occurring during June through December. These persistent flow reductions would affect rearing conditions at this location (to 42% lower in below normal, to 48% lower in dry and to 43% lower in critical water years).

Flow rates in the San Joaquin and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be small to moderate reductions in flows during the period relative to Existing Conditions.

Water Temperature

The percentage of months in which year-round in-stream temperatures would be outside of the 65°F to 82.4°F suitable water temperature range for juvenile and adult hardhead rearing was examined in the Sacramento, Trinity, Feather, American, and Stanislaus rivers. Water temperatures outside this range could lead to reduced rearing habitat quality and increased stress and mortality. Water temperatures were not modeled in the San Joaquin River or Clear Creek.

Water temperatures in the Sacramento, Trinity, American, and Stanislaus rivers under H3 would be the same as those under Alternative 1A. The analysis for Alternative 1A indicates that there would be no temperature-related effects in these rivers during the April through November period.

In the Feather River below Thermalito Afterbay, the percentage of months under H3 outside of the 65°F to 82.4°F water temperature range for juvenile and adult hardhead occurrence would be similar to or lower than the percentage under Existing Conditions in all water years (Table 11-4-158).

H1/LOS

Flows under H1 in the Sacramento River upstream of Red Bluff during the year-round hardhead rearing period would generally be similar to flows under H3 except in wetter water years during September and December, in which flows would be up to 45% lower (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Year-round flows under H1 in the Trinity, San Joaquin, and Stanislaus rivers and in Clear Creek would be similar to flows under H3 with few exceptions. Flows under H1 in the Feather River at Thermalito Afterbay would be up to 29% greater than flows under H3 during January and December, up to 83% lower during September, and generally similar during the remainder of months. Flows under H1 in the American River at Nimbus Dam would be up to 8% greater than flows under H3 during December, up to 35% lower during September, and generally similar during the remainder of months. Flow reductions would not be frequent enough to have biologically meaningful effects on hardhead upstream rearing habitat.

The percentage of months under H1 outside the 65°F to 82.4°F water temperature range in the Feather River below Thermalito Afterbay during the year-round hardhead rearing period would be similar to the percentage under H3 in all water year types (Table 11-4-159).

H4/HOS

Flows under H4 in the Sacramento River upstream of Red Bluff during the year-round juvenile and adult hardhead rearing period would generally be similar to flows under H3 except during June, in which flows would be up to 12% lower, and during September, in which flows would be up to 13%

greater (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Year-round flows under H4 in the Trinity, San Joaquin, and Stanislaus rivers and in Clear Creek would be similar to flows under H3 with few exceptions. Flows under H4 in the Feather River at Thermalito Afterbay would generally be up to 330% greater than flows under H3 during January, April, and May, up to 39% lower during June through October, and similar to flows under H3 during February, March, November, and December. Based on these flow reductions, rearing habitat conditions would generally be less favorable under H4 relative to H3 in the Feather River. Flows under H4 in the American River below Nimbus Dam would generally be up to 32% greater than flows under H3 during August and September, up to 20% lower during June and October, and similar to flows under H3 during the remaining eight months.

The percentage of months under H4 outside the 65°F to 82.4°F water temperature range in the Feather River below Thermalito Afterbay during the year-round hardhead rearing period would be similar to the percentage under H3 in all water year types (Table 11-4-159).

Collectively, these results indicate that the impact is not significant because Alternative 4 would not cause a substantial reduction in hardhead habitat, and no mitigation is necessary. Flows would be substantially lower during the majority of the year-round adult rearing period in the American River, but based on the fact that this persistent effect occurs at only one location, it would not be expected to have biologically meaningful negative effects on the largemouth bass population. Flow reductions would occur throughout roughly half of the rearing period in the Feather River, but would be partially offset by substantial increases in flow during the preceding months. There would also be small to moderate flow reductions in the Trinity River in critical water years for roughly half the year that would have a localized effect juvenile and adult rearing in that water year type. Reduced flows in other rivers including the San Joaquin and Stanislaus rivers would not have biologically meaningful effects on hardhead. The percentages of months outside both temperature thresholds are generally lower under Alternative 4 than under Existing Conditions.

California Bay Shrimp

NEPA Effects: The effect of water operations on rearing habitat of California bay shrimp under Alternative 4 would be similar to that described for Alternative 1A (see Alternative 1A, Impact AQUA-203). For a detailed discussion, please see Alternative 1A, Impact AQUA-203. These effects would not be adverse.

CEQA Conclusion: As described above the impacts on California bay shrimp rearing habitat would be less than significant and no mitigation would be required.

Impact AQUA-204: Effects of Water Operations on Migration Conditions for Non-Covered Aquatic Species of Primary Management Concern

Also, see Alternative 1A, Impact AQUA-204 for additional background information relevant to non-covered species of primary management concern.

Striped Bass

NEPA Effects: Under Alternative 4 Scenario H3, average monthly flows in the Sacramento River downstream of the north Delta intake would be reduced 12–21% during the adult striped bass migration compared to baseline (NAA). Migration conditions for striped bass would be similar under all flow scenarios for Alternative 4. Sacramento River flows are highly variable inter-annually, but striped bass are still able to migrate upstream the Sacramento River during years of lower flows. The effect of reduced Sacramento flows under Alternative 4 would not be adverse.

CEQA Conclusion: Impacts would be as described immediately above and would be less than significant because the changes in flow under Scenario H3 (21–27% lower compared to Existing Conditions) would not interfere substantially with movement of pre-spawning striped bass through the Delta. Conditions would also be similar under the other flow scenarios for Alternative 4. No mitigation would be required.

American Shad

NEPA Effects: Flows in the Sacramento River below the north Delta diversion facilities under Scenario H3 would be reduced relative to the NEPA point of comparison (NAA) during March–May. Monthly flows on average under Scenario H3 would be reduced 14–21% relative to baseline (NAA). Conditions would be similar between Scenarios H1 and H3, while flows downstream of the north Delta intakes would be decreased less under Scenarios H4 relative to Scenario H3. Flows from the San Joaquin River at Vernalis would be unchanged under Alternative 4 flow scenarios. Sacramento River flows are highly variable inter-annually, and American shad are still able to migrate upstream the Sacramento River during lower flow years. Overall, the impact to American shad migration habitat conditions would not be adverse under Alternative 4.

CEQA Conclusion: Impacts would be as described immediately above and would be less than significant because the changes in flow under Scenario H3 (21–27% lower compared to Existing Conditions) would not interfere substantially with movement of American shad from the Delta to upstream spawning habitat. Flows would be less reduced under Scenario H4 because of reduced exports at the north Delta intakes compared to the other flow scenarios. No mitigation would be required.

Threadfin Shad

NEPA Effects: Threadfin shad are semi-anadromous, moving between freshwater and brackish water habitats. Threadfin shad found in the Delta do not actively migrate upstream to spawn. Therefore there is no effect on migration habitat conditions.

CEQA Conclusion: Impacts would be as described immediately above and would be less than significant because flow changes in the Delta under Alternative 4 would not alter movement patterns for threadfin shad. No mitigation would be required.

Largemouth Bass

NEPA Effects: Largemouth bass are non-migratory fish within the Delta. Therefore they do not use the Delta as a migration habitat corridor. There would be no effect.

CEQA Conclusion: As described immediately above, flow changes under Alternative 4 would not affect largemouth movements within the Delta. No mitigation would be required.

Sacramento Tule Perch

NEPA Effects: Similar with largemouth bass, Sacramento tule perch are a non-migratory species and do not use the Delta as a migration corridor as they are a resident Delta species. There would be no effect.

CEQA Conclusion: As described immediately above, flow changes would not affect Sacramento tule perch movements within the Delta. No mitigation would be required.

Sacramento-San Joaquin Roach

NEPA Effects: For Sacramento-San Joaquin roach, the overall flows and temperature in upstream rivers during migration to their spawning grounds would be similar to those described under Alternative 4, Impact AQUA-202 for spawning. As described there, the flows would slightly improve the upstream conditions relative to the NEPA point of comparison. These conditions would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of water operations on migration conditions for Sacramento-San Joaquin roach would be less than significant and no mitigation would be required.

Hardhead

NEPA Effects: For hardhead the overall flows and temperature in upstream rivers during migration to their spawning grounds would be similar to those described under Alternative 4, Impact AQUA-202 for spawning. As described there, the flows would slightly improve the upstream conditions relative to the NEPA point of comparison. These conditions would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of water operations on migration conditions for hardhead would be less than significant and no mitigation would be required.

California Bay Shrimp

NEPA Effects: The effect of water operations on migration conditions of California bay shrimp under Alternative 4 would be similar to that described for Alternative 1A (see Alternative 1A, Impact AQUA-204). For a detailed discussion, please see Alternative 1A, Impact AQUA-204. The effects would not be adverse.

CEQA Conclusion: As described above the impacts on California bay shrimp rearing habitat would be less than significant and no mitigation would be required.

Restoration Measures (CM2, CM4–CM7, and CM10)

The effects of restoration measures under Alternative 4would be similar for all non-covered species; therefore, the analysis below is combined for all non-covered species instead of analyzed by individual species.

Impact AQUA-205: Effects of Construction of Restoration Measures on Non-Covered Aquatic Species of Primary Management Concern

NEPA Effects: Refer to Impact AQUA-7 under delta smelt for a discussion of the effects of construction of restoration measures on non-covered species of primary management concern. The potential effects of the construction of restoration measures under Alternative 4 would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-7). For a detailed discussion, please see Alternative 1A, Impact AQUA-7. The effects would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of the construction of restoration measures would be less than significant and no mitigation would be required.

Impact AQUA-206: Effects of Contaminants Associated with Restoration Measures on Non-Covered Aquatic Species of Primary Management Concern

NEPA Effects: Refer to Impact AQUA-8 under delta smelt for a discussion of the effects of contaminants associated with restoration measures on non-covered species of primary management concern. The potential effects of the construction of contaminants associated with restoration measures under Alternative 4 would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-8). For a detailed discussion, please see Alternative 1A, Impact AQUA-8. The effects would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of the contaminants associated with restoration measures would be less than significant and no mitigation would be required.

Impact AQUA-207: Effects of Restored Habitat Conditions on Non-Covered Aquatic Species of Primary Management Concern

NEPA Effects: Refer to Impact AQUA-9 under delta smelt for a general discussion of the effects of restored habitat conditions on non-covered species of primary management concern. Although there are minor differences the effects are similar. The potential effects of restored habitat conditions under Alternative 4 would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-8 and AQUA-9). For a detailed discussion, please see Alternative 1A, Impact AQUA-8. In addition, see Alternative 1A, Impact AQUA-207 for a discussion of the different effects on non-covered species of primary management concern. The effects range from slightly beneficial to beneficial.

CEQA Conclusion: As described immediately above, the impacts of restored habitat conditions would range from slightly beneficial to beneficial and no mitigation would be required.

Impact AQUA-208: Effects of Methylmercury Management on Non-Covered Aquatic Species of Primary Management Concern (CM12)

NEPA Effects: Refer to Impact AQUA-10 under delta smelt for a discussion of the effects of methylmercury management on non-covered species of primary management concern. The potential effects of methylmercury management under Alternative 4 would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-10). For a detailed discussion, please see Alternative 1A, Impact AQUA-10. The effects would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of methylmercury management would be less than significant and no mitigation would be required.

Impact AQUA-209: Effects of Invasive Aquatic Vegetation Management on Non-Covered Aquatic Species of Primary Management Concern (CM13)

NEPA Effects: Refer to Impact AQUA-11 under delta smelt for a discussion of the effects of invasive aquatic vegetation management on non-covered species of primary management concern. The potential effects of invasive aquatic vegetation management under Alternative 4 would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-11) except for predatory species (striped bass and largemouth bass) and Sacramento tule perch. Invasive aquatic vegetation provides hiding habitat for predatory fish which improves their hunting success. Sacramento tule perch also use the cover of aquatic plants in the Sacramento and San Joaquin rivers and in Suisun marsh. Consequently, reducing the amount of invasive aquatic habitat will negatively affect these predatory species and Sacramento tule perch. However, this control will not substantially reduce the ability of the predatory species to hunt and there will still be many other habitats in which the predatory species can successfully hunt and in which Sacramento tule perch will thrive. The effect on them will not be adverse.

CEQA Conclusion: Refer to Impact AQUA-11 under delta smelt for a discussion of the effects of invasive aquatic vegetation management on non-covered species of primary management concern. There are minor differences and the effects are similar except for predatory species (striped bass and largemouth bass) and Sacramento tule perch. Invasive aquatic vegetation provides hiding habitat for predatory fish which improves their hunting success. Sacramento tule perch use the cover of aquatic plants in the Sacramento and San Joaquin rivers and in Suisun marsh. Consequently, reducing the amount of invasive aquatic habitat will negatively affect the predatory species and Sacramento tule perch. However, this control will not substantially reduce the ability of the predatory species to hunt and there will still be many other habitats in which the predatory species can successfully hunt and in which Sacramento tule perch will thrive. Therefore the effect on them will not be significant and no mitigation would be required.

Other Conservation Measures (CM12–CM19 and CM21)

The effects of other conservation measure under Alternative 4would be similar for all non-covered species; therefore, the analysis below is combined for all non-covered species instead of analyzed by individual species.

Impact AQUA-210: Effects of Dissolved Oxygen Level Management on Non-Covered Aquatic Species of Primary Management Concern (CM14)

NEPA Effects: Refer to Impact AQUA-12 under delta smelt for a discussion of the effects of dissolved oxygen management on non-covered species of primary management concern. The potential effects of dissolved oxygen management under Alternative 4 would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-12). For a detailed discussion, please see Alternative 1A, Impact AQUA-12. These effects would be beneficial.

CEQA Conclusion: As described immediately above, the impacts of oxygen level management would be beneficial and no mitigation would be required.

Impact AQUA-211: Effects of Localized Reduction of Predatory Fish on Non-Covered Aquatic Species of Primary Management Concern (CM15)

NEPA Effects: Refer to Alternative 1A, Impact AQUA-13 under delta smelt for a discussion of the effects of predatory fish (striped bass and largemouth bass) and predator management on non-predatory fish. The purpose of predatory fish management is to reduce the numbers of predatory fish and to reduce their hunting success. This management will have negative effects on predatory fish. However, the numbers of predatory fish are high and the extent of the habitats in which they hunt is extensive. Therefore the effects of this management will not be adverse.

CEQA Conclusion: Refer to Alternative 1A, Impact AQUA-13 under delta smelt for a discussion of the effects of predatory fish and predator management on non-predatory fish. The purpose of predatory fish management is to reduce the numbers of predatory fish and to reduce their hunting success. This management will have negative effects on predatory fish. However, the numbers of predatory fish are high and the extent of the habitats in which they hunt is extensive. Therefore the effects of this management will not be significant. No mitigation is required.

Impact AQUA-212: Effects of Nonphysical Fish Barriers on Non-Covered Aquatic Species of Primary Management Concern (CM16)

NEPA Effects: Refer to Impact AQUA-14 under delta smelt for a discussion of the effects of nonphysical fish barriers on non-covered species of primary management concern. The potential effects of nonphysical fish barriers under Alternative 4 would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-14). For a detailed discussion, please see Alternative 1A, Impact AQUA-14. The effects would be similar except for Sacramento-San Joaquin roach and hardhead which are unlikely to be present in their vicinity. California bay shrimp do not occur in these habitats and there would be no effect on them. The effects would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of nonphysical fish barriers would be less than significant and no mitigation would be required.

Impact AQUA-213: Effects of Illegal Harvest Reduction on Non-Covered Aquatic Species of Primary Management Concern (CM17)

NEPA Effects: Refer to Impact AQUA-15 under delta smelt for a discussion of the effects of illegal harvest reduction on non-covered species of primary management concern. The potential effects of illegal harvest reduction under Alternative 4 would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-15). For a detailed discussion, please see Alternative 1A, Impact AQUA-15. The effects would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of illegal harvest reduction would be less than significant and no mitigation would be required.

Impact AQUA-214: Effects of Conservation Hatcheries on Non-Covered Aquatic Species of Primary Management Concern (CM18)

NEPA Effects: Refer to Impact AQUA-16 under delta smelt for a discussion of the effects of conservation hatcheries on non-covered species of primary management concern. The potential effects of conservation hatcheries under Alternative 4 would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-16). For a detailed discussion, please see Alternative 1A, Impact AQUA-16. There would be no effect.

CEQA Conclusion: As described immediately above, conservation hatcheries would have no impact and no mitigation would be required.

Impact AQUA-215: Effects of Urban Stormwater Treatment on Non-Covered Aquatic Species of Primary Management Concern (CM19)

NEPA Effects: Refer to Impact AQUA-17 under delta smelt for a discussion of the effects of stormwater treatment on non-covered species of primary management concern. The potential effects of stormwater treatment under Alternative 4 would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-17). For a detailed discussion, please see Alternative 1A, Impact AQUA-17. The effects would be beneficial.

CEQA Conclusion: As described immediately above, the impacts of stormwater management would be beneficial and no mitigation would be required.

Impact AQUA-216: Effects of Removal/Relocation of Nonproject Diversions on Non-Covered Aquatic Species of Primary Management Concern (CM21)

NEPA Effects: Refer to Impact AQUA-18 under delta smelt for a discussion of the effects of removal/relocation of nonproject diversions on non-covered species of primary management concern. The potential effects of removal/relocation of nonproject diversions under Alternative 4 would be similar to those described for Alternative 1A (see Alternative 1A, Impact AQUA-18). For a detailed discussion, please see Alternative 1A, Impact AQUA-18. The effects would be similar except for Sacramento-San Joaquin roach, hardhead and Sacramento tule perch which are unlikely to be present near these diversions. The effects would not be adverse.

CEQA Conclusion: As described immediately above, the impacts of removal/relocation of nonproject diversions would be less than significant and no mitigation would be required.

Upstream Reservoirs

Impact AQUA-217: Effects of Water Operations on Reservoir Coldwater Fish Habitat

NEPA Effects: Similar to the description for Alternative 1A, this effect would not be adverse because coldwater fish habitat in the CVP and SWP upstream reservoirs under Alternative 4 would not be substantially reduced when compared to the No Action Alternative.

CEQA Conclusion: Similar to the description for Alternative 1A, Alternative 4 would reduce the quantity of coldwater fish habitat in the CVP and SWP as shown in Table 11-1A-102. There would be a greater than 5% increase (5 years) for several of the reservoirs, which could result in a significant impact. These results are primarily caused by four factors: differences in sea level rise, differences in climate change, future water demands, and implementation of the alternative. The analysis described above comparing Existing Conditions to Alternative 4 does not partition the effect of implementation of the alternative from those of sea level rise, climate change and future water demands using the model simulation results presented in this chapter. However, the increment of change attributable to the alternative is well informed by the results from the NEPA analysis, which found this effect to be not adverse. As a result, the CEQA conclusion regarding Alternative 4, if adjusted to exclude sea level rise and climate change, is similar to the NEPA conclusion, and therefore would not in itself result in a significant impact on coldwater habitat in upstream reservoirs. This impact is found to be less than significant and no mitigation is required.