6.0 RECOMMENDED MANAGEMENT AND RESTORATION ACTIONS

Based on the fish species identified as being of primary management concern (Chapter 2), their current status and stressors (Chapters 3 and 4), and the scientific understanding of restoration processes (Chapter 5), potential management and restoration actions are identified in this chapter. Potential actions were gathered from various sources including the CalFed Bay-Delta Program ERPP EIS/EIR, FWG technical and internal memoranda, and USFWS AFRP documents. Actions also were identified through numerous discussions with local stakeholders and scientists (representing CalFed, CDFG, USFWS, NMFS, USBR and the Corps), an extensive literature review, and through field surveys and site visits. Restoration opportunities that directly addressed factors that limit production of the fish species of priority management concern were specifically targeted.

The flow and temperature considerations report provided the foundation for identifying and prioritizing opportunities for restoration in the lower American River. The *Baseline Report* established that flow and water temperature improvements have the greatest potential for restoration with respect to the priority fish species of the FISH Plan. As a result, the most immediate opportunities that exist for fish habitat improvement involve hydrologic system operations and management actions. Managing the timing, temperature, and rate of flow released from Folsom and Nimbus dams is likely to produce the most immediate and effective results for fish restoration. Opportunities for physical fish restoration actions also exist within the hydrologic and regulatory constraints inherent in managing the American River Basin water supply.

A flow and water temperature management plan is essential to create favorable conditions for lower American River salmonids. Flow patterns are important in maintaining geomorphology of watersheds such as meander belts and stream channel configuration, as well as riparian and floodplain vegetation along stream banks. Flow influences the well-being of valley wetlands, riparian communities, and the habitat of fish and other aquatic organisms. Flow also is essential for the well-being of native resident fish, including anadromous salmonids. Sufficient flows are necessary for anadromous salmonid adult migration, spawning, egg incubation, and juvenile rearing and emigration, especially because these functions must now occur in the lowermost 23 miles of the American River located below Nimbus Dam. In some cases, flows exceeding natural, unimpaired river flows below Nimbus Dam are recommended because anadromous salmonids must conduct these functions in the non-traditional habitats of the lower river, instead of the upstream reaches located above the present dam sites.

Of all limiting factors and potential corrective actions, maintaining suitable water temperatures and instream flows will do more for salmonid production within the lower American River than all other actions combined. Therefore, the foremost objectives for the flow and water temperature management plan for the American River below Nimbus Dam are to: (1) optimize multi-species benefits within the context of a regulated, multi-purpose system through operational changes in the allocation of the available water supply, and surface water demand

reductions in drier years to maximize direct benefits to lower American River anadromous fish resources; and (2) control water temperatures in the lower American River, to the extent possible, to avoid high water temperatures, which cause adverse effects to young steelhead, or delay fall spawning of salmon.

Although the vast majority of chinook salmon fry leave the river within a few weeks after emergence, steelhead juveniles remain in the river and, therefore, are subjected to relatively high water temperatures throughout the summer. Impacts associated with inadequate flow and water temperature management are summarized as follows:

- Adult migration: Instream flows in the lower American River are typically not limiting to upstream passage. However, elevated water temperatures in late summer and early fall (sometimes extending well into October) often exceed 65ºF. Relatively high water temperatures delay the onset of adult fall-run chinook salmon spawning and impede reproductive success. Exposure of pre-spawning adult chinook salmon to relatively high water temperatures can result in increased pre-spawning mortality, reduced gamete production, infertility, and increased embryonic developmental abnormalities. Thus, instream flows may adversely affect adult upstream migration and pre-spawning activities, primarily through elevated water temperatures.

- Spawning habitat: Chinook salmon spawning is concentrated in several well-documented areas in the river, primarily between RM 14 and 22. During low flow conditions, the extent of available spawning habitat is further restricted. Redd surveys conducted by CDFG have shown that the incidence of redd superimposition increases at lower flow levels. Adult fall-run chinook salmon generally do not initiate spawning in the lower American River until water temperatures decrease to approximately 60°F.

- Redd dewatering: CDFG aerial redd surveys (Snider and McEwan 1992; Snider et al. 1993; Snider and Vyverberg 1995) have provided evidence that chinook salmon redds are dewatered as a result of flow reductions during the fall and winter months. The potential for significant losses is greatest in years when flows are low and redds are concentrated. Lower flows can translate into relatively warmer water temperatures during early fall months. Constant exposure of salmonid eggs to water temperatures above 56°F will result in some egg mortality, while incubation at constant water temperatures above 63°F is believed to result in complete egg mortality. Water temperatures above 56ºF can occur when eggs and alevins are incubating in the lower American River. This problem is most likely to occur for chinook salmon in October and November.

- Fry stranding: Fluctuating flows can result in considerable stranding and loss of chinook salmon and steelhead fry. Numerous observations of stranded fish have been recorded in the river over the last decade. In addition, flow fluctuations affect diversity, productivity, and availability of insects (a food source for juvenile salmon and steelhead) in the lower American River. Young salmonids that become stranded outside of the main channel as a result of instream flow reductions suffer mortality due to predation, thermal stress, starvation, and eventual desiccation.

- Rearing habitat and juvenile outmigration: The availability of rearing habitat is directly related to flow; however, physical habitat availability considerations are probably overridden

by water temperature concerns during late spring, summer, and early fall. In addition to direct thermal stress, elevated water temperatures during chinook salmon and steelhead rearing and outmigration temperatures can result in multiple indirect effects including increased risk of predation, decreased growth rates, starvation, and susceptibility to disease, all of which contribute to reduced juvenile survival. Thermal stress to juvenile steelhead is a particular problem during July through October, when water temperatures at Watt Avenue frequently exceed 65 °F.

1.1. SELECTION CRITERIA

6.1.1. DEVELOPMENT OF FISH PLAN RECOMMENDATIONS

Recommendations in the FISH Plan, which constitute the focal point of this chapter, are based on an overall process which included several developmental steps. These steps included:

- Development of Selection Criteria – This step began with developing TSC, and then FWG, agreement on a list of general attributes that FISH Plan recommendations should embody. The FWG/TSC then oversaw development of the Baseline Report, as well as conceptual models regarding the manner in which the lower American River ecosystem and related restoration processes function (see Chapters 4 and 5). The TSC's view was that the baseline information and conceptual models needed to drive the development of more specific selection criteria. Meanwhile, the TSC reviewed selection criteria used elsewhere to serve as examples of selection criteria for potential application to the lower American River.

  Using all of these inputs, staff developed a "strawman" list of selection criteria and related selection procedures. TSC members then discussed, revised, and refined the criteria and procedures through interest-based negotiations until they, and subsequently the FWG, were comfortable with the resulting criteria and procedures. The resulting criteria were developed:

  - Addresses needs of priority species
  - Provides high species conservation value
  - Has high scientific merit
  - Offers multiple and/or leveraged benefits
  - Is implementable
  - Addresses major stressors
  - Provides high habitat enhancement/management value
  - Offers high data benefits/learning potential
  - Is durable/sustainable

  Further details, including subcomponents of each of the above criteria, can be found in **Appendices A and B**.

- Idea Generation – This step involved developing a comprehensive list of possible fisheries and aquatic habitat enhancement ideas for consideration during development of the recommendations. Ideas were generated through a variety of means, including: (1) culling suggestions from lower American River resource management plans; (2) brainstormed ideas

generated through a TSC retreat; and (3) a stakeholder field investigation via boat. Collectively, these venues generated a list of approximately 180 ideas for consideration.

- Application of Criteria – The FWG asked its TSC to take the lead in analyzing the list of approximately 180 fisheries and aquatic habitat enhancement ideas with respect to the agreed-upon selection criteria. The TSC analyzed these ideas in three primary steps, as follows:

    - *Initial Sort*. For each brainstormed idea, the TSC first categorized it by "type" of action[1] and then, using the agreed-upon "first sort" criteria (see Appendix A), jointly determined whether to "Include," "Maybe Include," or "Omit" the proposed action in the FISH Plan.

    - *Detailed Scoring Exercise*. For those ideas the TSC proposed to include among the FISH Plan recommendations, the group undertook a detailed scoring exercise as a first cut at prioritizing them. The detailed scoring exercise focused on the nine selection criteria described at the outset of this chapter (see Appendix B for further detail). Those recommendations dealing with research, monitoring, and evaluation were screened with a subset of the nine criteria, since the TSC determined that Criteria No. 3, 4, 5, and 8 would not be applicable to this type of recommendation.

    - *Professional Judgment*. TSC members next took a step back to reflect on the results of the detailed scoring exercise to see if the results dovetailed with TSC members' professional judgment. To help elicit their professional judgments, TSC members undertook an exercise known as "n/3," where "n" is the sample size. Each TSC member identified the 17 recommendations that they believed to be the most important in addressing the needs of priority fish species and aquatic habitat on the LAR. The results were then tallied as a way to cross-check the results of the detailed scoring exercise, and a few agreed-upon refinements were made. The n/3 results also were used to prioritize ideas from the "maybe include" list that the TSC decided to include, as well as to inform the TSC's efforts to group their proposed recommendations according to whether they were deemed first, second, or third priority.

      The TSC's professional judgment also was informed by presentations on several projects that were being considered by various agencies working in the LAR. As the TSC reached agreement on the content of the recommendations, they also offered their professional judgment in combining and sequencing their recommendations to put forth a cohesive package. They then submitted this package to the FWG for approval, which was elicited on May 24, 2001.

    - *Narrative Descriptions*. Once the TSC and FWG agreed on the list of recommendations to include in the FISH Plan, the TSC turned its attention to negotiating narrative text to elucidate each recommendation. The TSC established

[1] "Types" of proposed actions included: Regular/Implementation; Research/Modeling; Pilot/Demonstration Project; and Monitoring/Evaluation.

an ad hoc subgroup to identify key points for inclusion in the narrative descriptions for the monitoring and evaluation-oriented recommendations.

Appendix C contains the comprehensive list of fisheries and aquatic habitat enhancement ideas and indicates how each was addressed.

1.2. RECOMMENDATIONS

The recommendations presented herein are categorized by priority and type. The recommendations are considered to be of relatively high priority in that each is expected to contribute significantly to the improvement of conditions for the fish species of primary management concern. The recommendations are divided into first, second and third priority actions based on an assessment of the extent of each action's potential contribution to restoration goals, and confidence in the effectiveness of the action. Restoration/management actions are indicated by numbers (e.g., 1, 2, 3) whereas specific monitoring and evaluation actions are indicated by letters (e.g., A, B, C).

The recommended actions generally involve physical actions or changes in operations. All of the recommended actions are explicitly assumed to include monitoring and evaluation activities that enhance the recommended actions. For example, several recommended monitoring and evaluation activities will contribute to the refinement of the flow management plan (Recommendation No. 1). These monitoring and evaluation components also may support and be applicable to other management and restoration actions. The monitoring and evaluation components will generate the data needed for the adaptive management function that is integral to implementation of the FISH Plan. The monitoring and evaluation components may not be at the same assigned priority as the action or actions that they support. First Priority Actions.

1. DEVELOP AND IMPLEMENT AN ECOLOGICALLY-BASED FLOW MANAGEMENT PLAN FOR THE LOWER AMERICAN RIVER, INCLUDING WATER TEMPERATURE MANAGEMENT CONSIDERATIONS, SUBJECT TO SWRCB APPROVAL.

The flow management plan, subject to SWRCB approval, should consider:

1.1 The development of an updated flow management plan for the lower American River. This management plan should specify target flows and water temperatures to be met in the lower American River, including appropriate flow fluctuation and ramping criteria.

1.2 The updated flow management plan should provide benefits to priority fish species identified in the FISH Plan.

1.3 The updated flow management plan will include a monitoring and evaluation plan as part of the adaptive management process for both real-time and long-term management application. Chapter 7, Lower American River Science-Based Management Framework, describes the monitoring and evaluation plan which involves measuring and sampling both physical and biological attributes of the system.

1.4 The AROG should be considered the primary forum for adaptive management with regard to implementation of the updated flow management plan for the lower American River.

1.5 Possible strategies for meeting target flows under the updated flow management plan include:

- Modifying CVP operations; and
- Acquiring water as needed from willing sellers, with consideration given to reservoir available carryover storage and flows needed to meet needs considering water temperature objectives.

1.6 Flow management plan implementation also may include entering into agreements with landowners and water districts to limit diversions of natural flows to improve streamflows, consistent with the Water Forum Agreement.

1.7 Operations under the flow management plan will be coordinated with flows that occur naturally in the Sacramento Valley and with storage releases from Shasta, Oroville, and other tributary reservoirs.

1.8 Reservoir storage levels and releases at Folsom Reservoir necessary to maintain suitable temperatures for steelhead and chinook salmon will be determined and incorporated into the flow management plan. Implementation will include coordination of techniques and tools to optimize use of the Folsom Reservoir coldwater pool.

The following description encompasses each of the elements of the above action.

Project Background

SWRCB Decision 893 (D-893), adopted in the 1950s, is the current regulatory instream flow requirement for the lower American River. Under D-893, a minimum daily flow of 500 cfs is to be maintained at the mouth of the American River between September 15 and December 31, with a minimum of 250 cfs at all other times. Numerous other lower American River instream flow regimes and allocation strategies have been developed since adoption of D-893 including D-1400, Water Forum F-Pattern, and AFRP flow objectives, including the Department of Interior 1997 Final Administrative Draft Implementation and 3406(b)(2) implementation. A complete description of these flow regimes and allocation schedules is provided in the *Baseline Report*.

Augmentation of flow during dry years could provide significant benefits from both a physical flow and water temperature perspective. Conversely, flow fluctuations below Nimbus Dam can dewater salmonid redds and reduce survival of juvenile anadromous fishes due to stranding and isolation from the main channel. Suitable water temperatures are not always provided during the spring period for juvenile chinook salmon and steelhead. In addition, improved temperatures of water released from Folsom and Nimbus dams are needed for over-summer rearing conditions for juvenile steelhead, and spawning of fall-run chinook salmon in October and November. However, limited operational flexibility and coldwater pool availability in Folsom Reservoir complicates coldwater pool management during most water years. The AROG meets at least monthly to evaluate and recommend flow releases and temperature control operations within the constraints of operational flexibility, water availability, and coldwater pool availability in Folsom Reservoir.

Installation and operation of a Temperature Control Device (TCD) at Folsom Dam, which is currently under construction, will increase the annual availability of cold, hypolimnetic water for releases into the lower American River. In addition, with the relatively recent reconfiguration of

the Folsom Dam shutters, USBR operators possess the ability to better control the temperature of water released downstream. However, determining the most appropriate location (from a temperature perspective) in the water column from which to draw water into the penstock requires a better understanding of the thermal characteristics of the reservoir and how release temperature relates to water temperatures downstream. The multitude of uses of Folsom Reservoir waters must be reevaluated within the context of reservoir operations so that adequate coldwater storage exists to meet target water temperatures throughout the year. Various operations should be coordinated to ensure that all management and operation information is available and utilized to provide flow releases which meet water temperature objectives.

Project Description

The AFRP recognizes that to achieve the recommended seasonal instream flows, modifications will be needed to the operations of Folsom Reservoir and the remainder of the CVP, as well as advance and continued planning and adaptive management. Clearly, annual management for appropriate instream flows must be flexible, because the amount of water available to meet target flows will vary with water year type (USFWS 1995).

An effort to improve the existing lower American River flow standard was developed by the USFWS under the direction of the AFRP Core Group. In order to double natural production of anadromous fish in the Central Valley, USFWS recommended flow objectives by water year type for the lower American River. It is important to note that since these flows were developed, numerous initiatives have affected the implementability of these flow objectives including litigation regarding accounting and allocation of 3406(b)(2) water. Also, more recent efforts have been undertaken which may supercede this specific flow regime.

The Water Forum proposed an improved pattern of fishery flow releases from Folsom Reservoir, consistent with Central Valley Project Improvement Act (CVPIA) provisions. One of the seven elements, and perhaps the most important assurance needed for the Water Forum, was an updated lower American River flow management plan. The Water Forum Agreement sets out a process for recommending an updated flow management plan to the SWRCB.

Over the past several months, a Technical Committee comprised of representatives from USBR, NMFS, CDFG, USFWS, the Water Forum, and the City of Sacramento has been meeting with the purpose of developing a proposal for a lower American River flow management plan. The lower American River flow management plan continues to be developed.

The development of a flow management plan for the lower American River includes on-going collaborative efforts to develop flow ramping criteria, and to operationally implement these criteria to reduce the adverse effects of flow fluctuations on lower American River fish resources. Development and implementation of flow fluctuation and ramping criteria for operation of Folsom and Nimbus dams will improve conditions for steelhead, chinook salmon, and possibly splittail by minimizing losses due to redd dewatering, fry and juvenile stranding. Minimizing losses due to flow fluctuations contributes to the natural production of chinook salmon and steelhead, and will become increasingly important as other enhancement actions improve environmental conditions in the lower American River (CalFed Bay-Delta Program 1997). McEwan and Nelson (1991) recommended that USBR adjust overall CVP operations and procedures so that ramping problems can be eliminated, without sacrificing Delta water quality or habitat conditions in the upper Sacramento River for winter-run chinook salmon. Operations

at Folsom Dam relating to the release of water downstream also should be modified to provide gradual rates of reduction. If flow rates become significantly elevated above target levels for a week or more during the spawning period, the USFWS (1995) suggested that flows should be maintained at or near this new level through February to prevent redd dewatering and fry stranding.

Because maintaining adequate water temperatures is an essential component of a lower American River flow management plan, water temperature management is another component of this action. In order to maintain suitable water temperatures for the lower American River, the following objectives must be accomplished: (1) maintain lower American River water temperatures in the spawning and rearing reach between Arden Bar and Nimbus Dam at or below 60ºF beginning as early in October as possible, based on annual coldwater pool availability, and maintain water temperatures in the upper portion of the reach between Nimbus Dam and Sunrise Bridge below 65ºF from spring through fall (CalFed 2000); and (2) identify and implement actions that maintain mean daily water temperatures between 61°F and 65°F for at least one month from April 1 to June 30 for American shad spawning, consistent with actions to protect chinook salmon and steelhead, and when hydrologic conditions are adequate to minimize adverse effects to water supply operations (USFWS 1999). To contribute to achieving these objectives, Folsom Dam target water temperature releases must be developed. The following actions may be pursued to implement Folsom Dam target temperature releases: (1) conduct a study to refine the appropriate target water temperature releases for various seasons, boundary conditions, and river mile locations; and (2) institute procedures to identify and implement appropriate real-time target water temperatures throughout the year.

Another factor that will contribute to achieving the above-discussed objectives is continuing to implement and refine, to the extent necessary and possible, coldwater pool management for Folsom Reservoir. Such real-time operations need to consider time of year, reservoir storage, projected reservoir inflows, coldwater pool availability, and other factors in determining how best to operate the shutters throughout any given year. To assist in the development of real-time operations protocols, the following objectives should be addressed by USBR's current water temperature monitoring program:

- Optimally manage Folsom Reservoir's coldwater pool via real-term operation of the water release shutters to provide maximal thermal benefits to lower American River steelhead and chinook salmon throughout the year, within the constraints of reservoir coldwater pool availability.

- Better define the thermal characteristics (thermocline and extent of coldwater pool) in Folsom Reservoir for the purpose of optimizing water temperature release at Folsom Dam.

- Define the thermal characteristics in Lake Natoma for the purpose of better understanding the relationship between releases from Folsom Dam and temperatures downstream.

- Coordinate techniques and tools to optimize use of coldwater pool (i.e., integrate existing tools with computer modeling for scheduling in-river temperature reductions; install and monitor several water temperature profiling stations in Lake Natoma).

Potential Project Benefit

The ecologically-based flow and water temperature management plan will potentially provide benefits in terms of improved flows and water temperatures. Implementation of this plan would provide benefits to steelhead, chinook salmon, and other aquatic resources in the lower American River. In addition to the benefits that will be derived from the implementation of the plan, equally important benefits will be derived from improved Folsom Reservoir coldwater pool management. Increased coldwater pool volume will benefit juvenile steelhead rearing during summer and fall-run chinook salmon spawning during fall. Moreover, coordinating techniques and tools to optimize use of coldwater pool will provide long-term temperature management capability for the lower American River (USBR 2001).

Project Implementation Considerations

The Corps and USBR are responsible for Folsom Dam facility modifications and operations. USBR continues to incorporate and refine coldwater pool management as part of its operations. CDFG, NMFS and USFWS are responsible for assessing water temperatures and their effects on salmonids, as well as flow fluctuation effects on redd dewatering and juvenile stranding. USBR needs to continue to work with the AROG to integrate temperature scheduling (USBR 2001). Studies to implement criteria for flow fluctuation are in progress. After the studies are completed, results need to be implemented and operations criteria developed (CalFed Bay-Delta Program 1997).

2. DEVELOP AND IMPLEMENT A COMPREHENSIVE WATER TEMPERATURE MONITORING PLAN FOR THE LOWER AMERICAN RIVER.

2.1 Develop and implement a basin-wide water temperature monitoring program.

Project Background

The USBR-sponsored Function Analysis Workshop in January 2001 identified the need for a basin-wide program to provide reliable data for forecasting, model development, design modifications, coordination, and accomplishment of actions and usage in management and operational decisions.

Project Description

Many efforts in the recent past have conducted water temperature monitoring along the upper and lower American River and temperature profiling of Folsom Reservoir and Lake Natoma. The project will build on prior efforts toward developing a long term, continuous, and comprehensive temperature monitoring program. This program includes the North and South Forks American River, Folsom Reservoir, Lake Natoma, and the lower American River temperature monitoring, and meteorological monitoring.

This program contemplates the use of existing USGS, Fairbairn WTP, and possibly a new USGS temperature monitoring station at Sacramento Bar in order to develop a sufficient data set to accurately describe the thermal dynamics of Folsom and Nimbus Reservoirs and the lower American River. The existing USGS temperature monitoring stations are located at the North Fork American River at Auburn, the South Fork American River at Pilot Hill, the American

River below Folsom Dam, the lower American River at Hazel Avenue, the lower American River at William Pond, and the lower American River at Watt Avenue. A meteorological monitoring station should be established at the Fairbairn WTP station to monitor wind speed and air temperature on the river for the purpose of characterizing the localized weather conditions on the thermal behavior of the river. Existing bathymetric surveys of Folsom Lake and Lake Natoma will be used to help assess the transport through, and mixing of, cold water in the reservoirs.

Four, or more, temperature profiling stations will be located in Lake Natoma to identify thermal stratification. These stations are part of USBR's ongoing temperature monitoring program and are comprised of a series of optic StowAway® Temperature data loggers (Onset Computer Corporation) suspended from buoys on a seasonal basis.

One permanent and up to six temporary water temperature profiling stations will be located in Folsom Reservoir to describe thermal stratification throughout the year. The four temporary stations are part of USBR's ongoing water quality monitoring program which entails collecting water quality data approximately bi-weekly using a boat and DataSonde® 4 (Hydrolab Corporation) at six locations in Folsom Reservoir. The permanent water quality profiling station will be an integral part of the temperature control device currently being constructed on the Folsom Dam municipal and industrial water supply intake.

In addition, temperature data will be available from acoustic flow meters being installed in the power penstocks which will measure the average temperature of the water passing through the temperature shutters located on the penstocks.

The program includes two flow monitoring stations just upstream of Folsom Reservoir, one on the North Fork and one on the South Fork. The station on the North Fork is planned to be an integral part of Placer County Water Agency's permanent pump station, the construction of which is scheduled to be completed in spring 2004.

Potential Project Benefits

This action facilitates the acquisition of accurate data to better manage cold water in Folsom Reservoir. The data collected will have a level of accuracy and precision necessary to provide a basis for identifying the suitability of thermal conditions for fish along the lower American River, serve as a benchmark for measuring or forecasting the impacts of infrastructure modifications, and serve as basis for informing operational decisions. The stations will be spaced appropriately to adequately describe the thermal character existing in the system throughout the year. To make use of the information developed by past water temperature monitoring efforts, monitoring equipment and monitoring locations are chosen to produce data consistent with that recorded in previous monitoring programs.

Project Implementation Considerations

The monitoring program is in place with the exception of the permanent profiling station in Folsom Lake which is planned to be completed in 2002, the flow station on the North Fork American River which is planned to be completed in 2004, a flow station on the South Fork American River which has not been scheduled for installation, and a USGS station at Sacramento Bar which is still being evaluated.

3. DEVELOP AND IMPLEMENT PHYSICAL ACTIONS AND OPERATIONAL AND MANAGEMENT MEASURES TO IMPROVE WATER TEMPERATURES IN THE LOWER AMERICAN RIVER.

3.1 Conserve cold water in Folsom Reservoir.

3.1.1 Evaluate potential to construct curtains at tributary inflows to Folsom Reservoir, forcing cold water to bottom of reservoir.

Project Background

Cold water inflows to Folsom Reservoir mix with the warmer surface water, and then cannot be used for cold water releases from Folsom Dam (USBR 2001).

Project Description

Temperature curtains constructed at tributary inflow locations may force available cold water to the depths of Folsom Reservoir, where it can remain cold and then flow to Folsom Dam. Modeling may be needed to verify actual water temperature benefits (USBR 2001).

Potential Project Benefits

The above action will maximize Folsom Reservoir's coldwater pool. Considered a portable structure, it can be moved, stored, and deployed over a period of days. Additionally, the above action is more acceptable than permanent structures and can be 90 percent completed from shore (USBR 2001). This action, however, would disrupt but not eliminate public access. It may require relocation corresponding to changed water surface elevations, and may be subject to vandalism and damage.

Project Implementation Considerations

Constructing curtains at tributary inflows to Folsom Reservoir should be considered after full evaluation of potential benefits and disadvantages, relative to other possible water temperature-related actions.

3.1.2 Formalize change in USBR standard operating procedure for Folsom Dam to permit release from the spillway gates to save cold water.

Project Background

Current standard operating procedures are to first release water out of the river outlet works whenever turbines need to be bypassed. If flows exceed 30,000 cfs, flows are released over the spillway gate. Providing increased operational flexibility, formalized in USBR's standard operating procedure for Folsom Dam, would allow expedient utilization of the spillway gates and preserve cold water without the necessity of first seeking variance from current standard operating procedures.

Project Description

Preferential utilization of spillway gates may increase capability to manage cold water at Folsom Reservoir. This action consists of formally incorporating preferential utilization of the spillway gates at Folsom Dam into USBR's standard operating procedure.

Potential Project Benefits

If water is released from the spillway gates first, it would facilitate effective long-term management of the available coldwater pool in Folsom Reservoir for the benefit of anadromous salmonids. This action has value individually, but will collectively have leveraged benefits, when combined with managing/allocating the coldwater pool in Folsom Reservoir, conserving coldwater in Folsom Reservoir, re-operating upstream operations, and developing a TCD for El Dorado Irrigation District.

Project Implementation Considerations

USBR is the appropriate lead agency for this action.

3.1.3 Evaluate opportunities for re-operation of upstream reservoirs for benefit of Folsom Reservoir coldwater pool management.

Project Background

Upstream reservoirs, including facilities owned and operated by PCWA, PG&E, and SMUD, currently are not operated to release water for coldwater pool management in Folsom Reservoir. Opportunities may exist to reoperate upstream reservoirs to benefit Folsom Reservoir coldwater pool management *via* delivery of cold water during spring to enhance downstream water temperatures for the remainder of the year.

Project Description

This action involves evaluation of the opportunity to acquire a given amount of water from upstream reservoirs, to be stored and delivered (on demand) for downstream temperature control. Additional opportunities include reoperation of upstream reservoirs.

Potential Project Benefits

Increased coldwater pool availability, particularly during the period of July through October, will benefit juvenile steelhead rearing and chinook salmon spawning (CalFed Bay-Delta Program 1997). Moreover, coordinating techniques and tools to optimize use of a larger coldwater pool in Folsom Reservoir will provide increased long-term temperature management capability for the lower American River (USBR 2001).

Project Implementation Considerations

Reclamation plans to conduct an initial evaluation of the potential temperature benefits of reoperating Sacramento Municipal Utility District's reservoirs on the main stem and tributaries of the South Fork American River in 2002.

3.1.4 Construct and operate a temperature control device for El Dorado Irrigation District.

Project Background

El Dorado County Water Agency (EDCWA) and USBR are proposing the execution of a long-term water service contract. Under the contract, up to 15,000 acre-feet annually (AFA) of CVP water would be provided to EDCWA and its member districts from Folsom Reservoir. All water diverted for the use of EID will be taken from Folsom Reservoir at EID's existing intake for treatment at EID's El Dorado Hills WTP. The proposed action would include installation of a TCD on the district's expanded intake structure.

Project Description

Similar to the proposed TCD at Folsom Dam, EID is proposing to install a TCD at its intake on the south shore of Folsom Reservoir. The EID TCD likely would consist of a pipeline with inlets at various locations corresponding to different elevation levels within the reservoir. Operators would have the flexibility to selectively draw from varying depths in the reservoir, thereby using or conserving the coldwater pool depending on the current needs of the fishery downstream in the lower American River.

Potential Project Benefits

Increased coldwater pool availability, particularly during the period of July through October, will benefit juvenile steelhead rearing and fall-run chinook salmon spawning. Increased operational flexibility resulting from increased coldwater pool availability will provide long-term coldwater pool management capability. This action, in concert with other actions increasing coldwater pool availability at Folsom Reservoir will provide leveraged benefits.

Project Implementation Considerations

The EID TCD is currently in the planning, design, and environmental documentation process. USBR and EID are the lead agencies for this action.

3.2 Access coldwater in Folsom Reservoir.

3.2.1 Improve capability to control Folsom Dam release water temperatures for the benefit of priority lower American River fish species by improving effectiveness of Folsom Dam power penstock inlet port, shutters, and guidance structure.

Project Background

Monitoring and evaluation of management actions at Folsom Dam indicate that water is entering along the vertical extent of the power penstock inlet structure at Folsom Dam, rather than at discrete vertical shutter locations. This leakage complicates effective coldwater pool management of Folsom Reservoir for the benefit of anadromous salmonids in the lower American River. In addition, current practices demand that all temperature shutter units are changed at once, which results in "stair-step" changes in water temperature. Scheduling to control blending also is troublesome. Therefore, current operations are not adequate to meet water temperature objectives in the lower American River (USBR 2001).

Project Description

The above action includes: (1) ascertaining whether current operations are meeting water temperature requirements through long-term temperature scheduling, a combination of existing tools, and proposed modifications; (2) conducting an investigation of the cause of the leakage and developing and implementing a remedial plan; and (3) improving management/operations of shutters to reduce the "stair-step" changes in water temperature to gradual changes, and blending of available water supplies.

Potential Project Benefits

Improving the capability to control Folsom Dam releases will: (1) facilitate effective long-term management of the available coldwater pool in Folsom Reservoir for the benefit of anadromous salmonids; and (2) allow blending of water supplies for quality control.

Project Implementation Considerations

USBR is responsible for the operation of Folsom Dam. A further evaluation needs to be conducted of repairs necessary to reduce the leakage, including a cost-benefit analysis to compare repair versus replacing the structures with a fully automated TCD (see Action 2.3.2, below).

3.2.2 Evaluate the effectiveness and construct, as appropriate, of a fully automated temperature control device.

Project Background

The current shutter configuration at Folsom Dam provides limited operational flexibility for vertical access to water in Folsom Reservoir to release to the lower American River. In addition, adjustments to the shutter configuration, made to access target temperatures of release water in Folsom Reservoir, are labor intensive and require advance planning, notification, and personnel allocation. Currently, the shutters are adjusted only 3-4 times a year because readjustment requires a significant expenditure of capital and labor, as well as closure of Folsom Dam Road.

Project Description

Studies are currently underway to evaluate the installation of an automated TCD. Automation would allow the shutters to be adjusted in multiple configurations, on a frequent, as-needed basis. Additional evaluations are necessary to ascertain anticipated water temperature benefits, and design configurations and construction costs.

Potential Project Benefits

An automated TCD would provide significant increased operational flexibility and opportunity to access and release target water temperatures for the benefits of aquatic resources in the lower American River. In addition, the increased operational flexibility would provide real-time coldwater pool management benefits and minimize operational planning and logistics concerns.

Project Implementation Considerations

Implementation is dependent upon full evaluation of costs and benefits. In addition, the eventuality and timeliness of implementation will be dependent upon identification and acquisition of financing.

3.2.3 Evaluate the effectiveness of accessing coldwater between the lower river outlet works and the penstocks to address needs of priority lower American River fish species.

Project Background

Coldwater pool availability in Folsom Reservoir is not always sufficient to meet water temperature objectives in the lower American River. Currently, the only means available to access the coldwater pool below the existing power penstocks is to release this water through the lower American River outlet works.

Project Description

Conduct an evaluation to determine benefits and costs of alternative means of accessing coldwater between the lower river outlet works and the existing power penstocks at Folsom Dam. The evaluation should include a determination of whether dissolved oxygen and nitrogen super-saturation present a water quality problem below Nimbus Dam.

Potential Project Benefits

If accessing coldwater between the lower river outlet works and the penstock is proven effective, then it would facilitate effective long-term management of the available coldwater pool in Folsom Reservoir for the benefit of anadromous salmonids.

Project Implementation Considerations

USBR is the appropriate lead agency for this action.

3.2.4 Assess ability to access low-elevation coldwater pool with hydroelectric power generation and to economically utilize coldwater pool below penstock intakes.

Project Background

During emergency temperature conditions, accessing coldwater with low level outlet works translates into loss of power generation (USBR 2001).

Project Description

Evaluate using an existing or new outlet to produce power while accessing the low level coldwater pool. An additional outlet could be constructed under the flip bucket of the emergency spillway. This new outlet could pull water from lower elevations than the existing power plants.

Potential Project Benefits

The above action would result in additional coldwater that would be available for fall-run chinook salmon and steelhead without foregoing hydroelectric power generation. In addition, it generates 50-200 MW of additional hydropower capacity (USBR 2001).

Project Implementation Considerations

This action requires additional evaluation of feasibility, costs, and benefits, and subsequently should be considered relative to the entire suite of potential actions directed at improving water temperatures in the lower American River.

3.2.5 Modify the existing automated temperature selection schedule for multi-species benefits to accommodate potential modifications to the existing power penstock shutters at Folsom Dam, or other infrastructure actions.

Project Background

Limited coldwater pool availability in Folsom Reservoir requires a mechanistic process or "tool" to implement a water temperature management strategy and achieve target temperature objectives in the lower American River. An automated temperature selection procedure currently exists to assist decision makers in balancing the limited coldwater resource for multi-species benefits. However, the existing automated temperature selection schedule may need to be modified to reflect ongoing and future temperature-related actions and regulatory changes.

Project Description

USBR recently developed and continues to evaluate the application of a Folsom Reservoir coldwater pool management model that includes an automated water temperature selection procedure. The selection procedure needs to reflect the ongoing and future water temperature-directed actions. For example, installation and operation of a TCD at Folsom Dam (which is currently under construction) will increase the annual availability of cold, hypolimnetic water for releases into the lower American River. In addition, with the relatively recent reconfiguration of the Folsom Dam shutters, USBR operators possess the ability to better control the temperature of water released downstream. However, determining the most appropriate location (from a water temperature perspective) in the water column from which to draw water into the penstock requires a better understanding of the thermal characteristics of the reservoir and how release temperature relates to water temperatures downstream. The multitude of uses of Folsom Reservoir waters must be reevaluated within the context of reservoir operations so that adequate coldwater storage exists to meet target water temperatures throughout the year. Various operations should be coordinated to ensure that all management and operation information is available and used to operate water flows to meet temperature requirements (USBR 2001).

Potential Project Benefits

The existing automated temperature selection schedule is appropriate under existing conditions. If conditions change (i.e., new species are listed or infrastructure is modified), the schedule may need to be updated for optimal multi-species benefits for the lower American River fish species of primary management concern.

Project Implementation Considerations

An updated automated selection model for Folsom Dam would be used in conjunction with the AROG.

3.3 Improve the transport of cold water from Folsom Dam to Nimbus Dam through Lake Natoma and release to the lower American River.

3.3.1 Evaluate the effectiveness of temperature control structures for the Nimbus Dam spillway and power intake to help address needs of priority lower American River fish species. Potential actions include the installation of temperature curtains at the plunge zone of Lake Natoma and around the Nimbus Dam powerplant intake, and removal of a portion or all of the concrete debris wall in front of the intake. Also, evaluate operations of Nimbus Dam during occasional spills to minimize release of warm water from Lake Natoma.

Project Background

While managing the coldwater pool in Folsom Reservoir is a priority for maintaining cool water temperatures in the lower American River, lesser but significant benefits also can be attained by managing releases from Nimbus Dam. The temperature of the top several feet of Lake Natoma can increase 5 to 10°F from late spring through early fall. Water released into the lower American could be 1 to 2°F lower if warmer surface waters were not included in releases. Because summer water temperatures often reach 65°F or above, 1 to 2°F additional heating is significant (CalFed 2000). In addition, the Nimbus powerplant withdraws surface water because a concrete debris wall around the powerplant intake allows withdrawal of water mostly above elevation 105 ft msl (top of the debris wall). The existing concrete debris wall is 25 feet high and extends upward about 15 feet from surface. Water entering the powerplant inlet must pass over the wall and may represent relatively warmer water (USBR 2001).

The Water Forum, SAFCA, and Reclamation have collaborated on a proposal to CalFed, which includes one aspect of this action: to install two portable temperature curtains in Lake Natoma.

Project Description

To withdraw the coldest water available in Lake Natoma while excluding the withdrawal of warm surface water, evaluations of the following actions should be undertaken: (1) install a surface-suspended curtain downstream of where the cold water from Folsom Reservoir "plunges" below the warm surface water in Lake Natoma; (2) install a surface suspended curtain around the power plant intake to allow for withdrawals from the bottom of Lake Natoma; and (3) evaluate the benefits of removing the debris wall.

Potential Project Benefits

Potential benefits to steelhead juvenile rearing and fall-run chinook salmon spawning in the lower American River will be derived from managing releases from Nimbus Dam. Installing a temperature curtain at the plunge zone of Lake Natoma would limit mixing and consequently reduce Nimbus Dam flow release temperatures (USBR 2001). In addition, installing a temperature curtain around the Nimbus Dam powerplant intake will allow potential access to coldwater stored and passed through Lake Natoma, thereby lowering the outflow temperature

from Nimbus Dam (USBR 2001). The curtains will be installed at strategic locations in Lake Natoma for the purpose of determining the curtains' effectiveness in reducing water temperatures in critical anadromous salmonid spawning and rearing habitat in the lower American River. Reducing water temperatures during the warmer summer months (generally May through October) will result in improved survival of rearing anadromous salmonids, and the conservation of cold water in Folsom Reservoir will aid fall spawning.

Removing the concrete debris wall may reduce the temperature of water releases from the Nimbus powerplant during times that Lake Natoma is stratified, and may avoid the need to bypass the Folsom powerplant to meet downstream water temperature objectives (USBR 2001).

Project Implementation Considerations

A pilot project sponsored by the Water Forum and SAFCA in collaboration with Reclamation (who holds jurisdictional authority over the project site) has been proposed to CalFed. If funded, the Water Forum will oversee the administration and general management of the project. SAFCA is a cost share partner and will also oversee general project management. Reclamation, through a Memorandum of Understanding, will oversee design, construction, installation, monitoring, and assessment of two portable temperature curtains.

Data collection, design, and construction and evaluation, would take three years. Verification that coldwater from Folsom Dam will flow along the river channel through Lake Natoma to the Nimbus powerplant intake will be based on bathymetric and temperature profile information.

3.3.2 Improving efficiency of water transport through Lake Natoma (e.g., modifying channel in Lake Natoma).

Project Background

Currently, coldwater is inefficiently transported through Lake Natoma and Nimbus Dam (USBR 2001). A pre-dam channel exists, which may impede transport of cold water or induce mixing in Lake Natoma between Folsom and Nimbus dams (USBR 2001).

Project Description

Coldwater transport efficiency may be improved by modifying the channel in Lake Natoma. Channel modifications can be done in conjunction with constructing a temperature curtain. Both bathymetric profiles (in-stream channels from Folsom Dam to Nimbus Dam; thermal plunge areas) and temperature profiles (from Folsom Dam to Nimbus Dam) have been conducted. Information from these profiles will aid in the evaluation of channel modifications. A TCD for Nimbus Dam spillway bay(s) also could be constructed (see action 3.3.1). Finally, locations in Lake Natoma which impede transport of cold water or induce mixing between Folsom and Nimbus dams could be identified and modified (USBR 2001).

Potential Project Benefits

Improving cold water transport efficiency through Lake Natoma would lower the temperature outflow from Nimbus Dam, benefiting rearing juvenile steelhead and spawning fall-run chinook

salmon (USBR 2001). The above-described action may provide an effective conduit for cold bottom water to Nimbus power intakes (USBR 2001).

Project Implementation Considerations

USBR would be the appropriate lead agency for this action. Implementation is dependent on identifying locations suitable for modification with certainty. Reclamation's Technical Service Center has been asked to provide an initial evaluation of the benefits to modifying the channel.

6.1.2. AQUATIC, RIPARIAN, AND WETLAND HABITAT

4. DEVELOP A PLAN OR POLICY FOR MANAGEMENT OF LARGE WOODY DEBRIS IN THE LOWER AMERICAN RIVER, CONSISTENT WITH RECREATION SAFETY NEEDS, INCLUDING A PILOT PROJECT.

Project Background

Woody debris accumulates naturally in streams and plays important roles in stream mechanics and fish habitat. Juvenile outmigrants and young steelhead rearing in the river need instream cover to escape fish and avian predators. In addition to protective cover, instream structure provides a substrate for aquatic invertebrates to colonize, thereby increasing prey availability for juvenile salmonids (USFWS 1995). Woody debris also provides microhabitat with reduced current velocities and risk of predation where these fish can more effectively hold to feed. Finally, woody material increases pools, increases structural complexity, holds other organic matter and increases channel stability. Habitat diversity in the lower American River is limited in downstream sections (e.g., in the vicinity of the H Street or Fair Oaks Boulevard Bridge) and below. Large woody debris has been removed from the river as part of bank protection projects or in response to safety complaints (to eliminate hazards to recreationists, especially swimmers and rafters). Lack of vegetative and woody cover reduces habitat diversity available to juvenile salmonids.

Project Description

Development and implementation of a woody debris maintenance program would facilitate improving and/or restoring instream cover for salmonid rearing. The following actions should be considered in the development of the plan: (1) modifying current practices for removing and placing large woody debris; and (2) implementing a pilot project to place large woody debris into the river to meet the needs of priority fish species. Woody debris maintenance should be used in conjunction with other measures to improve environmental conditions for juvenile salmonid rearing in the lower American River.

A management plan is needed to determine the best possible approaches to improve and maintain woody debris. The management plan could include terminating the practice of clearing trees and other objects from the river (CalFed Bay-Delta Program 1997). This practice has reduced instream cover for juvenile salmon and steelhead (USFWS 1995). In addition, trees and logs could be added to selected rearing habitats on the river to enhance instream cover for juvenile salmonids.

Potential Project Benefits

Establishment and maintenance of instream woody cover will provide needed cover for juvenile salmonids, and should result in increased survival due to reduced predation losses. Such instream cover will also provide a substrate for aquatic invertebrates to colonize, ultimately increasing food availability for juvenile salmonids (USFWS 1995).

Project Implementation Considerations

Development of the lower American River woody debris management plan or policy should include analysis and documentation of proposed project benefits to fish resources and priorities set accordingly. Implementation should be coordinated with the work of the LAR Task Force's Woody Debris Subgroup. The Reclamation Board will need to review the plan on policy; if implementation requires modification to the channel or levees between Nimbus Dam and Discovery Park, a Reclamation Board permit probably will be required.

6.1.3. LEVEES AND BANK PROTECTION

5. IDENTIFY AND EVALUATE LOCATIONS IN THE LOWER AMERICAN RIVER WHERE EXISTING REVETMENTS COULD BE MODIFIED TO INCORPORATE BANK PROTECTION HABITAT FEATURES TO AID IN PRESERVATION AND RE-ESTABLISHMENT OF BOTH HIGH-QUALITY NEARSHORE AQUATIC AND RIPARIAN HABITATS, AND IMPLEMENT MEASURES WHERE APPROPRIATE AND POSSIBLE TO DO SO WITHOUT HAVING AN IMPACT ON THE INTEGRITY OF THE BANK PROTECTION.

Project Background

Many existing revetments along the lower American River are constructed from riprap. Riprap reduces the ability of vegetation to colonize river banks, and therefore reduces shading of river waters, decreases insect production and availability to fishes, reduces habitat complexity and diversity, and reduces instream cover (CalFed 2000). However, there are ways to improve such revetments (see below).

Project Description

Conduct a survey of existing revetments and evaluate opportunities to modify existing revetments to incorporate habitat features in continuing and future bank protection projects that would: (1) protect aquatic and terrestrial species and their habitat along the lower American River; and (2) enhance riparian and SRA habitat. Such habitat features might include scalloped embayments and associated hard point, multi-stage bench areas, SRA habitat, habitat complexity, diversity, roughness, in-stream aquatic, nearshore, overflow habitat, and other features.

Potential Project Benefits

Such habitat features could reduce the adverse effect of levees and bank protection on aquatic and terrestrial species and their habitats along the lower American River (CalFed 2000).

Project Implementation Considerations

The above action should be implemented subject to rigorous experimental design, monitoring, and adaptive management. The Reclamation Board will need to review any plans that involve modification to the channel or levees between Nimbus Dam and Discovery Park; such activities can be expected to require a Reclamation Board permit.

6.1.4. ARTIFICIAL PROPAGATION OF FISH

6. ESTIMATE RELATIVE PROPORTION OF HATCHERY AND NATURALLY-PRODUCED CHINOOK SALMON AND STEELHEAD TO ANNUAL SPAWNING ESCAPEMENT AND COMMERCIAL AND SPORTS FISHERIES TO ENHANCE MANAGEMENT CAPABILITIES.

Project Background

Uncertainty currently exists regarding the relative contribution of hatchery-produced chinook salmon and steelhead to the total annual production, including commercial and sport fisheries, and spawner escapement. This uncertainty hampers lower American River management efforts.

Project Description

The origin of the spawner population (e.g., in-river versus hatchery produced) would be determined by using various identifiers. Such identifiers may include tags (likely only applied to hatchery produced salmon) and marks (thermal, clips, chemical) applied to hatchery produced fish and unique, natural signatures including microchemistry and structure.

Potential Project Benefits

An improved understanding of the relative contributions of natural and hatchery-produced salmonids to total annual production would allow improved management capabilities for the lower American River. Such improved capabilities could include refinement of flow and water temperature regimes, monitoring activities, identification of specific restoration actions, and more effective adaptive management. This improved understanding also would contribute to the assessment of progress toward state and federal goals regarding increased production of naturally spawned salmonids from the lower American River.

Project Implementation Considerations

This action has sufficient certainty of success to justify full implementation, subject to program priority setting, phased implementation, and adaptive management. CDFG is the appropriate lead agency for this action.

7. UNDERTAKE LONG-TERM MODIFICATION OF THE DIVERSION STRUCTURE AT THE NIMBUS SALMON AND STEELHEAD HATCHERY TO PROTECT SALMON AND STEELHEAD AND OTHER LOWER AMERICAN RIVER RESOURCES FROM POTENTIAL IMPACTS ASSOCIATED WITH FLOW FLUCTUATIONS FOR OPERATIONS AND MAINTENANCE.

Project Background

Current maintenance practices at the diversion structure for the Nimbus Salmon and Steelhead Hatchery necessitate substantial flow decreases each fall. The diversion structure consists of eight piers on 30-foot spacings, including two riverbank abutments, which span the river and guide upstream migrants to the fish ladder and into the hatchery. Fish rack support frames and walkways are installed each fall via an overhead cable system. A pipe rack is then put in place, which supports pipe pickets (three-quarter inch steel rods spaced on two and one-half inch centers). The pipe rack rests on a submerged steel I-beam support frame, which has numerous voids underneath. Because there is no concrete foundation between the piers, riverbed scour underneath the support frame does allow for passage of migrants upstream, although the aim is to divert all of them into the hatchery. Each year it is necessary to substantially reduce flows in the river in order to repair scour holes underneath the support frame.

Project Description

Design and construct a new and improved diversion structure at the Nimbus salmon and steelhead hatchery. A prototype is currently being built and installed.

Potential Project Benefits

A new fish diversion structure at the hatchery would obviate the need to reduce flows in the river on an annual basis for diversion structure maintenance. In addition, it would reduce further genetic dilutions of native fall-run chinook salmon by better harvest selection capabilities and perhaps by reducing inter-breeding between hatchery-produced and native fish.

Project Implementation Considerations

USBR would be the appropriate lead agency for this action, in consultation with fish resource agencies. A prototype is scheduled to be tested in 2001 and designs completed in 2002.

6.1.5. STRANDING

8. COMPLETE THE INVENTORY OF AREAS THAT POSE A STRANDING THREAT TO JUVENILE SALMONIDS. CONDUCT FUNCTION ANALYSIS WORKSHOP TO IDENTIFY MEASURES TO REDUCE OR ELIMINATE STRANDING. IMPLEMENT MEASURES WHERE APPROPRIATE OPPORTUNITIES EXIST.

Project Background

The number of young salmonids that become stranded and lost in areas outside and inside of the main channel (e.g., in areas associated with floodplains, shallow ponds, and levee borrow areas)

can be significant. Sources of mortality in such cases include desiccation, predation by aquatic, terrestrial, and avian predators, as well as thermal stress.

Project Description

Complete the inventory of potential stranding areas in the lower American River. Through a function analysis workshop, identify areas in which the terrain could be mechanically modified to establish hydraulic connectivity with the main channel within the target flow range, and identify modifications in operations that would reduce the frequency and magnitude of flow fluctuation events.

Potential Project Benefits

This recommendation could ultimately reduce juvenile salmonid mortality that results from stranding.

Project Implementation Considerations

CDFG may be an appropriate lead agency for this action. If appropriate sites are identified, implement measures to reduce or eliminate stranding.

6.1.6. OTHER POTENTIAL MANAGEMENT ACTIONS

9. IDENTIFY THE FISHERY IMPACTS ON LOWER AMERICAN RIVER PRIORITY SPECIES CAUSED BY MEETING SACRAMENTO-SAN JOAQUIN RIVER DELTA WATER QUALITY CONTROL PLAN (WQCP) REQUIREMENTS AND NEEDS FROM FOLSOM RESERVOIR.

Project Background

Because of the close proximity of Folsom Dam and Reservoir to the Delta, and the relatively short period of time for the flow to reach the Delta, releases from Folsom Reservoir are commonly relied upon to meet Delta standards in lieu of releases from more distant CVP reservoirs on reductions in Delta exports. USBR presently attempts to minimize flow fluctuations, in both magnitude and frequency, associated with these releases. However, flow fluctuations still occur, as well as reduction of storage and coldwater supply in Folsom Reservoir.

Project Description

Identify, and bring to the attention of CalFed's Operations Group and the SWRCB, the fishery impacts on lower American River priority species resulting from meeting Sacramento/San Joaquin Delta WQCP requirements and needs from Folsom Reservoir. Evaluate USBR operating criteria with regard to balancing releases between Folsom and Shasta reservoirs. Focus on year-round implications of operational policy with respect to springtime releases. Document historical and recent historical operational decisions that involve the release of water from Folsom Reservoir to meet Delta standards. Document subsequent resource implications (e.g., fluctuating flows, raising of shutters, loss of coldwater) resulting from these decisions. Qualitatively assess the fishery impacts resulting from the management decisions. The AROG or its designee prepare a report or presentation for the CalFed Operations Group and the SWRCB.

Provide recommendations in the report for minimizing impacts to the lower American River fishery resources. Work with the CalFed organizations to incorporate these findings into their operations plans to minimize impacts to the lower American River.

Potential Project Benefits

This recommendation could ultimately lead to reductions in flow fluctuation, and provide additional operational flexibility regarding flow and coldwater pool releases for multiple species benefits in the lower American River.

Project Implementation Considerations

USBR would be the appropriate lead agency for this action.

10. IMPROVE AVAILABILITY AND MANAGEMENT OF LOWER AMERICAN RIVER RESEARCH DATA, WITH ATTENTION TO QUALITY CONTROL.

Project Background

Databases of lower American River water temperature data currently are available on the California Data Exchange Center (CDEC). However, additional water temperature data, as well as habitat characterization, biologic monitoring and operations information exist in various formats and reside with numerous entities and individuals and, therefore, is not easily accessible.

Project Description

The existing lower American River databases need to be expanded, and associated quality control activities must be specified for each database. In addition, potential database users need to know what data are available, and where the data and quality control information are located.

Potential Project Benefits

Expansion of existing databases, improving access to them, and disseminating information regarding the databases will improve the efficiency and effectiveness of lower American River projects.

Project Implementation Considerations

Coordination among many agencies is required to fully implement this project.

6.1.7. MONITORING AND EVALUATION COMPONENTS

A. TO IMPROVE MANAGEMENT CAPABILITIES, DETERMINE THE RELATIVE CONTRIBUTION OF FALL-RUN CHINOOK SALMON THAT LEAVE THE LOWER AMERICAN RIVER EARLY AS POST EMERGENT FRY TO THE LOWER AMERICAN RIVER SPAWNING STOCK ESCAPEMENT.[2]

Monitoring of juvenile chinook salmon emigration by CDFG over the past several years indicates that the vast majority of young fish leaving the river do so within a few weeks after emergence. However, it is unknown to what extent and under what conditions the fish that emigrate early in the season as fry, contribute to the number of adults eventually returning to the lower American River, compared to those relatively few individuals which exhibit an extended rearing period in the river and emigrate later as smolts. Management direction for juvenile chinook salmon could be affected by the results of this assessment. Management priorities for flows and water temperatures might be adjusted if this information were available, particularly during years when management decisions must respond to limitations on flow and coldwater pool availability.

B. INVESTIGATE TEMPORAL AND SPATIAL DISTRIBUTION OF STEELHEAD IN THE LOWER AMERICAN RIVER TO STRENGTHEN THE INFORMATION BASE FOR MANAGEMENT DECISIONS.

Although previously conducted monitoring provides important information regarding spatial and temporal distribution and habitat utilization of juvenile steelhead in the lower American River, additional monitoring and evaluation would improve the information base upon which recommended actions depend. Particularly during the critical over-summer juvenile steelhead rearing period, improved understanding of the interaction between population response and habitat characteristics and utilization, including flow and water temperature, will help refine specific recommendations regarding juvenile steelhead rearing.

C. USE BEST AVAILABLE INFORMATION (OR DEVELOP NEW INFORMATION AS NEEDED) TO COST-EFFECTIVELY CREATE A MULTI-POINT LOWER AMERICAN RIVER WATER TEMPERATURE PREDICTING AND ESTIMATING MODEL WITH SHORTER TIMESTEPS TO STRENGTHEN ADAPTIVE MANAGEMENT CAPABILITIES.

USBR currently uses a monthly water temperature planning model, and a weekly Folsom Reservoir coldwater pool management model to evaluate water temperatures in the lower American River. Real-time management of the coldwater pool in Folsom Reservoir and water temperatures in the lower American River would benefit from development of a daily water temperature model capable of predicting and estimating water temperatures at various locations along the river at shorter intervals of time. Development of such a model is an extensive effort and includes refinement of basin-wide water temperature monitoring. Initial activities associated with this overall effort include:

- Fixing the Fair Oaks gauge;
- Reviewing Lake Natoma thermal profiles; and

[2] Although recommendations may be species-specific, resulting plans should have a multi-species / ecosystem frame of reference.

- Assessing additional Lake Natoma temperature modeling improvements that may be necessary.

1.3. SECOND PRIORITY ACTIONS

6.1.8. AQUATIC, RIPARIAN, AND WETLAND HABITAT

11. IDENTIFY AND EVALUATE OPPORTUNITIES TO IMPLEMENT WETLAND/SLOUGH COMPLEX RESTORATION, WITH NEEDS OF ALL PRIORITY SPECIES IN MIND.

Project Background

Wetland/slough complexes are a variety of habitats occurring within transitional habitat zones between a river channel and shoreline and upland habitats. Sloughs are old river channels and/or secondary flood channels, incised with the floodplain or terrace surfaces, that remain hydrologically connected to the river through groundwater or surface water. These complexes contain a suite of wetlands ranging from perennial emergent marsh to seasonal wetlands and riparian forest (CalFed Bay-Delta Program 1997).

Project Description

This action focuses on identifying and evaluating the potential benefits and negative impacts of wetland/slough complex habitat restoration. A survey should be conducted to identify sites for habitat intervention. Vegetation plantings, irrigation, monitoring, and the use of any necessary remedial actions for site reconfiguration or revegetation also could be included in the evaluation.

Potential Project Benefits

Restoration of wetland/slough complex habitat would provide increased habitat complexity and diversity for rearing juvenile salmonids in the lower American River. However, exploring this type of intervention in an incremental fashion will enable avoidance of potential irreversible negative impacts.

Project Implementation Considerations

The identification and evaluation of potential wetland/slough complex restoration actions should include long-term monitoring and an operation and maintenance component (CalFed Bay-Delta Program 1997). It is particularly important that this type of restoration action be carried out according to accepted scientific methods (e.g., well-formulated hypotheses, systematic data collection, monitoring, and adaptive management) due to the uncertainties and irreversibility likely to be associated with such projects.

6.1.9. NATURAL FLOODPLAIN AND FLOOD PROCESSES

12. INVENTORY LOCATIONS FOR CREATING SHALLOW INUNDATED FLOODPLAIN HABITAT FOR MULTI-SPECIES BENEFITS AND IMPLEMENT WHERE SUITABLE OPPORTUNITIES ARE AVAILABLE. PROTECT EXISTING OVERFLOW AREAS.

Project Background

Overbank flooding is an important regenerative process needed to maintain riparian forests and woodlands. Much of the nutrient input in the riparian/floodplain zone is derived from infrequent overbank flooding (i.e., approximately every 1 to 1.5 years). Opportunities to restore floodplains and flood processes along the lower American River are constrained by the flood control requirements provided by Folsom Dam and the levee system throughout the lower river reach.

Project Description

Inventory locations for protecting and creating shallow, inundated, and adequately sustained (connected) floodplain habitat for multi-species benefits (including splittail spawning habitat, juvenile salmonid rearing, and terrestrial species' needs), and protect existing overflow areas. Where suitable locations can be identified, proceed with restoration action. In addition, existing overflow areas should be protected via an ordinance or statute that would discourage flood protection or other construction in these areas.

Potential Project Benefits

Enhancing floodplain overflow areas, as well as protecting existing overflow areas, will help to maintain and restore a riparian corridor that supports a variety of aquatic and terrestrial species.

Project Implementation Considerations

Protecting and enhancing floodplain overflow areas should be implemented in stages with the appropriate monitoring to judge benefit and success (CalFed 2000). As part of the program, develop and implement a monitoring program to assess the effectiveness of restoration actions undertaken, looking at ecosystem-wide impacts. Implement the project subject to disciplined experimental design, monitoring, and adaptive management.

13. IDENTIFY OPPORTUNITIES TO, AND POTENTIAL BENEFITS AND DETRIMENTS OF, ENHANCING OR CONSTRUCTING MAINSTEM AND SIDE CHANNEL HABITATS THAT PROVIDE FALL-RUN CHINOOK SALMON AND STEELHEAD SPAWNING AND REARING HABITAT, AND IMPLEMENT MEASURES WHERE SUITABLE OPPORTUNITIES ARE AVAILABLE.

Project Background

The lower American River consists in large part of impaired stream channel configurations that do not provide shaded side channel habitats. Side channels along the river can be restored to provide rearing habitat.

Project Description

Identify specific sites in which new mainstem side channels could be constructed (e.g., by regrading the floodplain and planting vegetation. The evaluation should include identification of

opportunities to revegetate disturbed side channel, and an evaluation of benefits and detriments associated with doing so.

Potential Project Benefits

Enhanced and restored side-channel habitat could provide spawning and rearing habitat for fall-run chinook salmon and steelhead (CalFed 2000).

Project Implementation Considerations

If suitable opportunities and significant benefits are identified with minimal detriments, proceed with implementation subject to disciplined experimental design, monitoring and adaptive management.

6.1.10. HARVEST OF FISH AND WILDLIFE

14. TO ASSIST IN PROTECTING AND ENHANCING NATURAL PRODUCTION OF LOWER AMERICAN RIVER SALMONIDS, DEVELOP AND IMPLEMENT A MARKING AND SELECTIVE HARVEST PROGRAM FOR LOWER AMERICAN RIVER CHINOOK SALMON AND STEELHEAD, IDEALLY IN THE CONTEXT OF A CENTRAL VALLEY-WIDE EFFORT.

Project Background

For populations supplemented with hatchery-produced fish, selective harvesting may be necessary to limit the harvest of wild fish while harvesting hatchery-produced fish at a level that will reduce their potential to disrupt the genetic integrity of wild populations (CalFed 2000).

Project Description

Conduct an evaluation of the feasibility, costs, and benefits, and implementability of a marking and selective harvest program, for ocean and in-river sport and commercial fisheries. If supported by evaluation, implement the developed selective harvest program.

Potential Project Benefits

Selective harvest of hatchery-produced fish may alleviate harvest pressures on wild stocks, increase spawning stock escapements of wild stocks, and contribute to the genetic integrity of wild stocks.

Project Implementation Considerations

Although the contribution of wild stocks to total production of salmonids is presently unknown, CalFed (2000) suggests that selective harvest programs have sufficient certainty of success to justify full implementation subject to program priority setting, phased implementation, and adaptive management.

6.1.11. OTHER POTENTIAL MANAGEMENT ACTIONS

15. CONTINUE TO PROVIDE ONGOING LONG-TERM CONSULTATION/TECHNICAL ASSISTANCE TO LAR TASK FORCE, ITS COMPONENT COMMITTEES, AND RESPONSIBLE AGENCIES FOR LOWER AMERICAN RIVER MANAGEMENT.

Project Background

Consultation with fisheries and water resources experts will be necessary to identify and implement enhancement measures that will benefit steelhead, chinook salmon, and other aquatic resources in the lower American River. There must be management flexibility to allow for continued evaluation of the interaction among flow, water temperature, and other restoration actions on target fish populations.

Project Description

Consultation should include identification of actions that would enhance survival, preparation of feasibility studies and monitoring programs, and development of a plan to implement the measures (CalFed Bay-Delta Program 1997). Technical assistance also is necessary to review and provide input regarding design, implementation, and monitoring of specific actions.

Potential Project Benefits

Selection and implementation of measures to enhance conditions for steelhead, fall-run chinook salmon and other aquatic resources of the lower American River would be based on a fuller understanding of the resource needs and restoration opportunities as a result of on-going, long-term consultation and technical assistance.

Project Implementation Considerations

A management team consisting of representatives from USBR, CDFG, DWR, USFWS, NMFS, Corps, SWRCB, water interests, environmental organizations and other public interests is recommended to provide advice regarding the operations of Folsom Dam and Reservoir, as well as consideration, monitoring, and adaptive management of other restoration actions.

6.1.12. COARSE SEDIMENT SUPPLY

16. DEVELOP A COLLABORATIVE PROGRAM TO INVESTIGATE EROSION, BEDLOAD MOVEMENT, SEDIMENT TRANSPORT, AND DEPOSITIONAL PROCESSES AND THEIR RELATIONSHIP TO THE FORMATION AND MAINTENANCE OF FISH HABITAT IN THE LOWER AMERICAN RIVER.

Project Background

Sediment recruitment from the watershed above Folsom Dam has been eliminated. Lack of sediment recruitment from the upper watersheds will ultimately adversely influence the structural characteristics of the stream channel, impair riparian and riverine aquatic habitats, and reduce habitat complexity required by anadromous and resident fish species.

Project Description

Building on the Ayres Associates (1997) report on the development of a 2-D model regarding bedload mobilization at various flows ("*Two Dimensional Modeling and Analysis of Spawning Bed Mobilization, LAR*") (Ayers 2001), develop a collaborative program to investigate erosion, bedload movement, sediment transport, and depositional processes and their relationship to the formation and maintenance of fish habitat in the lower American River. These investigations also will focus on the specific factors that lead to the occurrence of armored gravel beds in the river below Nimbus Dam, which are of little value to salmonid spawning.

Potential Project Benefits

Insights gained concerning the issues listed above will result in finer resolution of long-term opportunities to improve the ecological health of the lower American River.

Project Implementation Considerations

A project has been initiated to investigate and determine the relationships of erosion, bedload movement, sediment transport and depositional processes to formation of point bars and riparian regeneration will rely on collaborative efforts that include stakeholder groups such as the Water Forum, state and federal agencies, and local governments.

17. ASSESS THE NEED TO DEVELOP A SPAWNING GRAVEL MONITORING AND MANAGEMENT PROGRAM FOR STEELHEAD AND FALL-RUN CHINOOK SALMON IN WHICH INTERVENTION WOULD BE BASED ON IDENTIFICATION OF SPECIFIC SITES WHERE INTERVENTION WOULD ENHANCE OR INCREASE SALMONID SPAWNING HABITAT.

Project Background

Several characteristics of spawning gravel may limit salmonid spawning habitat utilization in the lower American River. These characteristics are described below.

- Permeability: Poor subsurface flow (intragravel permeability) as well as interlocking substrate characteristics may limit salmonid spawning habitat utilization in the lower American River.
- Embeddedness: Some potential spawning grounds within the lower American River have become embedded with fines, thereby removing these areas from the total acreage of suitable spawning habitat. However, this is believed to be of lesser concern than the concerns regarding intragravel permeability.
- Gravel size: Observations of lower American River spawning gravel suggest that substrate particle sizes are relatively large by comparison to those typically used by chinook salmon and steelhead in other streams. This condition is related to the lack of recruitment of smaller-sized gravel from areas upstream of Nimbus and Folsom dams. Reduced availability of suitable-sized spawning gravel may, in part, limit spawning success of salmon and, to a greater degree, steelhead.
- Gravel recruitment: Folsom and Nimbus dams prevent recruitment of gravel from upstream areas. Even if spawning gravel is not a key limiting factor today, it may become one if

production increases and gravel naturally moves downstream without replacement (USFWS 1995).

It is important to note that simply adding gravel to the stream channel may not improve spawning conditions because an impermeable clay lens under the deposited gravel could limit upward percolation and, therefore, fish use for spawning, and other site-specific habitat characteristics. Hence, the specific river locations where potential gravel deposition occurs would largely dictate the benefits to fish resources (CalFed 2000).

Project Description

Pending results of related CDFG (2000) study[3], assess the need to develop a spawning gravel monitoring and management program for steelhead and fall-run chinook in which intervention (e.g., mechanical cleaning, gravel introductions, etc.) would be based on identification of specific sites (if any) where intervention would enhance or increase salmonid spawning habitat. The program should focus on maintaining natural ecological processes linked to stream channel maintenance, erosion and deposition, maintenance of salmonid spawning areas, and the regeneration of riparian vegetation through maintaining, improving, or supplementing gravel recruitment and natural sediment transport in the lower American River.

Potential Project Benefits

USFWS has characterized this action as a simple way to increase the reproductive success of lower American River salmonids. It is thought that overall production may be increased through: (1) increasing the availability of high-quality spawning substrate; (2) decreasing the frequency and magnitude of redd superimposition; (3) increasing the hatchability of eggs; and (4) decreasing mortality rates for yolk-sac fry (USFWS 1995).

Project Implementation Considerations

CDFG would identify sites where gravel is to be added or cleaned, and take the lead in implementing this action (USFWS 1995). Spawning gravel monitoring and management should be implemented in stages with the appropriate monitoring to judge benefit and success.

6.1.13. ARTIFICIAL PROPAGATION OF FISH

18. EVALUATE NIMBUS SALMON AND STEELHEAD HATCHERY PRODUCTION AND STOCKING PRACTICES TO IDENTIFY MEASURES THAT WOULD PROMOTE RESTORATION OF NATIVE FISH SPECIES IN THE LOWER AMERICAN RIVER.

Project Background

Salmon and steelhead runs on the lower American River have been influenced by introduction of non-native stocks during and after construction of Folsom Dam. In the lower American River,

[3] CDFG study, initiated in 1993, focuses on spawning habitat enhancement. CDFG surveyed spawning habitat use, looked at why some sites are used and others not, and tried different treatments. CDFG is now monitoring the results.

hatchery supplementation may be necessary to sustain fishery harvest and to maintain a naturally spawning population during droughts (CalFed 2000). Hatchery augmentation, however, should be limited to avoid inhibiting recovery and maintenance of wild populations. Although hatchery stocking may increase the raw numbers of fish in the river, it is counter-productive to the recovery of native stocks (USFWS 1995). Hatchery introductions have likely influenced phenotypic expressions (e.g., run timing) of lower American River fish. Moreover, when large numbers of hatchery fish are stocked and the proportion of the population made up of hatchery fish increases, so too does the fishing pressure on the remaining wild fish.

Hatchery-reared fish also may threaten the genetic integrity of wild stocks by interbreeding with the wild fish. Adverse impacts on salmonid populations due to straying generally increases as the percentage of the population composed of stocked fish increases. The lower American River is believed to receive a large number of hatchery-propagated strays from the Mokelumne and Feather rivers, as well as smaller contributions from other rivers. Straying has far-reaching genetic effects and reduces the ability of constant fractional marking approaches to identify hatchery contribution to overall stocks. (All hatchery steelhead are currently marked, but not tagged and there is little evaluation of the resulting data.)

Project Description

An evaluation of hatchery production and stocking practices at the Nimbus Salmon and Steelhead Hatchery is currently underway. Nimbus Hatchery has undergone a review by the Joint Hatchery Review Committee comprised of CDFG and NMFS staff during the period from September 1999 through December 2000. The review was initiated in response to the listing of California salmon and steelhead under the federal ESA. The primary goals of the review were: (1) identify and discuss programs, policies, and practices that are likely to arise as important issues in permitting hatchery programs under the ESA; (2) identify opportunities for integrating hatcheries into the process of recovering listed salmon and steelhead populations; and (3) discuss emerging views on the operation and management of hatcheries for the purpose of recovering depressed natural stocks. The draft final report of this review will be completed in late 2001.

Since mid-1999, the Nimbus Salmon and Steelhead Hatchery has been operating under a Production Goals and Constraints document, prepared by CDFG, that has oriented the hatchery toward a concern for genetic diversity. The document specifies that *"...[t]he annual egg allotment for all species cultured shall be distributed throughout the length of the spawning run in proportion to historical temporal distribution of the runs. Maintaining genetic diversity by distributing the egg allotment throughout the spawning run shall take precedence over meeting numeric production goals."*

Potential Project Benefits

Alternative production and stocking practices utilized by Nimbus Fish Hatchery could contribute to the restoration of native fall-run chinook salmon and steelhead stocks. For example, the use of broodstock from the length of the spawning run will increase the genetic diversity of propagated fish at the Nimbus Hatchery.

Project Implementation Considerations

The new Operational Plan is currently underway.

6.1.14. OTHER POTENTIAL RESTORATION ACTIONS

19. ASSESS FEASIBILITY OF PROVIDING ENHANCED OFF-SITE STEELHEAD HABITAT (E.G., COON CREEK, DRY CREEK, AUBURN RAVINE).

Project Background

In contrast to historical conditions where steelhead spawned and reared in tributaries in the watershed upstream of Nimbus Dam, steelhead are now restricted to the lowermost 23 miles of the mainstem lower American River.

Project Description

Steelhead spawning and rearing habitat is limited to the mainstem of the lower American River below Nimbus Dam. Off-site habitat should be provided via fish ladders or stream diversions and restoration of habitat (e.g., Coon Creek, Dry Creek, Auburn Ravine).

Potential Project Benefits

Benefits of off-site habitat include increased tributary spawning and rearing habitat for steelhead blocked by Nimbus Dam.

Project Implementation Considerations

Uncertainties associated with habitat availability, environmental impacts on the proposed creeks, funding availability and construction of fish passage devices need to be explored.

6.1.15. MONITORING AND EVALUATION COMPONENTS

D. DEVELOP AND IMPLEMENT A METHOD OF ESTIMATING ANNUAL STEELHEAD IN-RIVER SPAWNING POPULATION AND POPULATION TRENDS TO ASSIST IN MANAGEMENT DECISION-MAKING.

Presently, no consistent methodology is employed to estimate the number of steelhead returning annually to the lower American River. In contrast to chinook salmon, which spawn during the fall in the lower American River, steelhead spawn during winter months. The carcass survey used to estimate the annual number of fall-run chinook salmon spawning in the river cannot be consistently performed for steelhead because of frequent high flows and turbidity during the winter. Consequently, data is generally lacking regarding the number of steelhead that return to the river each year. Development and implementation of methodologies to consistently estimate the annual number of steelhead are necessary to facilitate management decisions and evaluate implementation of future restoration actions.

E. DEVELOP AN IN-RIVER PRODUCTION MODEL FOR FALL-RUN CHINOOK SALMON TO ASSIST IN UNDERSTANDING FACTORS CRITICAL TO THE WELL-BEING OF THIS SPECIES.

CDFG has developed, and is in the process of refining, a "survival index" that serves as a metric to facilitate interpretation of the effects of various abiotic factors on the annual production of juvenile fall-run chinook salmon in the lower American River. An in-river production model could be developed which would build upon CDFG's efforts in order to fully refine functional relationships affecting riverine chinook salmon production. Such a model could serve as an individual metric that combines and synthesizes numerous functional relationships into a single indicator. In addition, an in-river production model could be used as a sub-model within an adaptive management framework.

F. DEVELOP A JUVENILE STEELHEAD OVER-SUMMER SURVIVAL MODEL TO ASSIST IN UNDERSTANDING FACTORS CRITICAL TO THE WELL-BEING OF THIS SPECIES.

Presently, no single indicator exists to succinctly describe the sequential, cumulative effects of water temperature on the survival of juvenile steelhead in the lower American River. Specifically, frequently elevated water temperatures during the critical over-summer juvenile steelhead rearing period may affect the ultimate survival of juvenile steelhead through direct mortality and physiologic stress, and indirectly through increased susceptibility to predation. Development of a juvenile steelhead over-summer model will provide an inclusive indicator of these potential effects to facilitate management decisions, particularly regarding coldwater pool management.

G. DEVELOP A STOCK-RECRUITMENT MODEL FOR FALL-RUN CHINOOK SALMON TO GUIDE MANAGEMENT DECISION-MAKING.

A stock-recruitment model for fall-run chinook salmon in the lower American River could be developed, which would build upon Monitoring and Evaluation Component E. However, numerous sources of variation occur outside the lower American River basin, which would need to be addressed in such a model. If an appropriate co-variant type of analysis could be conducted addressing out-of-basin factors, then a stock-recruitment model may facilitate identification of in-river factors affecting annual production, and assist in the guidance of management decisions.

1.4. THIRD PRIORITY ACTIONS

6.1.16. AQUATIC, RIPARIAN, AND WETLAND HABITAT

20. IDENTIFY AND CHARACTERIZE OPPORTUNITIES TO IMPROVE THE COMPLEXITY AND DIVERSITY OF AQUATIC HABITATS IN THE LOWER AMERICAN RIVER, AND IMPLEMENT MEASURES WHERE SUITABLE OPPORTUNITIES ARE AVAILABLE.

Project Background

In the early 1990s, CDFG conducted a complete habitat characterization of the lower American River. This effort should be built upon to provide an update and identify specific areas for implementation of restoration actions, particularly those addressing instream object cover and nearshore habitat complexity and diversity.

Project Description

Building upon CDFG's effort, and utilizing more recent information, candidate areas could be identified for actions aimed at increasing habitat complexity and diversity. Aquatic habitats should be inventoried and characterized, and opportunities to improve habitats in the lower American River identified. This effort should be followed by a feasibility evaluation regarding specific habitat improvements.

Potential Project Benefits

Specific actions that increase habitat complexity and diversity would increase the quality and quantity of habitat available in the lower American River for juvenile salmonids.

Project Implementation Considerations

Actions undertaken to improve habitat first must be fully evaluated to determine project benefits to fish resources of the lower American River. If suitable opportunities and significant benefits are identified, a pilot project should be undertaken. Such a pilot project should include disciplined experimental design, monitoring fish impacts and related adaptive management mechanisms. All habitat improvement actions should be implemented in accordance with program priority setting, phased implementation, and adaptive management. CDFG, NMFS and USFWS would be the appropriate agencies to take the lead in this action.

21. IDENTIFY AND EVALUATE SUITABLE LOCATIONS AND BENEFITS OF ESTABLISHING/ PROVIDING SRA HABITAT ALONG THE LOWER AMERICAN RIVER TO BENEFIT PRIORITY FISH SPECIES, AND IMPLEMENT MEASURES WHERE APPROPRIATE OPPORTUNITIES EXIST.

Project Background

SRA cover consists of shoreline aquatic habitat with instream cover, woody debris, bank vegetation, overhanging cover, and fine-soil, naturally eroding banks (per USFWS definition).

Shorelines with SRA cover have a high degree of hydraulic complexity under low to moderate flows, and are often submerged under high flows. SRA cover provides high-value feeding areas, burrowing substrates, escape cover, and reproductive cover for numerous fish species, including fall-run chinook salmon and steelhead (CalFed Bay-Delta Program 1997).

Project Description

Identify and evaluate suitable locations and benefits of establishing/providing SRA habitat along the lower American River to benefit priority fish species. Shoreline with SRA cover could be restored by constructing terraces along the shoreline. This would include excavating and planting terrace surfaces along the channel. The soils of these terraces could be stabilized at the appropriate elevation for proper hydrologic conditions with structural features (e.g., log sills, wooden structures, or boulders) if necessary. Trees species planted on the terraces should be the same as those found along the river (e.g., oaks, cottonwood, alder, box elder, sycamore), and large specimens. These may be obtained from sources within the parkway (if removal does not cause habitat loss) or in the region. Care should be taken not to create navigational or flood control hazards (CalFed Bay-Delta Program 1997). Planting would be achieved by staking, waddling, whole plant transfer and/or container stock. This work may be achieved with small to moderately sized equipment (small excavator, backhoe, or bobcat) and hand labor (CalFed Bay-Delta Program 1997).

Potential Project Benefits

Enhanced SRA habitat would increase high-value feeding areas, burrowing substrates, and escape cover for lower American River priority fish.

Project Implementation Considerations

Actions undertaken to enhance SRA habitat first must be fully evaluated to determine project benefits to fish resources of the lower American River. If suitable opportunities and significant benefits are identified, proceed with implementation subject to rigorous experimental design and monitoring. SRA enhancement actions should be implemented in accordance with program priority setting, phased implementation and adaptive management (CalFed 2000).

22. IDENTIFY AND EVALUATE SUITABLE LOCATIONS TO USE LARGE IN-STREAM OBJECTS (E.G., BOULDERS) TO MODIFY FLOW DYNAMICS TO INCREASE COVER AND DIVERSITY OF IN-STREAM HABITAT FOR PRIORITY FISH SPECIES. IMPLEMENT MEASURES WHERE SUITABLE OPPORTUNITIES ARE AVAILABLE.

Project Background

Habitat diversity in the lower American River is limited in downstream sections. Lack of vegetative and woody debris, as well as large instream objects, reduces habitat diversity available to juvenile salmonids.

Project Description

Identify and evaluate suitable locations to use large in-stream objects (e.g., boulders) to modify flow dynamics to increase cover and diversity of in-stream habitat for priority fish species.

Monitor progress of related implementation efforts. Development and implementation of an in-stream objects maintenance program would facilitate improving and restoring instream cover for salmonid rearing. This program should be implemented in conjunction with a woody debris management program (per Recommendation No. 3) and other measures to improve environmental conditions for juvenile salmonid rearing in the lower American River. A monitoring component should be included to judge the benefit and success of the program.

Potential Project Benefits

An instream-object maintenance program will increase protective cover and diversity of instream habitat for priority fish species in the lower American River.

Project Implementation Considerations

If suitable opportunities and significant benefits are identified, proceed with implementation subject to rigorous experimental design, monitoring, and adaptive management. The action should be implemented in stages with the appropriate monitoring to judge benefit and success. The Reclamation Board will need to review any plans that involve modification of the channel or levees between Nimbus Dam and Discovery Park; such activities can be expected to require a Reclamation Board permit.

23. IDENTIFY AND EVALUATE SUITABLE LOCATIONS TO ESTABLISH/PROVIDE WETLAND FILTRATION HABITAT ON INFLOW POINT SOURCE DISCHARGES; CREATE SUCH HABITAT IF SUITABLE OPPORTUNITIES CAN BE IDENTIFIED.

Project Background

Water quality of the lower American River is affected by contaminants from urban runoff. Creating wetland filtration habitat would reduce the effects of contaminants on the lower American River.

Project Description

Identify and evaluate suitable locations to establish/provide wetland filtration habitat on inflow point source discharges and create such habitat if suitable opportunities can be identified. Investigate the impact of "first flush" urban run-off events to lower American River water quality. If impacts are considered significant, develop and implement a plan to establish wetland filtration habitat on inflow point source discharges. Creation of wetland filtration habitat includes grading to create appropriate elevations and hydrology. Planting appropriate vegetation also would be considered part of this action.

Potential Project Benefits

Creating wetland filtration habitat on inflow point source discharge will potentially contribute to increased treatment of urban runoff, benefiting all priority fish lifestages. There may be some detriment to water quality at the wetland locations.

Project Implementation Considerations

If suitable opportunities and significant benefits are identified, proceed with implementation. Federal, state, and local agencies would collaborate to implement this action.

6.1.17. CONTAMINANTS

24. DEVELOP COLLABORATIVE GUIDELINES TO REDUCE THE APPLICATION OF TOXINS ON LANDS THAT HAVE THE GREATEST RISK TO FISH POPULATIONS, WHERE POSSIBLE.

Project Background

Agricultural, commercial, and residential practices include the application of herbicides, pesticides, fumigants, and other agents which result in contaminant loading in the lower American River. The above-mentioned contaminants have the potential to adversely affect fish resources in the lower American River. However, chemicals can be useful tools in habitat restoration efforts under selected circumstances.

Project Description

Develop collaborative guidelines to reduce the application of herbicides, pesticides, fumigants, and other agents toxic to fish, on lands that have the greatest risk to fish populations (e.g., through outreach, painting warnings on sewer drains, where possible). Develop and implement a plan to reduce the use of toxins by homeowners, and related contaminant loading in the lower American River, including incentives for compliance.

Potential Project Benefits

Reducing the input of contaminants into waterways from the lands with the greatest inputs would provide significant improvement in water quality on the lower American River (CalFed 2000).

Project Implementation Considerations

Sacramento County Parks may be an appropriate lead agency for this action. This action needs additional research, demonstration, and evaluation to determine feasibility or ecosystem response (CalFed 2000).

6.1.18. HARVEST OF FISH AND WILDLIFE

25. TO ASSIST WITH MANAGEMENT DECISION-MAKING, ASCERTAIN WHETHER IN-RIVER ILLEGAL HARVEST OF FALL-RUN CHINOOK SALMON AND STEELHEAD IS ACTING AS A STRESSOR ON THOSE SPECIES IN THE LOWER AMERICAN RIVER.

Project Background

There is some concern that evaluations have not been conducted to determine whether in-river harvest, particularly illegal harvest, represents a significant stressor on fall-run chinook salmon

and steelhead in the lower American River. Illegal harvest of adult fall-run chinook salmon has been reported in the lower American River. Also, anecdotal observations suggest numerous juvenile steelhead/rainbow are being captured by angling throughout the lower American River particularly in spring through fall. Additional anecdotal information reports that few, if any, of these fish have been marked, suggesting that they are not of hatchery origin. Although the magnitude of the harvest of these fish, which may be naturally produced steelhead, has not been ascertained, concern exists regarding angling as a stressor on naturally-produced populations of steelhead in the lower American River.

Project Description

Ascertain whether illegal in-river harvest of chinook salmon and steelhead is acting as a stressor on those species in the lower American River. If so, recommend regulatory or enforcement modifications as needed. A compilation of available creel census and enforcement information would serve as the basis to conduct this evaluation. In addition, annual estimates of in-river harvest need to be considered within the context of annual spawning stock escapement and in-river production.

Potential Project Benefits

If illegal in-river harvest is identified as a significant stressor, then regulatory and/or enforcement modifications may contribute to accomplishing anadromous salmonid production goals for the lower American River.

Project Implementation Considerations

CDFG is the appropriate agency to take the lead in this action by monitoring harvest activities using creel census and CDFG game wardens.

6.1.19. ARTIFICIAL PROPAGATION OF FISH

26. EVALUATE ALTERNATIVE WAYS FOR ADDRESSING TEMPERATURE-RELATED ISSUES AT THE NIMBUS AND AMERICAN RIVER FISH HATCHERIES THAT WOULD NOT JEOPARDIZE THE NEEDS OF INSTREAM SPAWNING FALL-RUN CHINOOK SALMON AND STEELHEAD.

Project Background

USBR presently is in the process of completing relocation of the Nimbus Hatchery Water Intake Pipeline to a lower elevation in Lake Natoma. The water intake relocation may help to alleviate water temperature-related problems in the hatchery, and provide additional flexibility for decision making regarding management of Folsom Reservoir's coldwater pool. However, it is unclear whether this action will sufficiently address water temperature problems experienced by the hatcheries.

Project Description

Water temperature in the Nimbus Hatchery will be monitored upon completion of the relocated water intake pipeline. If water temperature-related problems remain, then specific measures to

reduce water temperature in the hatchery should be identified and a draft feasibility evaluation conducted. The effectiveness of the relocation in addressing hatchery water temperature problems is limited by the available coldwater pool.

Potential Project Benefits

The benefits to naturally spawning fall-run chinook salmon and steelhead in the river would be derived from increased operational flexibility associated with Folsom Reservoir coldwater pool management.

Project Implementation Considerations

CDFG would be the appropriate agency to take the lead in documenting monitoring results associated with this action.

6.1.20. OTHER POTENTIAL MANAGEMENT ACTIONS

27. COORDINATE THE PERMITTING PROCESS FOR LOWER AMERICAN RIVER RESTORATION ACTIONS THROUGH THE RIVER CORRIDOR MANAGEMENT PLAN, WHERE POSSIBLE.

Project Background

Obtaining various permits for actions that affect fish, particularly those listed under the federal Endangered Species Act or California Endangered Species Act, can be an extensive and prolonged process. Coordination of the permitting processes for beneficial actions would expedite implementation.

Project Description

Coordination of permitting processes could range from the simple support of public trust resource agency representatives to revision of legal and regulatory requirements.

Potential Project Benefits

This action will help to expedite the implementation of beneficial actions in the lower American River.

Project Implementation Considerations

Assess appropriate implementation methods, taking into consideration both requirements and stakeholder views.

28. CONDUCT HABITAT SUITABILITY ASSESSMENT FOR STEELHEAD IN THE MILE BELOW FOLSOM DAM IN LAKE NATOMA.

Project Background

The present location of Nimbus Dam blocked most of chinook salmon spawning habitat and all of the steelhead spawning habitat used historically. An evaluation should be conducted to determine where habitat could be restored in the mile below Folsom Dam in Lake Natoma.

Project Description

Conduct an evaluation to determine where chinook salmon and steelhead spawning habitat could be restored in the mile below Folsom Dam in Lake Natoma. It is anticipated that such a field survey and evaluation could be easily and efficiently conducted.

Potential Project Benefits

Eventual implementation would increase chinook salmon and steelhead spawning habitat availability; however, numerous issues remain regarding the accessibility of this potential habitat by upstream migrating adults, and downstream passage of juveniles through Lake Natoma and Nimbus Dam.

Project Implementation Considerations

Conduct habitat assessment and carefully evaluate results. Evaluation must include consideration of accessibility of potential habitat by adults and downstream transport of juveniles.

6.1.21. MONITORING AND EVALUATION COMPONENTS

H. USE EXISTING AERIAL PHOTOGRAPHS AS A BASELINE FOR MONITORING ACTIVITIES REQUIRING POSITIONAL ACCURACY.

Assessment of benefits and impacts associated with restoration actions will be facilitated by an accurate depiction of a baseline and historic record against which to compare restoration actions and projects. Channel geomorphology and stage-area discharge relationships should be developed to identify past and current spawning areas, as well as identify past and current side-channel and off-channel fry and juvenile rearing habitat in the lower American River. Aerial photographic interpretation also should be utilized to evaluate the potential for side-channel and off-channel isolation resulting from flow reductions. For establishing an accurate baseline of current conditions, stage-area discharge "maps" could be developed by conducting aerial photography of the lower American River at a series of different flow rates to encompass spawning periods (as well as other lifestages). Aerial photography would allow identification of the wetted perimeter at specific flow rates. If appropriate and cost effective, aerial photographs then could be digitized and orthorectified in GIS software. Through this process, the identification of flow thresholds at which side-channel and off-side channel habitats become isolated, and redd-dewatering occurs will be possible. The effects of flow changes on salmonid redds, and the differences in spatial availability of rearing habitats could be examined and

quantified by comparing the extent of this habitat between specified flows on stage-area discharge maps. Aerial photography for the development of stage-area discharge maps can be conducted at any time of the year.

This project will prove helpful in the determination of current and past anadromous salmonid spawning and rearing sites, and water depths at which salmonids construct redds. In addition, the information will help determine: (1) if flow rates affect spatial spawning distribution of salmonids (i.e., habitat utilization); (2) how flow rates associated with channel morphology affect areas of inundation utilized for salmonid spawning over the range of controlled flows anticipated to occur during the primary salmonid spawning period; (3) the stage-area discharge relationships for selected reaches of the river used by salmonid spawning; and (4) the likelihood that flow reductions of various magnitudes would dewater salmonid redds throughout the spawning and incubation period. After this information has been compiled, restoration actions may be compared to an accurate baseline, and potential benefits assessed.

I. EVALUATE EFFICACY OF INSTALLING AND OPERATING A FISH COUNTING WEIR TO IMPROVE ESTIMATES OF: (1) SPAWNING STOCK ESCAPEMENT; AND (2) JUVENILE OUTMIGRANT POPULATION.

Unavoidable variation in estimation is associated with available fish sampling methodologies when conducting spawning stock escapement and juvenile outmigrant population surveys. Managing resources in the lower American River will benefit from increased accuracy of spawning stock escapement and juvenile outmigration population estimation. A fish counting weir is one possible mean to provide improved estimates. However, numerous uncertainties surround the installation, operation, maintenance and longevity of a fish counting weir, which could take many forms (e.g., "Alaska style" flashboard and tower, bio-acoustics, concrete dam, tripod weir, etc.). In addition, lifestages and species of anadromous salmonids that would be accounted for, as well as mortality associated with the fish counting weir, must be taken into consideration. A feasibility assessment should be conducted regarding the potential for a fish counting weir in the lower American River.