3.5 Biological Resources—Aquatic

This section describes aquatic biological resources—specifically, sensitive fish habitat and important fish species—that could be affected by the proposed program. This section is composed of the following subsections:

- Section 3.5.1, "Environmental Setting," describes the physical conditions in the study area as they apply to aquatic biological resources.
- Section 3.5.2, "Regulatory Setting," summarizes federal, State, and regional and local laws and regulations pertinent to evaluation of the proposed program's impacts on aquatic biological resources.
- Section 3.5.3, "Analysis Methodology and Thresholds of Significance," describes the methods used to assess the environmental effects of the proposed program and lists the thresholds used to determine the significance of those effects.
- Section 3.5.4, "Environmental Impacts and Mitigation Measures for NTMAs," discusses the environmental effects of near-term management activities (NTMAs) and identifies mitigation measures for significant environmental effects.
- Section 3.5.5, "Environmental Impacts, Mitigation Measures, and Mitigation Strategies for LTMAs," discusses the environmental effects of long-term management activities (LTMAs), identifies mitigation measures for significant environmental effects, and addresses conditions in which impact analysis would be too speculative for evaluation (CEQA Guidelines, Section 15145).

NTMAs and LTMAs are described in detail in Section 2.4, "Proposed Management Activities."

In addition, see Section 3.6, "Biological Resources—Terrestrial," for a discussion of terrestrial sensitive habitats and sensitive plant and wildlife species.

3.5.1 Environmental Setting

Information Sources Consulted

Sources of information used to prepare this section include the following:

- *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* (NMFS 2009a)

- Discussions published in the *Federal Register* (FR) regarding the statuses of various aquatic biological resources

- *Inland Fishes of California* (Moyle 2002)

- *Working Paper: Habitat Restoration Actions to Double Natural Production of Anadromous Fish in the Central Valley of California* (USFWS 1995)

- *Recovery Plan for the Sacramento–San Joaquin Delta Native Fishes* (USFWS 1996)

- *Final Biological Opinion and Conference Opinion on the Long-Term Central Valley Project and State Water Project Operations Criteria and Plan. Endangered Species Act Section 7 Consultation* (NMFS 2009b)

- *Formal Endangered Species Consultation on the Proposed Coordinated Operations of the Central Valley Project (CVP) and State Water Project (SWP)* (USFWS 2008)

Geographic Areas Discussed

Aquatic biological resources are discussed only for the following geographic area within the study area (see Figure 1-4):

- Extended systemwide planning area (Extended SPA) divided into the Sacramento and San Joaquin Valley and foothills, and the Sacramento–San Joaquin Delta (Delta) and Suisun Marsh

The Extended SPA would experience nearly all of the potential effects of the proposed program on aquatic biological resources because almost all of the aquatic habitat in the study area is encompassed by the Extended SPA. In addition, none of the management activities included in the proposed program would be implemented in the SoCal/coastal CVP/SWP service areas. Also, implementation of the proposed program would not result in substantial or long-term reductions in water deliveries to the SoCal/coastal CVP/SWP service areas (see Section 2.6, “No Near- or Long-Term Reduction in Water or Renewable Electricity Deliveries”). Given these conditions, only negligible to no effects on aquatic resources, particularly native species, are expected in the portions of the Sacramento and San

Joaquin Valley watersheds that are beyond the Extended SPA or in the SoCal/coastal CVP/SWP service areas outside of the Sacramento and San Joaquin Valley watersheds. Therefore, those geographic areas are not discussed in detail in this section.

This section describes fish habitat first in the Sacramento and San Joaquin Valley and foothills, and then in the Delta and Suisun Marsh. Many of the fish species described are present both in waterways of the Sacramento and San Joaquin Valley and foothills and in the Delta and Suisun Marsh at some point in their life history; therefore, this section includes a single discussion of fish species for the entire Extended SPA.

Fish Habitat in the Extended Systemwide Planning Area

Numerous waterways in the Extended SPA are inhabited by native, sensitive, and/or recreationally valuable fish species that could be affected by the proposed program. The general characteristics of riverine aquatic habitats in the Extended SPA are described below, in the following order:

- Riverine aquatic habitats in waterways of the Sacramento and San Joaquin Valley and foothills:
  - Habitats in waterways below human-made structures or natural barriers that block upstream passage of fish
  - Habitats in the major floodplain bypasses
  - Reservoir habitat and conditions upstream from the major dams
- Aquatic habitats within the Delta and Suisun Marsh

Names and locations of various rivers, creeks, reservoirs, and other aquatic features in the Extended SPA are shown in Figures 3.13-1 and 3.13-2 in Section 3.13, “Hydrology.”

Sacramento and San Joaquin Valley and Foothills The Central Valley’s rivers consist of the Sacramento River and its main tributaries (Feather, Yuba, and American rivers and Cache Creek), the eastside tributaries (Cosumnes, Mokelumne, and Calaveras rivers), and the San Joaquin River and its tributaries (Merced, Tuolumne, and Stanislaus rivers). Fish habitat in these rivers is described below, along with habitat found in the major floodplain bypasses and reservoirs in the Sacramento and San Joaquin river systems.

Sacramento River The Sacramento River is California’s largest river system, one of the most important aquatic ecosystems in the State, and supports numerous fish species. Several key tributaries that feed the

Sacramento River—the Feather, Yuba, and American rivers and Cache Creek—are also important to aquatic resources. Most of these tributaries are especially important as spawning and rearing areas for anadromous species (species that spend part of their life cycle in the sea and return to their natal freshwater streams to spawn).

The Sacramento River is divided into three segments based on geomorphology: the upper segment, which extends from Keswick Dam to Red Bluff Diversion Dam (RBDD); the middle segment, which extends from RBDD to Colusa; and the lower segment, which extends from Colusa to the Delta. The upper Sacramento River tends to retain a more natural geomorphology, but downstream from RBDD, the river channels are confined by levees. Very different types of fish habitats are found in each segment, supporting either different species or different life stages of fish.

The upper Sacramento River typically has cool water temperatures because of regulated releases from Shasta and Keswick dams. In this segment, the river channel is stable and confined with little meander, and largely natural with some human-made portions. Riffle habitat with gravel substrates and deep pool habitats are more abundant than in reaches downstream from RBDD. Despite net losses of gravel that occurred after Shasta Dam was constructed, substrates in much of the upper Sacramento River contain gravel that salmonids need to spawn. This stretch of river provides much of the remaining spawning and rearing habitat of several anadromous fishes listed under the Federal Endangered Species Act (ESA) or the California Endangered Species Act (CESA). Therefore, the upper Sacramento River is one of the most sensitive and important sections of any river in California for native anadromous salmonids and green sturgeon (*Acipenser medirostris*).

Downstream from RBDD, the middle Sacramento River functions as a large alluvial river with active meander migration along the valley floor. This portion of the river is classified as meandering, and relatively stable, straight sections alternate with more sinuous, dynamic sections (SRCAF 2003). Point bars, islands, high and low terraces, instream woody cover, early successional riparian plant growth, and other evidence of river meander and erosion are common. Channel width varies and aquatic habitats consist of shallow riffles, deep runs, deep pools at bends, glides in straight reaches, and shallow vegetated floodplain areas that are inundated during high flows. This stretch of river is used by rearing and migrating salmonids, with some salmonids spawning in the upper portion. Green sturgeon, Sacramento splittail (*Pogonichthys macrolepidotus)*, striped bass (*Morone saxatilis*), and numerous other species also inhabit the middle Sacramento River.

Downstream from Colusa, the lower Sacramento River changes drastically from a dynamic and active meandering channel to a confined (i.e., restricted from migration) narrow channel. Setback levees exist along portions of the river upstream from Colusa, but levees encroach on and narrow the river channel as the river continues south to the Delta. Surrounding agricultural lands encroach directly on the levees, which have cut off the river from most of its riparian corridor, especially on the east side of the river. Most of the levees along the lower Sacramento River are lined with riprap, which reduces the ability of the levees to contribute erodible substrate, reduces habitat variability, and nearly eliminates the processes that lead to the development of complex shaded riverine aquatic (SRA) habitat preferred by native species, and is further described below. Channel width is fairly uniform, and river bends are essentially nonexistent in the straightened channel confined by levees. Therefore, aquatic habitats are fairly homogenous because depth profiles and substrate composition are fairly uniform throughout the reach.

Shaded riverine aquatic habitat is defined as the nearshore aquatic area at the interface between the river and adjacent riparian habitat. Such habitat has two principal attributes: an adjacent bank composed of natural, eroding substrates that support riparian vegetation that either overhangs or protrudes into the water; and water that contains variable amounts of instream woody material (IWM) such as leaves, logs, branches, roots, and detritus and has variable velocities, depths, and flows. The USFWS Mitigation Policy has classified shaded riverine aquatic habitat as Resource Category 1 because substantial amounts of such habitat have been lost along the Sacramento River, primarily from levee construction and installation of rock revetment (Fris and Dehaven 1993). The criterion for designating habitat in Resource Category 1 is identified as habitat that is of high value for evaluation species and is unique and irreplaceable on a national basis or in the ecoregion section that could be affected. The mitigation goal for habitat in Resource Category 1 is “no loss of existing habitat value.”

Main Tributaries to the Sacramento River Main tributaries to the Sacramento River within the Sacramento and San Joaquin Valley and foothills consist of the Feather, Yuba, and American rivers and Cache Creek. Aquatic habitats found in these tributaries are discussed below.

Feather River Aquatic habitats found in the lower Feather River vary as the river flows downstream from DWR’s Oroville Dam facilities to the confluence with the Sacramento River at Verona. The low-flow channel of the lower Feather River is approximately 8 miles long and conveys about 600 cubic feet per second (cfs) under current agreement with the California Department of Fish and Game (DFG). The low-flow channel contains mainly riffles and runs, which provide spawning habitat for most Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*) in the Feather River. Also present in the Feather River's low-flow channel are a series of remnant gravel pit pools/ponds that connect to the main channel. This stretch of the river is fairly confined by levees or high natural banks as it flows through the city of Oroville. The Feather River Salmon and Steelhead Hatchery has been successful in raising fall-run and spring-run Chinook salmon and Central Valley steelhead. However, this effort has caused hatchery-bred salmon and steelhead to dominate the run returns because ocean conditions and in-river habitat have not been optimum for wild production. The hatchery has transitioned to practices that intend to reduce the effects of the hatchery-raised fish on natural production, particularly for the spring-run.

From the downstream end of the low-flow channel, the Feather River is fairly active as it meanders south to Marysville; however, this stretch is bordered by active farmland, which confines the river in an incised channel in certain stretches. Minimum flow requirements are being established for the lower Feather River through the Federal Energy Regulatory Commission's Oroville Facilities relicensing process (DWR 2006). Green and white sturgeon (*Acipenser transmontanus*), American shad (*Alosa sapidissima*), and striped bass can be found in the lower Feather River.

Yuba River The lower Yuba River (downstream from Englebright Dam) is approximately 25 miles long, with about 16 miles of spawning habitat suitable for Chinook salmon. The upstream section of the lower Yuba River is confined by narrow bedrock cliffs and has minimal gravel input. Downstream from the "narrows," the river consists primarily of cobble/boulder substrate, much of which derives from historic and active mining activities. The mix of deep pools and riffle and run habitat provides healthy habitat conditions for salmonids. The channel is confined by cobble training walls. Daguerre Point Dam, approximately 11 miles upstream from the confluence with the Feather River, is a sediment retention dam that acts as a barrier for sturgeon and other fish (including striped bass and American shad) that cannot pass over the ladders. Under certain flow conditions, the ladder at Daguerre Point Dam is also an impassable barrier to salmon. Because of its substrate condition, the lower Yuba River meanders, with numerous gravel islands in the channel. It also changes its path after high-flow events. Flow requirements, which vary based on water year type, have been set for the Yuba River by the Yuba River Accord to ensure suitable conditions for Chinook salmon, steelhead, and American shad (SWRCB 2008).

The lower Yuba River sustains one of the few remaining natural (nonhatchery) populations of Chinook salmon and steelhead in the Central

Valley. Strays from the Feather River Salmon and Steelhead Hatchery and other Central Valley hatcheries can also be found there.

American River The lower American River (downstream from Nimbus Dam) is approximately 23 miles long, has a fairly low gradient, and has riffle, run, glide, and pool habitats. Multiple dams in the watershed have reduced gravel inputs to the system; however, the lower American River contains large gravel bars and side channels in many locations, forming gravel/cobble islands within the channel. Most of the lower American River is surrounded by the American River Parkway, preserving the surrounding riparian zone. The river channel is confined and incised with tall cliffs and bluffs adjacent to the river.

The State Water Resources Control Board (SWRCB) established minimum flow requirements for the lower American River through Water Right Decision 893 in 1958. However, the standards in that water right decision were deemed insufficient to protect fisheries by the SWRCB; the U.S. Department of the Interior, Bureau of Reclamation (Reclamation); and the Water Forum (a group of business and agricultural leaders, citizens' groups, environmentalists, water managers, and local governments in the Sacramento region). Therefore, flow management standards were developed with two coequal goals: (1) reliable and safe water supply; and (2) fish, wildlife, recreation, and aesthetic preservation (Water Forum 2004). Chinook salmon, steelhead, American shad, and striped bass spawn in the lower American River.

Cache Creek Within the Extended SPA, Cache Creek extends from the outlet of Clear Lake to the Yolo Bypass. Flows along the entire length of Cache Creek result from dam releases and diversions. Clear Lake is one of the largest freshwater lakes in California, and has the largest surface area of any freshwater lake in California. The lake's level is regulated by a dam at the outlet to Cache Creek. Before reaching the Sacramento River, Cache Creek flows into the Cache Creek Settling Basin and through the Yolo Bypass.

Eastside Tributaries Eastside tributaries within the Sacramento and San Joaquin Valley and foothills consist of the Cosumnes, Mokelumne, and Calaveras rivers. These rivers flow into the Delta. Aquatic habitats found in these tributaries are discussed below.

Cosumnes River The Cosumnes River and its tributaries have no large dams, but Reclamation operates two small dams on this river as part of the CVP. The Cosumnes River supports a spawning population of Chinook salmon, with historic populations estimated up to 17,000 spawners. However, since the 1960s, populations have ranged between 0 and 5,000 (USFWS 1995). Declines have been assumed to be caused by reduced river flows; at times the river even goes dry or subsurface preventing or delaying upstream migration. The lower reaches of the Cosumnes River also provide important rearing habitat for Sacramento splittail.

Mokelumne River Anadromous salmonids spawn and rear in approximately 33.5 miles of the regulated Mokelumne River downstream from East Bay Municipal Utility District's Camanche Dam. The 6 miles immediately downstream from the dam are characterized by large gravels and cobble, which change into a sand, mud, and sandstone substrate, with steeper gradients and riffle habitat. This stretch of river contains nearly all the suitable spawning habitat for Chinook salmon and steelhead in the Mokelumne. Downstream from this spawning habitat, the river is low gradient, characterized by alternating bar-complex and flat-water habitats.

Mokelumne Dam, approximately 20 miles downstream from Camanche Dam, blocks access by species such as green sturgeon and striped bass that cannot pass over fish ladders. Below the dam, the river is primarily low-gradient run-pool habitat, with riparian debris in the channel and short sections of low-gradient riffles. During low-flow periods, the river channel may develop shallow riffles, impeding passage for both adult and juvenile salmonids. The banks along most of this river reach have substantial riparian growth.

Calaveras River Approximately 36–38 miles of the Calaveras River downstream from New Hogan Dam are accessible to anadromous fish. Two pathways to the upper portion of the lower Calaveras River, which are split by Bellota Dam, are available: the old Calaveras River channel (36 miles) and Mormon Slough via the Stockton Diverting Canal (38 miles). The latter is the main migration route used by anadromous salmonids due to higher diverted flows into Mormon Slough. Upstream from Bellota Dam, the Calaveras River is considered excellent salmonid habitat, with cold-water, riparian forests that include riparian vegetation and orchards, and floodplain habitat (Fishery Foundation of California 2004).

Downstream from Bellota Dam, the Calaveras River may have no flows other than tributary inputs from November through mid-April. In the reach downstream from the Stockton Diverting Canal, the river receives urban runoff from storm outlets, and has patches of native riparian and nonnative herbaceous and woody vegetation along its banks. Some sections in this reach have dense native riparian vegetation; others have dense stands of invasive species such as giant reed (*Arundo donax*) and Himalayan blackberry (*Rubus discolor*) that encroach the river channel and banks.

Near its confluence with the San Joaquin River, the lower Calaveras River is a narrow, managed, tidally influenced canal (DWR 2007).

San Joaquin River The San Joaquin River currently does not support spawning anadromous salmonids upstream from the confluence with the Merced River; however, with the ongoing implementation of the San Joaquin River Restoration Program (SJRRP), self-sustaining populations of spring-run Chinook salmon and steelhead are expected to be reestablished. The time frame for reintroduction is as follows: (1) a Reintroduction Period between the present and December 31, 2019; (2) an Interim Period between January 1, 2020, and December 31, 2024; (3) a Growth Population Period between January 1, 2025, and December 31, 2040; and (4) a Long-term Period beyond January 1, 2041. The San Joaquin River provides a migratory corridor for salmonids to its major tributary rivers.

With successful implementation of the SJRRP, primary habitat for salmonid spawning and rearing would occur in the 37 miles between Friant Dam and Gravelly Ford. The river in this section is an incised, gravel-bedded channel that has been affected by gravel mining, reduced flows and high water temperatures, and introduced aquatic and riparian species. Downstream sections are meandering, low-gradient channels, often with sparse riparian vegetation, low to no flows, and high water temperatures, and are constrained by levees. The section of the San Joaquin River defined by the SJRRP as Reach 4B extends from the Sand Slough Control Structure to where the flood flows in the bypass system rejoin the mainstem of the San Joaquin River and continue to the confluence of the Eastside Bypass. Reach 4B has been perennially dry for more than 40 years, except when agricultural return flows are put through the channel, leaving standing water in many locations. As a result, the upstream end of the Reach 4B channel is poorly defined with dense vegetation and other fill material. The riparian corridor upstream from the Mariposa Bypass is narrow, but nearly unbroken. The downstream portion of Reach 4B contains wider floodplains than upstream reaches and vast areas of natural vegetation.

Downstream from the confluence with the Merced River, the San Joaquin River is a relatively wide (approximately 300-foot-wide) channel with little canopy or overhead vegetation and minimal bank cover. Aquatic habitat in the San Joaquin River is characterized primarily by slow-moving glides and pools, is depositional in nature, and has limited water clarity and habitat diversity. Many of the fish species in the lower San Joaquin River use this lower segment of the river to some degree, even if only as a migratory pathway to and from upstream spawning and rearing areas.

Main Tributaries to the San Joaquin River Main tributaries to the San Joaquin River within the Sacramento and San Joaquin Valley and foothills consist of the Merced, Tuolumne, and Stanislaus rivers, all of which support populations of Chinook salmon and steelhead. Aquatic habitats found in these tributaries are discussed below.

Merced River The 10 miles of the Merced River between Crocker-Huffman Dam—the current barrier for fish passage—and State Route 59 are where most Chinook salmon and steelhead spawn. This reach has moderate flow and is confined by piles of dredger tailings and sparse riparian vegetation. Gravel mining pits are common for approximately 20 miles. The middle stretch of river (approximately 18 miles) is a low-gradient, meandering, and levee-confined system in a narrow corridor, often isolated from its floodplain. The lower 8 miles of the Merced River are sand-bedded, with the most extensive and continuous stand of native riparian vegetation in the river.

Tuolumne River The Tuolumne River provides roughly 52 miles of waterway accessible to anadromous salmonids. The lower Tuolumne River has two distinct geomorphic zones: a gravel-bedded zone (upper 28 miles) and a sand-embedded zone (lower 24 miles). The gravel-bedded zone is characterized by gravel beds, a discontinuous riparian corridor, gravel mining pits, and dredger tailings. The sand-embedded zone is more affected by urban runoff and encroachment and is dominated by sandy substrate.

Stanislaus River Aquatic habitats in the lower Stanislaus River vary longitudinally. The river provides spawning, rearing, and/or migratory habitat for a diverse assemblage of common Central Valley native and nonnative fish species. Aquatic habitats consist of riffles, runs, pools, and glides. Floodplain and associated riparian habitat vary with the presence of levees and encroachment of agricultural and urban uses.

Floodplain Bypasses Three major floodplain bypasses in the Sacramento River system—the Butte Basin, Sutter Bypass, and Yolo Bypass—provide access to broad, inundated floodplain habitat during most years. These bypasses, located along the mainstem of the Sacramento River, include 10 overflow structures: six weirs, three flood relief structures, and an emergency overflow roadway. The San Joaquin River system has fewer developed bypass systems—the Chowchilla and Eastside bypasses. These bypasses are not used extensively by fish, but the SJRRP is anticipated to modify portions of the lower bypass system to facilitate salmon migration.

Unlike other Sacramento River and Delta habitats, floodplains and floodplain bypasses are seasonally dewatered (as high flows recede) from late spring through autumn. This prevents introduced fish species from establishing year-round dominance except in perennial water sources (Sommer et al. 2003). Moreover, many native fish are adapted to spawn and rear in winter and early spring during the winter flood pulse (Moyle 2002). Introduced fish typically spawn from late spring through summer when most of the floodplain is not available to them.

Butte Basin The Butte Basin lies east of the Sacramento River, extending from the Butte Slough outfall gates near Meridian to Big Chico Creek near Chico Landing. Flood flows are diverted out of the Sacramento River into the Butte Basin and Sutter Bypass via several designated flow relief structures into overflow areas (i.e., low points along the east side of the river) that allow high flood flows to exit the Sacramento River channel.

Sutter Bypass The Sutter Bypass is a narrow floodwater bypass that conveys Feather and Sacramento river flood flows from the Butte Basin, and Colusa, Moulton, and Tisdale weirs. The bypass area is an expansive land area in Sutter County used mainly for agriculture. In times of high water (when the river stage exceeds 45.45 feet), Sacramento River water enters the bypass through the Butte Slough outfall and Tisdale Weir, inundating the bypass with as much as 12 feet of water. The Sutter Bypass, in turn, conveys flows to the lower Sacramento River region at the Fremont Weir near the confluence with the Feather River, and then into the Sacramento River and the Yolo Bypass.

Yolo Bypass The Yolo Bypass is a land area of approximately 59,000 acres that conveys Sacramento River floodwaters around Sacramento during times of high runoff. Flows are diverted from the Sacramento River into the bypass when the river stage exceeds 33.5 feet (corresponding to 56,000 cfs at Verona). Fremont Weir controls Sacramento River flood stages at Verona by diverting most floodwaters from the Sacramento River into the Yolo Bypass. The Sacramento Weir, just north of Sacramento, diverts flows into the Yolo Bypass downstream of the Fremont Weir. During large flood events, up to 80 percent of Sacramento River flows are diverted into the bypass. The Yolo Bypass also collects flows from the Cache Creek settling basin, Willow Slough, Knights Landing Ridge Cut, and Putah Creek.

Chowchilla Bypass The Chowchilla Bypass Bifurcation Structure regulates the flow split between the San Joaquin River and the Chowchilla Bypass. The Chowchilla Bypass extends to the confluence of Ash Slough and is approximately 22 miles long, leveed, and 600–700 feet wide. Sand deposits are removed from the bypass as needed, and vegetation is periodically removed from the channel.

Eastside Bypass The Eastside Bypass circumvents 32.5 miles of the San Joaquin River. This bypass extends from the confluence of Ash Slough and the Chowchilla Bypass to the confluence with the San Joaquin River. Within the Eastside Bypass, the Mariposa Bypass connects the Eastside Bypass to Reach 4B of the San Joaquin River. The Eastside Bypass is subdivided into three sections:

- Section 1 extends from Ash Slough to the Sand Slough Bypass confluence. This reach receives flows from the Chowchilla River at river mile (RM) 136.
- Section 2 extends from the Sand Slough Bypass to the head of the Mariposa Bypass at RM 147.2.
- Section 3 extends from the head of the Mariposa Bypass to the San Joaquin River at RM 168.5, and receives flows from Deadman, Owens, and Bear creeks.

Reservoirs Reservoirs have been one of the major sport-fish habitats in the Central Valley since the advent of the SWP and CVP. Numerous reservoirs exist in the Extended SPA: Shasta Lake, Lake Oroville, Englebright Reservoir, Clear Lake, Folsom Lake, Camanche Reservoir, New Hogan Reservoir, New Melones Reservoir, New Don Pedro Reservoir, Lake McClure, and Millerton Lake.

The nature of each reservoir and its fish fauna is determined by the reservoir’s size, elevation, location, and water quality. In general, reservoirs are much less productive per surface acre than natural lakes because reservoirs are generally deep, steep-sloped basins, and fluctuating water levels greatly limit habitat diversity. Central Valley reservoirs generally fall into one of two categories: warm-water reservoirs, suitable for black bass, sunfish, and catfish; or “two-story” reservoirs that contain a zone of deep, well-oxygenated water in summer that is suitable for trout, topped by warm-water surface waters suitable for black bass, sunfish, and catfish.

Warm-water reservoirs usually have low fertility and yield relatively small crops of game fish. Because of extensive drawdowns, inshore zones inhabited by warm-water species are usually relatively unproductive. The deep, open-water portion of a large reservoir also does not provide satisfactory habitat for most game fish.

Extreme water-level fluctuation in reservoirs is perhaps the most important environmental factor influencing the productivity of reservoir fish populations, and is a direct result of reservoir management priorities.

Fluctuating water levels are largely responsible for other fishery management problems, such as limited cover habitat, limited littoral habitat, and shoreline erosion. Central Valley reservoirs operate to store water during winter and spring and then release water in summer and fall. This pattern of storage and releases results in variable, seasonal availability of water in reservoirs. Surface-water elevation fluctuations in some Central Valley reservoirs could exceed 100 vertical feet annually.

Delta and Suisun Marsh The Delta, and Suisun Marsh on the western edge of the Delta, are located at the confluence of the Sacramento and San Joaquin rivers. This is the most important, complex, and controversial geographic area in California for anadromous fish production, estuarine fish species, introduced fish species, and distribution of water resources for numerous beneficial uses.

The Delta's environmental conditions depend primarily on the physical structure of Delta levees and channels, inflow volume and source, Delta Cross Channel operations, Delta exports and diversions, and tides. The CVP and SWP affect Delta conditions primarily by controlling upstream storage and diversions, reservoir releases, Delta water conveyance pathways, and Delta exports and diversions. These factors also determine Delta outflow and the location of the entrapment zone, an area of high organic carbon that is critically important to numerous fish and invertebrate species and to the overall ecology of the Delta and Suisun Marsh.

In addition to these physical factors, environmental conditions contribute to interactive, cumulative conditions that substantially affect Delta fish populations. Water temperature, predation (primarily by introduced fish species), food production and availability, competition with introduced exotic fish and invertebrate species, reduced habitat complexity, and pollutant concentrations are all important contributors to cumulative conditions.

An estimated 25 percent of all sportfishing for warm-water and anadromous species and 80 percent of California's commercial fishery depend on species that live in or migrate through the Delta. The Delta serves as a migration corridor for all Central Valley anadromous species as they return to their natal rivers to spawn, and during juvenile outmigration downstream to the ocean. Adult Chinook salmon move through the Delta during most months of the year. Salmon and steelhead juveniles depend on the Delta as transient rearing habitat while they migrate through the system to the ocean; these juveniles could remain for several months, feeding in marshes, tidal flats, and sloughs. All life stages of striped bass are found in the Delta and approximately 45 percent of striped bass spawn there. Numerous resident species live in the Delta year round, such as delta smelt, Sacramento splittail, and introduced threadfin shad (*Dorosoma petenense*).

Since about 2002, four pelagic (occupying the open water) fish species have been subject to the Pelagic Organism Decline (POD) (Sommer et al. 2007). The POD refers to the sudden, overlapping declines of pelagic fishes in the San Francisco Bay/Sacramento–San Joaquin Delta estuary (Bay-Delta) that were first recognized in data collected in 2002–2004. The species identified in the POD consist of delta smelt, longfin smelt, threadfin shad, and (age-0) striped bass. Together, these species account for most of the resident pelagic fish biomass in the tidal water upstream from X2, the position at which 2 parts per thousand (ppt) salinity occurs in the Bay-Delta.

The declines of three of the four POD species became noticeable between 2001 and 2002; however, studies have revealed that at least for delta smelt, the POD downtrend actually began earlier, around 1999 (Manly and Chotkowski 2006, as cited in USFWS 2008). Abundance indices for the POD species since 2001 have included record lows for all but threadfin shad. The causes of the POD and earlier declines are not fully understood, but studies are under way to evaluate potential causes. Among these potential causes are the stock-recruitment relationship (i.e., previous abundance), a decrease in habitat carrying capacity or production potential, predation and entrainment, and a decline in primary productivity (Moyle et al. 1992; Bennett 2005; Feyrer et al. 2007; Baxter et al. 2010). In 2011, both delta smelt and longfin smelt populations showed an increase, with delta smelt populations at their highest since 2001 and longfin smelt at their highest since 2006. However, these increases are still a fraction of historic abundances.

Fish Species in the Extended Systemwide Planning Area

Various fish species in the Extended SPA are considered important either for their legal status or for their economic, ecological, or recreational value. The lower Sacramento and San Joaquin rivers, their tributaries, and the Delta and Suisun Marsh provide vital fish spawning, rearing, and/or migratory habitat for a diverse assemblage of native and nonnative species. The key life stages and needs of the species of primary management concern with the greatest potential to be affected by the proposed program are discussed below. These species collectively represent a diversity of life histories and environmental/habitat requirements, and they are among the most sensitive to environmental perturbation; therefore, findings from assessments of these species can be effectively used to make inferences about other fish species that use the Extended SPA. The seasonal timing of important life stages for these species in the study area is presented (represented by the gray boxes) in Table 3.5-1. Special-status species and occurrence within the Extended SPA are shown in Table 3.5-2.

Table 3.5-1. Life History and Distributions of Life Stages for Key Fish Species in the Extended Systemwide Planning Area

Life Stage/ Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fall-Run Chinook Salmon												
Adult migration							■	■	■	■	■	■
Spawning										■	■	■
Egg incubation	■	■	■							■	■	■
Rearing/emigration	■	■	■	■	■	■						
Late Fall–Run Chinook Salmon												
Adult migration	■	■	■								■	■
Spawning	■	■	■	■								
Egg incubation	■	■	■	■	■	■						
Rearing/emigration				■	■	■	■	■	■	■	■	■
Winter-Run Chinook Salmon												
Adult migration	■	■	■	■	■	■						■
Spawning				■	■	■	■	■				
Egg incubation				■	■	■	■	■	■	■		
Rearing/emigration	■	■	■				■	■	■	■	■	■
Spring-Run Chinook Salmon												
Adult migration			■	■	■	■	■	■	■	■		
Spawning								■	■	■	■	
Egg incubation								■	■	■	■	■
Rearing/emigration	■	■	■	■	■						■	■
Steelhead												
Adult migration	■	■	■				■	■	■	■	■	■
Spawning	■	■	■	■								■
Egg incubation	■	■	■	■	■	■	■	■				■
Rearing/emigration	■	■	■	■	■	■	■	■	■	■	■	■
Green Sturgeon												
Adult migration		■	■	■	■	■	■					
Spawning		■	■	■	■	■	■					
Egg incubation		■	■	■	■	■	■					
Rearing/emigration	■	■	■	■	■	■	■	■	■	■	■	■
Pacific Lamprey												
Adult migration					■	■	■	■	■	■		
Spawning	■	■	■	■	■	■	■					
Larvae and Juvenile Rearing	■	■	■	■	■	■	■	■	■	■	■	■
Emigration	■	■	■	■	■	■	■					
Delta Smelt												
Adult migration	■	■	■									■
Spawning	■	■	■	■	■	■	■					
Larvae and juvenile rearing	■	■	■	■	■	■	■					
Estuarine rearing	■	■	■	■	■	■	■	■	■	■	■	■
Longfin Smelt												
Adult migration	■	■	■									■
Spawning	■	■	■	■	■	■	■					
Larvae and juvenile rearing	■	■	■	■	■	■	■					
Estuarine rearing	■	■	■	■	■	■	■	■	■	■	■	■
Sacramento Splittail												
Adult migration	■	■	■									■
Spawning	■	■	■	■	■	■	■					
Larvae and juvenile rearing			■	■	■	■						
Adult and juvenile rearing	■	■	■	■	■	■	■	■	■	■	■	■

Table 3.5-1. Life History and Distributions of Life Stages for Key Fish Species in the Extended Systemwide Planning Area (contd.)

Life Stage/ Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hardhead												
Adult foraging and spawning					■	■	■					
Spawning						■	■	■	■	■		
Larvae and juvenile rearing						■	■	■	■	■		
Adult and juvenile rearing	■	■	■	■	■	■	■	■	■	■	■	■
Striped bass												
Adult migration			■	■	■	■	■	■				
Spawning						■	■	■	■	■		
Larvae and juvenile rearing						■	■	■	■	■		
Adult and juvenile rearing	■	■	■	■	■	■	■	■	■	■	■	■

Sources:Moyle 2002; Wang 1986; NMFS 2005
Key:
■ = period of potential occurrence

Table 3.5-2. Special-Status Species and Occurrence Within the Extended Systemwide Planning Area

Species	Status	Distribution
Central Valley fall-/ late fall–run Chinook salmon	SSC, SC	Sacramento and San Joaquin rivers and their major tributaries, Eastside Tributaries; Delta, Suisun Bay; Suisun and Napa marshes, San Francisco Bay, Pacific Ocean
Central Valley spring-run Chinook salmon	ST, FT	Feather, Sacramento, and Yuba rivers; Beegum, Battle, Clear, Cottonwood, Antelope, Mill, Deer, Butte, and Big Chico creeks; Delta, Suisun Bay; Suisun and Napa marshes, San Francisco Bay, Pacific Ocean
Sacramento River winter-run Chinook salmon	SE, FE	Sacramento River (Keswick Dam to Chipps Island); Delta, Suisun Bay; Suisun and Napa marshes, San Francisco Bay, Pacific Ocean
Central Valley steelhead	FT	Sacramento and San Joaquin rivers and their major tributaries, Eastside Tributaries; Delta, Suisun Bay; Suisun and Napa marshes, San Francisco Bay, Pacific Ocean
Southern distinct population segment of the North American green sturgeon	FT	Sacramento River; lower Feather River; Yuba River; ; Delta, Suisun Bay; Suisun and Napa marshes; San Francisco Bay, Pacific Ocean
Delta smelt	SE, FT	Lower Sacramento River; lower San Joaquin River, San Joaquin River ; Delta, San Francisco Bay, Pacific Ocean
Longfin smelt	ST, Federal Status Review underway	Klamath, Eel, and San Francisco Bay/Sacramento–San Joaquin Delta estuaries; Delta, Suisun Bay; Suisun and Napa marshes , San Francisco Bay
Sacramento splittail	SSC	Delta; Suisun Bay; Suisun and Napa marshes; Sacramento and San Joaquin rivers
Hardhead	SSC, SC, USFS sensitive species	Low/mid-elevation streams in Sacramento and San Joaquin river watersheds
Pacific lamprey	No status	Sacramento and San Joaquin rivers and their major tributaries; Delta, San Francisco Bay, Pacific Ocean
River lamprey	SSC	Sacramento and San Joaquin rivers and their major tributaries
Striped bass	No status	Sacramento River and its major tributaries; San Joaquin River; ; Delta, San Francisco Bay, Pacific Ocean

Source: Data compiled by MWH in 2011
Key:
Delta = Sacramento–San Joaquin Delta
SSC = State species of special concern
SC = Federal species of concern
ST = State threatened species
SE = State endangered species
FT = Federal threatened species
FE = Federal endangered species
USFS = U.S. Forest Service

Chinook Salmon The Sacramento River and its tributaries support four separate runs of Chinook salmon—fall-run, late fall–run, winter-run, and spring-run, denoting when adults enter freshwater and begin their upstream migration. Spring-run Chinook salmon are both State-listed and federally listed as threatened. Winter-run Chinook salmon are both State-listed and federally listed as endangered. Fall- and late fall–run salmon are not currently listed by either the State or federal government, but because of low population numbers, the State identified them as a species of special concern and the National Marine Fisheries Service (NMFS) identified them as a species of concern. Most Chinook salmon and all steelhead spawn between Keswick Dam and RBDD, but fall-run Chinook salmon spawn as far downstream as Colusa. The San Joaquin River tributaries currently support only fall-run Chinook salmon, although with implementation of the SJRRP, spring-run Chinook salmon are expected to be successfully reintroduced.

Fall-Run Chinook Salmon On March 9, 1998 (63 FR 11481), NMFS issued a proposed rule to list fall-run Chinook salmon as threatened; however, NMFS determined that the fall-run did not warrant listing and identified it as a candidate species (64 FR 50393, September 16, 1999). NMFS also determined that both late fall–run and fall-run are a single evolutionarily significant unit (ESU), but because they are separate in timing and effects, they are distinguished as separate in this document. They later designated Central Valley fall- and late fall–run as a species of concern (69 FR 19975, April 15, 2004).

Adult fall-run Chinook salmon migrate from July through December. Fall-run Chinook salmon spawn between early October and late December, and incubation takes place from October through March. Spawning activity peaks in October and November as water temperature drops. Fall-run Chinook salmon move upstream from the ocean in the late summer and early fall in mature condition and spawn soon after arriving at their spawning grounds. Juvenile Chinook salmon emerge from the gravel and migrate downstream to the ocean soon after emerging, rearing in the streams for only few months.

Late Fall–Run Chinook Salmon Late fall–run Chinook salmon mostly inhabit the Sacramento River, spawning upstream from RBDD. They migrate into the Sacramento River between October and April and spawn from January through April. Spawning activity peaks in February and March, followed by egg incubation from January through June and fry emergence from April through June. Rearing and emigration of fry and smolts occur from April through December. Juvenile late fall–run Chinook salmon rear in the streams during the summer; in some streams, they remain throughout the year.

Sacramento River Winter-Run Chinook Salmon The Sacramento River upstream from RBDD is the only currently known spawning reach for winter-run Chinook salmon, which have been in a major decline since the 1960s. The sharp decline in adult escapement during the late 1980s and early 1990s prompted listing of the winter-run Chinook salmon ESU as endangered under the ESA on January 4, 1994 (59 FR 440), and under the CESA on September 22, 1989. In 2009 NMFS submitted a draft recovery plan that includes proposed management actions to help protect Sacramento River winter-run Chinook salmon (NMFS 2009a).

The portion of the Sacramento River from Keswick Dam to Chipps Island (near Suisun Bay), all waters in the Delta westward from Chipps Island to the Carquinez Bridge, all waters of San Pablo Bay, and all waters of San Francisco Bay north of the San Francisco–Oakland Bay Bridge have been designated as critical habitat for winter-run Chinook salmon (58 FR 33212, June 16, 1993). Critical habitat consists of the river water, river bottom, and adjacent riparian zone (i.e., those adjacent terrestrial areas that directly affect a freshwater aquatic ecosystem).

Adult winter-run Chinook salmon leave the ocean and migrate through the Delta into the Sacramento River from November through July, passing RBDD on the Sacramento River between mid-December and July. Spawning takes place from mid-April through August, and egg incubation continues through mid-October.

Juvenile winter-run Chinook salmon rear in the upper Sacramento River from July through March (Hallock and Fisher 1985). Juveniles move downstream in the river from August through October, and possibly through November. Juveniles have been observed in the Delta from October through December. In general, juvenile abundance in the Delta increases in response to increased Sacramento River flow (USFWS 1995). The Sacramento River channel is their main migration route through the Delta.

Spring-Run Chinook Salmon On September 16, 1999, NMFS listed the Central Valley spring-run Chinook salmon ESU as threatened under the ESA. The Central Valley spring-run Chinook salmon ESU consists of all naturally spawned populations of spring-run Chinook salmon in the Sacramento River and its tributaries, as well as artificially propagated Feather River spring-run Chinook salmon (70 FR 37177, June 28, 2005). In 2009 NMFS submitted a draft recovery plan that includes proposed management actions to help protect Central Valley spring-run Chinook salmon (NMFS 2009a). The State listed spring-run as threatened on February 5, 1999.

Critical habitat for spring-run Chinook salmon comprises roughly 1,272 miles of occupied stream habitat and 427 square miles of estuarine habitat. This critical habitat encompasses the lower Feather River; the Sacramento and Yuba rivers; Beegum, Battle, Clear, Cottonwood, Antelope, Mill, Deer, Butte, and Big Chico creeks; the north Delta (the central and south Delta were excluded); and Suisun, San Pablo, and north San Francisco bays (70 FR 52488, September 2, 2005).

Adult spring-run Chinook salmon enter the mainstem Sacramento River in February and March, when they are sexually immature. Adults hold over summer in deep, cold-water pools near spawning habitat until they spawn between late August and October. In most locations, juveniles emerge in November and December, but they may emerge later when water temperature is cooler. Spring-run Chinook salmon may migrate downstream as young-of-year juveniles or as yearlings. Based on observations in Butte Creek and the Sacramento River, young-of-year juveniles migrate from November through June. Yearling spring-run Chinook salmon migrate from October through March, with peak migration in November (Cramer and Demko 1997, Hill and Webber 1999).

Central Valley Steelhead On March 19, 1998, the naturally spawned Central Valley steelhead was federally listed as threatened by NMFS (63 FR 13347). The Central Valley steelhead distinct population segment (DPS) includes all naturally spawned populations of steelhead (and their progeny) in the Sacramento and San Joaquin rivers and their tributaries. Resident rainbow trout were previously included as protected fish; however, in 2006, NMFS directed that only the anadromous form should be listed as threatened, and the resident form did not warrant listing (71 FR 834, January 5, 2006). It is difficult, if not impossible, to distinguish anadromous and resident juvenile *O. mykiss*, but adults are different enough in appearance to distinguish. In 2009 NMFS submitted a draft recovery plan that includes proposed management actions to help protect Central Valley steelhead (NMFS 2009a).

Critical habitat for Central Valley steelhead encompasses the lower Feather River; Battle, Cottonwood, Antelope, Mill, Deer, Big Chico, and Butte creeks; the Sacramento, Yuba, American, Cosumnes, Mokelumne, Calaveras, San Joaquin, Merced, Tuolumne, and Stanislaus rivers; and the Delta.

Central Valley steelhead migrate upstream from July through May. Spawning in the Sacramento River basin typically occurs from late December through April, with most spawning occurring from January through March. Unlike Chinook salmon, which die after spawning, steelhead can survive spawning and live to spawn more than once. The eggs hatch 19–80 days after spawning, depending on water temperature (warmer temperatures result in faster hatching times), and the young remain in the gravel for several weeks before emerging as fry (Raleigh et al. 1984).

Steelhead juveniles rear a minimum of 1 year, and typically 2 years, in freshwater before emigrating to the ocean as smolts. Smolt emigration generally occurs from November through May, although based on salvage data at State and federal pumping plants in the Delta, March and April appear to be the peak months for emigration in most years. After spending 2–3 years in the ocean, steelhead return to their natal streams to spawn as 4- or 5-year-olds.

Green Sturgeon North American green sturgeon have been separated into two DPSs: the northern DPS (all populations north of and including the Eel River) and the southern DPS (coastal and Central Valley populations south of the Eel River). The southern DPS is federally listed as threatened under the ESA (71 FR 17757, April 7, 2006). In the Extended SPA, critical habitat has been designated for the Sacramento River, the lower Feather and Yuba rivers, the Delta, and Suisun, San Pablo, and San Francisco bays (74 FR 52300, October 9, 2009).

Little is known about the life history of green sturgeon because of its low abundance, low sportfishing value, and limited spawning distribution; however, the spawning and larval ecology of green sturgeon are assumed to be similar to those of white sturgeon (Moyle 2002; Beamesderfer and Webb 2002). Green sturgeon are mostly marine fish but migrate into rivers to spawn. Green sturgeon also make extensive ocean migrations; consequently, most recoveries of individuals tagged in San Pablo Bay have come from the ocean and from rivers and estuaries in Oregon and Washington.

Within estuaries, green sturgeon reportedly tend to concentrate in deep areas with soft bottoms. In rivers, adult (and juvenile) green sturgeon have been observed primarily on clean sand (EPIC et al. 2001). Adult green sturgeon are benthic, usually found in the Sacramento River in deep, off-channel areas with little current. Both the upstream and downstream migrations of green sturgeon begin in late February and continue through July (Beamesderfer and Webb 2002), and reach above RBDD to near Keswick Dam.

Most females reach sexual maturity at 20–25 years while males reach sexual maturity at 15–17 years (Beamesderfer and Webb 2002). Green sturgeon are thought to spawn every 3–5 years (70 FR 65, April 6, 2005) from February to July, with a peak in mid-April to mid-June (Kohlhorst 1976, Moyle 2002, Beamesderfer and Webb 2002). The reported range of preferred/optimal water temperatures for green sturgeon spawning is unclear, but spawning success is related to water temperature (Beamesderfer and Webb 2002). Green sturgeon spawn in deep pools in large, turbulent rivers (Moyle et al. 1992); the preferred spawning substrate is likely large cobble-containing crevices in which eggs can become trapped and develop, but may also range from clean sand to bedrock (EPIC et al. 2001, Beamesderfer and Webb 2002).

Sturgeon eggs have been found in the Sacramento River from mid-February through July (Kohlhorst 1976; Moyle 2002; Beamesderfer and Webb 2002). The importance of water quality is uncertain, but silt is known to prevent green sturgeon eggs from adhering to each other (USFWS 1996), and sand and silt may suffocate the eggs (EPIC et al. 2001). Water temperatures above 68 degrees Fahrenheit (°F) (20 degrees Celsius (ºC)) are reportedly lethal to green sturgeon embryos (Beamesderfer and Webb 2002).

Juvenile green sturgeon reportedly occur in shallow water (Radtke 1966) and probably move to deeper more saline areas as they grow (EPIC et al. 2001). Rearing juveniles remain in freshwater for 1–4 years before returning to their marine environment (Beamesderfer and Webb 2002; EPIC et al. 2001). Juveniles in the Delta feed primarily on opossum shrimp and amphipods (Radtke 1966, Moyle 2002).

Delta Smelt Delta smelt was federally listed as threatened in 1993 (58 FR 12854, March 5, 1993); critical habitat was designated on December 19, 1994. Critical habitat includes the portion of the Sacramento River from Keswick Dam to Chipps Island, all waters westward from Chipps Island to the Carquinez Bridge, all waters of San Pablo Bay, and all waters of San Francisco Bay north of the San Francisco–Oakland Bay Bridge. Delta smelt were upgraded from threatened to endangered status under the CESA on January 20, 2010.

Delta smelt are endemic to the Delta. During the spawning season, adults move into the Delta's channels and sloughs. When Delta outflows are high, delta smelt may occur in San Pablo Bay. Delta smelt have relatively low fecundity and most live for 1 year (Moyle 2002).

Estuarine rearing habitat for juvenile and adult delta smelt is typically found in the waters of the lower Delta and Suisun Bay, where salinity is 2–7 ppt. Delta smelt tolerate 0–19 ppt salinity. They typically occupy open shallow waters (less than 10 feet deep), but they also occur in the main channel in the areas where freshwater and brackish water mix.

Adult delta smelt begin a spawning migration, which may encompass several months, toward the upper Delta and freshwater in December or January. Spawning occurs between February and July, with peak spawning from April through mid-May. Delta smelt spawn in shallow edge-waters in upstream Delta channels, including the Sacramento River above Rio Vista, Cache Slough, Lindsey Slough, and Barker Slough (near the downstream end of the Yolo Bypass). Eggs are broadcast over the bottom of the channel, where they attach to firm sediment, woody material, and vegetation. Larval smelt feed on rotifers and other zooplankton. Larvae and juveniles gradually move downstream toward rearing habitat in the estuarine mixing zone.

Longfin Smelt DFG has designated the longfin smelt (*Spirinchus thaleichthys*) as threatened and fully protected under the CESA, but the U.S. Fish and Wildlife Service (USFWS) did not pursue listing longfin smelt under the federal ESA. Historically, longfin smelt populations were found in the Klamath, Eel, and Bay-Delta estuaries and in Humboldt Bay. In the Central Valley, longfin smelt are rarely found upstream from Rio Vista or Medford Island (northwest of Stockton) in the Delta. Adults concentrate in Suisun, San Pablo, and north San Francisco bays (Moyle 2002).

Longfin smelt are found in San Pablo Bay from April through June and disperse in late summer. In fall and winter, yearlings move upstream into freshwater to spawn. Longfin smelt spawn downstream from Medford Island in the San Joaquin River and downstream from Rio Vista on the Sacramento River. Spawning may occur as early as November, and larval surveys indicate that it may extend into June (Moyle 2002).

High outflows transport the larvae into Suisun and San Pablo bays. In low-outflow years, larvae move into the western Delta and Suisun Bay. Higher outflows reflect positively in juvenile survival and adult abundance. Rearing habitat is better in Suisun and San Pablo bays because juveniles require brackish water in the 2- to 18-ppt range. If juveniles stay in the Delta, they may become entrained and exposed to more adverse conditions (Moyle 2002), such as continued predation by introduced fish species.

Sacramento Splittail On September 22, 2003, USFWS delisted the native Sacramento splittail as a threatened species because habitat restoration actions such as the CALFED Bay-Delta Program (CALFED) and the Central Valley Project Improvement Act (CVPIA) were expected to prevent the splittail from becoming endangered in the foreseeable future (68 FR 55139, September 22, 2003). Splittail is identified as a species of special concern under the CESA.

Splittail are found primarily in the Delta, Suisun Bay, Suisun Marsh, and Napa Marsh, but juveniles have been found in the Sacramento River as far upstream as RBDD (Sommer et al. 1997), and in the San Joaquin River as far upstream as Salt Slough (just upstream from the Merced River confluence (Moyle 2002). Sommer et al. (1997, 2002) found that the Yolo and Sutter bypasses provide important spawning habitat for splittail.

Adult splittail migrate from Suisun Bay and the Delta to upstream spawning and rearing habitat from December through April. This species prefers low water velocities for spawning and early rearing. Splittail spawn in Suisun Marsh in late April and May and in the upper Delta and lower reaches and flood bypasses of the Sacramento and San Joaquin rivers between early March and May (Moyle et al. 1995). Spawning has been observed to occur as early as January and may continue through early July (Wang 1986; Moyle 2002).

Larval splittail are commonly found in shallow, vegetated areas near spawning habitat. Larvae eventually move into deeper and more open-water habitat as they grow. During late winter and spring, young-of-year juvenile splittail (i.e., production from spawning in the current year) are found in sloughs, rivers, and Delta channels near spawning habitat. Juvenile splittail gradually move from shallow, nearshore areas to the deeper open-water habitat of Suisun and San Pablo bays (Wang 1986). In areas upstream from the Delta, juvenile splittail can be expected to be present in the flood bypasses when these areas are inundated during winter and spring (Jones & Stokes Associates 1993; Sommer et al. 1997).

Hardhead Hardhead are widely distributed throughout the low- to mid-elevation streams in the main Sacramento–San Joaquin River drainage. Undisturbed portions of larger streams at low to middle elevations are preferred by hardhead. They are fairly intolerant of low-oxygen waters, particularly at higher water temperatures. Pools with sand-gravel substrates and slow water velocities are the preferred habitat; adult fish inhabit the lower half of the water column, while the juvenile fish remain in the shallow water closer to stream edges. Hardhead typically feed on small invertebrates and aquatic plants at the bottom of quiet water (Moyle 2002). Hardhead, a native species, is a State species of special concern, and a U.S. Forest Service sensitive species in California.

Pacific Lamprey Pacific lamprey (*Entosphenus tridentata*) are found within the Extended SPA and are native to California waters. Pacific lamprey enter freshwater anywhere from a few months to a few years prior to spawning during the late spring through the fall, indicating there are potentially multiple runs. Spawning occurs in low gradient reaches, in gravel typically in pool tails or riffles. After spawning, the ammocoetes (larvae) spend 3 to 4 years in freshwater, feeding on detritus, diatoms and algae, before metamorphosing into juveniles. Ammocoetes rear in sand and mud substrates, gradually moving downstream over the rearing period. As they metamorphose, pacific lamprey move from fine substrate in lower velocity waters into areas with silt covered gravels with greater water velocity (Luzier et al. 2011). Juveniles move downstream, presumably during high flow events in winter and spring. After reaching the ocean, they spend approximately 3.5 years in saltwater (Beamish 1980). Adults are parasitic, often found feeding on Chinook salmon, rockfish, and flatfish (Luzier et al. 2011).

River Lamprey River lamprey (*Lampetra ayresi*) is designated as a State species of special concern by DFG. River lamprey congregate upstream from saltwater for 4 months as young adults, rapidly grow to 10 inches to 12 inches (25 centimeters to 31 centimeters), and enter the ocean in late spring (Moyle 2002). After approximately 3 months in the ocean, river lamprey return to freshwater to spawn in the fall (Moyle 2002). River lamprey may hold in freshwater for up to 8 months until spawning from April through June (Beamish 1980).

Striped Bass Striped bass are anadromous fish that have been an important part of the sportfishing industry in the Delta. They were introduced into the Bay-Delta between 1879 and 1882 (Moyle 2002). Striped bass will not use fish ladders; therefore, their range in the Sacramento River is limited to the reach of the river below RBDD. Striped bass may move into the lower reaches of the major tributary rivers in the Extended SPA year round, but probably most often between April and June, when they spawn. The species tends to remain in deep, slow-moving water, where it has access to prey without expending a great deal of energy. Striped bass are a major predatory fish in the Delta, especially near human-managed facilities, and are a source of mortality for delta smelt, juvenile Chinook salmon and steelhead, and other fish species.

Reservoir Fisheries In most reservoirs, fish populations decline with the aging of the reservoirs. For a variety of reasons, new reservoirs often develop outstanding populations of fish that gradually decline as the reservoirs mature. Loss of cover in the form of inundated vegetation is a major contributing factor. Most Central Valley reservoirs are more than 25 years old, and these factors are likely reducing reservoir fish communities from the population levels sustained shortly after these same reservoirs were filled.

Mid-elevation reservoirs support a mixture of native fishes (species that lived in the streams before dam construction) and introduced exotic species. In many cases, the native species have become uncommon after an initial 5–10 years of abundance. Over time, a variety of exotic species tends to dominate the fish fauna in these reservoirs. The exact species composition in each reservoir is related to the history of introductions, but some species are almost universal in their occurrence: bluegill, largemouth bass, carp, golden shiner, black crappie, brown bullhead, mosquitofish, and rainbow trout (hatchery strains). A few native species, such as Sacramento sucker and hitch, are permanently established in a number of Central Valley reservoirs (Moyle 2002).

3.5.2 Regulatory Setting

The following text summarizes federal, State, and regional and local laws and regulations pertinent to evaluation of the proposed program's impacts on aquatic biological resources.

Federal

Endangered Species Act The ESA protects and promotes recovery of threatened and endangered species, many of which are aquatic and present in the Extended SPA. Section 4 of the ESA outlines a process to list species in danger of becoming extinct. Section 9 prohibits take of any threatened or endangered species, including harm associated with habitat modifications. Section 7 and Section 10 provide for exemptions on take prohibitions. Under the ESA, the definition of "take" is to "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." USFWS and NMFS have also interpreted the definition of "harm" to include significant habitat modification that could result in take. If it is likely that implementing an action authorized, undertaken, or funded by a federal agency would result in take of a federally listed species, a federal interagency consultation, under Section 7 of the ESA, is required. Additionally, some species may be in decline or at risk, but insufficient information is available to indicate a need to list them as either threatened or endangered; these species are listed as "species of concern." USFWS has jurisdiction over terrestrial and nonanadromous fish species, and NMFS is responsible for protecting anadromous fish and other marine species, including marine mammals.

Sustainable Fisheries Act (Essential Fish Habitat) In response to growing concern about the status of fisheries in the United States, Congress passed the Sustainable Fisheries Act of 1996 (Public Law 104-297). This law amended the Magnuson-Stevens Fishery Conservation and Management Act (Public Law 94-265), the primary law governing marine fisheries management in the federal waters of the United States. Under the Sustainable Fisheries Act, consultation is required by NMFS on any activity that might adversely affect Essential Fish Habitat (EFH). EFH consists of those habitats that fish rely on throughout their life cycles. It encompasses habitats necessary to allow sufficient production of commercially valuable aquatic species to support a long-term sustainable fishery and contribute to a healthy ecosystem.

Fish and Wildlife Coordination Act The Fish and Wildlife Coordination Act, as amended in 1964, was enacted to protect fish and wildlife when federal actions result in the control or modification of a natural stream or body of water. The statute requires federal agencies to consider the effect that water-related projects would have on fish and wildlife resources.

Federal agencies must consult and coordinate with State fish and game agencies and USFWS to address ways to conserve wildlife resources by preventing loss of and damage to these resources, and to further develop and improve them. Adoption of the CVFPP is a State action and would not trigger the need to comply with the Fish and Wildlife Coordination Act, but related federal flood management actions must comply with this law.

Executive Orders The executive orders discussed below were issued to provide direction to federal agencies regarding invasive species, floodplain management, and protection of wetlands, and affect related federal flood management actions.

- **Executive Order 13112: Invasive Species—**This executive order directs federal agencies to prevent and control introductions of invasive nonnative species in a cost-effective and environmentally sound manner to minimize their economic, ecological, and human health impacts. As directed by Executive Order 13112, a national invasive species management plan guides federal actions to prevent, control, and minimize invasive species and their impacts (NISC 2008). To support implementation of this plan, the U.S. Army Corps of Engineers (USACE) released the *U.S. Army Corps of Engineers Invasive Species Policy* (USACE 2009). This policy calls on agencies to address the effects of invasive species in impact analyses completed for civil works projects.

- **Executive Order 11988: Floodplain Management—**This executive order requires federal agencies to provide leadership and take action to avoid development in the base (100-year) floodplain; reduce the hazards and risk associated with floods; minimize the effect of floods on human safety, health, and welfare; and restore and preserve the natural and beneficial values of the base floodplain.

- **Executive Order 11990: Protection of Wetlands—**This executive order directs federal agencies to provide leadership and act to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in implementing civil works.

Central Valley Project Improvement Act Implementing the CVPIA changed management of the CVP by making protection of fish and wildlife a project purpose, equal to water supply for agricultural and urban uses. The CVPIA affects water exports from the Delta to San Luis Reservoir and increases operational pressures on the reservoir to meet south-of-Delta water demands. CVPIA Section 3406(b)(2) authorized and directed the

Secretary of the Interior to, among other actions, dedicate and manage 800 thousand acre-feet of CVP yield annually to meet the following goals:

- Implement the fish, wildlife, and habitat restoration purposes and measures authorized in the CVPIA.
- Assist the State of California in its efforts to protect the waters of the San Francisco Bay-Delta estuary.
- Help meet obligations legally imposed on the CVP under State or federal law following the date of enactment of the CVPIA.

CVPIA Section 3406(d)(1) required the Secretary of the Interior to immediately provide specific quantities of water (i.e., “Level 2” supplies) to national wildlife refuges in the Central Valley. The CVPIA requires delivery of Level 2 water in all year types except critically dry water years, when Level 2 water can be reduced by 25 percent. Section 3406(d)(2) of the CVPIA refers to “Level 4” refuge water supplies, the quantities required for optimum habitat management of existing refuge lands. Level 4 water supplies amount to about 163 thousand acre-feet above Level 2 water supplies. The availability of Level 4 refuge water supplies is influenced by the availability of water for transfer from willing sellers.

CVPIA Section 3406(c)(1) mandated development of a reasonably prudent, feasible comprehensive plan to be presented to Congress to address concerns about fish, wildlife, and habitat on the San Joaquin River. However, Public Law 111-11 declared that the 2006 settlement of a lawsuit between several parties on restoration of the San Joaquin River, which led to formation of the SJRRP, “satisfies and discharges all of the obligations of the Secretary [of the Interior] contained in Section 3406(c)(1).”

CALFED Bay-Delta Program CALFED is a collaborative effort of 25 State and federal agencies focusing on restoring the ecological health of the Bay-Delta, while ensuring improvements to water quality and reliability of the water supply for all users of Bay-Delta water resources. CALFED includes a range of balanced actions that are used in a comprehensive, multiagency approach to managing Bay-Delta resources. The following are CALFED’s objectives:

- 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 elements since the CALFED record of decision was certified in 2000.

San Joaquin River Restoration Program The SJRRP was formed in response to the 2006 settlement of an 18-year-old lawsuit between the U.S. Departments of the Interior and Commerce, the Natural Resources Defense Council, and the Friant Water Users Authority. The Settlement establishes two primary goals: (1) to restore and maintain fish populations in "good condition" in the mainstem San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally reproducing and self-sustaining populations of salmon and other fish; and (2) to reduce or avoid adverse water supply impacts on all of the Friant Division long-term contractors that may result from the Interim and Restoration flows provided for in the Settlement.

The State has expressed strong support for this settlement and has pledged cooperation and the State's financial resources to help it succeed. The settling parties and the California Resources Agency (now the California Natural Resources Agency), DWR, and DFG entered into a memorandum of understanding to allow the State to play a major, collaborative role in planning, designing, funding, and implementing actions called for by the Settlement Act to restore the San Joaquin River.

National Wildlife Refuge Complex Comprehensive Conservation Plans USFWS's San Luis National Wildlife Refuge (NWR) Complex consists of San Luis NWR, Merced NWR, San Joaquin River NWR, and Grassland Wildlife Management Area. These refuges comprise wetlands, grasslands, riparian habitats, and agricultural fields, and many support fisheries resources. The management goals and objectives for each refuge include managing and providing habitat for endangered and sensitive species. Those goals and objectives are set forth in 15-year comprehensive conservation plans prepared by USFWS pursuant to the National Wildlife Refuge System Improvement Act of October 1997.

Clean Water Act The objective of the Clean Water Act (CWA) is "to restore and maintain the chemical, physical, and biological integrity of the nation's waters." The CWA is the major federal legislation that governs federal oversight of discharges into "jurisdictional waters" by federal, state, local, and private activities. Jurisdictional waters are waters of the United States, including wetlands. Waters of the United States include wetlands and lakes, rivers, streams, and their tributaries. Wetlands are defined for regulatory purposes in CWA Section 404 (described further below) as "areas inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support and, under normal circumstances do support, vegetation typically adapted for life in saturated soil conditions."

The CWA establishes the basic structure for regulating discharge of pollutants into the waters of the United States and gives the U.S. Environmental Protection Agency (EPA) the authority to implement pollution control programs such as setting wastewater standards for industries. In certain states such as California, EPA has delegated authority to state agencies for most but not all CWA purposes.

Section 303 Section 303 of the CWA requires states to adopt water quality standards for all surface waters of the United States. Section 303(d) of the CWA requires states and authorized Native American tribes to develop lists of water quality–impaired segments of waterways. Each state's or tribe's list identifies waters that do not meet the water quality standards necessary to support the beneficial uses of a waterway, even after point sources (identifiable localized sources of pollution) have installed the minimum required pollution control technology. Only waters impaired by "pollutants" (clean sediments, nutrients such as nitrogen and phosphorus, pathogens, acids/bases, temperature, metals, cyanide, and synthetic organic chemicals (EPA 2002)) are to be included on the list. Waters impaired by other types of pollution (e.g., altered flow, channel modification) are not included.

Section 303(d) of the CWA also requires states to maintain a list of impaired water bodies so that a total maximum daily load (TMDL) can be established. A TMDL is a plan to restore the beneficial uses of a stream or to otherwise correct an impairment. It establishes the allowable pollutant loadings or other quantifiable parameters (e.g., pH, temperature) for a water body, thereby providing the basis for establishing water quality–based controls. The calculation used to establish TMDLs for a water body must include a margin of safety to ensure that the water body can be used for the purposes of State designation. The calculation also must account for seasonal variation in water quality (EPA 2002). The Central Valley Regional Water Quality Control Board (Central Valley RWQCB) develops TMDLs for the Sacramento and San Joaquin rivers, and for many tributaries associated with these rivers (see the discussion of the Porter-Cologne Water Quality Control Act (Porter-Cologne Act) below).

Sections 401, 402, and 404 Section 401 of the CWA regulates the water quality aspects of a proposed activity, which also affect fisheries and other aquatic resources. Section 401 certification is the responsibility of the SWRCB and the appropriate RWQCB (in this case, the Central Valley RWQCB), which certifies that the activity is consistent with State-issued water quality control plans, called basin plans. Section 401 also requires federal agencies to obtain certification from the State or Native American tribes before issuing permits that would result in increased pollutant loads to a water body. The certification is issued only if such increased loads would not cause or contribute to exceedences of water quality standards.

Section 402 created the National Pollutant Discharge Elimination System permitting program. This program covers discharges of point sources of pollution, including stormwater discharges, into a surface water body.

Section 404 of the CWA regulates the discharge of dredged and fill material in jurisdictional waters. Specifically, a permit must be obtained from USACE under Section 404 for the discharge of dredged or fill material into waters of the United States, including wetlands (defined above). Under the 404 permit process, certain activities, such as maintenance, can be covered by nationwide permits; other activities, such as emergency response, are covered by regional permits. Activities not covered under either nationwide or regional permits need to be addressed through an individual permit process. Water quality certification under Section 401 of the CWA is required for all projects receiving Section 404 permits.

Rivers and Harbors Act, Sections 10 and 408 Section 10 of the Rivers and Harbors Act of 1899 (33 U.S. Code (USC) 401 et seq.) requires project proponents to obtain authorization from USACE before constructing any structure over, in, or under navigable waters of the United States. Under Section 14 of the Rivers and Harbors Act (33 USC 408)—most often referred to as Section 408—the Secretary of the Army is authorized to permit alterations/modifications to existing USACE project levees in certain circumstances. The Secretary of the Army has delegated this approval authority to the USACE Chief of Engineers. The authority to approve relatively minor, low-impact alterations/modifications related to operational and maintenance-related responsibilities of the nonfederal entities responsible for the flood control system (e.g., the Central Valley Flood Protection Board (Board), local reclamation districts) has been further delegated to the applicable USACE District Engineer, in accordance with 33 CFR 208.10.

Placement of structures such as pump houses, stairs, pipes, bike trails, sidewalks, fences, driveways, power poles, and instrumentation can be approved by a District Engineer, provided that these alterations/modifications do not adversely affect the functioning of the project and flood-fighting activities. The types of alterations/modifications that require approval by the Chief of Engineers under 33 USC 408 include degradations, raisings, and realignments and other alteration/modifications to the flood protection system not discussed above. In administering Sections 10 and 408, USACE must consider the environmental effects of actions regulated under these statutes, especially with respect to aquatic resources and fisheries.

For activities in the SPFC, the Board acts as the nonfederal sponsor. In this capacity, the Board coordinates reviews and submits project requests, project designs, and technical engineering documents to USACE for consideration under 33 USC 408 and 33 USC 208.10.

Federal Power Act, Section 18 Section 18 of the Federal Power Act authorizes the U.S. Departments of the Interior and Commerce to require fishways in new licenses granted by the Federal Energy Regulatory Commission (discussed further in Section 3.9, “Energy”) when it can be demonstrated that fish populations would benefit from the provision of fish passage.

State

California Water Code The California Water Code authorizes the SWRCB to allocate surface water rights, and to permit diversion and use of water throughout California. The SWRCB considers effects on fisheries as part of its permitting process. Division 7 of the California Water Code, known as the Porter-Cologne Act, regulates activities that affect water quality (see the separate discussion of the Porter-Cologne Act below). Division 5 of the Water Code specifies roles and responsibilities for flood control for the State and for numerous local agencies throughout California.

California Endangered Species Act As part of the CESA and Section 2081 of the California Fish and Game Code, a permit from DFG is required for projects that could result in the taking of a species that is State-listed as threatened or endangered. Under the CESA, “take” is defined as an activity that would directly or indirectly kill an individual of a species; however, the CESA definition does not include “harm” or “harass,” as the federal ESA definition does. As a result, the threshold for take is higher under the CESA than under the federal ESA.

California Fish and Game Code The sections of the California Fish and Game Code listed below provide environmental protections and could apply to specific CVFPP projects as they are defined and proposed.

- **Section 1602, Streambed Alteration—**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 DFG.

- **Fully Protected Species under the California Fish and Game Code—**Protection of fully protected species is described in four sections of the California Fish and Game Code that list 37 fully protected species (Sections 3511, 4700, 5050, and 5515), many of which are present in the Extended SPA. These statutes prohibit take or possession at any time of fully protected species.

- **Section 5937—**Under most conditions, sufficient volumes of water are required to pass through a fishway at all times. In the absence of a fishway, sufficient water must be allowed to pass over, around, or through a dam to keep in good condition any fish that may be planted or exist below the dam.

California Code of Regulations, Title 23 Under Title 23 of the California Code of Regulations, the Board cooperates with local, State, and federal agencies in establishing, planning, constructing, operating, and maintaining flood control works in the Central Valley. The Board is required to enforce appropriate standards for constructing, maintaining, and protecting adopted flood control plans that will best protect the public from floods along the Sacramento and San Joaquin rivers and their tributaries. The Board issues encroachment permits to maintain the integrity and safety of flood control project levees and floodways.

Porter-Cologne Water Quality Control Act The Porter-Cologne Act is California's statutory authority for the protection of water quality. Under the act, the State must adopt water quality policies, plans, and objectives protecting the State's waters for the use and enjoyment of the people. The act sets forth the obligations of the SWRCB and RWQCBs to adopt and periodically update their basin plans. A basin plan identifies the designated beneficial uses for specific surface water and groundwater resources, applicable water quality objectives necessary to support the beneficial uses, and implementation programs that are established by the RWQCBs to maintain and protect water quality from degradation. The Porter-Cologne Act also requires waste dischargers to notify the RWQCBs of their activities by filing reports of waste discharge. In addition, the act authorizes the SWRCB and RWQCBs to issue and enforce waste discharge requirements, National Pollutant Discharge Elimination System permits, Section 401 water quality certifications, or other approvals. The RWQCBs also have the authority to issue waivers to reports of waste discharge/waste discharge requirements for broad categories of "low threat" discharge activities that have minimal potential for adverse effects on water quality, when implemented according to prescribed terms and conditions.

State Lands Commission The State Lands Commission has exclusive jurisdiction over all ungranted tidelands and submerged lands owned by the State, and the beds of navigable rivers, sloughs, and lakes. A project cannot use these State lands unless a lease is first obtained from the State Lands Commission.

Regional and Local

Sacramento River Watershed Program The Sacramento River Watershed Program (SRWP), founded in 1996, brings together dozens of groups and thousands of people who are concerned about the health of the Sacramento River and its watershed. As one of the largest watersheds in the United States, the Sacramento River watershed serves as an important source of drinking water and recreation, as well as a vital economic artery for commerce and agriculture. Therefore, preserving and maintaining the water quality of the Sacramento River watershed is crucial. The program is overseen by a 21-member board of trustees and functions through several committees and work groups.

The program provides a network for building a basinwide context to improve watershed health. It operates through consensus-based collaborative partnerships, coordination of research and monitoring, and mutual education among the stakeholders of the Sacramento River watershed. The SRWP works to support and preserve the integrity of local efforts. The program strives to resolve watershed issues with local participation and a watershed-wide perspective. The SRWP also helps disseminate information about the watershed and conducts monitoring activities to continually assess water quality and other indicators of watershed health.

Lower Yuba River Accord The Lower Yuba River Accord (Yuba Accord) enables Yuba County Water Agency to successfully operate the Yuba River Development Project (Federal Energy Regulatory Commission Project No. 2246, 362 megawatts) for hydropower, irrigation, flood control, recreation, and fisheries benefits. As a settlement agreement, the Yuba Accord is the final product of negotiations among stakeholders, which include local irrigation districts, State and federal resource agencies, and conservation groups. The State approved the agreement in 2008, and the project is now fully operational. The Yuba Accord is unprecedented in that it combines increased instream flows for wild, native salmon and steelhead with increased supplemental water supplies for California cities and farms, while preserving the project’s capacity to generate clean, renewable hydropower. The Yuba Accord also reaffirms the water rights of Yuba County Water Agency and its member irrigation districts.

Lower American River Corridor Management Plan The *Lower American River Corridor Management Plan* serves to promote a cooperative approach to managing and enhancing the lower American River within the framework of the *American River Parkway Plan 2008* (Sacramento County 2008). The goals of the river corridor management plan are to protect and enhance fisheries and instream habitat, protect and enhance vegetation and wildlife habitat, improve the reliability of the existing flood control system, and enhance the lower American River's wild and scenic recreation values (Lower American River Task Force 2002).

Bay Delta Conservation Plan The *Bay Delta Conservation Plan* (BDCP) is being developed in compliance with the federal ESA and the California Natural Communities Conservation Planning Act. When complete, the BDCP will provide the basis for the issuance of endangered species permits for the operation of the State and federal water projects. Once approved, the plan would be implemented over the next 50 years. The heart of the BDCP is a long-term conservation strategy that sets forth actions needed for a healthy Delta and alternative water conveyance. The BDCP is being prepared through collaboration among local, State, and federal water agencies; State and federal fish and wildlife agencies; environmental organizations; and other interested parties. These organizations have formed the BDCP Steering Committee, with the goal of identifying water flow and habitat restoration actions to recover endangered and sensitive species and their habitats in California's Delta. The lead agencies for the BDCP environmental impact report/environmental impact statement are DWR, Reclamation, USFWS, and NMFS; these agencies are acting in cooperation with DFG, EPA, and USACE.

San Joaquin River Parkway Master Plan The *San Joaquin River Parkway Master Plan* is a regional resource management plan for the San Joaquin River area between Friant Dam and State Route 99. The San Joaquin River Conservancy, a regionally governed agency created by the State, is charged with implementing this master plan. The plan's main tenets are the protection of natural resources, public education, and the promotion of low-impact recreational use of the river corridor (SJRC 2000).

Lower Feather River Corridor Management Plan The *Lower Feather River Corridor Management Plan* is being developed by DWR to establish a vision for future management, restoration, and maintenance of flood control facilities, conveyance channels, and floodplain and related habitat on the Feather River from the Sutter Bypass to the Yuba River confluence (approximately 20 miles). The plan will implement the new collaborative approach for planning, designing, and implementing projects within and adjacent to flood control features that DWR is responsible for maintaining and repairing.

County and City Policies and Ordinances Numerous counties and cities throughout the study area have established a multitude of policies and ordinances that address local protection of fisheries, sensitive species, and aquatic resources; many of them are applicable to the CVFPP. Should a place-based project be defined and pursued as part of the proposed program, and should the CEQA lead agency be subject to the authority of local jurisdictions, the applicable county and city policies and ordinances would be addressed in a project-level CEQA document as necessary.

3.5.3 Analysis Methodology and Thresholds of Significance

This section provides a program-level evaluation of the direct and indirect effects on aquatic resources of implementing management actions included in the proposed program. These proposed management actions are expressed as NTMAs and LTMAs. The methods used to assess how different categories of NTMAs and LTMAs could affect aquatic resources are summarized in "Analysis Methodology"; thresholds for evaluating the significance of potential impacts are listed in "Thresholds of Significance." Potential effects related to each significance threshold are discussed in Section 3.5.4, "Environmental Impacts and Mitigation Measures for NTMAs," and Section 3.5.5, "Environmental Impacts, Mitigation Measures, and Mitigation Strategies for LTMAs."

Analysis Methodology

Impact evaluations were based on a review of the management actions proposed under the CVFPP, expressed as NTMAs and LTMAs in this PEIR, to determine whether these actions could potentially result in impacts on aquatic resources. NTMAs and LTMAs are described in more detail in Section 2.4, "Proposed Management Activities." The overall approach to analyzing the impacts of NTMAs and LTMAs and providing mitigation is summarized below and described in detail in Section 3.1, "Approach to Environmental Analysis." NTMAs can consist of any of the following types of activities:

- Improvement, remediation, repair, reconstruction, and operation and maintenance of existing facilities
- Construction, operation, and maintenance of small setback levees

- Purchase of easements and/or other interests in land
- Operational criteria changes to existing reservoirs that stay within existing storage allocations
- Implementation of the vegetation management strategy (VMS) included in the CVFPP
- Initiation of conservation elements included in the proposed program
- Implementation of various changes to DWR and Statewide policies that could result in alteration of the physical environment

All other types of CVFPP activities fall within the LTMA category. NTMAs are evaluated using a typical "impact/mitigation" approach. Where impact descriptions and mitigation measures identified for NTMAs also apply to LTMAs, they are also attributed to LTMAs, with modifications or expansions as needed. However, because many LTMAs are more general and conceptual, additional impacts are described in a broader narrative format. Impacts of LTMAs that are addressed in this narrative format are those considered too speculative for detailed evaluation, consistent with Section 15145 of the CEQA Guidelines.

In general, impacts on the different sensitive species of fish were combined to address specific avenues of impacts, such as water quality changes from construction activities. This was determined to be appropriate because the avenues of impacts (e.g., pile driving, water quality changes, or riparian alteration) would have similar effects on the different species. An action high up in the watershed would not have a direct effect on delta smelt, but it could have indirect effects. Because this is a program-level document, site-specific actions are not known; therefore, more specific analysis of potential effects on a particular species or the habitat elements used by that species is not possible.

Following the narrative description of these additional impacts is a list of suggested mitigation strategies that could be employed, indicating the character and scope of mitigation actions that might be implemented if a future project-specific CEQA analysis were to find these impacts to be significant.

Thresholds of Significance

The following applicable thresholds of significance have been used to determine whether implementing the proposed program would result in a significant impact. These thresholds of significance are based on Appendix G of the CEQA Guidelines, as amended. An impact on aquatic resources is considered significant if implementation of the proposed program would do any of the following when compared against existing conditions:

- Have a substantial adverse effect, either directly or through habitat modifications, on any fish species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by DFG, NMFS, or USFWS
- Interfere substantially with the movement of any native resident or migratory fish species or impede the use of native fish nursery sites
- Have a substantial adverse effect on riparian vegetation that functions as shaded riverine aquatic habitat
- Substantially reduce the habitat of a fish species; cause a population to drop below self-sustaining levels; or threaten to eliminate a fish community
- Reduce the number or restrict the range of a rare or endangered aquatic species
- Substantially reduce habitat designated as critical habitat or Essential Fish Habitat (EFH)
- Substantially conflict with the provisions of an adopted habitat conservation plan (HCP), natural community conservation plan, or other approved local, regional, or State HCP

The substantial effects referred to in these criteria may occur through various mechanisms, such as modification of riparian vegetation and riverine habitat; long-term modification of channels or reservoirs (e.g., storage); and long-term reduction in the acreage of federally protected waters of the United States capable of supporting aquatic species. See Section 3.6, “Biological Resources—Terrestrial,” for additional discussions of riparian and wetland impacts.

3.5.4 Environmental Impacts and Mitigation Measures for NTMAs

This section describes the physical effects of NTMAs on aquatic biological resources. For each impact discussion, the environmental effect is determined to be either less than significant, significant, potentially significant, or beneficial compared to existing conditions and relative to the thresholds of significance described above. These significance categories are described in more detail in Section 3.1, “Approach to Environmental Analysis.” Feasible mitigation measures are identified to address any significant or potentially significant impacts. Actual implementation, monitoring, and reporting of the PEIR mitigation measures would be the responsibility of the project proponent for each site-specific project. For those projects not undertaken by, or otherwise subject to the jurisdiction of, DWR or the Board, the project proponent generally can and should implement all applicable and appropriate mitigation measures. The project proponent is the entity with primary responsibility for implementing specific future projects and may include DWR; the Board; reclamation districts; local flood control agencies; and other federal, State, or local agencies. Because various agencies may ultimately be responsible for implementing (or ensuring implementation of) mitigation measures identified in this PEIR, the text describing mitigation measures below does not refer directly to DWR but instead refers to the "project proponent." This term is used to represent all potential future entities responsible for implementing, or ensuring implementation of, mitigation measures.

Impact BIO-A-1 (NTMA): *Potential Effects on Special-Status Fish, Fish Movement, Nursery Ground Usage, Riparian Habitat, Designated Critical Habitat, and Essential Fish Habitat Caused by Siltation and Degradation of Water Quality during Construction or Operations and Maintenance Activities*

Any erosion resulting from construction or operations and maintenance activities (particularly with respect to levees) required for NTMAs could temporarily increase turbidity and sedimentation downstream from the construction sites if soils were to be transported during in-water work or in stormwater runoff. Sedimentation and increased turbidity or other contamination could degrade water quality and adversely affect fish habitat (riparian habitat, critical habitat, and EFH), fish movement, and fish populations (including special-status fish species).

Fish population levels and survival have been linked to levels of turbidity and siltation in a watershed. Prolonged exposure to high levels of suspended sediment can create a loss of visual capability, leading to a reduction in feeding and growth rates; a thickening of the gill epithelium, potentially causing the loss of respiratory function; clogging and abrasion of gill filaments; and increases in stress levels, reducing the tolerance of fish to disease and toxicants (Waters 1995).

High levels of suspended sediment also cause the movement and redistribution of fish populations, and can affect physical habitat. Once suspended sediment is deposited, it can reduce water depths in pools, decreasing the water's physical carrying capacity for juvenile and adult fish (Waters 1995) and thereby decreasing the quality of critical habitat or EFH. Increased sediment loading can degrade food-producing habitat downstream from the project area as well. Sediment loading can interfere with photosynthesis of aquatic flora and displace aquatic fauna. Many fish are sight feeders, and turbid waters reduce the efficiency of these fish in locating and feeding on prey. Some fish, particularly juveniles, can become disoriented and leave areas where their main food sources are located, ultimately reducing their growth rates. Additionally, benthic macroinvertebrates, a main food source for numerous fishes, can be found in much lower densities in highly turbid areas.

Avoidance behavior is the most common result of increases in turbidity and sedimentation. Fish will not occupy areas that are not suitable for survival unless they have no other option. Therefore, habitat can become limited in systems where high turbidity precludes a species from occupying habitat required for specific life stages.

The potential also exists for contaminants such as concrete, fuels, oils, and other petroleum products used in construction activities to be introduced in the water system, either directly or through surface runoff. Contaminants may be toxic to fish and benthic macroinvertebrates or may change oxygen diffusion rates and cause acute and chronic toxicity to aquatic organisms, thereby reducing growth and survival.

Project proponents or others implementing construction activities must file a notice of intent with the Central Valley RWQCB to discharge stormwater associated with construction activity. As part of the final design and construction specifications for NTMAs, project proponents or others implementing construction activities would be required to implement standard best management practices (BMPs) related to erosion, siltation, and “good housekeeping.” Before implementing NTMAs, construction contractors would be required to prepare and implement storm water pollution prevention plans (SWPPPs) and comply with the conditions of the National Pollutant Discharge Elimination System general stormwater permit for construction activity (Order No. 2009-0009-DWQ). The SWPPPs would describe the construction activities to be conducted, BMPs to be implemented to prevent discharges of contaminated stormwater into waterways, and inspection and monitoring activities to be conducted.

The SWPPP for each NTMA would include pollution prevention measures; a demonstration of compliance with all applicable standards of the Central Valley RWQCB and other relevant water quality, erosion, and sediment control standards; checklists for maintenance inspections; detailed construction timelines; and a BMP monitoring and maintenance schedule. BMPs would include requirements to conduct all work according to site-specific construction plans; install silt fences near riparian areas and existing drainages; reseed cleared areas with native vegetation and stabilize disturbed soils before the onset of the winter rainfall season; conduct maintenance on a regular basis; and immediately repair and replace BMPs that have failed.

The SWPPP also would specify appropriate handling, storage, and spill response practices for hazardous materials to reduce the possibility of adverse impacts from use, accidental spills, or releases of contaminants. BMPs would be applied to meet the “maximum extent practicable” and “best conventional technology/best available technology” requirements and to address compliance with water quality standards. A monitoring program would be implemented during and after construction to ensure that the NTMA would comply with all applicable standards and that the BMPs would be effective.

Where in-water work might be necessary, these activities would also require authorization from USACE under Section 404 of the CWA and from the appropriate RWQCB under Section 401 of the CWA. Permit conditions from these agencies would include further actions to monitor and protect water quality, such as using construction methods that minimize soil disturbance and contain sediment via silt curtains or other means.

Project proponents and others implementing construction activities must develop and implement a SWPPP to avoid increased sedimentation and turbidity and/or release of contaminants that could degrade aquatic habitats and adversely affect aquatic species. They could be required to implement additional measures if in-water work is required. Therefore, this impact would be **less than significant**. No mitigation is required.

Impact BIO-A-2 (NTMA): ***Effects on Special-Status Fish, Fish Movement, Nursery Ground Usage, Riparian Habitat, Designated Critical Habitat, and Essential Fish Habitat Caused by Loss of Overhead Cover and Instream Woody Material as Part of the Vegetation Management Strategy***

Implementing the VMS (as described in Section 2.4.3, “Other Near-Term Management Activities,” in Chapter 2.0, “Program Description”) would result in a gradual reduction of existing riparian habitats in some locations on and along existing levees, as dead or diseased trees are removed and not replaced by either natural recruitment or planting. Trees and other woody vegetation would be removed over an extended period—and eventually eliminated entirely—from the designated vegetation management zone, an area typically extending 15 feet beyond the landside levee toe to 20 feet below the waterside levee crown. Immature trees and woody vegetation would be removed, existing mature trees either would be lost eventually to natural mortality or would be removed if they posed an unacceptable threat, and new trees and woody vegetation would not be reestablished. However, vegetation would generally be retained on the water side of levees more than 20 feet below the levee crown.

Specifically, under the VMS, immature trees and woody vegetation in the vegetation management zone that measure less than 4 inches in diameter at breast height (dbh) would be removed in an authorized manner as part of levee maintenance. Larger trees and woody vegetation greater than 4 inches dbh would be subject to a long-term life-cycle management (LCM) plan to be implemented by levee maintenance agencies. These larger trees would be allowed to live out their normal life cycles if they do not pose an unacceptable threat, but would not be replaced in the vegetation management zone after their death or removal. (The LCM plan allows the immediate removal of trees that pose an unacceptable threat.) Removal of woody vegetation in both size categories would be conducted in consultation with the appropriate resource agencies.

Over time, a net loss in the extent and quality of riparian habitat would occur in the vegetation management zone on existing levees as the lost vegetation is not replaced. Vegetation less than 4 inches dbh would be removed relatively quickly after plan adoption. Larger riparian vegetation (e.g., mature cottonwoods and black willows) is expected to gradually decline, and the vegetation management zone would ultimately consist almost exclusively of smaller, nonwoody vegetation. Overhanging vegetation, most often from large trees, provide stream shade, which is a component of shaded riverine aquatic habitat.

The effects of vegetation removal under the VMS would vary substantially depending on the existing conditions along a particular levee segment:

- In locations where little to no woody vegetation grows in the vegetation management zone, and existing levee maintenance practices prevent this vegetation from establishing, the VMS would result in little change from existing conditions.

- If the ordinary water level approaches the waterside edge of the vegetation management zone, and the only woody riparian vegetation on the waterside of the levee is a thin strip in the management zone (20 feet or less below the crown), much of the woody riparian vegetation on this side of the levee could be removed over time.

- If woody riparian vegetation grows on the levee’s waterside both in and below the vegetation management zone, riparian vegetation would be lost in the management zone but retained below it. As a result, the strip of waterside riparian habitat would be thinner than under existing conditions.

- In situations where woody riparian vegetation grows on both sides of a levee, and with some vegetation in the vegetation management zone, the current nonriparian corridor between the landside and waterside riparian vegetation (likely a levee crown patrol road and portions of the levee slope) would become wider as vegetation in the management zone on both sides of the levee moves toward an increased amount of smaller and nonwoody vegetation.

Numerous other vegetation removal scenarios could be described here. However, the key point is that as the VMS is implemented, adverse effects on riparian vegetation and associated aquatic resources could range from minimal to substantial, depending on factors such as location, amount, and quality of vegetation affected; its proximity to water; and the continuity with other riparian vegetation. Where adverse effects are found, they would result primarily from one of three scenarios:

(1) Thin strips of riparian vegetation that grow entirely within the vegetation management zone would be substantially or entirely removed.

(2) Riparian vegetation grows both inside and outside of the vegetation management zone, and habitat in the management zone ultimately would be removed. As a result, thinner corridors of riparian habitat would remain outside of the management zone.

(3) Woody riparian habitat exists on both sides of the levee, separated by a nonriparian zone along the levee (likely, at a minimum, along a crown patrol road). If some riparian habitat occurs within the vegetation management zone, this habitat would be removed over time, causing the nonriparian zone between the landside and waterside habitat to become wider. However, this mechanism would be very unlikely to affect aquatic resources, and potential adverse effects would typically be limited to terrestrial biological resources. (See Section 3.6, “Biological Resources—Terrestrial.”)

However, a component of both the VMS and the CVFPP Conservation Framework is also the enhancement of existing riparian habitats and restoration and creation of riparian habitat at various locations. Riparian forest corridors would be established, as appropriate, in areas outside the vegetation management zone along both the waterside and landside of existing levees. The greatest opportunities to increase the extent of riparian vegetation would be on the landside because of space limitations often found between levees and the water bodies they are designed to contain. It is most likely that restoration and creation of riparian forest corridors would be in proximity to levees in rural areas where undeveloped land is available and human disturbance would be minimized.

The VMS would also inform the design of new setback levees by recommending an expanded floodway that would accommodate both vegetation and water conveyance. Under this approach, woody vegetation may be permitted on the waterside slopes and berms of new levees where a specifically designed waterside planting berm is incorporated into the levee design. In some cases, woody vegetation provides environmental and engineering benefits to levee integrity (e.g., erosion protection, soil reinforcement, sediment recruitment). In these cases, the vegetation could remain on existing levees that are repaired or improved, particularly where the levee prism is widened or a root or seepage barrier is installed. With these efforts, existing riparian habitat could be retained or expanded along levees at some locations.

The combined elements of the VMS would result in the removal of riparian vegetation in some areas and the enhancement, restoration, or creation of riparian vegetation in other areas. The final result would be a gradual change in the location of riparian vegetation, with habitat lost in some areas but gained in other areas. There is the potential that ultimately a net gain in riparian vegetation could result. The recovery and restoration of native habitats is a supporting goal of the CVFPP, and increasing and improving the quantity, diversity, quality, and connectivity of riverine habitats (including riparian habitat) is a goal of the Conservation Framework. However, there is currently insufficient detail in these plans to ensure that, in all time periods and in all areas, there would be a balance between habitat losses and gains, resulting in no net overall loss in the extent and quality of riparian vegetation in the program area relative to existing conditions.

With the CVFPP Conservation Framework, planting riparian vegetation below the vegetation management zone could enhance existing riparian habitats and result in restoration or creation of additional riparian habitat at various locations. A portion of the affected riparian habitat—both the gains (below the vegetation management zone) and the losses (in and below the vegetation management zone, if a matter of public safety)—may qualify as shaded riverine aquatic habitat. This is an important habitat component for aquatic species, including special-status fish species. Shaded riverine aquatic habitat is also considered part of the critical habitat and EFH particularly for salmonid species.

The effect of implementing the VMS (i.e., LCM) would be gradual for woody vegetation greater than 4 inches dbh. Therefore, the rate at which these habitat components would be enhanced, restored, and created under the CVFPP Conservation Framework could match or exceed the rate of potential habitat loss associated with the VMS. Ultimately, habitat improvements resulting from implementation of the Conservation Framework would likely exceed losses resulting from implementation of the VMS on a net basis. The final outcome would be a gradual change in the locations of riparian/shaded riverine aquatic vegetation as habitat is lost in some areas but gained in other areas.

It cannot be assured that habitat gains generated by the CVFPP Conservation Framework would always exceed losses at a specific location. If vegetation removal were required in a general area that currently has a high volume of riparian vegetation, the removal and offsite mitigation would have less of an effect on the overall system because changes in overall conditions in the area would be small. However, if vegetation were removed in an area where minimal riparian vegetation is available, this removal—even with offsite mitigation—would have a greater effect on the fisheries. The effect would be greater because it is more likely that connectivity between patches of riparian habitat could be limited and long stretches of river shoreline would have little to no riparian vegetation. Although clearly not every levee segment in the SPFC contains riparian vegetation that functions as SRA habitat, it is reasonable to assume that there would be some areas where SRA currently exists along relatively long river reaches where this habitat would be removed. Therefore, implementation of the VMS could have, at least in some areas, a substantial adverse effect on riparian vegetation that functions as SRA habitat.

Because overhead cover and IWM (and thus shaded riverine aquatic habitat) would be lost as a result of implementation of the VMS along the banks and levees, this impact would be **potentially significant**.

Mitigation Measure BIO-A-2a (NTMA): ***Secure Applicable State and/or Federal Permits and Implement Permit Requirements***

Not all measures listed below may be applicable to each management action. Rather, these measures serve as an overlying mitigation framework to be used for specific management actions. The applicability of measures listed below would vary based on the lead agency, location, timing, and nature of each management action.

The project proponent will ensure that the following measures are implemented to reduce the effects of repairing, reconstructing, and improving levees on trees within stream zones, shaded riverine aquatic habitat, IWM, listed fish species, and designated critical habitat:

- A Section 1602 streambed alteration agreement will be obtained from DFG before any trees are removed from a stream zone that is under DFG jurisdiction unless the activity is implemented by USACE. The project proponent will comply with all terms and conditions of the streambed alteration agreement, including measures to protect habitat or to restore, replace, or rehabilitate any habitat.

- The project proponent will consult or coordinate with USFWS and NMFS as required under the federal ESA, and with DFG as required under the CESA, regarding potential impacts on listed fish species, including the loss of habitat. The project proponent will implement any additional measures developed through the ESA and CESA consultation processes, including the conditions of Section 7 biological opinions, Section 10 HCPs, and Section 2081 permits.

Where an existing approved HCP, NCCP, or similar plan covers an NTMA and provides for compliance with applicable State or federal regulations, the project proponent may participate in and comply with the terms of such a plan to achieve the permit compliance measures listed above. Any mitigation plantings in the floodway will not be permitted if they would result in substantial increases in flood stage elevations, or alter flows in a manner that would have a substantial adverse effect on the opposite bank.

Mitigation Measure BIO-A-2b (NTMA): ***Ensure Full Compensation for Losses of Riparian Habitat Functions and Values Caused by Implementing the Vegetation Management Strategy Along Levees***

DWR will coordinate with the Board and levee maintenance agencies tasked with implementing the VMS to develop and implement a plan to record data on riparian vegetation lost or removed due to implementation of the VMS, and to ensure adequate compensation for losses of riparian habitat functions and values. Although this mitigation measure is written as if a single plan is prepared, multiple plans addressing individual regions, watersheds, river corridors, or other geographic subdivisions are also acceptable.

The plan will be completed and suitable for implementation before the start of riparian habitat removal under the VMS. The plan will include mechanisms to, at a minimum, record and track the acreage, type, and location of riparian habitat to be removed through implementation of the VMS or lost over time through LCM.

The plan will also address compensation for the loss and degradation of riparian habitat through the enhancement, restoration, or creation of riparian habitat in other locations. Assessment of the value of lost or degraded habitat and of compensation habitat will take into account issues such as the differing functions of waterside and landside riparian habitat, continuity and connectivity of habitat, types of riparian habitat removed vs. type of compensation habitat (e.g., riparian scrub vs. cottonwood riparian forest), and ability of habitat to support special-status species. DWR will track habitat compensation efforts and only authorize implementation of vegetation removal under the VMS at a rate and in locations consistent with the volume and type of compensation habitat that has been established. This habitat compensation tracking program will be included in the program MMRP prepared to support this PEIR.

The plan must, at a minimum, meet the following basic performance standard:

- Authorized losses of habitat do not exceed the function and value of available compensation habitat.

DWR will coordinate with USFWS, NMFS, and DFG during preparation and implementation of the plan to incorporate into the plan appropriate compensation for effects on special-status species from vegetation management along the levee system.

Various mechanisms may be employed to provide compensation habitat under the plan, as long as the performance standard identified above is met. The mechanisms include but are not limited to the following:

- Implementation of the CVFPP Conservation Strategy Framework
- Participation in existing NCCPs, HCPs, or other conservation plans
- Purchase of habitat credits at an established mitigation bank
- Habitat restoration implemented by a levee maintenance agency or other entity

Any mitigation plantings in the floodway will not be permitted if they would result in substantial increases in flood stage elevations, or alter flows in a manner that would have a substantial adverse effect on the opposite bank.

In many cases, implementing Mitigation Measures BIO-A-2a (NTMA), and BIO-A-2b (NTMA) related to implementation of the VMS would reduce impacts to an overall less-than-significant level and even sometimes to a beneficial level. The extent, type, function, and values of any riparian habitat removed would be fully compensated for by enhancing, restoring, or creating riparian habitat elsewhere. However, removing riparian habitat in some locations and enhancing, restoring, or creating habitat elsewhere would result in overall relocation of riparian habitat within the Extended SPA. It is possible that although some stream or river reaches may benefit from compensatory habitat, habitat values in other stream or river reaches could be substantially reduced, adversely affecting special-status fish species that must move through these river reaches. Potential adverse effects include increased predation risk, increased water temperatures, and reduced food availability. In addition, planting vegetation in the floodway may not be authorized by the Board, USACE, or other agencies if the vegetation would impede flood flows sufficiently that a rise in water surface elevation would cause a significant increase in risk to public safety. Therefore, it cannot be assured that in all instances fisheries impacts would be mitigated to a less-than-significant level. Therefore, Impact BIO-A-2 (NTMA) would be **potentially significant and unavoidable**.

Impact BIO-A-3 (NTMA): ***Effects on Special-Status Fish, Fish Movement, Nursery Ground Usage, Riparian Habitat, Designated Critical Habitat, and Essential Fish Habitat Caused by Loss of Overhead Cover and Instream Woody Material during Construction***

Riverbank construction work for NTMAs could require not only removal of overhead cover, but also removal from the river channel of IWM—an important component of shaded riverine aquatic habitat. The loss of IWM results in the loss of refugia for special-status fish from predators and high flows. Riverbank construction could also reduce the amount of pool-forming structures, and reduce the river channel's storage capacity for sediment and organic matter as flows are passed more quickly downstream (USFWS and NMFS1998). Note that material that can function as IWM and vegetation that can provide shaded riverine aquatic habitat may be above normal water levels in a river or stream system; thus, this material does not provide habitat values at all times. However, when water elevations rise, the IWM and vegetation becomes inundated or is near the water surface, and it provides habitat benefits at these times.

IWM is particularly important to healthy riverine ecosystems, and may be the most important structural component promoting stable fisheries resources. Because IWM has a key role in maintaining the complexity of essential habitat and refugia for special-status fish, the potential loss of IWM could reduce both habitat quality and carrying capacity.

Riparian habitat provides structure (through shaded riverine aquatic habitat) and food for fish. Shade decreases water temperatures, and low overhanging branches can provide sources of food by attracting terrestrial insects. As riparian areas mature and banks erode, the vegetation sloughs off into the rivers. This process creates structurally complex habitat consisting of IWM that offers refugia from predators, decreases water velocities, and provides habitat for aquatic invertebrates. For these reasons, many fish species are attracted to shaded riverine aquatic habitat, particularly emigrating juvenile anadromous salmonids.

When riparian vegetation and soft substrates are lost, less organic material (leaves, detritus, woody debris) enters the stream's ecosystem, which can affect biological production at all trophic levels. The magnitude of these effects depends on the degree to which riparian vegetation and natural substrates are preserved or recovered during the life of the project.

Because overhead cover and IWM (and thus shaded riverine aquatic habitat) would be lost as a result of construction along the banks and levees, this impact would be **significant**.

Mitigation Measure BIO-A-3 (NTMA): ***Inventory and Replace Shaded Riverine Aquatic Habitat***

The project proponent will require that the following measures be implemented to reduce the effects of program construction activities on special-status fish, fish movement, nursery sites, riparian habitat, designated critical habitat, and EFH. These measures may already be incorporated into the conditions of permits identified above in Mitigation Measure BIO-A-2a.

- An inventory of shaded riverine aquatic habitat will be conducted before construction activities begin. Any shaded riverine aquatic habitat that is removed will be replaced, with replacement to occur on site when feasible. This includes IWM and other instream structures, overhead shade, and shallow-water habitat.

- Mitigation credits may be purchased from a public or private mitigation bank approved by DFG, USFWS and/or NMFS. The final number of credits to be purchased will be determined by agency staff.

- A mitigation and monitoring plan will be developed and implemented to ensure that the proposed bank treatments and any off-site mitigation treatments fully compensate for losses of shaded riverine aquatic habitat.

On-site revegetation is the preferred method of compensation, and could reduce the impact to a less-than-significant level, and even potentially to a beneficial level. If on-site compensation is not feasible, off-site mitigation will be established either before or as soon as feasible after existing vegetation is removed, or mitigation bank credits will be purchased before existing vegetation is removed. As much of the mitigation habitat as feasible will be created at or near the project site. If off-site mitigation is necessary, a location that does not currently support riparian vegetation and is capable of supporting riparian habitats will be preferred. Revegetation requirements may be accomplished as part of implementation of the CVFPP Conservation Framework. Any mitigation plantings in the floodway will not be permitted if they would result in substantial increases in flood stage elevations, or alter flows in a manner that would have a substantial adverse effect on the opposite bank.

However, as described above at the conclusion of Mitigation Measure Bio-A-2b, removing riparian habitat in some locations and enhancing, restoring, or creating habitat elsewhere would result in overall relocation of riparian habitat within the Extended SPA. It is possible that although some stream or river reaches may benefit from compensatory habitat, habitat values in other stream or river reaches could be substantially reduced, adversely affecting special-status fish species that must move through these river reaches. In addition, planting vegetation in the floodway may not be authorized by the Board, USACE, or other agencies if the vegetation would impede flood flows sufficiently that a rise in water surface elevation would cause a significant increase in risk to public safety. Therefore, it cannot be assured that in all instances fisheries impacts would be mitigated to a less-than-significant level. Therefore, Impact BIO-A-3 (NTMA) would be **significant and unavoidable**.

Impact BIO-A-4 (NTMA): ***Effects on Special-Status Fish, Fish Movement, Nursery Ground Usage, Designated Critical Habitat, and Essential Fish Habitat Caused by an Increase in Hydrostatic Pressure, Underwater Noise, and Vibrations during Construction***

Should any in-river construction work be needed for NTMAs, pile driving could occur when cofferdams are placed to separate construction activities from the active flowing channel. Pile-driving equipment and activities would produce pressure waves and would create underwater noise and vibration, thereby temporarily altering in-river conditions.

Hydrostatic pressure waves and vibration generated by pile driving can adversely affect all life stages of fish. Effects on fish from changes in hydrostatic pressure are not related to the distance of the fish from the point of impact, but to the level and duration of the sound exposure (Hastings and Popper 2005). Hydrostatic pressure waves may rupture the swim bladders and other internal organs of all life stages of fish, and could permanently injure their inner ears and lateral line organs (Caltrans 2001; Hastings and Popper 2005). These injuries could reduce the ability of fish (including special-status fish species) to orient in the water column, capture prey, and reduce the ability of fish to avoid predators (Caltrans 2001). Therefore, this impact would be **potentially significant**.

Mitigation Measure BIO-A-4 (NTMA): ***Conform to NMFS Guidelines for Pile-Driving Activities***

Several measures may be effective in reducing potential impacts on listed fish species, either by decreasing the level of underwater sound or by decreasing the number of fish exposed to the sound. The project proponent and construction contractors will implement the following measures to the extent feasible, as construction activities and site-specific conditions allow:

- Use fewer piles, smaller piles, or a different type of pile to minimize the number and/or intensity of pile hammer impacts.
- Drive piles when species of concern are not present, as determined either from surveys or by known migration and use patterns for species occurring in the project area.
- Use a vibratory hammer rather than an impact hammer.
- Use a cushioning block between the hammer and pile.
- Use a confined or unconfined air bubble curtain.
- Drive piles during periods of reduced currents.

Pile-driving activities at project sites will be monitored to ensure that the effects of pile driving on listed fish species are minimized. If any injury or mortality to fish is observed, DFG, NMFS and/or USFWS will be immediately notified and in-water pile driving will cease.

Implementing this mitigation measure would reduce Impact BIO-A-4 (NTMA) to a **less-than-significant** level.

Impact BIO-A-5 (NTMA): ***Effects on Special-Status Fish, Fish Movement, Nursery Ground Usage, Riparian Habitat, Designated Critical Habitat, and Essential Fish Habitat Caused by Rock Placement***

Levee projects under the proposed program may involve placing rock riprap material, generally on the waterside of the levee. A relatively comprehensive review of the effects of riprap on riverine and riparian systems (Fischenich 2003) indicated that in most cold-water systems, riprap adversely affected fish and fish habitat, but that in warm-water systems, the effects were generally beneficial. This difference was attributed to a general lack of hard substrate in the warm-water systems studied. The Sacramento and San Joaquin rivers are generally considered cold-water systems, but in the more alluvial reaches, hard substrates may be uncommon compared to the higher gradient areas. Overall, the effect of riprap placement on the aquatic ecosystem is highly dependent on the system and site-specific design (Fischenich 2003). In general, using riprap in rivers or on the waterside of levee banks has been shown to affect natural river processes and functions in all of the following ways:

- Reducing recruitment of spawning gravels (Buer et al. 1989)
- Preventing new accretion of point bars and other deposition areas where riparian vegetation can colonize (Buer at al. 1989)
- Preventing meander migration (Buer et al. 1989; Fischenich 2003), which over time reduces habitat renewal, diversity, and complexity
- Limiting the channel's lateral mobility(Buer et al. 1989; Fischenich 2003), potentially reducing habitat complexity
- Causing water velocity to increase at a high rate as discharge increases, which in turn may accelerate channel scour (Fischenich 2003)
- Reducing the contribution of nutrient inputs to the stream by inhibiting plant growth adjacent to the stream (Fischenich 2003)
- Reducing riparian vegetation (Fischenich 2003) and therefore recruitment of IWM to the stream system
- Possibly increasing macroinvertebrate biomass, depending on the existing substrate characteristics (Fischenich 2003)

Protecting levee slopes with riprap generally results in nearshore hydraulic conditions that are characterized by greater depths and faster, more homogeneous water velocities than are found along natural banks. Higher water velocities minimize deposition and retention of sediment and woody debris. These changes reduce habitat complexity relative to habitat found along natural shorelines, especially by eliminating the shallow, slow-velocity habitat preferred by juvenile salmonids.

Replacing natural bank substrates with riprap can adversely affect important ecosystem functions. Living space and food for terrestrial and aquatic invertebrates is changed from natural to artificial substrates, eliminating an important food source for special-status fish species. Part of the proposed program could involve removing riprap and creating setback levees and floodplain habitat, which would help offset the effects of placing any new levee riprap. In addition, under the proposed program, vegetation could be incorporated into the rock material of new and existing riprap, minimizing adverse effects. However, a net increase in the extent of rock riprap on the SPFC could occur; therefore, this impact would be **potentially significant**.

Mitigation Measure BIO-A-5 (NTMA): ***Implement Mitigation Measures BIO-A-2a and BIO-A-2b (NTMA)***

Mitigation Measures BIO-A-2a and BIO-A-2b include activities that would minimize and compensate for adverse effects of rock placement on aquatic resources. Additional opportunities may exist for on-site vegetation planting as part of rock placement projects.

In many instances, implementing these mitigation measures could reduce impacts to an overall less-than-significant level and even sometimes result in a benefit to aquatic resources. However, replacing all vegetation and IWM (and the resulting shaded riverine aquatic habitat) may not be possible in all instances because some areas, especially urban areas, may lack the right-of-way needed to implement vegetation replacement. In addition, the planting of vegetation in the floodway may not be authorized by the Board, USACE, or other agencies if the vegetation would impede flood flows sufficiently that a rise in water surface elevation would cause a significant increase in risk to public safety. Because it cannot be assured that Impact BIO-A-5 (NTMA) can always be reduced to a less-than-significant level, this impact would be **significant and unavoidable**.

Impact BIO-A-6 (NTMA): ***Effects on Special-Status Fish, Fish Movement, Nursery Ground Usage, Riparian Habitat, Designated Critical Habitat, and Essential Fish Habitat Caused by the Increased Availability of Floodplain Habitat Generated by Setback Levees***

Numerous studies have found that floodplain habitat is valuable to native fish species in the Central Valley. Seasonally flooded habitat provides spawning, rearing, and foraging habitat for splittail and rearing habitat for Chinook salmon (Sommer et al. 1997; Sommer et al 2001; Sommer et al. 2002; Baxter et al. 1996; Jones & Stokes 1999). Floodplain inundation benefits the fisheries by increasing habitat availability and food supply and reducing predation rates. The duration and timing of inundation are key factors in the success of splittail spawning and rearing. A positive correlation exists between the number of days of inundation and the abundance of juvenile splittail in years when floodplains are inundated continuously for at least 4 weeks between March and April (Sommer et al. 1997; Jones & Stokes 2001).

Chinook salmon that rear in seasonally flooded habitat have higher survival and growth rates than juveniles that remain in the main river channel to rear (Jones & Stokes 1999; Sommer et al. 2001). When they rear in flooded habitat, juvenile salmon have been found to have growth rates of more than 1 millimeter per day and as much as 20 millimeters in 2–3 weeks (Jones & Stokes 2001). The water temperature is typically higher in floodplain habitat than in habitats in main channels. Although increased temperature increases metabolic requirements, the productivity in flooded habitat also increases, resulting in higher growth rates (Sommer et al. 2001). The production of drift invertebrates in the Yolo Bypass has been found to be one to two times greater than in the Sacramento River (Sommer et al. 2001).

In addition, flooded vegetation support invertebrates that are a substantial source of food for rearing juveniles. An increase in the areas of flooded habitat can reduce the competition for food and space and potentially reduce the possibility that these fish will encounter predators (Sommer et al. 2001).

Setting back levees provides an opportunity to increase the amount of floodplain habitat. Where setbacks expand a watercourse's floodway, this new area available for inundation could provide additional resting and rearing habitat for native fish species. Although expanded inundation areas resulting from setback levees are not of the same magnitude as flooded bypasses, these areas could contribute to habitat values, and they provide an opportunity for development of shaded riverine aquatic and IWM habitat that benefits these fish species.

However, stranding has been identified as a risk for juvenile fish that use floodplain habitat, and this issue may occur in setback levee areas as well. Fish stranding is a function of fish presence, hydrology, and topography. Often, human-created structures such as borrow pits, artificial ponds, and drainage ditches have resulted in fish stranding (Jones & Stokes 1999). Typically, as flows recede, juvenile fish will move from the draining area. Juvenile splittail have been observed moving off of the floodplain habitat with receding flow (Sommer et al. 1997; Baxter et al. 1996). However, juvenile Chinook salmon may not return to the main channel with receding flows, resulting in stranding. Deeper ponds that have no outlet back to the river can trap young fish, resulting in mortality if flows do not increase and reestablish a connection with the river. Mortality may result when water temperatures increase or oxygen levels decline while the water body evaporates, when the water body evaporates completely, or from predation by pisciverous (fish-eating) birds and mammals attracted to the trapped fish. The ability of fish to return to the main channel appears to be determined by size and readiness to migrate downstream in response to smoltification (the physiological change allowing salmon to function in salt water) (Jones & Stokes 1999).

Although creating new floodplain habitat can provide a substantial benefit to fish populations, fish stranding in floodplain habitat created by a new setback levee could outweigh these benefits through direct mortality to special-status fish species. Therefore, this impact would be **potentially significant**.

Mitigation Measure BIO-A-6 (NTMA): ***Design and Implement Floodplain Habitat to Minimize Stranding***

To avoid or minimize the potential for fish stranding associated with the creation of new floodplain habitat, the existing topographic and hydrologic characteristics of the floodplain will be examined to define the flooding regime, drainage patterns, water depths, and potential risks of fish stranding.

Potential floodplain habitat will slope to a main channel or slough to facilitate complete drainage and avoid depressions or other low-lying floodplain features that may strand fish. Periodic recontouring (e.g., filling and excavation) of floodplain surfaces may be required to avoid stranding fish.

Implementing this mitigation measure would reduce Impact BIO-A-6 (NTMA) to a **less-than-significant** level and assist in maximizing the overall benefits of creating new floodplain habitat.

3.5.5 Environmental Impacts and Mitigation Measures for LTMAs

This section describes the physical effects of LTMAs on aquatic biological resources. LTMAs include a continuation of activities described as part of the NTMAs and all other actions included in the proposed program, and consist of all of the following types of activities:

- Widening floodways (through setback levees and/or purchase of easements)
- Constructing weirs and bypasses

- Constructing new levees
- Changing operation of existing reservoirs
- Achieving protection of urban areas from a flood event with 0.5 percent risk of occurrence
- Changing policies, guidance, standards, and institutional structures
- Implementing additional and ongoing conservation elements

Actions included in the LTMAs are described in more detail in Section 2.4, "Proposed Management Activities."

Impacts and mitigation measures identified above for NTMAs would also be applicable to many LTMAs and are identified below. The NTMA impact discussions and mitigation measures are modified or expanded where appropriate, or new impacts and mitigation measures are included if needed, to address conditions unique to LTMAs. The same approach to future implementation of mitigation measures described above for NTMAs and the use of the term "project proponent" to identify the entity responsible for implementing mitigation measures also apply to LTMAs.

In addition, as described previously and in Section 3.1.2, "Analysis Methodology," because many LTMAs are more general and conceptual, additional impacts of those LTMAs are also described below in a broader narrative format, along with a list of suggested mitigation strategies that could be applied to these impacts. This more general analysis is provided in the subsection titled "LTMA Impact Discussions and Mitigation Strategies."

LTMA Impacts and Mitigation Measures

Impact BIO-A-1 (LTMA): ***Potential Effects on Special-Status Fish, Fish Movement, Nursery Ground Usage, Riparian Habitat, Designated Critical Habitat, and Essential Fish Habitat Caused by Degradation of Water Quality during Construction or Operations and Maintenance Activities***

This impact would be similar to Impact BIO-A-1 (NTMA) because the same impact mechanisms would occur. LTMAs could occur throughout the study area and could be larger in scale than NTMAs; as a result, this impact has a greater potential to occur than Impact BIO-A-1 (NTMA). However, as described previously for NTMAs, protective measures such as implementation of a SWPPP are part of the LTMAs, and compliance with federal and State permits for construction activities would require additional protective measures. Therefore, this impact would be **less than significant**. No mitigation is required.

Impact BIO-A-2 (LTMA): ***Effects on Special-Status Fish, Fish Movement, Nursery Ground Usage, Riparian Habitat, Designated Critical Habitat, and Essential Fish Habitat Caused by Loss of Overhead Cover and Instream Woody Material as Part of the Vegetation Management Strategy***

This impact would be similar to Impact BIO-A-2 (NTMA) because the same impact mechanisms would occur. Therefore, this impact would be **potentially significant**.

Mitigation Measure BIO-A-2 (LTMA): ***Implement Mitigation Measures BIO-A-2a (NTMA) and BIO-A-2b (NTMA)***

Implementing this mitigation measure would reduce Impact BIO-A-2 (LTMA), but it cannot be assured that the impact would be reduced to a less-than-significant level in all cases. Impact BIO-A-2 (LTMA) would be **potentially significant and unavoidable**.

Impact BIO-A-3 (LTMA): ***Effects on Special-Status Fish, Fish Movement, Nursery Ground Usage, Riparian Habitat, Designated Critical Habitat, and Essential Fish Habitat Caused during Construction***

This impact would be similar to Impact BIO-A-3 (NTMA) because the same impact mechanisms would occur. Therefore, this impact would be **significant**.

Mitigation Measure BIO-A-3 (LTMA): ***Implement Mitigation Measures BIO-A-3 (NTMA)***

Implementing this mitigation measure would reduce Impact BIO-A-3 (LTMA), but it cannot be assured that the impact would be reduced to a less-than-significant level in all cases. Impact BIO-A-3 (LTMA) would be **significant and unavoidable**.

Impact BIO-A-4 (LTMA): ***Effects on Special-Status Fish, Fish Movement, Nursery Ground Usage, Designated Critical Habitat, and Essential Fish Habitat Caused by an Increase in Hydrostatic Pressure, Underwater Noise, and Vibrations during Construction***

This impact would be similar to Impact BIO-A-4 (NTMA) because the same impact mechanisms would occur. Therefore, this impact would be **potentially significant**.

Mitigation Measure BIO-A-4 (LTMA): ***Implement Mitigation Measure BIO-A-4 (NTMA)***

Implementing this mitigation measure would reduce Impact BIO-A-4 to a **less-than-significant** level.

Impact BIO-A-5 (LTMA): ***Effects on Special-Status Fish, Fish Movement, Nursery Ground Usage, Riparian Habitat, Designated Critical Habitat, and Essential Fish Habitat Caused by Rock Placement***

This impact would be similar to Impact BIO-A-5 (NTMA) because the same impact mechanisms would occur. Therefore, this impact would be **potentially significant**.

Mitigation Measure BIO-A-5 (LTMA): ***Implement Mitigation Measure BIO-A-5 (NTMA)***

Implementing this mitigation measure would reduce Impact BIO-A-4 (LTMA), but not to a less-than-significant level. Impact BIO-A-4 (LTMA) would be **potentially significant and unavoidable**.

Impact BIO-A-6 (LTMA): ***Effects on Special-Status Fish, Fish Movement, Nursery Ground Usage, Riparian Habitat, Designated Critical Habitat, and Essential Fish Habitat Caused by the Increased Connectivity of Floodplain Habitat Generated by Setback Levees***

This impact would be similar to Impact BIO-A-6 (NTMA) because the same impact mechanisms would occur. Therefore, this impact would be **potentially significant**.

Mitigation Measure BIO-A-6 (LTMA): ***Implement Mitigation Measure BIO-A-6 (NTMA)***

Implementing this mitigation measure would reduce Impact BIO-A-6 (NTMA) to a **less-than-significant** level and assist in maximizing the overall benefits of creating new floodplain habitat.

Impact BIO-A-7 (LTMA): ***Effects on Passage by Special-Status Fish and Fish Movement***

Structural modifications at weirs would help improve fish passage in ways that would reduce migration delays and reduce predation. This improved passage would be beneficial to special-status fish species and fish movement. This impact would be **beneficial**. No mitigation is required.

LTMA Impact Discussions and Mitigation Strategies

Because of the more general and conceptual nature of many LTMAs, a great deal of uncertainty exists about how some LTMAs may be implemented and what environmental effects may result from their implementation. This uncertainty is to be expected for a broad, multiyear, and in some areas, conceptual program such as the CVFPP. Although these uncertainties exist, sufficient information exists to at least disclose additional potential impacts of LTMAs besides those discussed in the impact/mitigation pairings above. The following additional LTMA impacts are described in a broad narrative format; because of the uncertainty surrounding these impacts, no determination regarding their significance is provided. Consistent with Section 15145 of the CEQA Guidelines, these impacts are too speculative for evaluation beyond the narrative disclosure provided here.

Future project-specific CEQA evaluations for individual LTMAs will be used to determine the potential for the impacts described below to occur, determine their level of significance, and identify project-specific mitigation measures for significant impacts. Examples of potential mitigation strategies are provided after the following narrative impact discussions to disclose the nature and extent of mitigation actions that might be necessary to address these impacts.

For more information on this approach to evaluating LTMA impacts and providing mitigation strategies, see Section 3.1.2, “Analysis Methodology.”

Impact discussions are divided among the geographic areas in the program study area (i.e., Extended SPA, Sacramento and San Joaquin Valley watersheds, and SoCal/coastal CVP/SWP service areas). They are further subdivided according to the type of action (i.e., construction of conveyance facilities, facilities operations and maintenance from storage or conveyance actions, and other management actions).

LTMA Impact Discussions

Extended Systemwide Planning Area

Construction of Conveyance Facilities Construction-related impacts of LTMAs on aquatic biological resources are thoroughly described and evaluated above in the analysis of NTMAs and LTMAs. A more general narrative description of additional construction-related LTMA impacts in the Extended SPA is not required.

Facilities Operations and Maintenance from Storage or Conveyance Actions Operational changes in multiple Central Valley reservoirs as would occur under the LTMAs may affect the aquatic habitat conditions of downstream rivers. The full extent of potential operational changes and the possible interactions of those changes in multiple reservoirs are unknown. As a result, altered flow patterns could benefit fish in some instances and adversely affect them in other instances. Generally, changing reservoir operations would minimize damaging peak flood flow releases. Such changes could include using forecast-based operations (increasing reservoir releases earlier than would otherwise occur in anticipation of incoming storms) or coordinating reservoir operations to minimize peak downstream flows. These actions, however, could also slightly reduce the amount of water available for later releases if the reservoir releases were not fully offset by inflows from storms. The following beneficial and adverse changes to important river dynamic processes could occur:

- Redd scouring or siltation
- Alteration of ecologically important geomorphic processes resulting from altered frequency and magnitude of high flows (channel forming and maintenance)
- Altered floodplain inundation

Because the locations and extent of proposed changes in reservoir operations have not been defined, any effects on fish resulting from flow changes associated with LTMAs are speculative at best, and the impact could range from potentially significant to beneficial.

Changes in flow and reservoir operations could also affect water temperatures in Central Valley rivers. Fish species have different responses to water temperature conditions depending on their physiological adaptations. In general, salmonids have evolved under conditions where water temperatures are fairly cool. Delta smelt and splittail can tolerate warmer temperatures. In addition to species-specific thresholds, different life stages have different water temperature requirements. Eggs and larval fish are the most sensitive to warm water temperatures.

Because the location and extent of proposed changes in reservoir operations have not been defined, any effects on fish resulting from changes in water temperature associated with LTMAs are speculative at best, and the impact could range from potentially significant to beneficial.

Fluctuations in reservoir elevations could affect the spawning and rearing of reservoir fishes, particularly bass species. Water-level fluctuations associated with reservoir management are perhaps the most important factor affecting reservoir fish. Water-level fluctuations directly affect black bass species, such as largemouth bass (*Micropterus salmoides*) and spotted bass (*M. punctulatus)*, which construct nests for their eggs in shallow-water habitat (Kohler et al. 1993; Thorton et al. 1990; Aasen and Henry 1980). Falling water levels expose nests to wave action or dewater them entirely, while rising water levels may expose the nests to cold water that kills the eggs or slows their development.

Because proposed changes in operations have not been defined, any effects on fish resulting from changes in reservoir elevation fluctuations associated with LTMAs are speculative at best, and the impact could range from potentially significant to less than significant.

Other Management Actions Impacts on aquatic biological resources resulting from “other management actions” included in LTMAs are thoroughly described and evaluated above in the analysis of NTMAs and LTMAs. A general narrative description of additional LTMA impacts related to other management actions in the Extended SPA is not required.

Sacramento and San Joaquin Valley Watersheds

Facilities Operations and Maintenance from Storage or Conveyance Actions The mechanisms for and effects of operating and maintaining storage facilities in the Sacramento and San Joaquin Valley watersheds would be similar to those described above for operating and maintaining water storage facilities in the Extended SPA. Mitigating these potentially significant adverse impacts to less-than-significant levels may not always be possible.

None of the program’s management actions related to conveyance would be implemented in the portions of the Sacramento and San Joaquin Valley watersheds outside the Extended SPA. Therefore, no impacts on aquatic biological resources would result from conveyance-related management actions in this area.

Other Management Actions Impacts on aquatic biological resources of "other management actions" included in the LTMAs are thoroughly described and evaluated above in the analysis of NTMAs and LTMAs. A general narrative description of additional LTMA impacts related to other management actions in the Sacramento and San Joaquin Valley watersheds is not required.

SoCal/Coastal CVP/SWP Service Areas None of the program's management actions would be implemented in the SoCal/coastal CVP/SWP service areas. There would also be no substantial or long-term changes to water deliveries in this area and reservoir levels would be affected only minimally, if at all. Therefore, no impacts on aquatic resources would occur.

LTMA Mitigation Strategies The following mitigation strategies are example of approaches that may be considered to address significant impacts via the mechanisms described above. These mitigation strategies may be considered, as applicable, during project-level evaluation of specific LTMAs. For more information on LTMA mitigation strategies, see Section 3.1.2, "Analysis Methodology."

Specific mitigation measures identified above in the NTMA and LTMA impact/mitigation pairings are not identified again in the mitigation strategies. It is assumed that mitigation measures described in the impact/mitigation pairings above would already be required, as applicable, as part of the project-level evaluation of specific LTMAs. Not all mitigation strategies will apply to all LTMAs; the applicability of mitigation strategies will vary based on the location, timing, and nature of each management action. In addition, some mitigation strategies on their own may not constitute sufficient mitigation under CEQA but must be coupled with other mitigation strategies to reduce the impacts of LTMAs to less-than-significant levels.

The following potential mitigation strategies have been identified for aquatic biological resources, if necessary and feasible, to minimize certain types of significant or potentially significant impacts from project-level LTMAs:

- Create or enhance in-reservoir habitat in the form of woody debris or other hard structures to provide refugia and/or shallow-water spawning habitat for black bass or other fish species of high recreational value in reoperated reservoirs.

- Maintain or increase cold-water storage in reservoirs to minimize temperatures in downstream rivers below reoperated reservoirs.

- Minimize reservoir releases that increase downstream flow fluctuations and adversely affect the success of salmon spawning below reoperated reservoirs.

- Ensure that any changes to reservoir operations continue to allow sufficient flow releases downstream to meet all relevant minimum and other instream flow requirements below reoperated reservoirs.

- Ensure that any changes to reservoir operations maintain downstream riverine geomorphic conditions that maintain or enhance physical habitat conditions for all runs of salmon, steelhead, and other special-status fish species below reoperated reservoirs.

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