Initial Fisheries and In-Stream Habitat Management and Restoration Plan For The Lower American River (FISH Plan)

Status Report

September 2005

Table of Contents

Table of Contents (continued)

FISH Plan Section / FISH Plan Page Number

Table of Contents (continued)

FISH Plan Section / FISH Plan Page Number

Introduction

The Initial Fisheries and In-Stream Habitat Management and Restoration Plan for the Lower American River (FISH Plan) articulates a broadly-shared understanding regarding the management and restoration actions that are most important to undertake to improve conditions for priority fish species in the lower American River. The FISH Plan serves as the aquatic habitat management element of a multi-agency River Corridor Management Plan (RCMP) that was developed by the Lower American River Task Force. It also is intended to serve as the Habitat Management Plan for the lower American River, as required under the Sacramento Area Water Forum Agreement. The FISH Plan was developed in 2001 and is presently being updated.

The purpose of this report is to describe the progress being made for each recommendation in the FISH Plan, and to present the recommendations of the Water Forum staff regarding how each recommendation should be addressed in the future.

The following information is provided for each recommendation in the FISH Plan:

FISH Plan Section/Page is provided for easy reference to the FISH Plan. Each new section is distinguished by a

FISH Plan Title is verbatim from the FISH Plan.

Summary Description is additional information that embellishes the FISH Plan Title. This is only provided where the FISH Plan Title does not capture the scope of the recommendation in the FISH Plan.

Progress Report describes progress in three aspects of each recommendation: Evaluation, Implementation, and Monitoring.

Discussion is only provided where additional information is needed to provide rationale to support the recommendations.

Recommendations are the recommendations of Water Forum staff regarding future actions to be taken. The purpose of the recommendations is to stimulate discussion as the FISH Plan is being updated.

Acronyms

CDEC	California Data Exchange Center
CDFG	California Department of Fish and Game
CFM	Constant Fractional Marking
COE	U.S. Army Corps of Engineers
ESA	Endangered Species Act
EWA	Environmental Water Account
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FISH	Fisheries and In-stream Habitat
LAR	Lower American River
NOAA	National Oceanic and Atmospheric Administration
Reclamation	U.S. Bureau of Reclamation
RM	River Mile
SAFCA	Sacramento Area Flood Control Agency
SOP	Standard Operating Procedure
SRA	Shaded Riverine Aquatic
SWRCB	State Water Resources Control Board
TCD	Temperature Control Device
USBR	U.S. Bureau of Reclamation
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WQCP	Water Quality Control Plan

6.2. Recommendations
First Priority Actions

❖ **Reference**
FISH Plan Section/Page: 1/6-5

FISH Plan Title: Develop and implement an ecologically based flow management plan for the lower American River, including water temperature management considerations, subject to SWRCB approval

Progress Report
Evaluation: Ongoing. Since 1999, the Water Forum, in conjunction with Reclamation, the USFWS, NOAA Fisheries, CDFG, and other agencies, has been working toward an updated and improved flow standard for the LAR to be presented to the SWRCB. All parties continue to meet and expect to reach agreement by the end of 2005.

Implementation: Not started

Monitoring: Not started

Recommendations
It is recommended that progress continue, as described above.

❖ **Reference**
FISH Plan Section/Page: 2.1/6-9

FISH Plan Title: Develop and implement a basin-wide water temperature monitoring program

Summary Description: The program described in the FISH Plan includes temperature monitoring stations on the North and South Forks American River upstream of Folsom Reservoir, temperature profile stations in Folsom Reservoir and Lake Natoma, and temperature monitoring stations downstream of Nimbus Dam on the lower American River. The program also includes a flow monitoring station on the North and South Forks of the American River upstream of Folsom Reservoir.

Progress Report
Evaluation: Completed. The need for monitoring stations has been assessed by Reclamation, and several stations identified in the FISH Plan may be eliminated. They are the flow station on the South Fork American River, the temperature station at Sacramento Bar on the lower American River, and the ongoing temperature profile stations in Lake Natoma. See "Discussion" below for the rationale for eliminating these stations.

Implementation: Ongoing. All monitoring stations identified in the FISH Plan are active except as discussed below. The temperature and flow monitoring stations are operated by the USGS, under a contract with Reclamation. The temperature profile stations are operated by Reclamation.

Monitoring: Not applicable

Discussion

North Fork flow gauge: The flow station on the North Fork American River will be installed as part of the Placer County Water Agency's new pump station at Auburn, which has been delayed until early 2007.

South Fork flow gauge: Installing and operating a flow gauge on the South Fork American River immediately upstream of Folsom Lake is problematic in that access is very limited and vandalism is likely. The South Fork temperature gauge has been vandalized repeatedly and the USGS has given up trying to maintain its data transmission capability via satellite. There is a flow gauge at Chili Bar Dam and except during major storm events there are minimal accretions to the river downstream.

Sacramento Bar flow gauge: Sacramento Bar is at river mile 19. Because there are temperature monitoring stations at Hazel Avenue (river mile 23), and at William Pond Park (river mile 13.5). The utility of having an additional station at Sacramento Bar is questionable.

Lake Natoma temperature profiles: The temperature profile stations in Lake Natoma were installed to gain information to support Lake Natoma modeling efforts (see items 6.2.3.3.1 and 6.2.3.3.2). Additional data is not needed for these studies.

Recommendations
It is recommended that the ongoing monitoring plan, as described in the FISH Plan, be continued, except that a new flow gauge on the South Fork American River and a new temperature gauge at Sacramento Bar be eliminated from the FISH Plan; and that temperature profiles in Lake Natoma be a low priority, unless a new special study is conducted.

❖ **Reference**
FISH Plan Section/Page: 3.1.1/6-10

FISH Plan Title: Evaluate potential to construct curtains at tributary inflows to Folsom Reservoir, forcing cold water to bottom of reservoir

Progress Report
Evaluation: Not started

Implementation: Not applicable.

Monitoring: Not applicable

Recommendations
Because of the physical and recreational challenges associated with curtains in the tributary arms of the lake, it is recommended that several individuals from Reclamation who have experience

with curtains and modeling do a subjective analysis, as a priority 2 in the FISH Plan. If the results are that the approach is feasible, then a more quantitative evaluation could be done.

❖ **Reference**
FISH Plan Section/Page: 3.1.2/6-11

FISH Plan Title: Formalize change in USBR standard operating procedure for Folsom Dam to permit release from the spillway gates to save cold water

Summary Description: When the FISH Plan was developed, the standard operating procedure (SOP) for Folsom Dam was to release water in excess of power plant capacity first from the river outlets and then from the spillway gates, if possible. Under certain reservoir conditions, this practice released cold water from the reservoir when it would have been possible to release warmer water through the spillway gates. By changing the SOP to release water first from the spillway gates, when possible, cold water could be conserved in the reservoir.

Progress Report
Evaluation: Complete. The benefits of changing the SOP were considered by Reclamation and it agreed to modify the SOP.

Implementation: Ongoing. Reclamation updated its SOP for Folsom Dam in 2003. The updated SOP provides for first using spillway gate 3, when possible, to conserve cold water. Using spillway gate 3 first is optional, at the discretion of Reclamation.

Monitoring: Not applicable. The FISH Plan does not call for monitoring.

Recommendations
It is recommended that Reclamation's discretion to use spillway gate 3, rather than the river outlets, be monitored to assure that cold water is conserved whenever possible. Monitoring could be accomplished by Reclamation reporting its operations to the American River Operations Work Group, and documenting the operations in the meeting notes.

❖ **Reference**
FISH Plan Section/Page: 3.1.3/6-12

FISH Plan Title: Evaluate opportunities for re-operation of upstream reservoirs for benefit of Folsom Reservoir coldwater pool management

Progress Report
Evaluation: Complete. Reclamation conducted a cursory evaluation of the benefits of re-operating upstream reservoirs and concluded that there is little opportunity to enhance the coldwater pool. Any enhancements would require higher releases of cold water in the spring during years that it could be stored in Folsom Reservoir (considering flood control operations). The upstream reservoirs are primarily operated for hydroelectric power generation and releases are made according to power demand, which is typically not high in the spring.

Implementation: Not applicable. Based on the evaluation, no further action is planned, at this time.

Monitoring: Not applicable.

Discussion

Both the Sacramento Municipal Utility District and Pacific Gas and Electric are in re-licensing procedures with the Federal Energy Regulatory Commission (FERC) for their projects on the South and Middle Forks of the American River, respectively. Re-licensing could result in modifications to the upstream reservoirs.

Recommendations

As a 3rd priority, it is recommended that re-licensing activities be monitored to assure that any changes in operation do not adversely affect the cold-water pool in Folsom Reservoir, and to recommend to FERC, any opportunities to improve the cold-water pool. This could be achieved by having the utilities/FERC include an analysis of the effect of re-licensing on the cold-water pool; and by having LAR stakeholders further evaluate, and recommend, opportunities to improve the cold-water pool conditions as part of the re-licensing process.

❖ **Reference**

FISH Plan Section/Page: 3.1.4/6-12

FISH Plan Title: Construct and operate a temperature control device for El Dorado Irrigation District.

Summary Description: When the FISH Plan was developed it was proposed that a temperature control device (TCD) be installed on the El Dorado Irrigation District's water supply intake in Folsom Reservoir as part of its plant expansion plans. Presently the intake diverts water from the coldwater pool. Installation and operation of a TCD would allow the District to draw warmer water from the reservoir, which would conserve cold water for use in protecting salmonids in the LAR.

Progress Report

Evaluation: Not applicable. The FISH Plan does not call for a specific evaluation. An Environmental Assessment/FONSI for the project was prepared by Reclamation in October 2002; and a variety of environmental documents for other projects have assumed that the TCD would be installed in the future.

Implementation: Ongoing. The project is presently in the design phase. Congress has authorized design and construction of the TCD, and $3 million was appropriated for design and construction in FY 2005.

Monitoring: Not applicable. The FISH Plan does not call for monitoring.

Discussion
The project will cost more than the $3 million already appropriated. Congress is anticipated to appropriate the necessary additional funds to complete the project.

Recommendations
It is recommended that the progress of design and construction be monitored. Once installed, use of the TCD to optimize conservation of the coldwater pool should be monitored. Monitoring of design, construction, and operations could be accomplished through periodic reports by Reclamation to the American River Operations Work Group and documented in the meeting notes.

❖ **Reference**
FISH Plan Section/Page: 3.2.1/6-13

FISH Plan Title: 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.

Summary Description: This 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 leakage around the temperature shutters, 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 to blend water of varying temperature available in the reservoir.

Progress Report
Evaluation: Ongoing. Sub-action (1) is an ongoing evaluation. Since the time the FISH Plan was prepared, Reclamation has been developing an annual plan to optimally use the cold-water pool for the benefit of over-summering steelhead and spawning salmon. It has become apparent that in some years there is not enough cold water available to meet target temperatures for both species. Sub-action (2) was started, but not completed. A formal investigation of the cause and magnitude of leakage through the shutters has not been conducted; however, Tracy Vermeyen did a qualitative analysis from Reclamation's Technical Service Center in Denver, Colorado. The qualitative analysis showed there is significant potential for leakage around the shutter system's superstructure (above elevation 428 ft) and to a lesser degree around the shutter guides (below elevation 428 ft). A one dimensional selective withdrawal model (SELECT) was used to estimate the impact of leakage on Folsom power plant release temperatures but the results were not reasonable. It was concluded that the results were poor because the model is not well suited for simulating the effects of leakage along long vertical leakage paths.

Implementation: Ongoing. Sub-action (3) is ongoing. In recent years, Reclamation has decreased the “stair-step” changes in Folsom Dam releases water temperature by making more frequent shutter changes, by drawing water from different levels in the reservoir and blending the water through the various penstocks.

Monitoring: Ongoing. Reclamation has been monitoring water temperatures in the river and DFG has been monitoring the health of salmon and steelhead. In the fall of 2003, there was significant pre-spawning salmon mortality that corresponded with warm water temperatures because the cold water in the reservoir had been depleted. Over-summering steelhead have appeared healthy, except in the late summer of 2004 when there was an outbreak of rosy anus. The condition disappeared once the water cooled in the fall.

Discussion

Ongoing monitoring and adaptive management of operations is needed to maintain temperatures suitable for the health of salmon and steelhead. Reclamation has been, and is expected to continue, funding the temperature monitoring program and developing and implementing an annual cold-water pool management plan. DFG has not fully funded the biological monitoring of steelhead and salmon in the past few years and has relied on financial assistance from the Water Forum and Reclamation. No funds have been allocated for evaluating the cause and magnitude of shutter leakage.

Recommendations

It is recommended that the development and implementation of an annual cold-water pool management plan, including the biological monitoring component, be continued indefinitely by Reclamation. Securing a reliable, long-term, funding source for the biological monitoring should be a high priority (FISH Plan priority 1). There is no evidence that the leakage around the shutters adversely affects the cold water pool, therefore there does not appear to be a compelling reason to evaluate the cause and magnitude of shutter leakage, therefore this component should changed to a level 3 priority in the FISH Plan.

❖ **Reference**

FISH Plan Section/Page: 3.2.2/6-14

FISH Plan Title: Evaluate the effectiveness of and construct, as appropriate, a fully automated temperature control device.

Summary Description: This action is to evaluate the costs and benefits of replacing the existing temperature shutters on the Folsom Dam penstocks with a fully automated temperature control device (TCD). If feasible, the TCD would be constructed.

Progress Report

Evaluation: Complete. In 2002 HDR Engineering evaluated Various TCD conceptual designs. Because of cost, SAFCA is considering moving forward with a fully mechanized TCD on only one penstock, which would allow for refined temperature control on one unit, while still using the existing shutters on the other two units. This would allow refined temperature control of the total penstock releases.

Implementation: Not started. Design and construction are presently on hold pending a final decision on how to proceed and funding. Since the FISH Plan was developed, Reclamation has significantly improved its ability to manage the cold-water pool using the existing shutter system. This has decreased the incremental benefits of constructing a new TCD. In addition, the

Army Corps of Engineers (COE) has revised the cost estimates for the Folsom Dam modifications. Pending decisions regarding modification and raising of the dam, funding for the TCD is uncertain.

Monitoring: Not applicable.

Discussion

SAFCA has $2 million committed to making water temperature improvements and Congress has authorized funds to make improvements on the temperature shutters as part of the Water Resources Development Act of 1999, but because of cost over runs on the dam, it is not likely that the Corps would be in a position to use appropriated funds for the TCD at this time.

Recommendations

It is recommended that SAFCA and Reclamation further evaluate the benefits of a new TCD and determine whether it is appropriate to proceed with a design at this time in light of the current funding situation.

❖ **Reference**

FISH Plan Section/Page: 3.2.3/6-14

FISH Plan Title: 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.

Summary Description: The evaluation is to determine the 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.

Progress Report

Evaluation: Partially complete. HDR Engineering evaluated several alternatives for accessing the cooler water below the existing penstock intakes and directing it into the penstocks. This evaluation did not include a cost/benefit analysis comparing these alternatives (which involve physical modifications to the penstock intakes) vs. simply using the existing river outlets to release cooler water and foregoing the generation of power, as Reclamation did in the fall of 2001 and 2002. Reclamation presently includes an estimate of the costs of the foregone power when using the river outlets and bypassing the penstocks in its annual cold-water pool management plans. No evidence was found that dissolved neither oxygen nor nitrogen super-saturation presented a water quality issue downstream of Nimbus Dam after use of the river outlets in 2001 and 2003. Also, dissolved oxygen is routinely monitored as part of the conduct of temperature profiles in Folsom Lake.

Implementation: Ongoing. Although the evaluation has not been completed, Reclamation has been using the river outlets to blend lower-elevation cooler water with warmer water from the penstocks to meet water temperature criteria for salmon spawning, as needed. Bypassing the penstocks results in a loss of power generation. Power users have been reimbursed for this loss using funds from the Environmental Water Account (EWA). None of the alternatives which

were identified by HDR for directing water from below the penstocks into the penstocks are being pursued at this time.

Monitoring: Not applicable.

Discussion
Bypassing the power penstocks is practicable and technically and politically feasible, as long as there are funds for reimbursing the power users. Funding has been available from the EWA in the past, however the allocation is made on an annual basis.

Recommendations
It is recommended that Reclamation, using the HDR analysis, complete the cost/benefit evaluation. In the meantime it should continue to consider using the river outlets in its annual cold-water pool management plans as a FISH Plan priority 1.

❖ **Reference**
FISH Plan Section/Page: 3.2.4/6-15

FISH Plan Title: Assess ability to access low-elevation cold-water pool with hydroelectric power generation and to economically utilize cold-water pool below penstock intakes.

Summary Description: This action is to specifically evaluate constructing a new power plant in an existing or a new river outlet in order to continue to generate power while accessing the cold water below the existing penstocks.

Progress Report
Evaluation: Complete. This action was evaluated by Reclamation's Central Valley Operations and determined not to be cost effective.

Implementation: Not applicable.

Monitoring: Not applicable.

Recommendations
It is recommended that this action be eliminated from the FISH Plan. Documentation of this action should be included in an Appendix to the FISH Plan.

❖ **Reference**
FISH Plan Section/Page: 3.2.5/6-15

FISH Plan Title: 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.

Summary Description: Reclamation developed an automated temperature selection schedule for multi-species benefits to use in its cold-water pool management model for planning

applications. The selection schedule is specific to the existing infrastructure and priority fish species, and if they were changed, the selection schedule would need to be modified.

Progress Report
Evaluation: Not started. Neither the infrastructure nor the priority species have changed; therefore the selection schedule does not need to be modified, at this time.

Implementation: Not applicable.

Monitoring: Not applicable.

Recommendations
There is no reason to modify the schedule at this time. Also, Reclamation does not use the schedule in its planning studies and has no plans to do so. Therefore, it is recommended that this action be eliminated from the FISH Plan, and that action documented in an Appendix to the FISH Plan.

❖ **Reference**
FISH Plan Section/Page: 3.3.1/6-16

FISH Plan Title: 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 power plant intake, and removal of a portion of, or the entire, 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.

Progress Report
Evaluation: Ongoing. The Water Forum received a three-year, $454 thousand grant from the Anadromous Fish Restoration Program in 2003 to evaluate the effectiveness of the various temperature control structures identified in the FISH Plan, using mathematical hydrologic and thermodynamic models. Preliminary results are expected to be available by the end of 2005. The final report will be completed in 2006.

Implementation: Not applicable.

Monitoring: Not applicable.

Recommendations
It is recommended that the study be completed, as a FISH Plan priority 1. Subsequently, as a priority 1, decisions should be made regarding the implementation of the findings of the study.

❖ **Reference**
FISH Plan Section/Page: 3.3.2/6-18

FISH Plan Title: Improving efficiency of water transport through Lake Natoma (e.g. modifying channel in Lake Natoma).

Summary Description: This work is being done in conjunction with item 6.2.3.3.1.

Progress Report
Evaluation: Ongoing. The Water Forum received a three-year, $454 thousand grant from the Anadromous FISH Restoration Program in 2003 to evaluate the effectiveness of the various temperature control structures identified in the FISH Plan, using mathematical hydrologic and thermodynamic models. Preliminary results are expected to be available by the end of 2005. The final report will be completed in 2006.

Implementation: Not applicable.

Monitoring: Not applicable.

Recommendations
It is recommended that the study be completed, as a FISH Plan priority 1. Subsequently, as a priority 1, decisions should be made regarding the implementations of the findings of the study.

6.2.1. Aquatic, Riparian, and Wetland Habitat

❖ **Reference**
FISH Plan Section/Page: 4/6-18

FISH Plan Title: 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.

Summary Description: The debris maintenance program would facilitate improving and/or restoring instream cover for salmonid rearing, and should consider modifying current practices for removing and placing large woody debris and implementing a pilot project to place large woody debris into the river to meet the needs of priority species.

Progress Report
Evaluation: Completed. A significant concern of the managing agencies is that of liability associated with placing woody debris into the river, especially as it relates to health and safety. This issue was evaluated in 1996 and it was concluded that if the wood was placed so that it was pointing downstream, anchored to the bank so it did not float away, and if there was some surface indication that the material was there, it would be acceptable to include wood in projects. It was also discovered that woody complexes were superior to individual tree trunks for fish cover. Since then, wood has been placed at several erosion sites in the area. The concern over liability remains an issue.

Implementation: Partial implementation is ongoing. No plan or policy for woody debris management has been developed; however, several bank protection projects on the American River have woody complexes in the water, including Sites 1, 3, and 5. These serve as the pilot project identified in the FISH Plan. On the issue of liability, SAFCA, and others would like to see broadening legislation that would reduce liability for injuries associated with debris that has been placed in the river.

Monitoring: Ongoing. SAFCA conducted snorkel surveys of the bank protection and habitat restoration sites in 2004 and 2005.

Recommendations
It is recommended that the development of a plan be revitalized and that it include a statement/position related to the liability issue. The plan should consider all the issues outlined in the FISH Plan. Also, it is recommended that broadening legislation related to the liability issue be pursued, possibly in AB1665 (Reform of Flood Control System).

6.2.2. Levees and Bank Protection

❖ **Reference**
FISH Plan Section/Page: 5/6-19

FISH Plan Title: 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.

Progress Report
Evaluation: Ongoing. Three sites were evaluated and selected for implementation.

Implementation: Ongoing. Site RM1.8 was planted through existing riprap and through additional riprap added in 2004 as part of the FEMA Emergency Erosion Control Sites. Trees, shrubs and herbaceous plants were planted at RM 4.2 and RM 7.6. These sites were irrigated and maintained for several years, and are now considered self-sustaining.

Monitoring: Ongoing. RM 4.2 and 7.6 have been monitored for the last 5 years, and have met survival goals. Both sites have continued to grow over the last two years without supplemental irrigation and have created SRA habitat along the river.

Recommendations
It is recommended that additional sites be evaluated, and implemented. Impacts associated with beaver pruning on riparian woody vegetation require more focused research.

6.2.3. Artificial Propagation of Fish

❖ **Reference**
FISH Plan Section/Page: 6/6-20

FISH Plan Title: 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.

Progress Report
Evaluation: Ongoing. CDFG has been planning a Central Valley-wide Constant Fractional Marking (CFM) Program for production releases of fall-run Chinook salmon since 1998. In 2001 and 2002 a pilot CFM program was conducted at Central Valley hatcheries, including the Nimbus Hatchery. An implementation plan was developed in 2004 and a marking/tagging rate of 25% decided in early 2005. The project is included in the 2005 CALFED Ecosystem Restoration Program Workplan. The California Bay Delta Authority is expected to finally approve the work plan for funding in September 2005.

Implementation: Not started. Full program implementation (marking/tagging of fall-run production releases) is expected to start when funding is approved.

Monitoring: Not started.

Recommendations
It is recommended that the CFM Program be funded and implemented as a FISH Plan priority 1.

❖ **Reference**
FISH Plan Section/Page: 7/6-21

FISH Plan Title: Undertake long-term modifications 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.

Progress Report
Evaluation: Ongoing. Reclamation has been evaluating alternatives for replacing the existing diversion structure, including three configurations of fish ladders to the Nimbus stilling basin with removal of the existing structure and two configurations of a concrete structure across the river in the vicinity of the existing structure. Reclamation plans to decide on a proposed action late in 2005 and then issue a draft environmental assessment for public review and comment.

Implementation: Not started. Reclamation plans to initiate construction in 2007 or 2008.

Monitoring: Not applicable.

Recommendations
Several other projects in the area are contingent upon Reclamation's decision regarding the existing diversion structure; there it is recommended that Reclamation expedite selecting a proposed action and completing the environmental review and design activities.

6.2.4. Stranding

❖ **Reference**
FISH Plan Section/Page: 8/6-22

FISH Plan Title: 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.

Progress Report
Evaluation: Ongoing. CDFG identified stranding and isolation areas in its "Evaluation of Effects of Flow Fluctuations on the Anadromous Fish Populations in the Lower American River" report published in 2001. Reclamation, and others, sponsored a Lower American River Flow Fluctuation Function Analysis Workshop in 2002, and a variety of operational and physical solutions were recommended. Through ongoing monitoring, several problematic areas were identified that lent themselves to physical solutions, including one at a side channel at Lower Sunrise and one an isolation pool below the Sunrise Boulevard Bridge.

Implementation: Ongoing. Measures to correct stranding and isolation problems include both operational changes and physical modifications to the riverbed. In recent years, Reclamation has been modifying its historic operations to minimize flow fluctuations that can lead to the stranding and isolation of juvenile salmonids. Until 2004, other than identifying problem locations, little had been done to implement physical solutions. Two physical modification projects are now in the planning phase: the Lower Sunrise Side Channel Project and the Sunrise Isolation Pool Project. In 2004, the CDFG, the Water Forum, and SAFCA, with the assistance of other agencies, initiated a project to physically modify the Lower Sunrise Side Channel to prevent it from becoming dewatered at flows that might typically occur during the time of steelhead spawning and incubation. The Water Forum has funded initial studies, and in coordination with CDFG and SAFCA, is seeking a grant to design and construct the side channel modification from the Anadromous Fish Restoration Program. Additionally, in cooperation with several agencies, the Water Forum designed a channel to connect the Sunrise Isolation Pool to the main river at lower river flows. Construction of this pilot project, by volunteers, is planned for fall 2005.

Monitoring: Ongoing. CDFG will be monitoring the effectiveness of the channel constructed at the Sunrise Isolation Pool. CDFG and Reclamation will continue to monitor stranding and isolation events as part of their ongoing monitoring programs.

Recommendations
It is recommended that the stranding and isolation areas identified in the 2001 report be systematically evaluated for potential of implementing physical solutions, and that Reclamation

continue to implement operational solutions to minimize stranding and isolation of juvenile salmonids. Also, the Water Forum, SAFCA, CDFG, and other agencies are encouraged to expeditiously pursue funding for the Lower Sunrise Side Channel Project and to complete the Sunrise Isolation Pool Project.

6.2.5. Other Potential Management Actions

❖ **Reference**
FISH Plan Section/Page: 9/6-22

FISH Plan Title: 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.

Summary Description: Because of the close proximity of Folsom Dam and Reservoir to the Delta, releases from Folsom Dam are commonly relied upon to meet Delta standards in lieu of releases from more distant reservoirs or reductions in Delta exports. This FISH Plan item identifies, and bring to the attention of the CALFED Operations Group, and the SWRCB, the fishery impacts on lower American River priority species resulting from meeting water quality standards and needs from Folsom Reservoir. The FISH Plan calls for the following components to be included in the evaluation: Reclamation's criteria for balancing releases from Folsom and Shasta Reservoirs, focusing on year-round implications of spring time releases; documentation of historical and resent operational decisions related to Folsom releases to meet Delta standards, including resource implications such as fluctuating flows, temperature shutter changes, and loss of cold water; and a qualitative assessment of fishery impacts. The evaluation would be included in a report to the CALFED Operations Group and the SWRCB.

Progress Report
Evaluation: Completed. The Water Forum completed an analysis and a draft report of the impacts on the lower American River salmonid fisheries of Reclamation meeting Delta water quality standards as it did in 2001 through 2004 (Impacts on Lower American River Salmonids and Recommendations Associated with Folsom Reservoir Operations to Meet Delta Water Quality Objectives and Demands, December 2004).

Implementation: Completed. The draft report was sent to the SWRCB and the CALFED Operations Group.

Monitoring: Not Applicable.

Discussion
Although the draft report was not prepared in final, nor did it include an evaluation of long-term historical operations or Reclamation criteria for balancing the operations of Folsom and Shasta, it did present the point that meeting Delta water quality requirements and needs has a major effect on the protection of salmonids in the lower American River.

Recommendations
It is recommended that this action be considered complete, unless further issues are raised during current or future periodic reviews of the Delta standards. Reclamation's operations to meet Delta standards should be continually monitored through the American River Operations Work Group, or its successor. If meeting Delta standards continues to have adverse impacts on lower American River salmonids, or if new issues arise, this issue needs further review.

❖ **Reference**
FISH Plan Section/Page: 10/6-23

FISH Plan Title: Improve availability and management of lower American River research data, with attention to quality control.

Summary Description: Storage of existing lower American River data is scattered among various organizations. This activity would consolidate databases and/or make it common knowledge what data is available and where it can be accessed.

Progress Report
Evaluation: Not started.

Implementation: Not started.

Monitoring: Not started.

Recommendations
It is recommended that this effort be changed to a 2nd priority. It could be addressed in the monitoring portion of the update of the lower American River flow standard (Section 6.2.1).

6.2.6 Monitoring

❖ **Reference**
FISH Plan Section/Page: A/6-24

FISH Plan Title: 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.

Summary Description: Based on recent monitoring, the vast majority of young Chinook salmon leave the river within a few weeks of emergence. However, it is not known what the contribution of the early emigrating fish contribute to the returning adults relative to the juveniles that remain in the river and leave as smolts. This information is paramount to making decisions on operations that affect the different life stages of the fish.

Progress Report
Evaluation: Not started.

Implementation: Not started.

Monitoring: Not started.

Discussion
The best method for distinguishing between fish that leave the system as fry versus those that leave as smolts has yet to be determined. One method might be to examine otolith characteristics, however the method needs to be tested to determine whether it would work.

Recommendations
It is recommended that a study be conducted to determine if fish that leave the system as fry can be distinguished from those that leave as smolts by examining otolith characteristics, as a FISH Plan priority 1.

❖ **Reference**
FISH Plan Section/Page: B/6-24

FISH Plan Title: Investigate temporal and spatial distribution of steelhead in the lower American River to strengthen the information base for management decisions.

Progress Report
Evaluation: Not applicable.

Implementation: Ongoing. CDFG has been monitoring the spatial and temporal distribution of steelhead in the lower American River in summer and through fall since 2001, in accordance with the recommendations in the FISH Plan. Recently this has required supplemental financial support from Reclamation and the Water Forum.

Monitoring: Not applicable.

Recommendations
It is recommended that CDFG continue its monitoring of steelhead spatial and temporal distribution in the lower American River. Short and long-term funding for this activity needs to be established as a FISH Plan priority 1. Possible funding sources are through the Flow Management Standard process (item 6.2.1), or in conjunction with Reclamation's monitoring obligations.

❖ **Reference**
FISH Plan Section/Page: C/6-24

FISH Plan Title: 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.

Summary Description: When the FISH Plan was developed, Reclamation used a monthly temperature model for the lower American River. This action is to have Reclamation upgrade its

model to a daily temperature model. Included in this action is to correct the Fair Oaks temperature gauge, review the Lake Natoma thermal profiles, and assess the Lake Natoma temperature modeling results.

Progress Report
Evaluation: Not applicable.

Implementation: Ongoing. Since the development of the FISH Plan, Reclamation has developed a model with a one-week timestep, and plans to develop one with a daily timestep, pending funding. The Fair Oaks temperature gauge has been replaced with one at Hazel Avenue, the Lake Natoma thermal profiles have been reviewed and the Lake Natoma temperature modeling results are being assessed as part of sections 6.2.3.3.1 and 6.2.3.3.2.

Monitoring: Not applicable.

Recommendations
It is recommended that Reclamation continue to pursue funding and develop a model with a daily timestep, and to complete assessing the Lake Natoma temperature modeling results as part of sections 6.2.3.3.1 and 6.2.3.3.2.

6.3. Second Priority Actions

6.3.1. Aquatic, Riparian and Wetland Habitat

❖ **Reference**
FISH Plan Section/Page: 11/6-25

FISH Plan Title: Identify and evaluate opportunities to implement wetland/slough complex restoration, with needs of all priority species in mind.

Progress Report
Evaluation: Ongoing. Through the American River Parkway Plan Update Process, three sites have been investigated including, Woodlake, Bushy Lake, and the Gardenland/Urrutia property. It was noted that Woodlake might be a possible candidate for a slough complex or wetland that would filter out drainage water from pumps 151 and 152. Bushy Lake may also be a candidate for this type of enhancement as well.

Implementation: Ongoing. Design for the Gardenland/Urrutia property is underway. SAFCA and Sacramento County intend to submit a proposal for this project to the California River Parkways Grant Program (Proposition 50).

Monitoring: Not applicable.

Recommendations
It is recommended to continue developing ideas on how to enhance these areas in the parkway.

❖ **Reference**
FISH Plan Section/Page: 12/6-26

FISH Plan Title: Inventory locations for creating shallow inundated floodplain habitat for multi-species benefits and implement where suitable opportunities are available. Protect existing overflow areas.

Summary Description: This activity includes inventory, protecting existing overflow areas, and restoring suitable areas.

Progress Report
Evaluation: Ongoing. Extensive planning, design, and coordination with resource agencies has occurred for a major floodplain habitat enhancement opportunity at RM 0.5

Implementation: Not started. Construction of habitat enhancement at RM 0.5 may occur in 2006.

Monitoring: Not started. As needed, baseline monitoring will be done prior to construction and monitoring will continue after construction.

Recommendations
It is recommended that this activity remain in the FISH Plan as priority 2.

❖ **Reference**
FISH Plan Section/Page: 13/6-26

FISH Plan Title: 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.

Progress Report
Evaluation: Ongoing. Although a systematic inventory has not been conducted, three locations where new side channel development may be desirable have been identified. The proposed sites are at Nimbus Shoals, Sailor Bar and the bar at lower Sunrise (this is separate of the project described in Section 6.2.6.2.4.8). CDFG wishes to use the lower Sunrise site for a project that will serve as a guidepost for future side-channel projects. If that project is successful relative to its stated objectives, then the techniques could be applied elsewhere to measurably improve salmonid production.

Implementation: Not started. The Water Forum and CDFG intend to submit a proposal for the lower Sunrise project to the Anadromous Fish Restoration Program for funding in FY 2006.

Monitoring: Not applicable.

Recommendations
It is recommended that the project at lower Sunrise be pursued, and that the river be systematically inventoried for other opportunities if the lower Sunrise pilot project produces good results.

6.3.3. Harvest of Fish and Wildlife

❖ **Reference**
FISH Plan Section/Page: 14/6-27

FISH Plan Title: 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.

Progress Report
Evaluation: Not applicable.

Implementation: Ongoing. All hatchery-produced Central Valley steelhead are currently adipose-fin clipped and therefore identifiable as being of hatchery origin. Wild steelhead are by default marked by being unclipped. Current regulations only allow harvest of clipped steelhead so selective sport fishery is in place. Only a variable fraction of Central Valley Chinook salmon are clipped and coded-wire tagged, and there is no selective fishery.

Monitoring: Ongoing. Steelhead returning to the Nimbus Hatchery are monitored as to whether they are fin clipped, or not. None of the sport fishery is currently monitored, but a new DFG creel survey program will be implemented in 2006.

Discussion
A selective fishery for Chinook salmon will require external tag of all hatchery fish.

Recommendations
It is recommended to continue the ongoing monitoring program and implement the CFM program (see page 18).

6.3.4. Other Potential Management Actions

❖ **Reference**
FISH Plan Section/Page: 15/6-28

FISH Plan Title: Continue to provide ongoing long-term consultation/technical assistance to LAR Task Force, its component committees, and responsible agencies for lower American River management.

Summary Description: The activity includes the establishment of a management team, similar to, or the same as, the American River Operations Work Group.

Progress Report
Evaluation: Not applicable.

Implementation: Ongoing. The American River Operations Work Group continues to convene and provide consultation and technical assistance regarding Reclamation's operations on the American River.

Monitoring: Not applicable.

Discussion
The American River Operations Work Group has been very effective in providing its recommendation regarding the operation of Folsom and Nimbus Dams. The plan for revising the flow standard (section 6.2.1) includes establishing the American River Operations Work Group as the primary forum for adaptive management. Since development of the FISH Plan, the Water Forum envisions the establishment of a "River Management Group" that would supercede the American River Operations Work Group.

Recommendations
It is recommended that this activity continue and that the American River Operations Work Group, or its successor, continue to meet and to provide recommendations regarding the operation of Folsom and Nimbus Dams; and that the priority be raised to 1st.

6.3.5. Coarse Sediment Supply

❖ **Reference**
FISH Plan Section/Page: 16/6-28

FISH Plan Title: 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.

Progress Report
Evaluation: Not applicable.

Implementation: Ongoing. Although a formal collaborative program has not been developed, agency and academic experts in the field have been coordinating ad hoc efforts to understand these processes. Organizations have included CDFG, NOAA Fisheries, USFWS, Reclamation, CSUS, UC Davis, and others. In June 2005 a workshop was held to explore ways to improve aquatic habitat in the reach of river between Nimbus Dam and Sailor Bar, and a large portion of the discussion was in regard to these processes. A follow-up meeting on the subject is scheduled for September 2005. In addition, California State University, Sacramento has recently received a contract to develop a gravel budget for the LAR, and that effort will include coordination with Federal, State and Local agencies. Tasks associated with developing this gravel budget include collaboration with agency personnel, review of existing data sets and air photos, field mapping,

and a gravel mobility study. Although these ad hoc efforts have been very useful, they have not resulted in a comprehensive program.

Monitoring: Not Applicable.

Recommendations
It is recommended that the various coordination efforts be consolidated, and enhanced, into a more formal collaborative program among the organizations described above, and that program be documented.

❖ **Reference**
FISH Plan Section/Page: 17/6-29

FISH Plan Title: 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.

Progress Report
Evaluation: Ongoing. Although a formal comprehensive assessment has not been conducted, some activities have been started. One of the products of the recently awarded contract with California State University, Sacramento is to identify locations where intervention would increase or enhance salmonid spawning habitat.

Implementation: Ongoing.

Monitoring: Not applicable.

Recommendations
It is recommended that a comprehensive assessment be conducted building upon the collaborative effort described in item 6.3.5.16: the work of the California State University, Sacramento, the Nimbus Dam to Sailor Bar gravel activities, and other such efforts. The first step should be to identify what information is needed.

6.3.6. Artificial Propagation of Fish

❖ **Reference**
FISH Plan Section/Page: 18/6-30

FISH Plan Title: 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.

Progress Report
Evaluation: Not started.

Implementation: Not applicable.

Monitoring: Not applicable.

Discussion
Although this item of the FISH Plan has not started, several other activities have been or will be underway to address the issue. The CDFG prepared "Production Goals and Constraints" which were approved by NMFS. Production goals are 4 million Chinook salmon smolts and 430 thousand steelhead yearlings per year. CDFG and NMFS prepared a Final Report on Anadromous Salmonid Fish Hatcheries in California (December 3, 2001) that includes recommendations for operating the Nimbus Hatchery. CDFG expects to complete a genetic management plan, required by NMFS, by 2007. Reclamation is in the early planning stages of consulting with NMFS regarding the operation of the Nimbus Hatchery, pursuant to the federal Endangered Species Act (ESA). The consultation will evaluate the affects of the hatchery operations on wild stocks of fall-run Chinook salmon and steelhead, and will provide recommendations to minimize any adverse effects.

Recommendations
It is recommended that CDFG continue to conform to its production goals and constraints and complete the genetic management plan; and that Reclamation and NMFS complete the ESA consultation. Change to a 1st priority.

6.3.7. Other Potential Restoration Activities

❖ **Reference**
FISH Plan Section/Page: 19/6-32

FISH Plan Title: Assess feasibility of providing enhanced off-site steelhead habitat (e.g. Coon Creek, Dry Creek, Auburn Ravine).

Progress Report
Evaluation: Not started.

Implementation: Not applicable

Monitoring: Not applicable

Recommendations
It is recommended that this item be removed from the FISH Plan because it does not affect the lower American River.

6.3.8. Monitoring and Evaluation Components

❖ **Reference**
FISH Plan Section/Page: D/6-32

FISH Plan Title: Develop and implement a method of estimating annual steelhead in-river spawning population and population trends to assist in management decision-making.

Progress Report
Evaluation: Completed. In 2003, Reclamation developed a methodology.

Implementation: Ongoing. Since 2003 Reclamation has used the methodology to quantify the number of in-river steelhead, and the number of steelhead redds. Annual reports have been published.

Monitoring: Ongoing.

Recommendations
It is recommended that the monitoring be continued indefinitely as a FISH Plan priority 2.

❖ **Reference**
FISH Plan Section/Page: E/6-32

FISH Plan Title: Develop an in-river production model for fall-run Chinook salmon to assist in understanding factors critical to the well-being of this species

Progress Report
Evaluation: Not applicable

Implementation: Ongoing. CDFG have been assembling juvenile Chinook salmon production estimates from the screw trap data, and have been developing escapement estimates. These data are basic components for an in-river production model. CDFG has generated some simple models relating the "survival," or "production" index to flow variation, maximum flow, and other parameters during key phases of the early life history. Preliminary work has indicated that flow may be an important factor during key phases of early life history.

Monitoring: Ongoing. See above.

Recommendations
It is recommended that CDFG continue to further develop an in-river production model, especially in regard to flow during key stages of the early life history. A next step might be to develop a conceptual framework to identify what other factors may be important.

❖ **Reference**
FISH Plan Section/Page: F/6-33

FISH Plan Title: Develop a juvenile steelhead over-summer model to assist in understanding factors critical to the well-being of this species.

Progress Report
Evaluation: Not applicable.

Implementation: Ongoing. CDFG has been studying over-summering steelhead in the lower American River since 2001, which has provided a good body of information toward achieving the objective. The studies have included the special distribution of steelhead, growth patterns, temperature, and mobility. CDFG has developed a draft model in regard to temperature.

Monitoring: Ongoing. See above.

Discussion
DFG intends to formally summarize the four years of over-summering steelhead work, especially with regard to temperature. Physical habitat availability as a function of flow has emerged as an important factor, as evidenced in the fall of 2004, when flows were reduced from 1,500 cfs to 1,000 cfs, and rosy anus became more problematic with increased water temperature and crowding. CDFG will collaborate with U.C. Santa Cruz and the NMFS Santa Cruz Laboratory to study the effects of flow on steelhead prey availability/energetics. Predation has not been addressed, and CDFG suspects that it may be a limiting factor on juvenile steelhead production.

Recommendations
It is recommended that CDFG continue its over-summering steelhead work and complete its summery of the first four years of effort, and follow through with its plans to collaborate with U.C. Santa Cruz and the NMFS Santa Cruz Laboratory. In addition, it is recommended that the predation influences over steelhead production be investigated.

❖ **Reference**
FISH Plan Section/Page: G/6-33

FISH Plan Title: Develop a stock-recruitment model for fall-run Chinook salmon to guide management decision-making..

Progress Report
Evaluation: Not Applicable.

Implementation: Ongoing. Work related to this item is being done in conjunction with item 6.3.8.E.

Monitoring: Ongoing. See above

Recommendations
Because this item of the FISH Plan builds up item 6.3.8.E, it is recommended that this item be combined into 6.3.8.E.

6.4. Third Priority Actions
6.4.1. Aquatic, Riparian, and Wetland Habitat

❖ **Reference**
FISH Plan Section/Page: 20/6-34

FISH Plan Title: 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.

Summary Description: This project is to build upon the habitat characterization of the lower American River conducted by CDFG in the early 1990's.

Progress Report
Evaluation: Not started. Although a comprehensive study has not started, some site specific evaluations have been conducted associated with flood control projects along the river. Evaluations have included RM 0.5, and a preliminary evaluation of Woodlake by the COE.

Implementation: Ongoing. Several site-specific projects have been or are planned to be implemented, including the one that SAFCA has identified to create seasonally inundated floodplain habitat at RM 0.5. The plans and specifications are nearing sixty percent completion. Construction of this enhancement could occur in 2006.

Monitoring: Ongoing. The projects being implemented have an associated monitoring plan.

Recommendations
It is recommended that other opportunities be explored as they arise as priority 3.

❖ **Reference**
Fish Plan Section/Page: 21/6-34

Fish Plan Title: 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.

Progress Report
Evaluation: Although a comprehensive study has not started, some site specific evaluations have been conducted associated with flood control projects along the river. An evaluation has been completed at RM 0.5 to investigate opportunities to create a series of seasonally inundated benches to establish low floodplain habitat and associated riparian upland. Additional sites under investigation (specific evaluations have not occurred) have been identified along the south bank of the LAR in the vicinity of Sutter's Landing Park and the river edge of the Gardenland property.

Implementation: Ongoing. SAFCA is working with its federal and state flood control partners to implement a project at RM 0.5 in 2006.

Monitoring: Ongoing. The projects once implemented will have an associated monitoring plan.

Recommendations
It is recommended that as resources permit, a systematic evaluation should be completed with and emphasis on reaches 1 and 3 of the LAR.

❖ **Reference**
FISH Plan Section/Page: 22/6-35

FISH Plan Title: 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.

Progress Report
Evaluation: Ongoing. Although a comprehensive evaluation has not been started, one site at RM 0.5 has been identified.

Implementation: Ongoing. Design for RM 0.5 is in process.

Monitoring: Not started.

Recommendations
It is recommended to implement pilot projects as opportunities arise as priority 3.

❖ **Reference**
FISH Plan Section/Page: 23/6-36

FISH Plan Title: 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.

Progress Report
Evaluation: Ongoing. An evaluation is underway by MIG, Inc. as part of the Integrated Area Plan associated with the American River Parkway Plan Update. Three sites have been identified where wetlands could be developed or enhanced using urban runoff resulting in improved water quality of the runoff. The water sources and locations are: Chicken and Strong Ranch Slough at Bushy Lake, Sump 152 west of Bushy Lake, and Sump 151 near the Woodlake area.

Implementation: Not started.

Monitoring: Not started.

Recommendations
It is recommended that the evaluation be completed and the results implemented and the FISH Plan priority raised to second.

6.4.2. Contaminants

❖ **Reference**
FISH Plan Section/Page: 24/6-37

FISH Plan Title: Develop Collaborative Guidelines to Reduce the Application of Toxins on Lands that Have the Greatest Risk to Fish Populations, Where Possible.

Progress Report
Evaluation: Not started

Implementation: Not applicable.

Monitoring: Not applicable.

Discussion
Although development of comprehensive guidelines has not started, some activities are underway to reduce the inflow of toxins into the lower American River. The Central Valley Regional Water Quality Control Board has required, as part of it's permit conditions, that the County Department of Water Resources study the feasibility of diverting dry season discharge from Chicken Slough and Strong Ranch Slough into the sewer system for treatment. The County is currently conducting this study or will begin it shortly, due in 2006. In addition, SAFCA has requested that the County study the feasibility of using the COE's proposed treatment wetlands at Cal Expo as an alternative means of improving water quality from these two urban watersheds prior to discharge into the Lower American River.

Recommendations
It is recommended that the project remain in the FISH Plan as priority 3.

6.4.3. Harvest of Fish and Wildlife

❖ **Reference**
FISH Plan Section/Page: 25/6-37

FISH Plan Title: 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.

Progress Report
Evaluation: Completed. CDFG (Gary Hobgood) believes that with the present level of law enforcement, illegal harvest of Chinook salmon and steelhead is not of sufficient magnitude to act as a stressor on the populations of those species in the lower American River.

Implementation: Not applicable.

Monitoring: Not applicable.

Recommendations
It is recommended that CDFG continue to enforce the regulations along the lower American River and to monitor whether illegal harvest becomes a significant stressor in the future.

6.4.4. Artificial Propagation of Fish

❖ **Reference**
FISH Plan Section/Page: 26/6-38

FISH Plan Title: 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.

Summary Description: When the FISH Plan was developed, the temperature of water going to the hatchery occasionally became too warm for the fish in the hatchery. There was concern that by releasing colder water from Folsom Reservoir in the summer for purposes of the hatchery, it would deplete the cold water pool and there would not be sufficient cold water for spawning fall-run Chinook salmon and steelhead later in the year.

Progress Report
Evaluation: Not applicable.

Implementation: Not applicable.

Monitoring: Ongoing. Water temperatures at the hatchery are monitored on a continuous basis.

Discussion
Since the time the FISH Plan was developed, Reclamation has released cooler water to Lake Natoma for protection of in-river salmon and steelhead. As the water supply intake for the hatchery is located in Lake Natoma, the hatchery is receiving water at a temperature that is equivalent to what is released into the lower American River. The temperature of the water presently going to the hatchery meets temperature criteria for its efficient and effective operation.

Recommendations
It is recommended that Reclamation continue to release water at a temperature that is protective of in-river salmonids, which is also protective of salmonids being collected, spawned, incubated, and reared in the hatchery.

6.4.5. Other Potential Management Actions

❖ **Reference**
FISH Plan Section/Page: 27/6-39

FISH Plan Title: Coordinate the permitting process for lower American River restoration actions through the River Corridor Management Plan, where possible.

Progress Report
Evaluation: Not applicable.

Implementation: Ongoing.

Monitoring: Not applicable.

Discussion
Although this activity is a 3rd priority, the coordination has been taking place through the Lower American River Task Force with very good results.

Recommendations
It is recommended that this activity continue and that its priority be raised to 1.

❖ **Reference**
FISH Plan Section/Page: 28/6-39

FISH Plan Title: Conduct habitat suitability assessment for steelhead in the mile below Folsom Dam in Lake Natoma.

Summary Description: The assessment is specifically for where Chinook salmon and steelhead spawning habitat could be restored.

Progress Report
Evaluation: Completed. The Department of Water Resources and Reclamation conducted the assessments (Department of Water Resources, Preliminary Analysis, Natural Fish Bypass Channel, Lake Natoma, June 2002), and Reclamation (e-mail from Brian Deason, March 17, 2005). The area was not found suitable for restoring Chinook salmon and steelhead spawning habitat.

Implementation: Not applicable.

Monitoring: Not applicable.

Recommendations
Since the evaluation is complete and no habitat suitable for restoration was identified, it is recommended that this item be documented and eliminated from the FISH Plan.

6.4.6. Monitoring and Evaluation Components

❖ **Reference**
FISH Plan Section/Page: H/6-40

FISH Plan Title: Use existing aerial photographs as a baseline for monitoring activities requiring positional accuracy.

Summary Description: In addition to using existing aerial photographs, the project includes additional aerial photography at differing flow rates.

Progress Report
Evaluation: Not applicable.

Implementation: Ongoing. Existing aerial photographs are being used as applicable and additional aerial photographs have been taken on a project specific basis, however a comprehensive set of aerial photographs at differing flow rates have not been taken.

Monitoring: Not applicable.

Recommendations
Since a need for a comprehensive set of aerial photographs at differing flow rates has not been identified, it is recommended that existing aerial photographs continue to be used as applicable and that additional aerial photographs be taken as needed on a case-by-case basis.

❖ **Reference**
FISH Plan Section/Page: I/6-41

FISH Plan Title: Evaluate efficacy of installing and operating a fish counting weir to improve estimates of: (1) spawning stock escapement; and (2) juvenile outmigrant populations.

Progress Report
Evaluation: Not started.

Implementation: Not applicable.

Monitoring: Not applicable.

Recommendations
It is recommended that this item remain in the FISH Plan as priority 3.

1.0 INTRODUCTION

This Initial Fisheries and In-stream Habitat Management and Restoration Plan (FISH Plan) has been developed to better define the long-term ecosystem needs of the lower American River based on current understanding of the stressors affecting priority fish species and their critical habitats. The FISH Plan identifies and prioritizes opportunities for improving the health of the lower American River fish and aquatic habitats, including both new initiatives and modifications to existing management practices. It also identifies key data gaps and research efforts needed to address these gaps. A critical component of the FISH Plan is the strategy for assessing the effectiveness of the recommended restoration actions through monitoring, data interpretation, and adaptive adjustments. As new data regarding the health of the lower American River becomes available, this FISH Plan will be refined and updated to reflect new insights.

This FISH Plan will serve as the aquatic habitat management element (HME) of a multi-agency River Corridor Management Plan (RCMP) that was funded by the CalFed Bay-Delta Program (CalFed) in January 2000. In addition to the aquatic HME, the RCMP also will include a floodway management element, and a recreation management element. Other agencies providing financial support for RCMP development include the Sacramento Area Flood Control Agency (SAFCA) and the Sacramento Area Water Forum (Water Forum).

In addition to serving as the aquatic HME of the RCMP, the FISH Plan also is intended to serve as the Habitat Management Plan (HMP) for the lower American River, as required under the Water Forum Agreement, consistent with the mitigation described and certified in the Water Forum Agreement Environmental Impact Report (EIR) and adopted Mitigation, Monitoring, and Reporting Plan (MMRP).

A working group of stakeholders was established to develop the FISH Plan. This group, known as the Fisheries and Instream Habitat (FISH) Working Group (FWG), was given a two-fold charge: (1) to involve all primary stakeholders in a consensus-building effort, led by an independent third party and supported by a widely respected technical consultant, to develop this initial FISH Plan; and (2) to provide strategic advice to proponents of lower American River fisheries and aquatic habitat management and restoration projects who seek “early start” status for their projects.

FWG members were selected based on input provided by over 45 diverse stakeholders. Recommendations for membership resulted from those names that were consistently repeated during the stakeholder interviews. The FWG composition represents a cross-section of key stakeholder interests including:

- California Department of Fish and Game, Region II
- California Department of Water Resources
- National Marine Fisheries Service
- U.S. Bureau of Reclamation
- U.S. Army Corps of Engineers
- City of Sacramento, Department of Utilities
- Sacramento County Water Agency
- California Department of Fish and Game, Headquarters
- State Reclamation Board
- State Lands Commission
- U.S. Fish and Wildlife Service
- City of Sacramento, Parks Department
- County of Sacramento, Department of Planning
- County of Sacramento, Department of

- American River Flood Control District
- American River Fishing Guides Association
- American River Raft Rentals
- Golden State Trollers
- Save the American River Association
- Regional Parks, Recreation, and Open Space
- Sacramento Area Flood Control Agency
- American River Parkway Advisory Committee
- Central California Canoe Club
- CalFed Bay-Delta Program
- City and County Office of Metropolitan Water Planning (Water Forum)

This Initial FISH Plan was approved by the FWG (which includes Water Forum representatives and staff) on October 26, 2001; it has been integrated into the overall RCMP developed under the auspices of the Lower American River (LAR) Task Force.

1.1. Purpose and Scope of the FISH Plan

The FISH Plan articulates a broadly shared understanding regarding the management and restoration actions that have been identified as most important to undertake to improve habitat conditions for priority fish species (fall-run chinook salmon, steelhead, and splittail). The FISH Plan is intended to serve as a single blueprint for the restoration of lower American River fisheries and in-stream resources and provide a cohesive framework that can:

- Serve as a locus around which public and private entities working in the lower American River can voluntarily coordinate their efforts to responsibly steward lower American River fish and aquatic habitat;
- Serve as a local stakeholder-established framework for Stage 1 (7-year) CalFed Ecosystem Restoration Program Plan (ERPP) implementation; and
- Assist funding entities in assessing where habitat enhancement funds might most effectively be invested.

Individual fisheries and aquatic enhancement actions, as well as associated and regulatory compliance requirements, will remain the responsibility of individual project proponents. The FISH Plan is not intended to alter agencies' existing rights or responsibilities (e.g., with regard to policy and fiscal decision making). The FISH Plan includes:

- A description of physical and biological trends of the lower American River.
- Appropriate restoration, mitigation, and management actions for priority species and habitats on the lower American River.
- A plan for implementing these management, restoration, and research projects and mitigation strategies, which identifies:
  - Project priorities;
  - Agency roles and responsibilities;
  - A description of technical assistance needed to develop, update, administer and implement the plan and monitor results, including type, amount, and cost of technical assistance; and
  - Cost-sharing and administrative arrangement needed to implement the plan.

- An ecological and biological monitoring strategy for (1) evaluating the effectiveness of proposed restoration/mitigation actions (including the techniques, indicators, and performance standards to be used); and (2) interpreting the data to assess the effectiveness of FISH Plan implementation.
- Data gaps and recommended actions for a directed research program to improve understanding of the lower American River ecosystem.
- A process for updating the FISH Plan based on adaptive management principles.

In addition, recommendations included in the FISH Plan address several of the existing uncertainties regarding ecosystem function articulated by CalFed (CalFed 2000). These include the following:

- Natural flow regimes;
- Channel dynamics, sediment transport and riparian vegetation; and
- Flood management as an ecosystem tool.

1.2. FISH PLAN STUDY AREA

1.1.1. MOUTH OF THE AMERICAN RIVER TO FOLSOM DAM

The FISH Plan study area is located entirely within Sacramento County in the lower American River "Ecozone." The study area covers the American River corridor from the mouth of the American River at the Sacramento River to Folsom Dam. The corridor is bounded on the north and south by levees in the lower reach and bluffs and high terraces in the upper reach. The lower American River centerpoint coordinates are: 2186696, 331924, California Coordinates, Zone 2, in feet, North American Datum (NAD) 1927.

1.1.2. LOWER AMERICAN RIVER CORRIDOR AND WATERSHED BOUNDARIES

The restoration and management efforts proposed in the FISH Plan are confined within the boundaries of the lower American River corridor as described above. However, it is recognized that, in formulating the goals, objectives, and actions necessary to implement the FISH Plan, the FWG also may consider out-of-corridor habitat influences, where they directly affect the fisheries, aquatic, or riparian habitats of the lower American River.

The American River drains a roughly triangular watershed that is widest at the crest of the Sierra Nevada range, and narrows almost to the width of the river at its confluence with the Sacramento River at the City of Sacramento. Elevations range from 10,400 feet mean seal level (msl) at the headwaters to about 200 feet msl at Folsom Dam, with an average basin slope of 80 feet per mile.

Folsom Dam, a part of the federal Central Valley Project (CVP), has provided flood control, hydropower generation, and water supply storage to the surrounding environs since 1956. The reservoir is kept partly empty during the winter, so that temporary storage is available to regulate the runoff from major storms. The reservoir capacity of 975,000 acre-feet is relatively small compared to the average annual runoff of 2,700,000 acre-feet, but because of the large variability

in runoff and the need for continuous releases, the reservoir does not fill completely in many years.

Nimbus Dam, located approximately seven miles downstream from Folsom Dam, serves as a regulating facility for hydropower releases from Folsom Dam. It also serves as a diversion dam for the Folsom South Canal. Its reservoir, Lake Natoma, provides flat-water recreation but no significant water storage capabilities. The lower American River is defined as the 23-mile reach of the river downstream from Nimbus Dam (**Figure 1-1**).

1.3. BACKGROUND

1.1.3. LOWER AMERICAN RIVER TASK FORCE - RIVER CORRIDOR MANAGEMENT PLAN

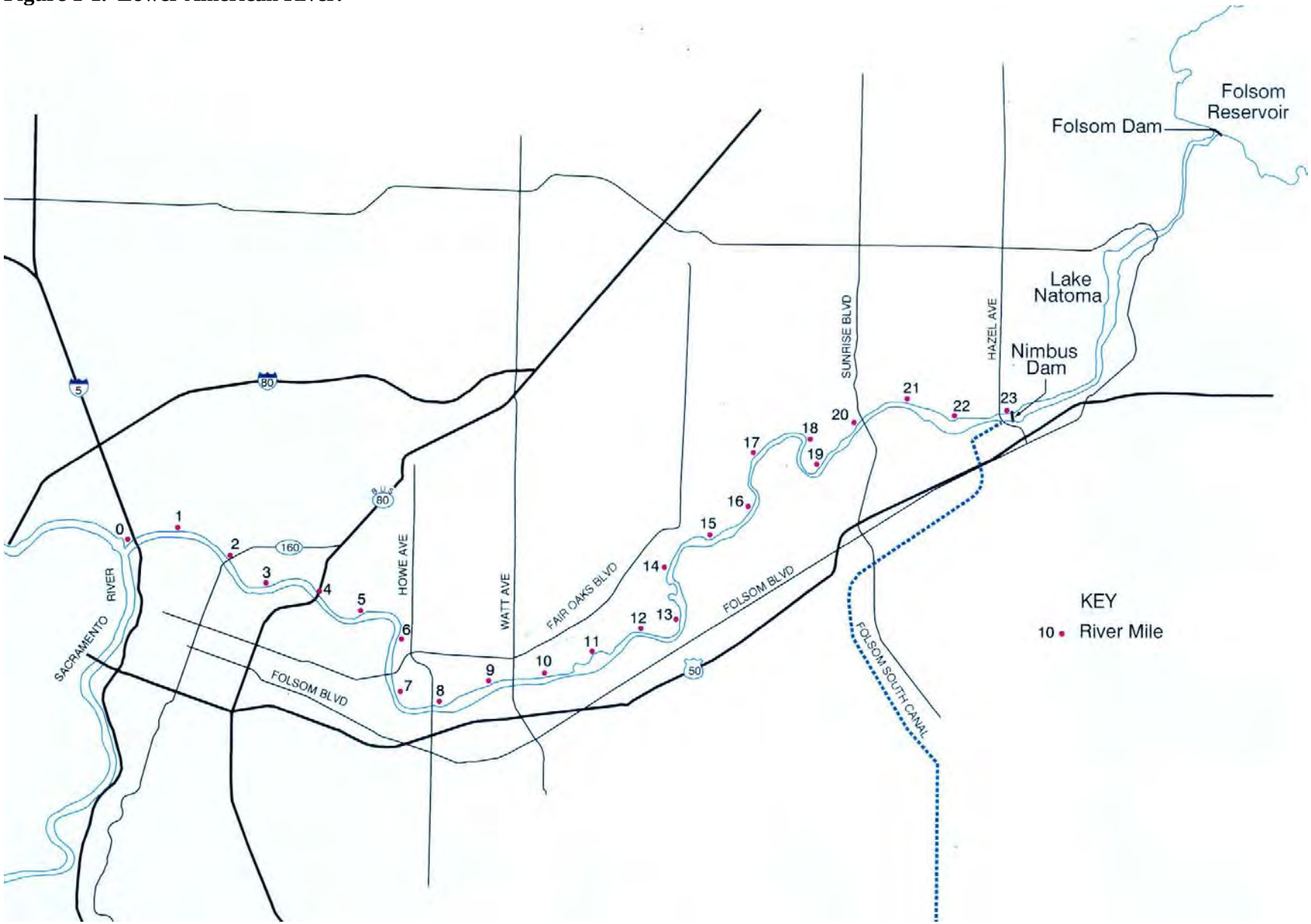
The RCMP has been developed through a stakeholder-driven consensus-building process that has taken place under the auspices of the LAR Task Force, in cooperation with the Water Forum. The LAR Task Force, convened by SAFCA on a monthly basis since 1994, provides a forum for regional coordination on lower American River management among approximately 50 stakeholder organizations. The LAR Task Force's mission is to identify opportunities for improving existing flood control facilities and management strategies along the lower American River, while protecting and enhancing existing environmental and recreational resources within the American River Parkway (Parkway). The LAR Task Force guided the preparation of the RCMP. The need for an RCMP has been identified by numerous interests, including CalFed, the Water Forum, SAFCA, and the Sacramento County Department of Regional Parks, Recreation, and Open Space (Sacramento County Parks).

Building upon earlier efforts to manage the lower American River for multiple beneficial uses, undertaken by the California Department of Fish and Game (CDFG), the Water Forum, the LAR Task Force, and previous LAR Technical Committee Workshops, the LAR Task Force will balance the river's multiple uses through a consensus-based framework. Specifically, the development of the RCMP for the lower American River is intended to: (1) establish consensus among biologists, resource managers, and other technical experts and stakeholders concerning the critical needs of the aquatic species in the lower American River and the priorities for restoration and recovery actions; and (2) provide an integrated planning framework to identify, prioritize, define and implement restoration actions in the lower American River. The RCMP also will serve as the mechanism for updating the American River Parkway Plan (Parkway Plan).

The RCMP has been developed based on information and recommendations generated by four working groups of the LAR Task Force: the FISH Working Group, the Floodway Management Working Group (FMWG), the Bank Protection Working Group (BPWG), and the Recreation Management Working Group (RMWG). Coordination with the [Folsom] Reservoir Operations Working Group (ROWG) takes place through overlapping membership. The RCMP is composed of: (1) the Aquatic Habitat Management Element (HME); (2) the Vegetation and Wildlife Management Element; (3) the Floodway Management Element; and (4) the Recreation Management Element. The FISH Working Group has developed the Aquatic Habitat Management Element. The Floodway Management Element, as well as the Vegetation and Wildlife Management Element, have been prepared and managed jointly by the FMWG and the BPWG. The Recreation Management Element has been developed by the RMWG.

The LAR Task Force integrated the efforts of these working groups in development of the three management elements, as well as providing guidance and review and comment on the draft RCMP.

Figure 1-1. Lower American River.



FLOODWAY MANAGEMENT ELEMENT

The Floodway Management Element of the RCMP has three key programs: (1) Vegetation Resource Management; (2) Facilities Redesign and Relocation; and (3) Anticipatory Erosion Control. FMWG has developed the Vegetation Resource Management and the Facilities Redesign and Relocation programs. BPWG has developed the Anticipatory Erosion Control Program. The FMWG and BPWG have collectively identified the terrestrial habitat restoration needs and priorities of the lower American River.

The Vegetation Resources Management Program serves as a master plan for maintaining riparian and terrestrial habitats, preserving flood conveyance capacity, and accommodating necessary maintenance activities, while remaining consistent with locally adopted recreation and open space goals for the Parkway. The Facilities Redesign and Relocation Program is intended to reduce the impacts of infrastructure maintenance on floodplain habitats, reduce the risk of structural damage due to flooding, and improve the flood conveyance capacity of the lower American River.

The Anticipatory Erosion Control Program addresses potentially critical sites, yet minimizes impacts to the environment by incorporating environmental features. Other, less-critical sites that nevertheless are potential flood control or mitigation sites are addressed as a secondary objective of the BPWG.

RECREATION MANAGEMENT ELEMENT

The Recreation Management Element includes recommendations regarding improvements necessary to facilitate public access to the Parkway and enhance the recreational experience of users, while protecting wildlife and habitat values within the Parkway. To this end, the RMWG element includes recommendations to help mitigate the adverse effects on recreation caused by planned activities within the lower American River corridor. This element also provides for adequate preservation, protection, and restoration of existing Parkway facilities and enhancement of ongoing educational and interpretive activities within the Parkway. Improved public safety and security within and adjacent to the Parkway are also included in the element's charge.

AQUATIC HABITAT MANAGEMENT ELEMENT

The HME includes the FISH Plan, Bibliography, *Baseline Report*, *State-of-the River Report*, and any Early Start Projects (ESPs) that were undertaken concurrent with FISH Plan development. These are described below.

Initial Fisheries and In-Stream Habitat Management and Restoration Plan

The HME focuses on the development of the FISH Plan. The FISH Plan focuses on five fish species of priority management concern, including fall-run chinook salmon (*Oncorhynchus tshawytscha*), steelhead (*Oncorhynchus mykiss*), splittail (*Pogoninchtys macrolepidotus*), American shad (*Alosa sapidissima*), and striped bass (*Morone saxatilis*). Special emphasis has been placed upon the first three of these species to facilitate compliance with applicable law—particularly, the federal Endangered Species Act (ESA) and the California Endangered Species Act (CESA)—and to be consistent with state and federal restoration plans. In particular, this

focus is consistent with: (1) CalFed's 2000 *Ecosystem Restoration Program Plan*, which identifies a vision, restoration actions, and strategies for the lower American River; (2) U.S. Fish and Wildlife Service's (USFWS) 2000 Final *Anadromous Fish Restoration Program* (AFRP), which identifies specific actions on the lower American River to protect anadromous salmonids; (3) CDFG's 1996 *Steelhead Restoration and Management Plan for California*, which identifies specific actions on the lower American River to protect steelhead; and (4) CDFG's *Restoring Central Valley Streams, A Plan for Action* (1993), which identifies specific actions on the lower American River to protect salmonids. Improvement of habitat conditions for these species of priority management concern will likely enhance conditions for American shad and striped bass, as well as for native resident aquatic species.

A key building block in the development of the FISH Plan was the collection and review of all currently available information on the five priority species associated with the lower American River. While the primary focus of the FISH Plan is on the fish species noted above, consideration of the various natural physical attributes, habitat elements, environmental stressors, and operational management protocols active in the lower American River also is essential in the development of any long-term restoration effort for the lower American River.

Before the FISH Plan could be developed, an assessment of the baseline conditions in the river had to be made. To this end, the FISH Working Group commissioned the preparation of the *Baseline Report* to summarize and present available information on historic trends and current status of the aquatic resources and associated habitats of the lower American River. This report provides the baseline against which the effectiveness of any future restoration efforts may be measured and evaluated. The *Baseline Report* provided a foundation for the FISHWG in developing the FISH Plan. Information contained in the *Baseline Report* will subsequently be used to develop a *State-of-the-River Report* for general audiences.

The FISH Plan includes ecosystem needs and stressors for the priority species and habitats of the lower American River to help identify and select actions for implementation. Actions include new management actions, modifications of existing practices, restoration projects, research projects, and mitigation/conservation measures. A key component of the Plan is its implementation strategy. The implementation strategy represents an important planning tool with which to coordinate the execution of the Plan recommendations. It prioritizes recommended management and restoration actions, and suggests relevant roles and responsibilities. The implementation strategy also describes cost-sharing and other administrative arrangements, as well as needed technical assistance and mechanisms for updating the FISH Plan.

The FISH Plan's ecological and biological monitoring evaluation and adaptive management process will incorporate appropriate metrics, monitoring protocols, and updated population census techniques. Enhanced monitoring efforts are proposed as part of this strategy to systematically measure the responsiveness of the priority fish populations to implemented restoration and management actions, including the Early Start Projects under contemplation. As noted previously, in order to effectively implement the FISH Plan on a long-term basis, adaptive management must be established as the principal process for iterative change. Accordingly, adaptive management principles (e.g., adjustment to targets, funding priorities, and restoration techniques based on an evaluation of preceding and ongoing efforts) will be the foundation for the long-term monitoring effort.

Each of these components of the FISH Plan, including the assessment of baseline conditions, the recommendation and prioritization of restoration actions, the implementation strategy, and the monitoring and adaptive management process, represent a consensus among biologists, resource managers, and other technical experts and stakeholders concerning the critical needs of the aquatic species in the lower American River.

Bibliography

As part of the *Baseline Report* development, a comprehensive bibliography has been produced, including relevant published and unpublished documents on the fisheries and aquatic habitat of the lower American River. This bibliography is computer key-word accessible and represents an important reference source for any planning process regarding the lower American River. The bibliography in its entirety is expected to be made available electronically on the internet in fiscal year 2001/2002.

Baseline Report

The *Baseline Report* provides the essential background information for the lower American River necessary to develop the FISH Plan and identify the specific actions for long-term restoration of the river and its habitats. Key attributes of the lower American River include fish, riparian habitats, water quality, hydrology, fluvial geomorphology, and instream habitats. This report provides a rigorous analysis of published and unpublished documents on the fisheries and aquatic habitats of the lower American River. It also discusses ecosystem functions, characteristics and stressors to the fish species of priority management concern.

State-of-the-River Report

This document will present a condensed version of the key findings of the *Baseline Report* by resource category. It is intended that this report be developed and presented in a user-friendly manner, primarily directed towards the lay reader. While the *Baseline Report* is meant to characterize the existing environmental conditions of the lower American River for planning purposes, the primary purpose of the State-of-the-River Report is community education.

Early Start Projects

ESPs are projects that were initiated while the FISH Plan was under development. When ESPs were brought before the FWG provided project proponents with strategic input related to the utility and design of their proposed projects. However, the FWG chose not to issue approvals nor disapprovals, as they believed this would be beyond their authority. In reviewing proposed ESPs, the TSC and FWG gave feedback as to whether the projects reflected the attributes sought by FISH Plan-recommended actions, including the following: (1) offers high scientific merit/data benefits; (2) addresses the needs of priority management species; (3) addresses a severe stressor; (4) results in multiple or ecosystem benefits; (5) leverages benefits; (6) does not preclude other key restoration opportunities; and (7) is supported by the professional judgment of the TSC members.

1.1.4. WATER FORUM AGREEMENT AND HABITAT MANAGEMENT ELEMENT

The HME for the lower American River, combined with other elements of the Water Forum Agreement, fulfills one of the Water Forum's two coequal objectives: to preserve the fishery,

wildlife, recreational, and aesthetic values of the lower American River. The HME contains five programmatic components that together address river flow, water temperature, physical habitat, and recreation issues for the lower American River. These programmatic components include the Habitat Management Plan, habitat improvement projects that benefit the lower American River ecosystem, monitoring and evaluation efforts, project-specific mitigation and/or conservation measures, and lower American River recreational activities.

As delineated in the Water Forum Agreement, the Habitat Management Plan is to include descriptions of reasonable and feasible projects that could be implemented to avoid and/or offset potential impacts to the lower American River fish and riparian resources due to the increased surface water diversions defined under the Water Forum Agreement. The Habitat Management Plan also is to identify and define the following:

- Performance standards to be used as indicators of the health of the lower American River;
- Conceptual (e.g., Mitigation banking or other) and technical framework for the Habitat Management Plan;
- Schedule and technical assistance required for development, implementation, and monitoring of the Habitat Management Plan;
- The manner with which the Habitat Management Plan will be coordinated with other programs, plans, initiatives, and/or mandates that affect the lower American River ecosystem;
- Logistics and responsibilities associated with administering the Habitat Management Plan;
- Implementation priorities, strategies, and schedules for the proposed projects;
- Lead organizations for implementation of each project;
- The manner with which the Habitat Management Plan could serve as the framework for addressing ESA and CESA requirements; and
- Cost-sharing obligations and specific funding commitments.

The FISH Plan serves as the Habitat Management Plan for the lower American River as required under the Water Forum Agreement, consistent with the mitigation described and certified in the Water Forum Agreement EIR and adopted MMRP.

1.1.5. CALFED BAY-DELTA PROGRAM

CalFed is a cooperative effort among state and federal agencies and California's environmental, urban, and agricultural communities. It was initiated in 1995 to develop a long-term strategy to restore environmental health and resolve water management problems in the Bay-Delta, and its numerous watersheds. In January 2000, CalFed approved funding for 31 restoration projects in the Bay-Delta estuary and its watershed under the federal Bay-Delta Act and California Proposition 204. Projects were selected from a pool of 226 proposals submitted to CalFed in April 1999. The lower American River RCMP development project was among those approved and partially funded by CalFed, with additional funding by the Water Forum and SAFCA.

The lower American River and its watershed have been recognized as important components in the pursuit of CalFed's vision and objectives for ecosystem restoration throughout California. Based on the core involvement of local, state, and federal agencies, as well as business and community groups, the comprehensive RCMP will serve as the planning framework that will

allow local entities to coordinate their management activities related to the lower American River and to assist CalFed in evaluating appropriate lower American River restoration actions.

The RCMP will provide for the following desired outcomes:

1) Improved coordination and assistance among community organizations, public trust resource managers, local businesses, and local, state, and federal agencies by the FWG.
2) Development of monitoring protocols and the application of adaptive management principles.
3) Improved river stewardship, reflecting enhanced riparian and aquatic habitat conditions, as well as enhanced flood management characteristics.

1.4. RELATED PLANS

1.1.6. FLOODWAY MANAGEMENT PLAN

The Floodway Management Plan (FMP) was developed in 1988 by SAFCA and a diverse group of stakeholders on the lower American River including local community and conservation groups in order to balance the needs of the flood control system with the needs of other competing resources. The FMP includes a floodplain management program aimed at restoring ecological processes, functions, and aquatic/riparian habitats that benefit important Bay-Delta fisheries (e.g., chinook salmon, steelhead, American shad, and splittail), while promoting the open space values of the local community and providing an acceptable level of flood control for the City of Sacramento. The RCMP is intended to provide the necessary framework through which the FMP, as well as the FISH Plan, will be implemented.

1.1.7. AMERICAN RIVER PARKWAY PLAN

The Parkway Plan includes important elements, such as flow management, fisheries and associated aquatic habitats, public open space, and flood control. The Parkway Plan, however, has not been updated since 1985 when the County of Sacramento and State Legislature adopted it. Accordingly, its plan elements do not necessarily reflect or incorporate the related planning efforts that have unfolded over the ensuing 16 years. The RCMP is intended to provide the foundation for an updated Parkway Plan, which would serve as the formal vehicle reflecting the support of both the City and County of Sacramento and the State Legislature for incorporating ecosystem restoration into a multiple use management program for the lower American River.

1.1.8. CALFED: ECOSYSTEM RESTORATION PROGRAM PLAN

Under CalFed's ERPP, the vision for the Lower American River Ecological Management Unit focuses on restoring important fish, wildlife, and plant communities. Restoration efforts should emphasize benefits to naturally spawning chinook salmon and steelhead populations, which co-exist with non-native American shad, striped bass, and hatchery stocks of chinook salmon and steelhead.

To accomplish this vision, CalFed recommends restoration and re-initiation of the ecological processes and functions that create and maintain habitats for fish, wildlife, and plant communities along the lower American River. The ERPP has identified the following ecological processes as desirable for the lower American River:

- Maintenance of natural streamflows in creeks to support riparian habitat and associated species;
- Re-distributing and/or supplementing gravel to continually replenish the supply of gravel needed by chinook salmon and steelhead for spawning habitat;
- Preserving natural floodplain processes by allowing winter-spring flows to overflow into riparian and wetland habitats; and
- Providing cooler spring-through-fall water temperatures by protecting and enhancing streamflow, enhancing riparian vegetation along creeks, reducing warmwater discharges to creeks, and reducing diversions from creeks.

From a habitat restoration perspective, the ERPP has identified several additional visions for protection and/or enhancement of seasonal wetlands, riparian and riverine aquatic habitat, freshwater fish habitat, and essential fish habitat, as well as visions for reducing known ecosystem stressors and addressing the needs of individual species. CalFed recognizes that many diverse actions could be implemented to work toward these visions. With regard to fisheries and aquatic habitat, these actions include improving seasonal flow and water temperature regimes, in-channel and riparian habitats, and modifying fishery regulations and hatchery operations. The RCMP and FISH Plan goals are consistent with the CalFed ERPP overall visions, and their specific visions for the lower American River.

1.1.9. CENTRAL VALLEY PROJECT IMPROVEMENT ACT: ANADROMOUS FISH RESTORATION PROGRAM

Section 3406(b)(1) of the Central Valley Project Improvement Act (CVPIA) of 1992 requires the Secretary of the Department of the Interior to …"*develop within three years of enactment and implement a program which makes all reasonable efforts to ensure that, by the year 2002, natural production of anadromous fish in Central Valley rivers and streams will be sustainable, on a long-term basis, at levels not less than twice the average levels attained during the period of 1967 to 1991…*".

Further, Section 3406(b)(1)(A) requires that the program…"*give first priority to measures which protect and restore natural channel and riparian habitat values through habitat restoration actions, modifications to Central Valley Project operations, and implementation of the supporting measures mandated by this subsection…*". Moreover, this section requires that the program *"…shall be reviewed and updated every five years; and shall describe how the Secretary intends to operate the Central Valley Project to meet the fish, wildlife, and habitat restoration goals and requirements set forth in this title and other project purposes*."

The USFWS and U.S. Bureau of Reclamation (USBR) are jointly implementing the CVPIA, including Section 3406(b)(1), through development of an AFRP to address the needs of those species identified for restoration actions in the CVPIA. A total of 172 actions have been identified to meet the intent of the CVPIA, 103 of which are assumed to have a high potential for

implementation in the near future. For the American River, eight actions have been identified, with five having a high potential for near-term implementation:

1. Develop and implement a river regulation plan that meets flow objectives by modifying CVP operations, using Section 3406(b)(2) water, and acquiring water from willing sellers as needed.
2. Develop a long-term water allocation plan for the American River watershed.
3. Reduce and control flow fluctuations to avoid and minimize adverse effects on juvenile salmonids.
4. Reconfigure Folsom Dam shutters for improved management of Folsom Reservoir's cold water pool and better control over the temperature of water released downstream.
5. Replenish spawning gravel and restore existing spawning grounds.
6. Improve the fish screen at the City of Sacramento E.A. Fairbairn Water Treatment Plant.
7. Modify the timing and rate of water diverted from the river annually to reduce entrainment losses of juvenile salmonids.
8. Develop a riparian corridor management plan to improve and protect riparian habitat and instream cover.

The goals and intent of the RCMP and FISH Plan are consistent with each of these recommended restoration actions.

1.1.10. CALIFORNIA DEPARTMENT OF FISH AND GAME: STEELHEAD RESTORATION PLAN FOR THE AMERICAN RIVER

In 1991, CDFG published *Steelhead Restoration Plan for the American River*. The report identifies two main objectives:

1. Restoring and maintaining naturally produced steelhead as an integral component of the American River ecosystem; and
2. Restoring the population to a level that will sustain a quality steelhead fishery and provide for other non-consumptive uses.

The report focuses on restoring habitat conditions within the lower American River and on supplementing the existing fisheries population with artificially reared fish. The report also recommends that overall CVP operations be adjusted to allow for the elimination of drastic flow fluctuations in the lower American River; identifies water temperature objectives during the spawning, incubation, emergence, and juvenile rearing life stages; and suggests maintenance of a minimum coldwater pool in Folsom Reservoir throughout the summer months. The goals and intent of the RCMP and FISH Plan are consistent with the CDFG Steelhead Restoration Plan.

1.1.11. CALIFORNIA DEPARTMENT OF FISH AND GAME: RESTORING CENTRAL VALLEY STREAMS: A PLAN FOR ACTION

In 1993, CDFG published *Restoring Central Valley Streams: A Plan for Action*. This report was developed to address the long-term protection and maintenance of anadromous fish habitat in Central Valley streams. For the lower American River, this report identified several priorities and recommendations including:

1. Maintaining specified instream flow releases below Nimbus Dam throughout the year;
2. Establishing minimum fall carryover storage at Folsom Reservoir to maintain suitable year-round stream temperatures;
3. Controlling rapid-flow fluctuations to protect anadromous fish fry and eggs;
4. Developing a coordinated multi-agency management plan; and
5. Developing and implementing a continuing program for the purpose of restoring and replenishing, as needed, spawning gravel lost from the construction and operation of CVP dams, various bank protection projects, and other actions that have collectively reduced the availability of spawning gravel and rearing habitat.

The goals and intent of the RCMP and FISH Plan are consistent with this CDFG program.

1.5. RELATED INITIATIVES

1.1.12. ENVIRONMENTAL DEFENSE FUND ET AL. V. EAST BAY MUNICIPAL UTILITY DISTRICT (EBMUD) LITIGATION

The *EDF et al. v. EBMUD* litigation addressed the ability of EBMUD to divert from the lower American River at the Folsom South Canal. A decision was rendered in 1989, but Judge Richard Hodge retained jurisdiction through the Alameda County Superior Court. One of the findings of Judge Hodge's decision ("Hodge Decision") addressed the apparent scientific uncertainty in the body of evidence. The court directed that studies be conducted to reduce the level of scientific uncertainty regarding anadromous salmonid resources in the lower American River, and their environmental requirements.

The intent of the RCMP and FISH Plan in assessing the current health of this ecosystem and identifying areas where either the existing information requires enhancement or corroboration, or whether other important information is currently lacking, is consistent with the goals and objectives of the Hodge Decision.

1.1.13. CALIFORNIA DEPARTMENT OF FISH AND GAME STREAM EVALUATION PROGRAM AND STREAM FLOW AND HABITAT EVALUATION PROGRAM

Since 1991, CDFG has conducted annual redd, emigration, community, and escapement surveys under their comprehensive Stream Evaluation Program. The results of surveys conducted under the Stream Evaluation Program are the primary sources of biological information on the lower American River, and were relied on heavily in the development of the *Baseline Report* and the FISH Plan. The FISH Plan (and its primary technical reference, the *Baseline Report*) provides a comprehensive synthesis of studies conducted under the Stream Evaluation Program from 1991 through 2000.

1.1.14. LOWER AMERICAN RIVER OPERATIONS WORKING GROUP

An operational working group has been established for the lower American River, known variously as the Lower American River Operations Group or, American River Operations Group, or Folsom ROWG. This group includes representatives from the USBR, USFWS, NMFS, CDFG, SAFCA, Water Forum, City of Sacramento, County of Sacramento, Western Area Power Administration (WAPA), and the Save the American River Association (SARA). It generally convenes monthly, or more frequently, with the purpose of providing input to the management of Folsom Reservoir for fish resources in the lower American River, within the confines of water availability and other operational considerations.

The USBR provides this group with information, such as flows for the prior several months, reservoir storage, projected reservoir inflow, water temperature data, and projected outflows. The ROWG uses this information to plan and develop the annual flow release schedule for Folsom Dam. This takes place on a monthly basis, or more frequently, with the group adapting and refining the projected flow release schedule for the next month, and making necessary adjustments for the remainder of the year.

The ROWG not only provides input into the flow release schedule for Folsom Dam, but also into the adaptive management of the coldwater pool in Folsom Reservoir. The coldwater pool is influenced by numerous factors, not the least of which are inflow, inflow water temperatures, diversions, storage, and the volume of cooler, hypolimnetic waters in the reservoir. Water temperatures in the lower American River also are influenced by these factors, as well as by decisions about which elevation from which to draw water for release from Folsom Reservoir into the Nimbus Hatchery and down the lower American River. The ROWG provides regular input regarding how best to manipulate the shutters on the power penstocks at Folsom Dam to most effectively manage the coldwater pool reserves and provide maximum thermal benefit to downstream aquatic resources.

Operational management prescriptions identified and proposed during the development of the FISH Plan are likely to be reviewed and refined by the ROWG.

1.1.15. LOWER AMERICAN RIVER FLOW MANAGEMENT PLAN

An effort to update a lower American River flow management plan was an outgrowth of several efforts to improve conditions for fish in the lower American River that began in the early 1990s. The SWRCB's interest in protecting public trust resources in the lower American River, included in its 1990 "*Report of Referee*" in the *EDF et al. v. EBMUD* case, contributed to the present effort.

In September 1993, the Water Forum was formed to evaluate water resources and future water supply needs of the Sacramento metropolitan region. One of the two co-equal objectives of the Water Forum Agreement is to "*Preserve the fishery, wildlife, recreational, and aesthetic values of the Lower American River.*" Seven elements are put forward in the Water Forum Agreement to support the areas' attainment of the objectives. The third element is "Support for an Improved Pattern of Fishery Flow Releases from Folsom Reservoir." Developing an ecologically based, flow management plan for the lower American River is one of the most important assurances contained in the Water Forum Agreement.

Over the years since completion of the Water Forum Agreement and EIR, the LAR Task Force and FWG have developed, as a first priority action in this Initial FISH Plan and the RCMP (its

parent document), a recommendation to "develop and implement an ecologically-based flow management plan for the lower American River, including water temperature management considerations, subject to SWRCB approval" (see Chapter 6). This recommendation is intended to implement the Water Forum Agreement third element.

The Water Forum initiated the process of developing the lower American River flow management plan with the convening of the Fish Biologists Working Group in December 1994. This group developed the initial methodology that matched river releases to varying life cycle needs of the fishery (then referred to as the "F" Pattern). In January 1999, the Water Forum, USFWS, and USBR agreed to continue working on a proposal to be presented to the SWRCB with the intent to update a flow management plan for the lower American River. A technical committee was commissioned to develop this proposal, consisting of individuals representing USBR, USFWS, NMFS CDFG, City of Sacramento, and the Water Forum. The objective of the lower American River flow management plan proposal was to increase the minimum release requirement for the river in conjunction with establishing an adaptive management process for Folsom Reservoir and lower American River operations. Currently, SWRCB Decision 893 (D-893) outlines the minimum flow requirement for the river for all months of the year. However, the USBR operates Folsom Dam to meet more recent minimum flow recommendations consistent with the CVPIA, AFRP, and other relevant habitat management plans geared toward the protection and enhancement of anadromous fish resources.

Development of the flow management plan proposal has focused on evaluation of functional relationships identified in the *Baseline Report*, primarily for fall-run chinook salmon and steelhead, and has emphasized adaptive management. Because development and implementation of a flow management plan will address numerous restoration objectives of the FISH Plan, the FISH Plan incorporates this effort into recommended actions. Because of the relationships between flow and water temperature, the flow management plan incorporates water temperature management considerations, as well as flow.

1.1.16. LONG-TERM REOPERATION OF FOLSOM DAM AND RESERVOIR

Long-term reoperation of Folsom Dam and Reservoir will require an agreement between the local flood control agency (i.e., SAFCA) and USBR to extend the period for establishing at least a 100-year level of flood protection for the greater Sacramento region in the Interim Operation Plan. The agreement would continue the existing interim variable-space flood control diagram for the reservoir, of 400,000 to 670,000 acre-feet flood storage capacity, until completion of flood control improvements at Folsom Dam and along the mainstem of the American River. Modifications of the outlets at Folsom Dam would allow a revised variable flood control diagram reflecting 400,000 to 600,000 acre-feet of variable space storage, yet still provide 100-year flood protection. In addition, mitigation actions associated with the original interim flood control reoperation agreement and the new long-term agreement potentially involve restoration actions within the scope of the FISH Plan.

Identification and implementation of mitigation actions associated with long-term flood control are consistent with the RCMP and the FISH Plan.

1.1.17. U.S. ARMY CORPS OF ENGINEERS' COMPREHENSIVE FLOOD CONTROL STUDY

In response to extensive flooding and damages experienced in 1997, the United States Congress authorized the Corps to provide a comprehensive analysis of the Sacramento and San Joaquin river basin flood management systems and to partner with the State of California to develop master plans for flood management into the next century. The Corps and the State Reclamation Board are leading a Comprehensive Study to improve flood management and integrate ecosystem restoration in the Sacramento and San Joaquin river basins.

The Comprehensive Study was authorized in October 1997 and initiated with the signing of the Feasibility Cost Sharing Agreement in February 1998. Phase I of the study concluded in March, 1999. The Phase II report will be completed in 2002.

The Comprehensive Study is the only project to address regional flood management issues and develop master plans to incorporate both flood damage reduction and river corridor ecosystem restoration in the Sacramento and San Joaquin River basins. Past and present efforts to address these issues form the starting point for the Comprehensive Study. The Comprehensive Study extends traditional flood management approaches into a broader array of integrated solutions that consider both flood protection and ecosystem restoration along the river systems. Ecosystem restoration efforts contemplated by the plan include:

- Reforest floodplain corridors;
- Protect existing natural physical processes;
- Re-establish suitable hydrologic regime to restore natural physical processes;
- Remove bank protection to restore natural processes;
- Allow riparian forest to reach maturity;
- Restore oxbows—grade and plant abandoned oxbows;
- Use hardpoint bank protection—protect pumps, diversions, etc., locally (e.g., with mini spur-dikes) rather than continuous revetment;
- Restore and reinforce high terraces and berms;
- Raise bypass levees to allow habitat development;
- Raise mainstem levees to allow habitat development;
- Allow habitat development within off-stream storage areas; and
- Create habitat nodes.

Phase II of the Comprehensive Study will continue to expand the public outreach programs, complete model development, formulate and evaluate alternative flood management and ecosystem restoration alternatives, develop programmatic environmental documentation, and identify additional policy and legislative requirements to support implementation. The ecosystem restoration efforts currently contemplated by the Corps' study are consistent with the RCMP and, as applicable, the FISH Plan.

2.0 GOALS AND OBJECTIVES

Defining the goals and objectives of the FISH Plan was the first step in developing this restoration plan. Combined with the Baseline Report, this restoration process can be identified, and restoration projects can be developed.

2.1. DECISION PROCESS

Representatives of approximately 25 organizations voluntarily collaborated to reach agreement, through consensus-based decision-making on the desired outcomes, goals, and objectives for fish and aquatic habitat in the lower American River, as well as recommendations regarding restoration actions and directed research. Attainment of these objectives, however, may require action by organizations in addition to those who have participated in the FWG.

The goals of the FISH Plan focus on enhancing and restoring lower American River fisheries, aquatic, and riparian habitat values. Although ecosystem attributes are included among the objectives under these goals, ecosystem structure, functions, and processes are addressed within the context of the regulated lower American River system. Habitat restoration, in this context, is an effort to improve the health of the river's fisheries and aquatic and riparian habitat, while recognizing fundamental constraints currently present in the system. Although the goals and objectives target enhancing lower American River conditions for the fish species of priority management concern, valuable biotic and abiotic interactions also will be protected through these efforts.

2.2. DESIRED OUTCOMES FOR SPECIES OF PRIORITY MANAGEMENT CONCERN

Several documents were referenced in the development of the desired outcomes, related goals, and objectives for species of priority management concern. The primary documents relied upon were:

- Convening Report for the FISH Working Group (2000);
- CalFed Ecosystem Restoration Program Plan (2000);
- CalFed Lower American River Technical Team Report (1997);
- U.S. Fish and Wildlife Service Anadromous Fish Restoration Program Working Paper on Restoration Needs (1995);
- U.S. Fish and Wildlife Service Final Restoration Plan for the Anadromous Fish Restoration Program (2000);
- California Department of Fish and Game Steelhead Restoration and Management Plan for California (1996);
- Sacramento Area Flood Control Agency Floodway Management Plan for the Lower American River (1998);
- California Department of Fish and Game Restoring Central Valley Streams: A Plan for Action (1993); and
- Habitat Management Element of the Water Forum Agreement (2000).

The desired outcomes, goals, and objectives herein are consistent with those contained in the above documents.

The goals and objectives for each species are based on the stressors that are negatively affecting them, as identified and extensively described in the *Baseline Report*.

2.2.1. INCREASE AND MAINTAIN VIABLE POPULATIONS OF NATURALLY SPAWNING FALL-RUN CHINOOK SALMON AND STEELHEAD

GOALS

To achieve the desired outcomes for fall-run chinook salmon and steelhead, goals were developed based on providing appropriate ecosystem processes and reducing losses for these fish species by lifestage.

- Provide appropriate spawning/incubation habitat quality and quantity.
- Provide appropriate rearing habitat quality and quantity.
- Provide appropriate juvenile outmigration conditions.
- Provide appropriate adult upstream migration conditions.
- Ensure that instream harvest is consistent with maintaining viable instream spawning salmonid populations.
- Ensure hatchery management is consistent with maintaining viable instream spawning salmonid populations.
- Reduce adverse effects of water diversions.

OBJECTIVES

Objectives were established to achieve the goals based on ecosystem attributes and to alleviate the identified stressors. These objectives include:

- Establish diverse and healthy in-channel habitat.
- Optimize seasonal flow management in the river.
- Establish an optimal seasonal temperature regime in the river.
- Ensure adequate water quality.
- Influence geomorphic processes within the floodplain to optimize habitat.
- Reduce the potential for stranding.
- Protect and restore riparian habitat.
- Maintain appropriate harvest management strategies.
- Maintain appropriate hatchery management strategies consistent with hatchery mitigation requirements.
- Reduce losses of juvenile salmon and steelhead due to entrainment and/or impingement at water intake structures.

2.2.2. ACHIEVE AND MAINTAIN A VIABLE POPULATION OF SPLITTAIL

GOALS

To achieve the desired outcomes for splittail, goals were developed based on providing appropriate ecosystem processes and reducing losses by lifestage.

- Provide appropriate spawning and rearing habitat quality and quantity.
- Reduce adverse effects of water diversions.

OBJECTIVES

Objectives were established to achieve the goals based on ecosystem attributes and to alleviate the identified stressors. These objectives include:

- Establish diverse and healthy in-channel habitat.
- Influence geomorphic processes within the floodplain to optimize habitat.
- Reduce the potential for stranding.
- Optimize seasonal flow management within the river.
- Ensure adequate water quality.
- Protect and restore riparian habitat.
- Reduce losses of juvenile splittail due to entrainment and/or impingement at water intake structures.

2.2.3. RESTORE OR MAINTAIN AN APPROPRIATE DISTRIBUTION AND ABUNDANCE OF OTHER NATIVE FISH SPECIES

GOALS

To achieve the desired outcomes for other native fish species, goals were developed based on providing appropriate ecosystem processes and reducing losses for these fish species by lifestage.

- Provide appropriate spawning and rearing habitat quality and quantity for other native fish.
- Reduce adverse effects of water diversions.

OBJECTIVES

Objectives were established to achieve the goals based on ecosystem attributes and to alleviate the identified stressors. These objectives include:

- Establish diverse and healthy in-channel habitat.
- Influence geomorphic processes within the floodplain to optimize habitat.
- Reduce the potential for stranding.
- Optimize seasonal flow management within the river.
- Ensure adequate water quality.
- Protect and restore riparian habitat.

- Reduce losses of other juvenile native fish due to entrainment and/or impingement at water intake structures.

2.2.4. MAINTAIN AMERICAN SHAD AND STRIPED BASS POPULATIONS OF SUFFICIENT ABUNDANCE TO SUSTAIN FISHERIES, CONSISTENT WITH RESTORING NATIVE SPECIES

GOALS

To achieve the desired outcomes for American shad and striped bass populations, goals were developed based on providing appropriate ecosystem processes and reducing losses for these fish species by lifestage.

- Provide appropriate spawning (American shad) and rearing (striped bass) habitat quality and quantity.
- Reduce adverse effects of water diversions.

OBJECTIVES

Objectives were established to achieve the goals based on ecosystem attributes and to alleviate the identified stressors. These objectives include:

- Establish diverse and healthy in-channel habitat.
- Influence geomorphic processes within the floodplain to optimize habitat.
- Reduce the potential for stranding.
- Optimize seasonal flow management within the river.
- Ensure adequate water quality.
- Protect and restore riparian habitat.
- Reduce losses of juvenile American shad, and striped bass due to entrainment and/or impingement at water intake structures.

3.0 CURRENT STATUS OF LOWER AMERICAN RIVER ECOSYSTEM

The *Baseline Report*, described in Chapter 2, provided a foundation upon which to build the FISH Plan. This chapter summarizes and presents the key information presented in the *Baseline Report* regarding the existing condition of the aquatic resources and associated habitats of the lower American River. This information informed development of the conceptual models for how the lower American River ecosystem and related restoration processes function; these processes are described in Chapters 4 and 5. It also informed development of the recommended restoration and management actions found in Chapter 6.

At this time, a number of supplementary analyses are still being conducted which may subsequently be included in the *Baseline Report*. This additional work includes several evaluations to better ascertain the relationships between physical habitat parameters and biological indices related to lifestage history and in-river production of fall-run chinook salmon and steelhead in the lower American River. Results of these analyses will be reflected in revisions in a subsequent draft of the report and, as appropriate, may be used to update this chapter.

1.1. WATERSHED DEVELOPMENT AND MIGRATION BARRIERS

Historically, anadromous salmonids had access to over 125 miles of habitat in the upper reaches of the American River. However, since the early 1900s, access has been impeded by dams constructed for mining debris containment, flood control, and water supply diversions. Many of these dams had inadequate or no fish ladders. In 1950, Old Folsom Dam's fish ladder was destroyed by floods, blocking fish passage upstream of River Mile (RM) 25. Construction of Folsom and Nimbus dams in 1955 permanently blocked upstream passage past RM 23, and reportedly blocked approximately 70 percent of the spawning habitat historically used by chinook salmon, and all of the historic steelhead spawning habitat. Anadromous salmonids are now restricted to the lower 23 miles of the American River extending from Nimbus Dam to the Sacramento River.

1.2. HYDROLOGY

Changes in American River hydrology have dramatically altered the ecology of the lower American River, relative to unimpaired conditions. Flows in the lower American River are now more evenly distributed throughout the year.

Annual peak flows historically occurred in the spring, but now occur in early winter. Historically, summer and early fall months were characterized by very low flows and high water temperatures. Summer flows are higher and water temperatures are presently lower than they were historically. This overall dampening of extremes results from the ability to store runoff and regulate flows, and make selective water temperature withdrawals from the penstock inlet ports at Folsom Dam. Under current hydrologic conditions the lower American River, which

historically was not extensively used by anadromous salmonids for spawning, can support naturally spawning fish populations including fall-run chinook salmon and steelhead.

1.3. GEOMORPHOLOGY

The current geomorphic character of the lower American River has been contoured by its hydrologic history. Gold mining from 1855 to 1884 inundated the river's spawning grounds with an estimated 257 million cubic yards of gravel, sand, silt and debris deposited in the river. Five to 30 feet of gravel, sand, and silt were deposited on the bed of the lower American River, from the present location of Nimbus Dam to the mouth, as a result of hydraulic mining and dredging. The riverbed at the mouth of the river underwent extreme change, as 15 square miles were covered with debris. Since 1955, the lower American River has generally incised down to its previous bed elevation.

While dams block further influx of sediment from upstream areas, banks, points, and bars still serve as sources of stored sediment in the lower American River. Generally, the riverbed is mobilized at flows of about 50,000 cubic feet per second (cfs), although parts of the riverbed remain immobile. Between 1968 and 1986, the lower American River exhibited between 1.1 and 13.9 feet of erosive lateral migration per year. Under the river's current sediment transport and erosive mechanisms, there is no indication that the lower American River will be starved of suitable spawning gravels in key reaches within the near future.

1.4. AQUATIC HABITAT

Geomorphic and hydrologic changes also have impacted the in-stream and riparian habitat of the lower American River. There has been an overall decrease in shaded riverine aquatic (SRA) habitat, a decrease in habitat complexity and diversity, a reduction in woody debris, and an increase in invasive exotic vegetation. The artificial levee system has caused localized bank erosion, incision, and general channelization of the river corridor. Modification of the spring and summer hydrograph from flow regulation has likely affected the potential for cottonwood regeneration. Reduction in the abundance of near-channel cottonwoods has reduced shaded channel surface. Large woody debris is noticeably deficient in many stretches of the lower American River, particularly in upstream areas. Generally, shoreline habitat has undergone a trend toward simplification.

1.5. FISH

Although development in the watershed has drastically and permanently transformed the lower American River ecosystem, the river still supports a very diverse and relatively prolific array of fish species. The lower American River supports approximately 43 species of native and nonnative fish, including several anadromous species. Two species of anadromous salmonids inhabit the lower American River: fall-run chinook salmon and steelhead.

3.1.1. CHINOOK SALMON

With over 125 miles of accessible riverine habitat, the lower American River historically supported spring- and fall-run chinook salmon. Spring-run chinook salmon typically entered the American River from May through July, and fall-run entered the river from September through December. By 1955, it is believed that spring-run chinook salmon had been extirpated from the American River.

It has been estimated that the American River historically may have supported runs exceeding 100,000 chinook salmon annually. Population numbers fell during the 1944-1955 period primarily due to migration barriers and habitat blockage, increasing agricultural diversions, acid drainage from hard rock mining, and over-fishing. Since 1955, chinook salmon populations have been augmented by hatchery operations.

Fall-run chinook salmon, a candidate species under the federal Endangered Species Act, has been the dominant run of chinook salmon in the lower American River since the 1940s. One goal of the 1992 Central Valley Project Improvement Act is to double (from the 1967-1991 baseline period) the natural production of anadromous salmonids in the Central Valley, including the lower American River. The doubling goal takes into account numerous factors including commercial and sport harvest. Nonetheless, for comparative purposes, from 1967 through 1991estimated annual in-river adult chinook salmon escapement averaged 32,307 fish, whereas estimated annual escapement has averaged 41,933 fish from 1992 through 1999. Remarkably, the preliminary estimate for this year's (fall 2000) spawning escapement exceeds 100,000 fish.

Since construction and operation of the Nimbus Hatchery began in 1955, lower American River chinook salmon runs have generally increased. Hatchery practices implemented to increase survival have contributed to this increase. A majority of the total annual spawning run was estimated to be comprised of hatchery-reared fish, based on coded-wire tagging studies conducted from 1978 to 1984. However, since the hatchery tagging experiments conducted from 1978 to 1984, no constant marking programs have been implemented in Central Valley hatcheries. The result is a lack of sufficient data to directly determine the current contribution of hatchery-reared fish to the total lower American River spawning population.

Water temperature affects fish behavior. Adult chinook salmon migrate up the Sacramento-San Joaquin Delta and into the lower American River generally from July to January. Spawning extends from as early as the beginning of October to January, and peak spawning typically occurs from mid to late-November. The timing of fall-run chinook salmon spawning is responsive to temperature changes in the lower American River, which are affected by changes in Folsom Dam shutter configuration and cold water pool management. Initiation of spawning can vary by one month or more (early October to mid-November), depending on the prevailing water temperature regime. Relatively high water temperatures at the beginning of the fall-run chinook salmon spawning season can delay the onset of spawning in many years. Spawning typically does not occur until mean daily water temperatures decrease to about 60°F. Also, Nimbus Hatchery data suggest that percent egg fertilization rapidly increases when daily median temperatures decline below 60°F. In the last ten years, mean daily water temperatures at or below 60°F in the upper reaches of the lower American River have typically not occurred until the end of the first week of November.

Spawning distribution (timing and location) also is influenced by flow conditions. Habitat availability and utilization are inversely related to, and directly affected by, flow conditions. Also, low flows are associated with an increase in redd superimposition.

Most (about 95 percent) of the spawning occurs in the upper eight miles of the lower American River (Ancil Hoffman Park area to the base of Nimbus Dam). The lowermost nine river miles downstream of Watt Avenue supports relatively little spawning. For successful salmonid incubation, spawning gravels must be sufficiently free of fines, and have sufficient intra-gravel flow to maintain adequate dissolved oxygen levels. Fall-run chinook salmon have a high selectivity for bar-complex run and flat-water glide habitats for spawning, depending on the flow conditions. Intragravel permeability appears to strongly influence spawning site selection.

Several environmental conditions influence the in-stream production of fall-run chinook salmon in the lower American River. Flow, water temperature, substrate, and cover are believed to be the most important of those factors. Flow and water temperature have been identified as particularly critical factors.

Juvenile fall-run chinook salmon require varying habitats at different developmental stages and time periods during their in-river residence period. Juvenile chinook salmon tend to aggregate in areas of moderate current and some cover in the form of large substrate or surface turbulence. Apparent trends in habitat use suggest that backwaters, runs, and glides contain the majority of juvenile fall-run chinook salmon early, when the fish are small. Riffles typically contain the smallest number of individuals, but the largest average size of juvenile fall-run chinook salmon.

Results of the last nine years (1992 through 2000) of seining and emigration surveys on the lower American River indicate that juvenile survival to emigration may be inversely related to January flow conditions. Also, fluctuating flow causes stranding in certain areas, but the magnitude of the impact on the population is still under investigation. Peak emigration was not found to be associated with peak flows.

Water temperature may directly contribute to the triggering of seaward migration. Water temperature moderates emigration timing by controlling the rate of growth and physiologic development of juvenile salmonids. However, most fall-run chinook salmon emigrate from the lower American River as post-emergent fry and, therefore, require additional growth and development after leaving the lower American River before entering the ocean if they are to attain a size conducive to survival to adulthood. Emigration timing varies from year to year but primarily occurs between late December and April. The timing of juvenile chinook salmon emigration in recent years is comparable to that observed during 1988 and 1989, but is much earlier than that observed during 1945 through 1947 period. The relatively early emergence and emigration currently observed in the lower American River is likely a result of the temperature-moderating effect of Folsom and Natoma lakes, or resulting from the different runs of chinook salmon that historically spawned upstream in the American River Basin.

As with other populations of fall-run chinook salmon in the Central Valley, fall-run chinook salmon of the lower American River have been subjected to increasing ocean harvest rates over the years. However, the ocean harvest index has dropped from more than 70% from 1985 through 1995, to near 50% in the past few years. This trend, if it continues, may contribute to

increases in the number of chinook salmon returning to Central Valley streams, including the American River.

3.1.2. STEELHEAD

The lower American River originally supported summer-, fall-, and winter-run steelhead. Summer-run steelhead typically entered the river between May and July, fall-run between September and November, and winter-run between December and April. All steelhead spawning occurred upstream of what is now the Nimbus Dam site. By 1955, it is believed that summer-run steelhead had been extirpated from the American River and only remnant populations of the fall- and winter-run steelhead remained.

Central Valley steelhead are listed as threatened under the federal Endangered Species Act, and their Evolutionarily Significant Unit (ESU) encompasses the lower American River. From 1956 through the late 1980s, the Nimbus Hatchery has propagated eggs of steelhead strains from other locations in California and Washington, planting the fry into the lower American River. Phenotypic expression of steelhead in the lower American River most closely resembles that of the historic winter-run strain of American River steelhead, as well as the Eel River strain of winter-run steelhead.

Natural production of steelhead in the American River will continue to be limited due to inaccessibility of the headwaters. The proportion of hatchery origin fish spawning in the river remains uncertain. It is known, however, that the vast majority of the steelhead returning to the hatchery is of hatchery origin.

Adult steelhead spawn primarily in the upper portion of the lower American River above RM 16. Steelhead use the upper portion of the river for spawning to a similar extent as fall-run chinook salmon. However, some steelhead spawning has been observed below Paradise Beach (RM 5), which is not observed for fall-run chinook salmon. Adult steelhead appear to prefer flat-water glide habitat for spawning.

Flow and temperature conditions affect the lifestage periodicity of lower American River steelhead. Cooler water temperatures upstream during the spring may be responsible for later steelhead emergence in upstream locations relative to downstream locations. Also, smaller average fish size in the uppermost reaches of the lower American River after March may indicate later spawning, slower developmental rates, and later and protracted emergence due to longitudinal temperature differences.

Young-of-the-year steelhead (YOY) begin appearing in rotary screw traps at the earliest in mid-January (1997) but more typically in mid-March. Steelhead YOY begin appearing in seining surveys, however, typically before mid-March. The earlier appearance of YOY in seining surveys suggests that emergence and emigration are not necessarily coincident. Despite rotary screw trap catches of YOY, it appears that few steelhead, if any, actively emigrate as YOY.

Yearling steelhead typically appear in the rotary screw traps during the winter prior to March, somewhat earlier than YOY. The presence of apparent in-river produced yearling fish in February and March strongly suggest some over-summer survival, but the origin of these fish is uncertain. Furthermore, the presence of YOY steelhead in October indicates over-summer

survival. Yearling fish catches in the fall and winter may indicate, however, that YOY steelhead spend summers outside of the lower American River and return during late fall and winter.

Summer water temperature appears to be the most important stressor affecting steelhead, because steelhead rear throughout the year in the lower American River. Summer water temperatures frequently exceed those reported as suitable for juvenile steelhead rearing.

Early YOY rearing occurs primarily in upstream areas of the lower American River, proximate to spawning areas. By late summer, young-of-the-year steelhead are distributed throughout the lower American River and exhibit site fidelity. Limited mark and recapture evaluations of juvenile steelhead collected by seining in the lower American River since 1996 indicate that juveniles tend to occupy specific habitats throughout the summer. Yearling steelhead are found in bar complex and side channel areas characterized by habitat complexity in the form of velocity shelters, hydraulic roughness elements, and other forms of cover. Larger fish typically inhabit fast-water areas such as riffles.

1.6. WATER QUALITY

Current water quality does not appear to be a major stressor affecting fish populations in the lower American River. In general, ambient water quality characteristics meet applicable regulatory standards. Occasional exceedances for toxicity, selected heavy metals, coliform, chlorpyrifos, and diazinon exist, however. Generally, concentrations of contaminants increase downstream from Nimbus Dam to Discovery Park.

Groundwater contamination exists below the lower American River. The highest concentrations and widest distribution of chemicals are found within the middle of the three aquifers lying below the lower American River. Concentrations of TCE (trichloroethylene) also are found in the upper aquifer bordering the lower American River. However, Aerojet groundwater contamination, at present, does not appear to pose a water quality threat to fish resources in the lower American River.

1.7. CONCLUSIONS

The *Baseline Report* provided the basis for prioritizing opportunities for restoration in the lower American River. The *Baseline Report* established that flow and temperature improvements have the greatest potential for restoration with respect to the fish of primary management concern. As a result, the most immediate opportunities that exist for fish habitat improvement involve hydrologic systems operations and management actions. Manipulating 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. Within the hydrologic and regulatory constraints inherent in attempting to manage the American River Basin water supply, opportunities for physical fish restoration actions also exist. The FISH Plan is the mechanism for investigating and pursuing these opportunities, using the *Baseline Report* as an information baseline.

4.0 CONCEPTUAL MODELS OF LOWER AMERICAN RIVER ECOSYSTEM STRUCTURES, FUNCTIONS, AND PROCESSES

The conceptual models and hypotheses presented in this chapter are based on the status of aquatic species and habitat within the lower American River ecosystem, as summarized in Chapter 3. Background information on the aquatic species of priority management concern, their use and need of habitat types, physical processes, and ecosystem functions provided the foundation for identifying the stressors affecting these fish species. In this chapter, conceptual models are presented that incorporate our knowledge of the stressors to fall-run chinook salmon, steelhead, and splittail, by lifestage, as well as the corresponding hypotheses. As discussed in Chapter 2, although species of priority management concern also include other native fish and the non-native American shad and striped bass, federal ESA and CESA species listings (and candidate listings) direct a management focus upon fall-run chinook salmon, steelhead, and splittail in the lower American River. In addition, although the focus of this report is on these three species, restoration priorities will be based on ecosystem-based management. Ecosystem-based management achieves species management objectives by sustaining and enhancing the fundamental ecological structures and processes that contribute to the well-being of the species. Improving conditions for these three species, therefore, also will generally provide suitable conditions for other native fish species, and for American shad and striped bass.

1.1. IDENTIFICATION OF STRESSORS AND INTERCONNECTIONS WITHIN THE LOWER AMERICAN RIVER ECOSYSTEM

Conceptual models were developed that depict the lifestage cycle of fall-run chinook salmon, steelhead, and splittail, their use of lower American River reaches by lifestage, and the temporal and geographic distribution corresponding to each stressor. Key stressors that were identified in the draft *Baseline Report* are presented here with an attempt to define the linkages/relationships between the stressors and species responses (e.g., high water temperatures delay the onset of fall-run chinook salmon spawning).

The conceptual models describe the causal interconnections among key ecosystem components, demonstrating how physical and biotic system components respond to stressors. Using the information gained in the *Baseline Report*, the conceptual models consider the environmental (e.g., water temperature), ecological (e.g., food availability, predation by non-native species), physical (e.g., barriers), hydrologic (e.g., flow) and geomorphic (e.g., channel structure) factors that affect the various lifestages of fish species of priority management concern in the lower American River. Expected seasonal variations are included in the above factors as a component in the models.

The temporal and geographic distribution of lifestage activities and stressors presented are a general characterization based on information presented in the lower American River *Baseline Report*. Specific distributions for any particular year depend on many factors that vary each year. The ranges shown encompass what was found to be typical, or normal ranges for each activity based on available knowledge.

4.1.1. FALL-RUN CHINOOK SALMON

Figure 4-1 is a conceptual model of the lifecycle of lower American River fall-run chinook salmon. The model displays the temporal distribution of each lifestage activity, and provides a brief description of the activities that characterize each lifestage. This model was informed by the lower American River *Baseline Report* and represents the best available knowledge of the lifestage periodicity of lower American River fall-run chinook salmon.

Conceptual models are subsequently presented which identify the stressors associated with each lifestage activity, with respect to river conditions. In these models, the temporal and geographic distribution of each individual stressor is identified. Figure 4-1 includes the adult bay entry and estuarine migration, juvenile estuarine residence and maturation, and smolt ocean entry and maturation lifestages. However, conceptual models of stressors which do not take place in the lower American River are not presented.

Fall-run chinook salmon reside in the Pacific Ocean from one to four years, but most often from two to three years, prior to returning as adults to spawn in the lower American River. Many natural ocean processes (e.g., El Niño/La Niña, distribution fronts and gyres, global warming) may affect the success of maturing fish to feed and grow, compete with other species or escape predation, resulting in periodic changes in natural mortality during the 1 to 4 years of ocean life. High oceanic natural mortality, particularly when combined with high harvest rates, affects the number of adults returning to spawn in the lower American River annually. Because the Pacific Ocean and Bay-Delta are outside of the scope of the FISH Plan for the lower American River, no conceptual model is presented for out-of-basin stressors.

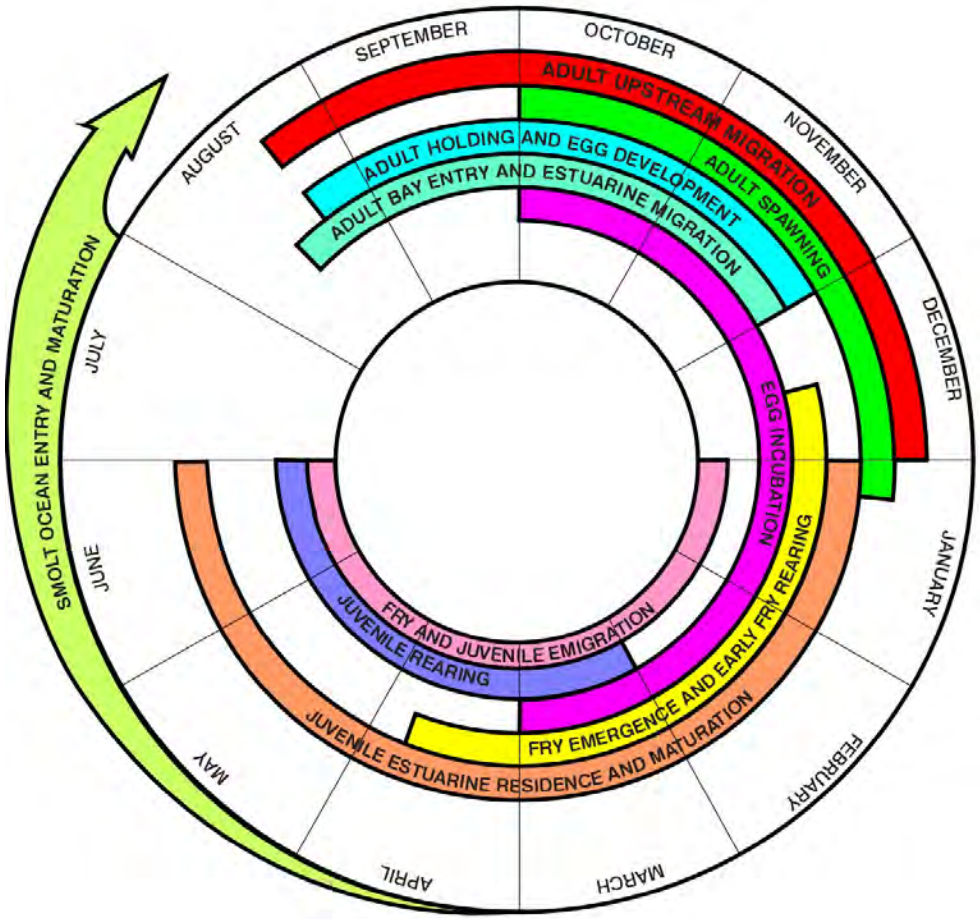
ADULT UPSTREAM MIGRATION

In the lower American River, the only stressor identified for adult fall-run chinook salmon upstream migration is high water temperature (**Figure 4-2**).

High Water Temperature

Adult fall-run chinook salmon generally migrate through the lower American River from late August through December. Water temperatures during late summer and fall are largely controlled by the operations of Folsom and Nimbus dams. Although migrating adults have been observed to tolerate short-term exposure to water temperatures from 77°F to 80°F, water temperatures over 65°F in the lower reaches of the Sacramento River and along the migration corridor of the lower American River (RM 0 to 5) may deter or delay upstream migration, resulting in late and less successful spawning, incubation and emergence (e.g., decreased fertilization, increased egg retention, reduced embryo viability, presence of abnormalities in the emergent fry).

Figure 4-1. American River fall-run chinook salmon life cycle.



Adult Bay Entry and Estuarine Migration

Adults enter the San Francisco Bay and swim up the Delta to the mouth of the lower American River.

Adult Upstream Migration

Adults enter the lower American River and select spawning sites.

Adult Holding and Egg Development

Early arriving adults hold for up to a month until ripe and/or until water temperatures decline to suitable levels.

Adult Spawning

Females find suitable gravels, make a nest (redd), and fill the nest with eggs. Males fertilize the eggs. Females guard nest for up to 2 weeks, then both males and females die.

Egg Incubation

Eggs incubate for 50 to 100 days before hatching, depending on water temperature regime.

Fry Emergence and Early Fry Rearing

Yolk sac fry emerge from the gravel and seek low-velocity shoreline habitat.

Juvenile Rearing

Some fry, particularly those emerging after March, rear to parr size in the river before emigrating in May and June.

Fry and Juvenile Emigration

Most young fish leave the river as post-emergent fry within a few weeks after emergence. Some young fish rear and grow during winter and spring, and emigrate from the river as smolts.

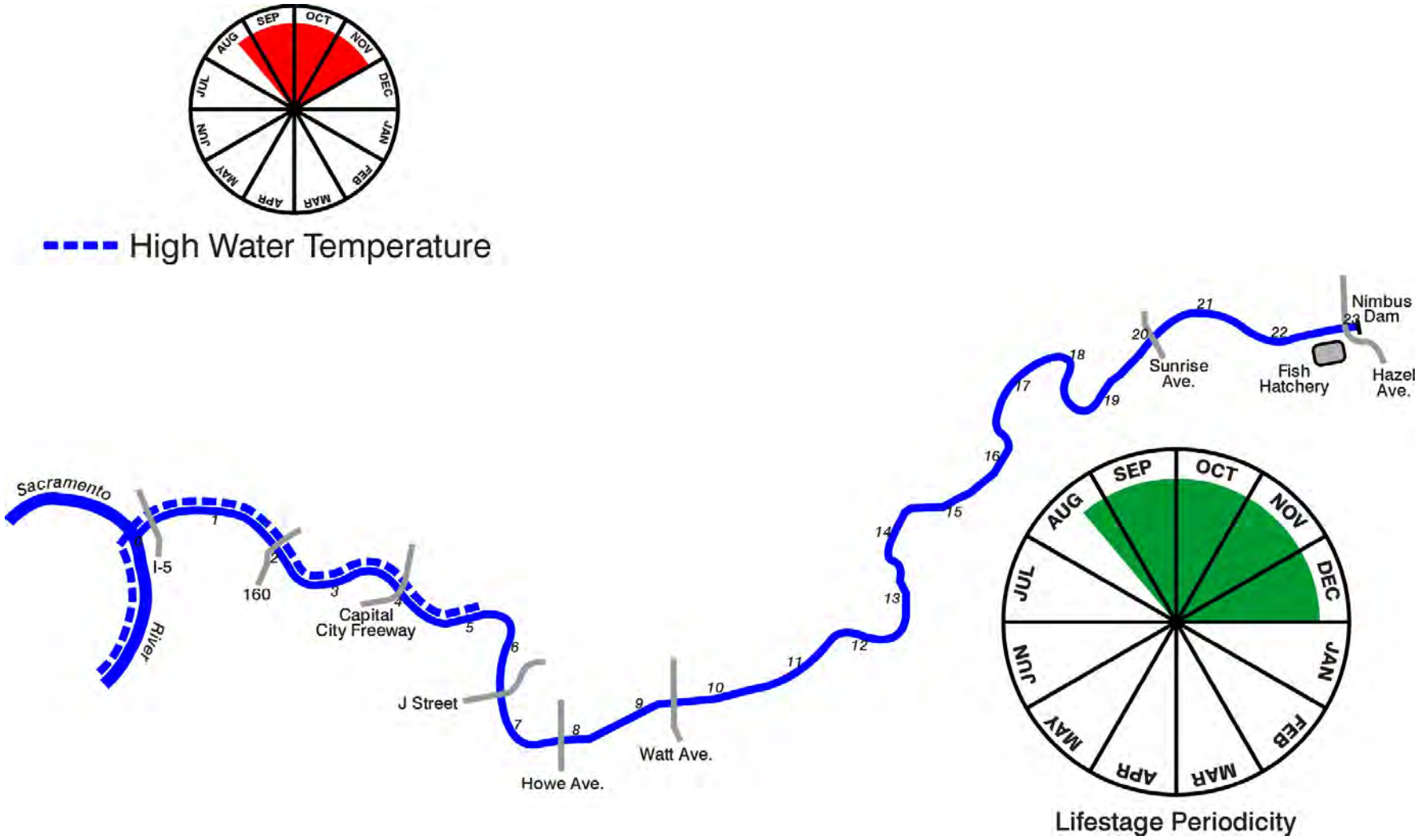
Juvenile Estuarine Residence and Maturation

Juveniles of all sizes progress through the Delta, growing and maturing prior to ocean entry.

Smolt Ocean Entry and Maturation

Smolts enter the ocean and grow to adulthood from 1 to 4 years, typically 2 years.

Figure 4-2. Adult fall-run chinook salmon upstream migration, and temporal and geographic distribution of potential stressors.



ADULT HOLDING AND EGG DEVELOPMENT

In the lower American River, the egg stressor identified to adult holding and egg development is high water temperature (**Figure 4-3**). The geographic distribution presented corresponds to the entire reach of the river encompassing spawning locations.

High Water Temperature

Although pre-spawning adults have been observed to tolerate short-term exposures to temperatures from 77ºF to 80ºF during migration, extended exposures to high water temperatures can cause decreased egg fertilization, increased egg retention, reduced embryo viability, and presence of abnormalities in the emergent fry.

ADULT SPAWNING

Identified below and in **Figure 4-4** are the stressors associated with fall-run chinook salmon adult spawning. The geographic distribution of the stressors to the spawning lifestage corresponds to spawning site locations. Note that low gravel permeability may be a stressor throughout the primary spawning grounds.

High Water Temperature

Fall-run chinook salmon do not initiate spawning until water temperatures in the primary spawning grounds (RM 9.3 to RM 22.9) decrease to about 60ºF (*Baseline Report*, Figure 2-19). Moreover, it is known that exposure to elevated water temperatures upon entering the river prior to spawning may result in fatty acids being sequestered from the ova, resulting in an improper embryo development under the declining fall water temperatures (*Baseline Report*, p. 2-41).

Low Substrate Permeability

As result of a 1994 CDFG quantitative evaluation of spawning habitat, intra-gravel permeability was identified as the main physical attribute that differentiates habitat currently used for spawning from apparently suitable habitat that remains unused (*Baseline Report*, p. 2-57). Gravel size alone does not appear to explain the fall-run chinook salmon female's choice of a particular site to build its nest (redd). High gravel permeability would allow intra-gravel flows, permitting sufficient cleansing and dissolved oxygen for successful egg incubation.

Low Flow Rate

Although substrate composition is an important factor in spawning site selection, flow rate directly influences physical spawning habitat availability. Low flows and, therefore, low physical spawning habitat availability may limit the number of adults which can spawn, and may result in increased egg retention. Moreover, flow rate influences the potential for redd superimposition, with greater imposition occurring at lower flows.

Figure 4-3. Adult fall-run chinook salmon holding and egg development, and temporal and geographic distribution of potential stressors.

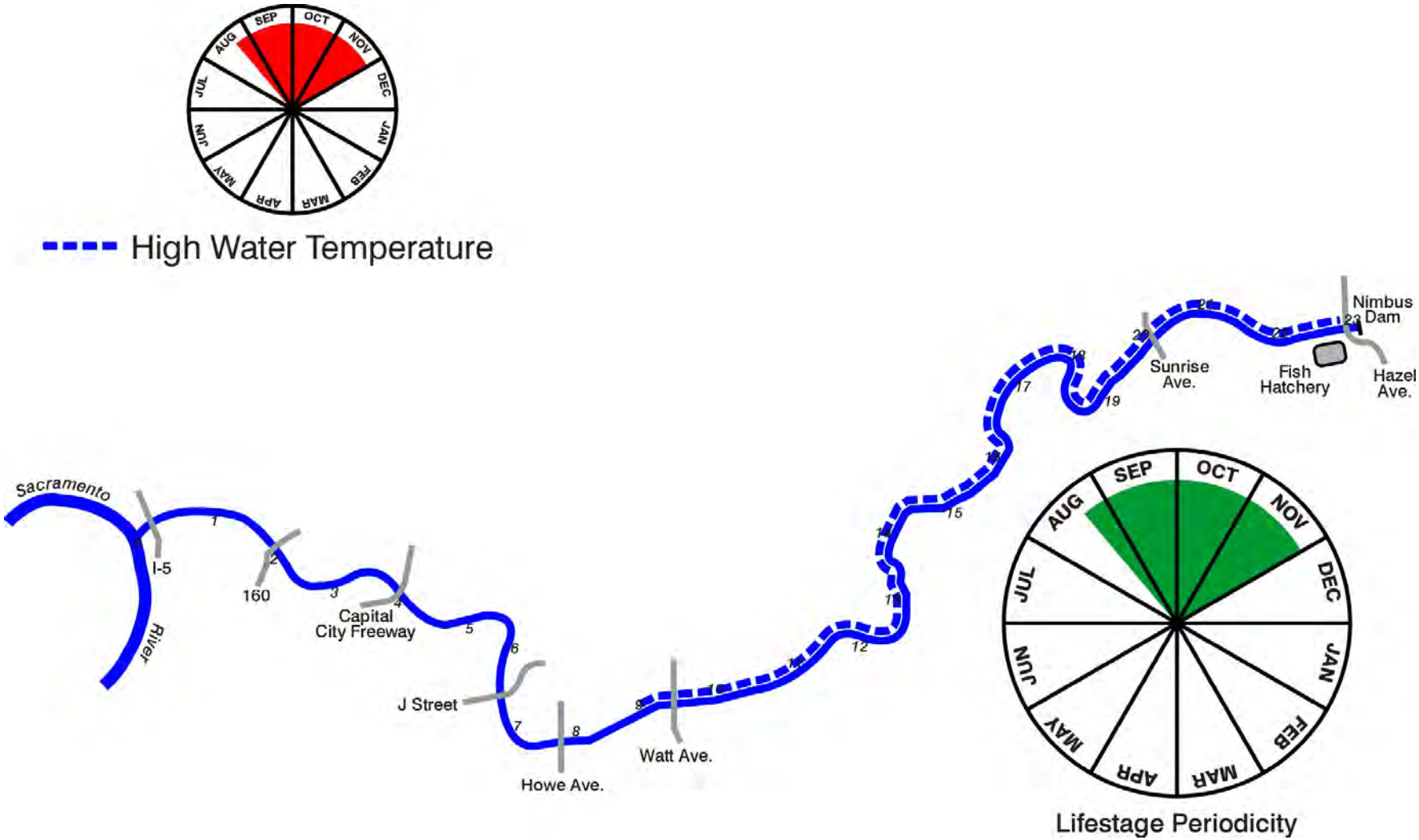
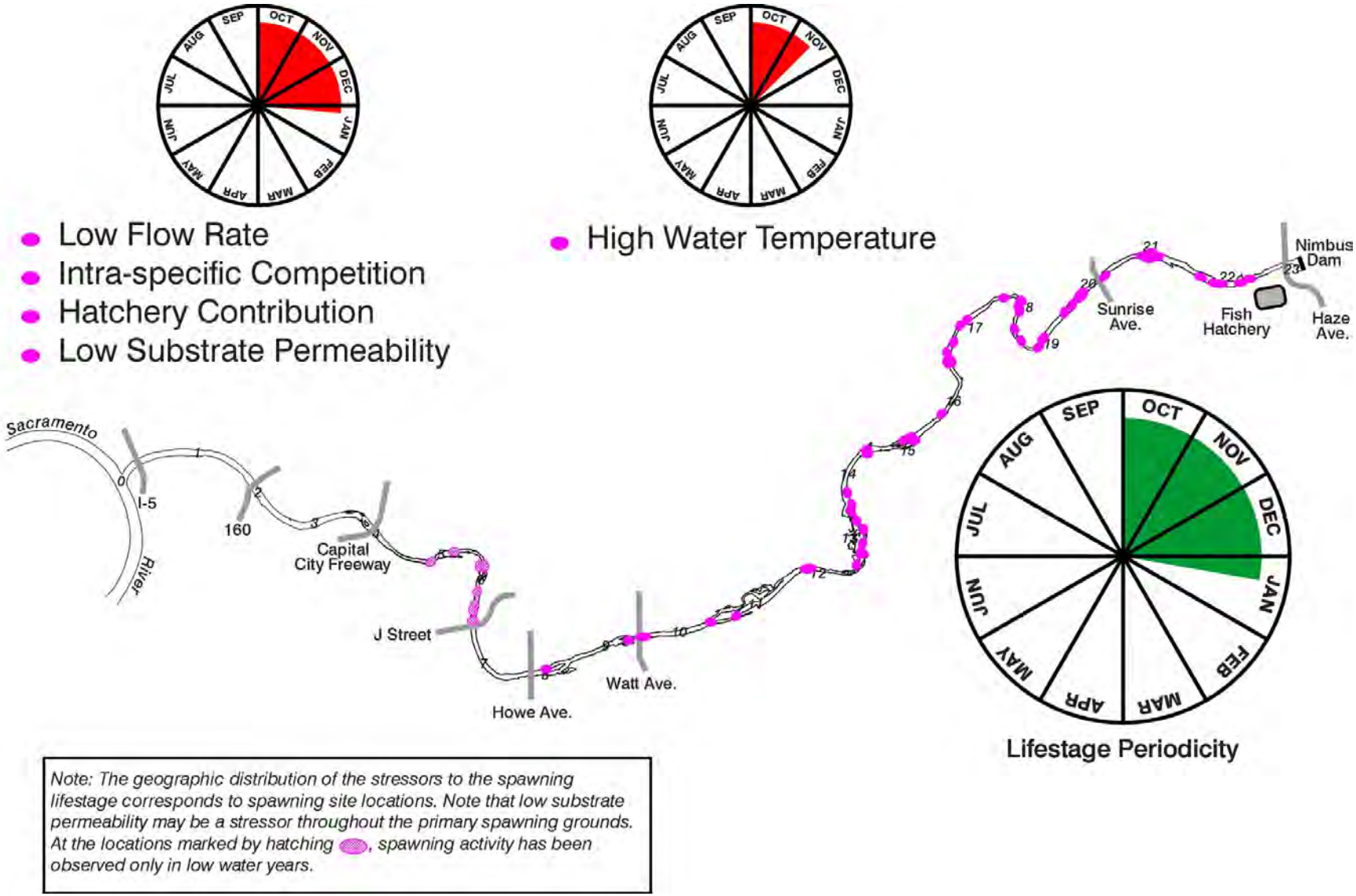


Figure 4-4. Adult fall-run chinook salmon spawning, and temporal and geographic distribution of potential stressors.



Intra-Specific Competition

When physical spawning habitat availability is limited, the incidence of redd superimposition increases. Spawning habitat availability is associated with flow rate.

Hatchery Contribution

It presently is unknown what proportion of the annual number of adults spawning in the river is composed of hatchery-origin fish. It has been suggested, however, that the majority of in-river fall-run chinook salmon spawners are of hatchery origin. Currently, it is uncertain to what extent hatchery-origin fish compete with naturally spawned fish for available habitat. A second concern is that hatchery practices have decreased the genetic diversity of the population of fall-run chinook salmon spawning in the lower American River.

EGG INCUBATION

Identified below and in **Figure 4-5** are the stressors associated with fall-run chinook salmon egg incubation. The geographic distribution of the stressors to the egg incubation lifestage corresponds to spawning site locations.

High Water Temperature

Laboratory studies performed on incubating chinook salmon eggs from Sacramento and American River stocks, often under constant water temperatures, have indicated that high water temperatures during egg incubation increases egg mortality (see *Baseline Report*, Appendix B). For example, constant incubation temperatures over 62ºF and below 38ºF reportedly may result in 100 percent egg mortality (Hinze 1959). Moreover, high water temperatures appear to increase the incidence of abnormal embryo development and the rate of embryo development. An increase in the rate of embryo development shortens the incubation period, leading to an altered schedule of subsequent life stages.

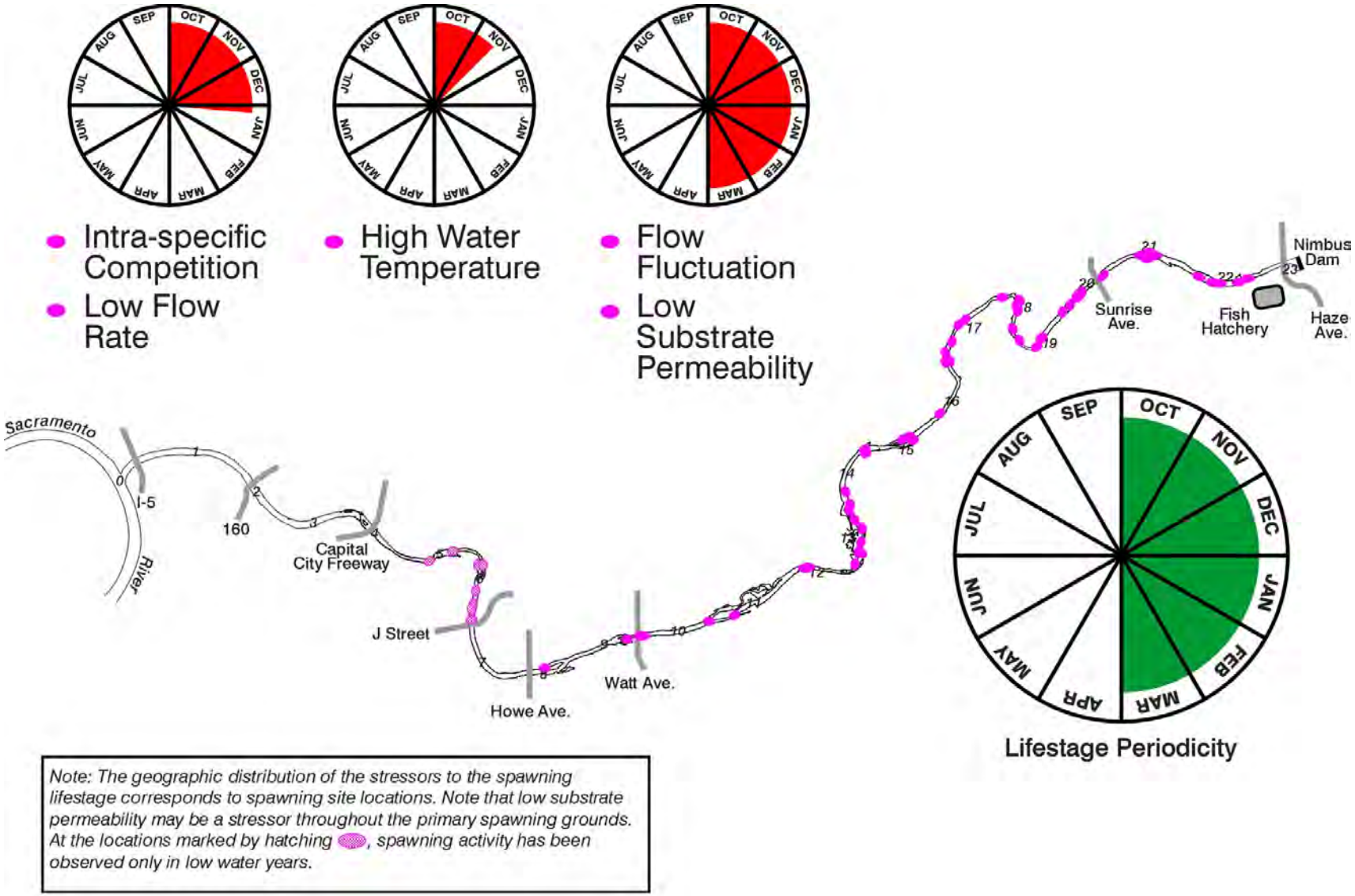
Low Substrate Permeability

For a successful incubation, gravel must be sufficiently free of fine sediment to allow water to flow through it and bring dissolved oxygen to the eggs and carry off metabolic wastes (*Baseline Report*, p. 2-66). Consequently, intra-gravel permeability must be high to allow a successful incubation. When suitable spawning gravel is limited, redds may be built on gravel with less than suitable intra-gravel permeability, reducing the egg survivability.

Flow Fluctuations

Flow reductions can expose redds to the atmosphere, causing desiccation (i.e., redd dewatering) and egg mortality (*Baseline Report*, p. 2-58 to 2-60).

Figure 4-5. Fall-run chinook salmon egg incubation, and temporal and geographic distribution of potential stressors.



Intra-Specific Competition

As mentioned earlier, one indication of limited habitat for spawning salmon is the degree of redd superimposition. When superimposition occurs, a newly arrived spawning female builds a new redd on top of an existing one, by digging up the existing redd (*Baseline Report*, p. 2-57). This digging process reduces egg survival.

FRY EMERGENCE AND EARLY FRY REARING

Identified below and in **Figure 4-6** are the stressors associated with fall-run chinook salmon fry emergence and early fry rearing, and the lower American River reach to which each stressor corresponds.

Reduced Habitat Complexity and Diversity

After emergence, fry seek low velocity areas near shore (Briggs 1954; Brown et al., 1991; *Baseline Report*, p. 2-77 to 2-78). The preponderance of rip-rap downstream of Howe Avenue has resulted in a decrease in habitat complexity and diversity.

Low Flow Rate

Flow rate directly affects rearing physical habitat availability in the river channel. Low flow rates also may reduce accessibility of nearshore habitat characterized by habitat complexity and diversity in the form of large woody debris and SRA cover. Also, during spring, flow rate is related to water temperature and low flow rates are often associated with warmer water temperatures.

Flow Fluctuations

Large fluctuations in flow risk stranding fry near the river edges and in shallow pools which, in turn, may affect the size of the emigrating population (*Baseline Report*, p. 2-78).

Flood Flows

Flood flows can be deleterious to recently emerged young fry; mortality may result from physical injury, stranding, or displacement and subsequent predation.

FRY AND JUVENILE EMIGRATION

Identified below and in **Figure 4-7** are the stressors associated with fall-run chinook salmon fry and juvenile emigration, and the lower American River reach to which each stressor corresponds. Juveniles emigrating from the lower American River when Delta conditions are least favorable for juvenile chinook salmon can severely reduce the survival rate for those fish. Changing diversion practices, temperature conditions, and flow conditions in the Delta can affect survival of emigrating juvenile chinook salmon.

Figure 4-6. Fall-run chinook salmon fry emergence and early fry rearing, and temporal and geographic distribution of potential stressors.

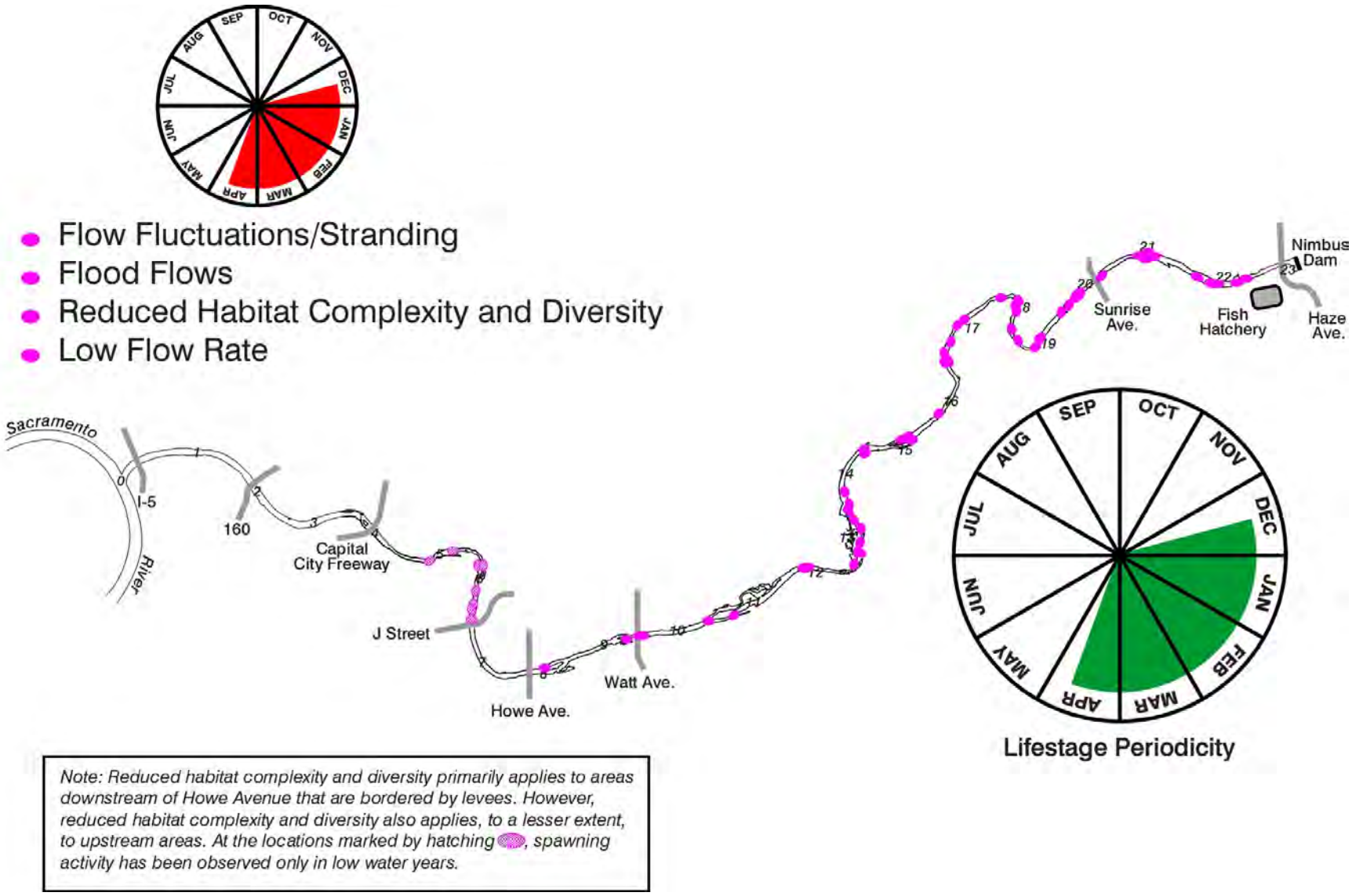
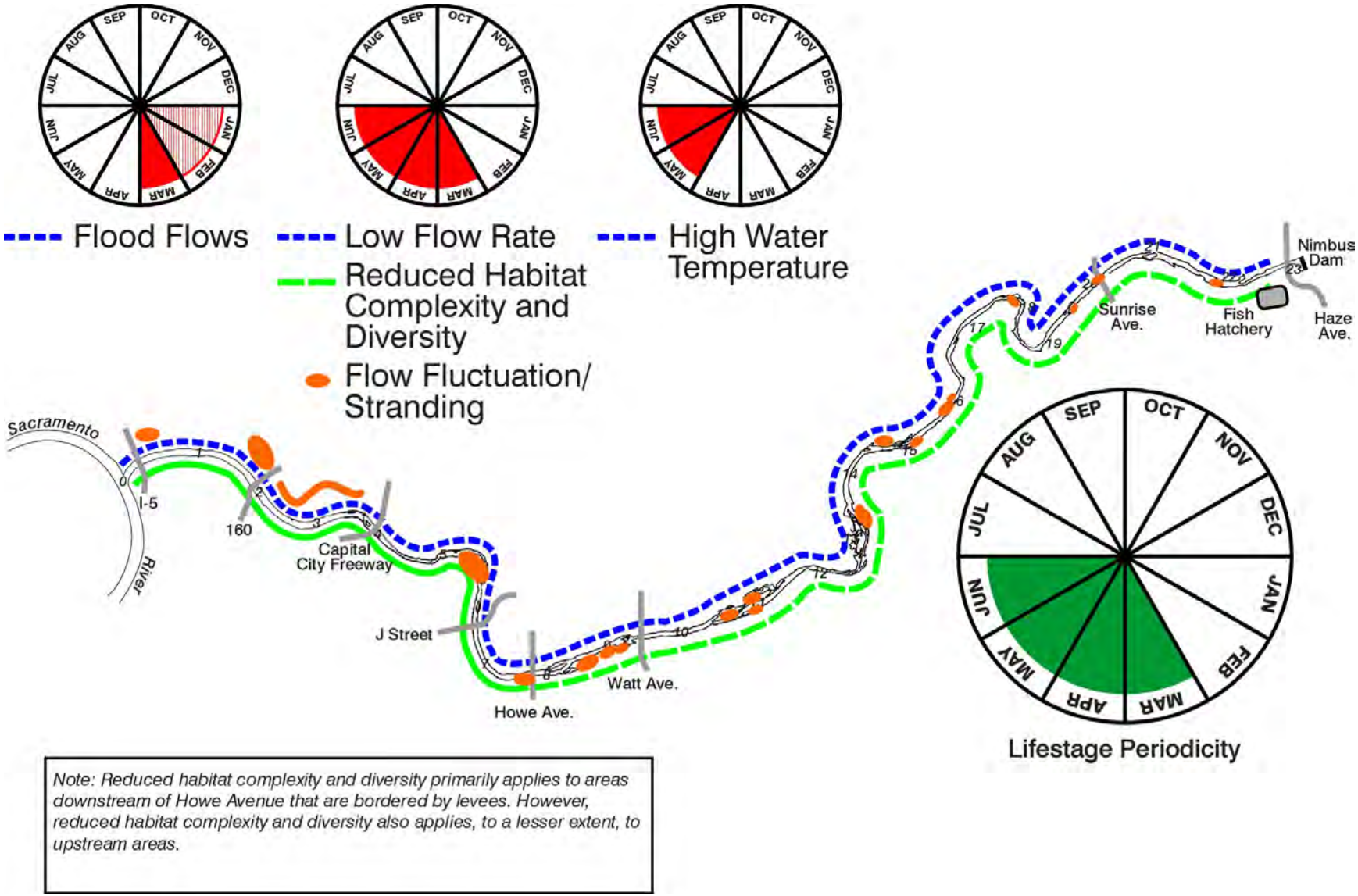


Figure 4-7. Fall-run chinook salmon juvenile rearing, and temporal and geographic distribution of potential stressors.



Note: Reduced habitat complexity and diversity primarily applies to areas downstream of Howe Avenue that are bordered by levees. However, reduced habitat complexity and diversity also applies, to a lesser extent, to upstream areas.

High Water Temperature (RM 9.5 to 23)

Elevated spring water temperature is one factor suspected of influencing downstream migration of juvenile fall-run chinook salmon. Water temperatures that are too high, too early in the spring may prematurely evacuate salmon from the river. Water temperature during the spawning and incubation stages also affects the emigration timing of fry and juveniles. High temperatures accelerate spawning and incubation periods, contributing to early emigration and a reduction in emigration survival (*Baseline Report*, p. 2-89).

Flow Fluctuations

Large fluctuations in flow risk stranding emigrating fry and juveniles near the river edges and in shallow pools (*Baseline Report*, p. 2-78), which, in turn, may affect the size of the emigrating population.

Reduced Habitat Complexity and Diversity

After emergence, fry seek low velocity areas near shore. As they grow, juvenile fall-run chinook salmon seek faster moving water and harbor around channel obstructions (*Baseline Report*, p. 2-77 to 2-78). The stream channel has simplified due to channel constriction, levee construction, rip-rapping of the shoreline, removal of woody debris, and has resulted in reduced fry and juvenile habitat quality.

SRA cover consists of instream object cover and overhanging cover. Instream object cover provides structure which promotes hydraulic diversity and microhabitats for juvenile salmonids, as well as escape cover from predators. Overhanging cover provides localized shading and potential reduction in surface water temperatures, and also may serve as a food source of terrestrial insects.

JUVENILE REARING

Identified below and in **Figure 4-8** are the stressors associated with fall-run chinook salmon juvenile river rearing, and the lower American River reach to which each stressor corresponds.

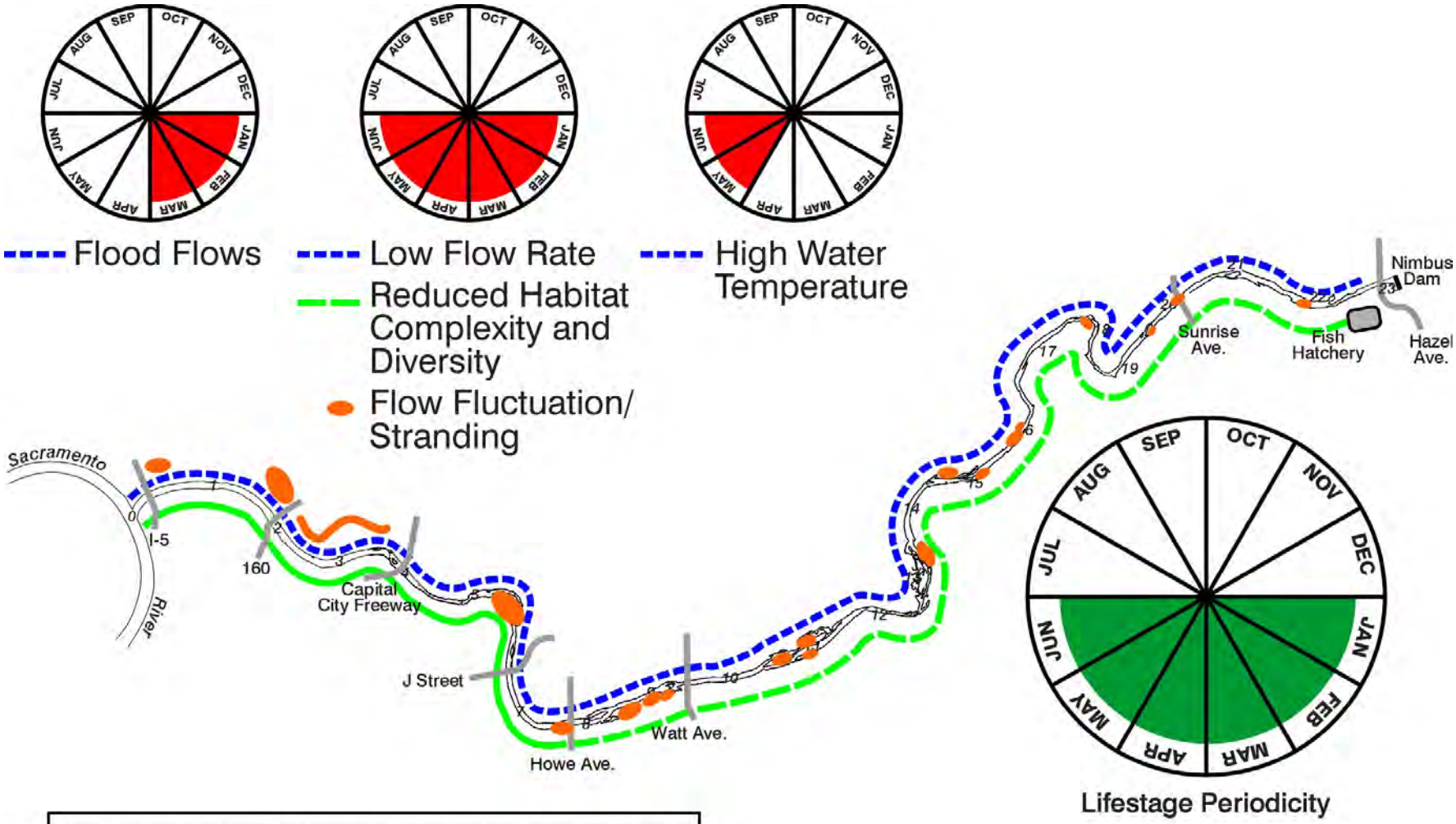
High Water Temperature

High water temperatures negatively impact the health, behavior and survival of rearing juvenile chinook salmon (*Baseline Report*, p. 2-83). With high water temperatures, the level of predation and the risk of disease affecting rearing juvenile chinook salmon are increased. Direct effects to the fish physiologic function also can lead to increases in mortality (see explanation for Post Emergent Fry and Juvenile River Emigration).

Low Flow Rate

See explanation for Fry Emergence and Early Fry Rearing and Fry and Juvenile Emigration.

Figure 4-8. Fall-run chinook salmon fry and juvenile emigration, and temporal and geographic distribution of potential stressors.



Note: Reduced habitat complexity and diversity primarily applies to areas downstream of Howe Avenue that are bordered by levees. However, reduced habitat complexity and diversity also applies, to a lesser extent, to upstream areas.

Flow Fluctuation

Large fluctuations in flow risk stranding emigrating fry and juveniles near the river edges and in shallow pools (*Baseline Report*, p. 2-78), which, in turn, may affect the size of the emigrating population.

Reduced Habitat Complexity and Diversity

See explanation for Fry Emergence and Early Fry Rearing and Fry and Juvenile Emigration.

4.1.2. STEELHEAD

Figure 4-9 is a conceptual model of the lifecycle of lower American River steelhead. The model displays the temporal distribution of each lifestage activity, and gives a brief description of the activities that characterize each lifestage. This model was informed by the lower American River *Baseline Report* and represents the best available knowledge of the lifestage periodicity of lower American River steelhead.

Conceptual models are subsequently presented which identify the stressors associated with each lifestage activity, with respect to river conditions. In these models, the temporal and geographic distribution of each individual stressor is identified. Conceptual models of stressors which do not take place in the lower American River are not presented.

ADULT SPAWNING AND EGG INCUBATION

Identified below and in **Figure 4-10** are the stressors associated with steelhead adult spawning and egg incubation. The geographic distribution of the stressors to the spawning and egg incubation lifestages corresponds to spawning site locations. Note that substrate composition and permeability may be a stressor throughout the primary spawning grounds.

High Water Temperature

Water temperatures exceeding those reported for successful spawning and egg incubation can occur as early as mid-April in the lower American River.

Substrate Composition and Permeability

Substrate size, particularly in the upper reaches of the lower American River, may exceed that which is commonly reported for steelhead spawning. Also, as result of a 1994 CDFG quantitative evaluation of fall-run chinook salmon spawning habitat, intra-gravel permeability was identified as the main physical attribute that differentiates habitat currently used for spawning from apparently suitable habitat that remains unused (*Baseline Report*, p. 2-57).

Figure 4-9. American River steelhead life cycle.

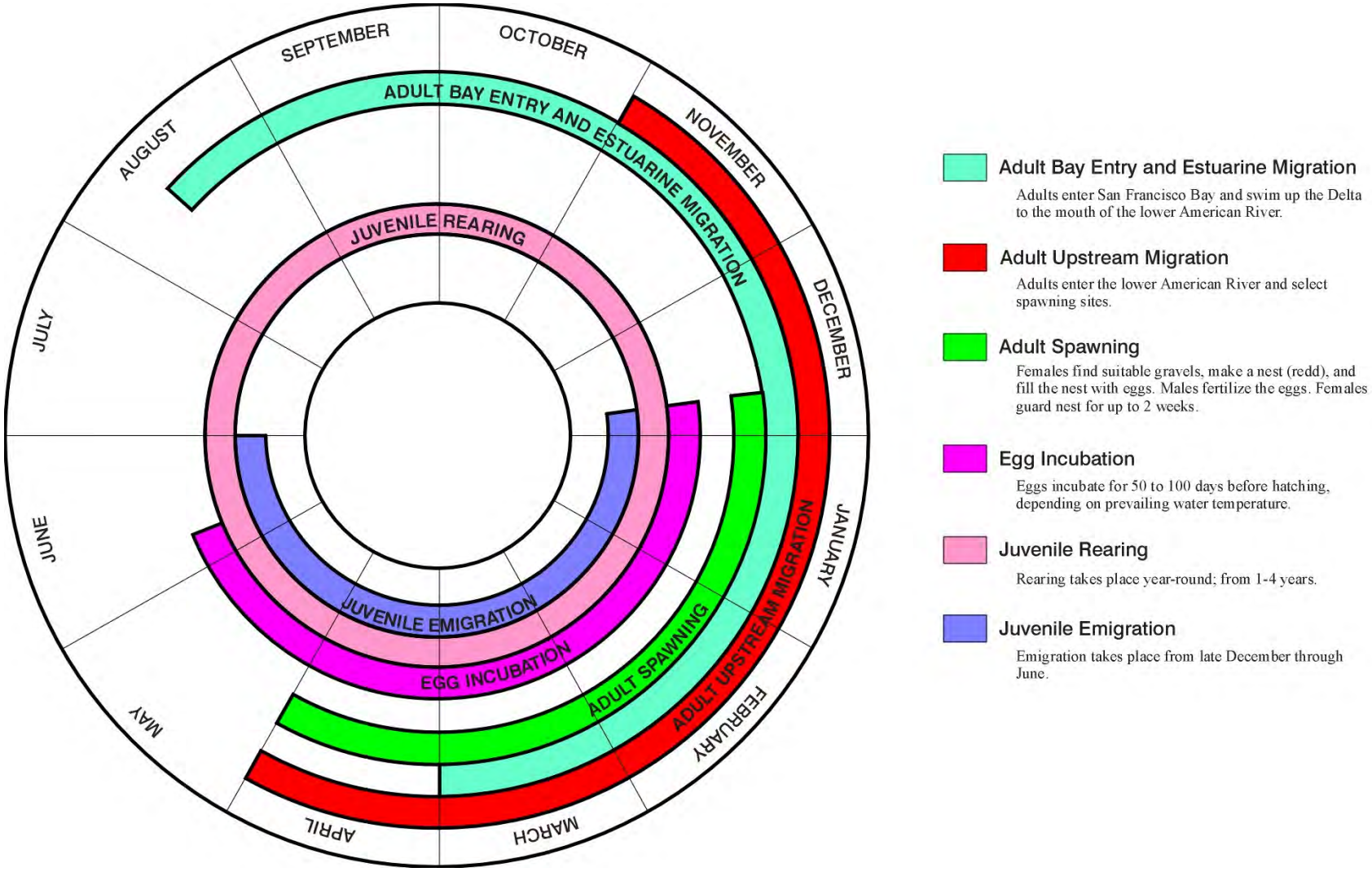
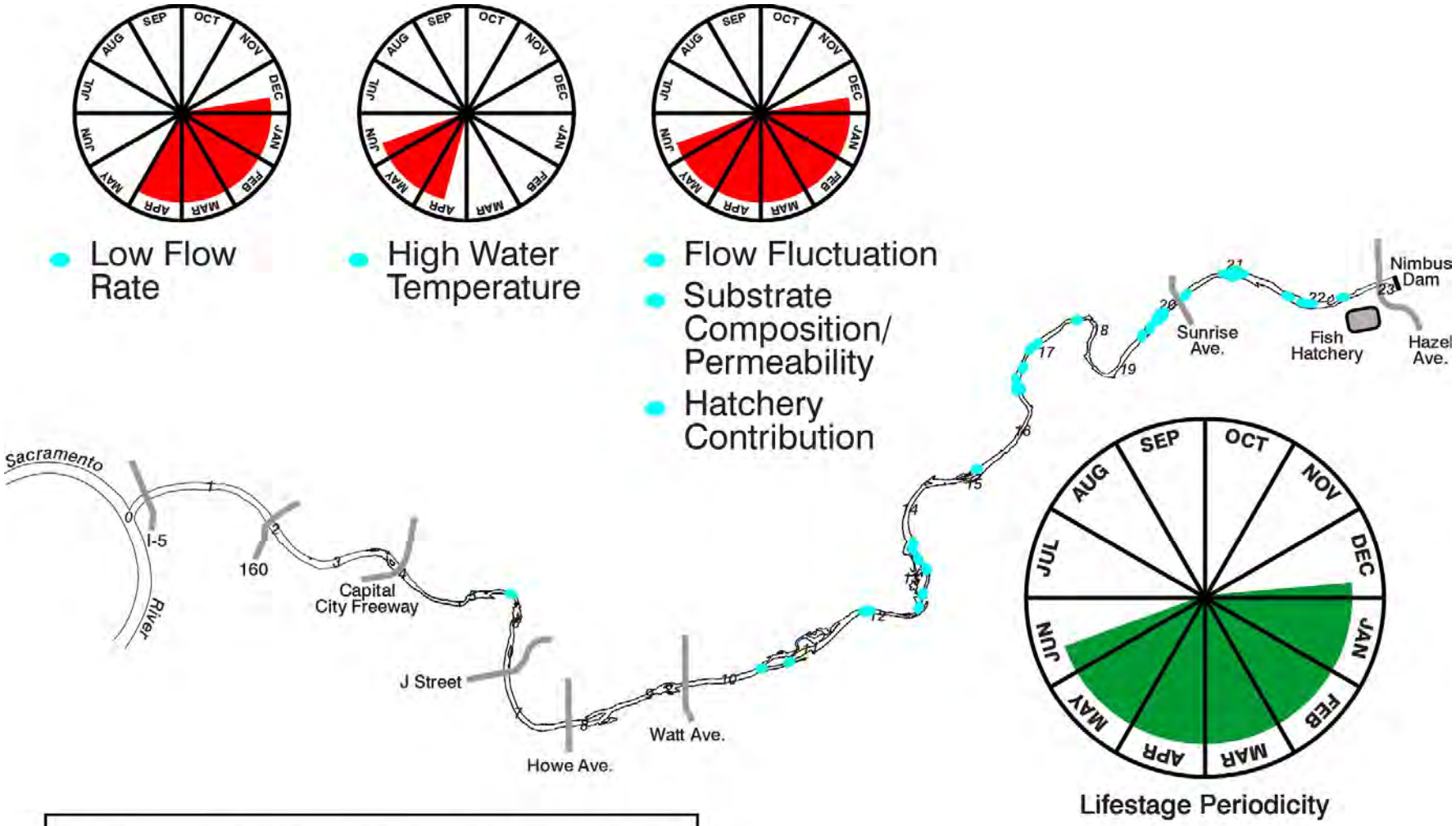


Figure 4-10. Steelhead spawning and egg incubation, and temporal and geographic distribution of potential stressors.



Note: The geographic distribution of the stressors to the egg incubation lifestage corresponds to spawning site locations. Note that low substrate permeability may be a stressor throughout the primary spawning grounds.

Substrate permeability considerations also may pertain to steelhead. High gravel permeability would allow intra-gravel flows, providing sufficient cleansing and dissolved oxygen for successful egg incubation.

Low Flow Rate

Although substrate composition is an important factor in spawning site selection, flow rate directly influences physical spawning habitat availability. Low flows and, therefore, low physical spawning habitat availability may limit the number of adults which can spawn, and may result in increased egg retention.

Hatchery Contribution

It presently is unknown what proportion of the annual number of adults spawning in the river is composed of hatchery-origin fish. It has been suggested, however, that the majority of in-river steelhead spawners are of hatchery origin. Currently, there is no way to verify the concern that hatchery origin fish compete with naturally spawned fish for available habitat. A second concern is that hatchery practices have decreased the genetic diversity of the population of steelhead spawning in the lower American River.

Flow Fluctuation

Flow reductions can expose redds to the atmosphere, causing desiccation (i.e., redd dewatering) and egg mortality.

JUVENILE REARING

Identified below and in **Figure 4-11** are the stressors associated with juvenile steelhead rearing, and the geographic and temporal distribution to which each stressor corresponds.

High Water Temperature

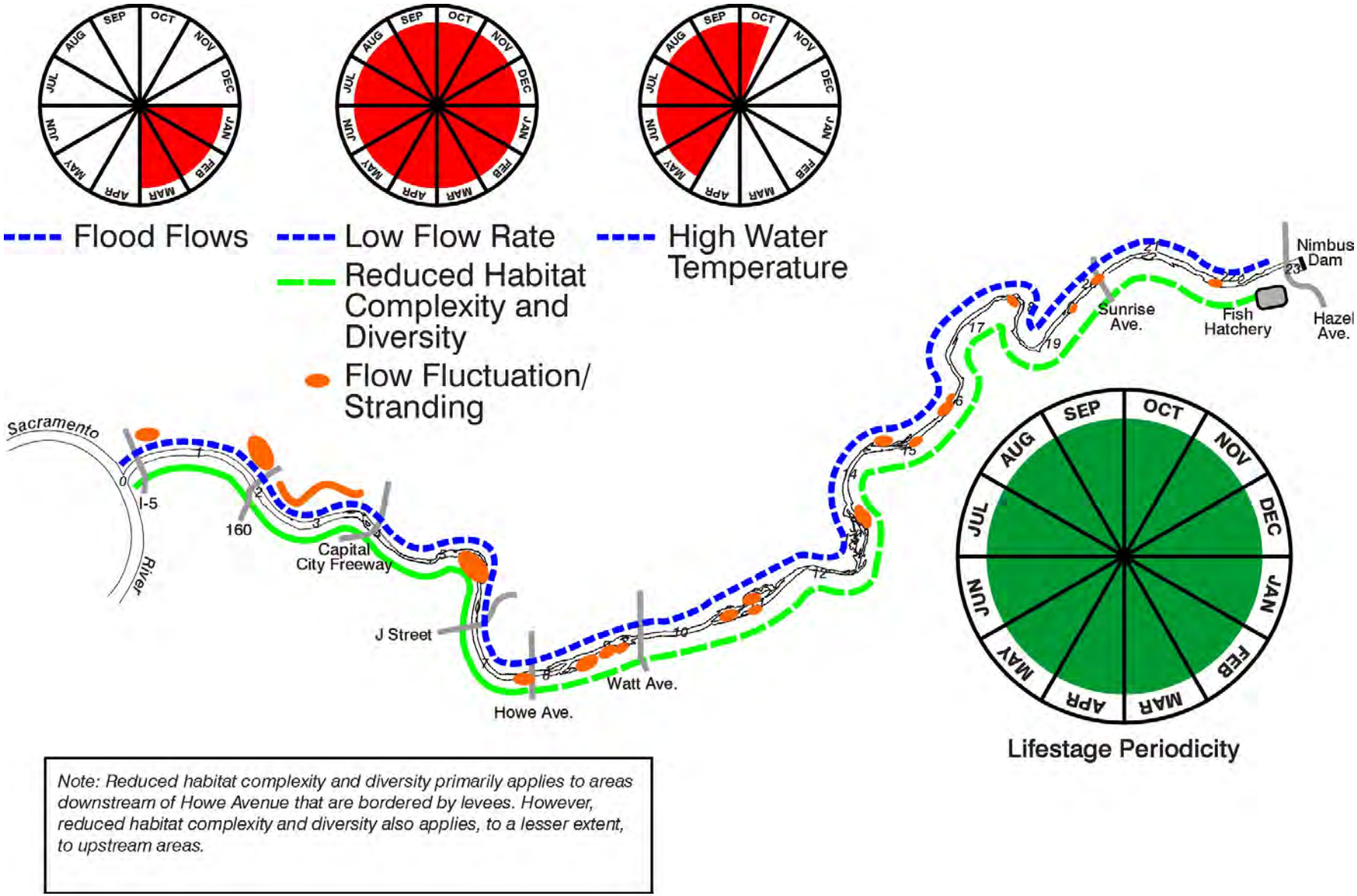
The environmental factor probably most limiting to natural production of steelhead in the lower American River is high water temperatures during summer and fall (Snider and Gerstung 1986; *Baseline Report*, p. 2-119). Water temperatures in the lower American River normally exceed 60°F from July to September, and often exceed 70°F. With these high water temperatures, the health, behavior and survival of rearing juvenile steelhead can be negatively affected.

For example, high summer and fall water temperatures may increase predation and the risk of disease, effectively leading to increased mortality among the rearing juvenile steelhead. Direct effects on fish physiology/bioenergetics can also lead to increases in mortality.

Low Flow Rate

Flow rate directly affects rearing physical habitat availability in the river channel. Low flow rates also may reduce accessibility of nearshore habitat characterized by habitat complexity and diversity in the form of large woody debris and SRA cover. Also, during spring, flow rate is related to water temperature and low flow rates are often associated with warmer water temperatures.

Figure 4-11. Steelhead juvenile rearing, and temporal and geographic distribution of potential stressors.



Note: Reduced habitat complexity and diversity primarily applies to areas downstream of Howe Avenue that are bordered by levees. However, reduced habitat complexity and diversity also applies, to a lesser extent, to upstream areas.

Flow Fluctuations

Large fluctuations in flow risk stranding fry near the river edges and in shallow pools which, in turn, may affect the size of the emigrating population (*Baseline Report*, p. 2-78).

Flood Flows

Flood flows are deleterious to recently emerged young fry; mortality may result from physical injury, stranding, or displacement and subsequent predation.

Reduced Habitat Complexity and Diversity

After emergence, fry seek shallow, low velocity areas near shore. As they grow, juvenile steelhead seek faster moving water and harbor around channel obstructions (*Baseline Report*, p. 2-77 to 2-78). The stream channel has simplified due to channel constriction, levee construction, rip-rapping of the shoreline, removal of woody debris, and has resulted in reduced fry and juvenile habitat quality.

SRA cover consists of instream object cover and overhanging cover. Instream object cover provides structure which promotes hydraulic diversity and microhabitats for juvenile steelhead, as well as escape cover from predators. Overhanging cover provides localized shading and reduction in surface water temperatures, and also may serve as a food source of terrestrial insects.

4.1.3. SPLITTAIL

Adult splittail inhabit the Delta and Sacramento and San Joaquin rivers for most of their lifestages; they also inhabit the lower reaches of tributary rivers, particularly in high flow years. Splittail primarily spawn in the lower American River for short periods of time between February and May. Hatching to swim-up to the Sacramento River takes two to three weeks. Therefore, conceptual models for other lifestages of splittail are not presented, and the discussion of stressors affecting splittail focuses exclusively on the spawning lifestage.

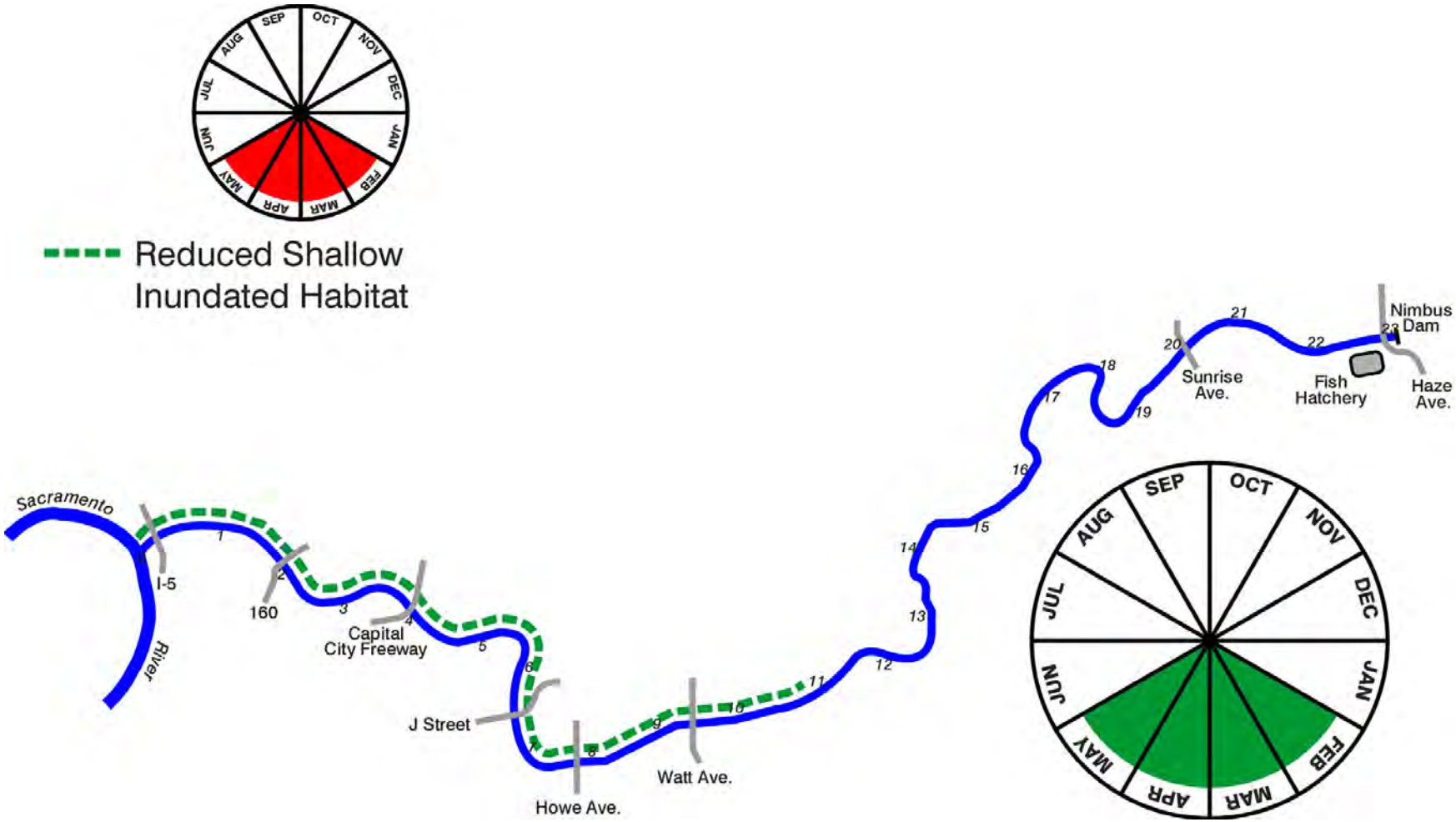
SPAWNING

Identified below and in **Figure 4-12** is the stressor associated with splittail spawning, and the geographic and temporal distribution to which each stressor corresponds.

Reduced Shallow Inundated Habitat

The lower American River has limited shallow areas with frequent, periodic flooding. This type of habitat is used by splittail for spawning and early rearing. Flow levels contribute to the flooding of these floodplains increasing survival of rearing splittail juveniles. For example, in 1998, high flows and consistent floodplain inundation resulted in record Age-0 abundance for abundance indices to date (*Baseline Report*, p. 2-126). Potential splittail spawning habitat may exist in the lower American River, particularly from the river mouth to Gristmill, near RM 12.

Figure 4-12. Splittail spawning and early rearing, and temporal and geographic distribution of potential stressors.



5.0 CONCEPTUAL MODELS OF RESTORATION PROCESSES

In this chapter, conceptual models of restoration projects are presented based on concepts of how the ecosystem is believed to function, how it has been altered or degraded, and how various actions might improve conditions. The conceptual models presented in Chapter 4 depicting the lifecycles of the species of priority management concern, and the stressors affecting these species, suggest the direction of potential restoration actions. Restoration processes which specifically target these stressors are identified for potential management interventions.

Ultimately, conceptual models for project implementation, complete with hypotheses, monitoring plans, experimental design and adaptive management plans, will be developed for selected projects. Until projects are proposed and defined in detail, the implementation models cannot be defined on a project-specific basis. Consequently, conceptual models have been developed for categories of potential restoration actions, including those associated with:

- water temperature
- floodplain habitat
- instream habitat
- flow
- shaded riverine aquatic habitat
- coarse sediment supply

The example conceptual models of restoration processes are presented on **Figure 5-1** through **Figure 5-6**. Stressors that were identified in Chapter 4, are set forth and a restoration process is established based on this stressor. An example restoration project is then described which would work towards the identified restoration processes. The conceptual model then shows how project success would be measured by the monitoring plan. Both the project objective (e.g., did the project increase the diversity and abundance of SRA habitat) and the desired outcome (e.g., did the increase in quality of SRA habitat facilitate population increases for the targeted fish species) would be measured. Features of the experimental plan are provided. Testable hypotheses and null hypotheses are identified for each example project. Adaptive management is incorporated into project implementation.

Ecological and biological monitoring will be an essential component of project implementation. Features of the experimental design are identified on the example conceptual models. The variables that need to be measured in order to document the status and trends of fish populations, and more generalized system indicators that can provide the basis for assessing progress in meeting the desired outcomes presented in Chapter 2, also will be described in the experimental design.

Hypotheses are formulated for each component of the conceptual models. These hypotheses attempt to define the linkages/relationships between potential interventions and the ecosystem response (i.e., flow and water temperature or flow and channel habitat). The hypotheses underlying the projects will be tested through comprehensive monitoring.

Conceptual models of restoration processes for the river-wide ecological and biological monitoring and evaluation plan (Monitoring Plan, described in Chapter 7) will be developed as each element of the Monitoring Plan is defined.

Figure 5-1. Conceptual model and hypotheses for example temperature project

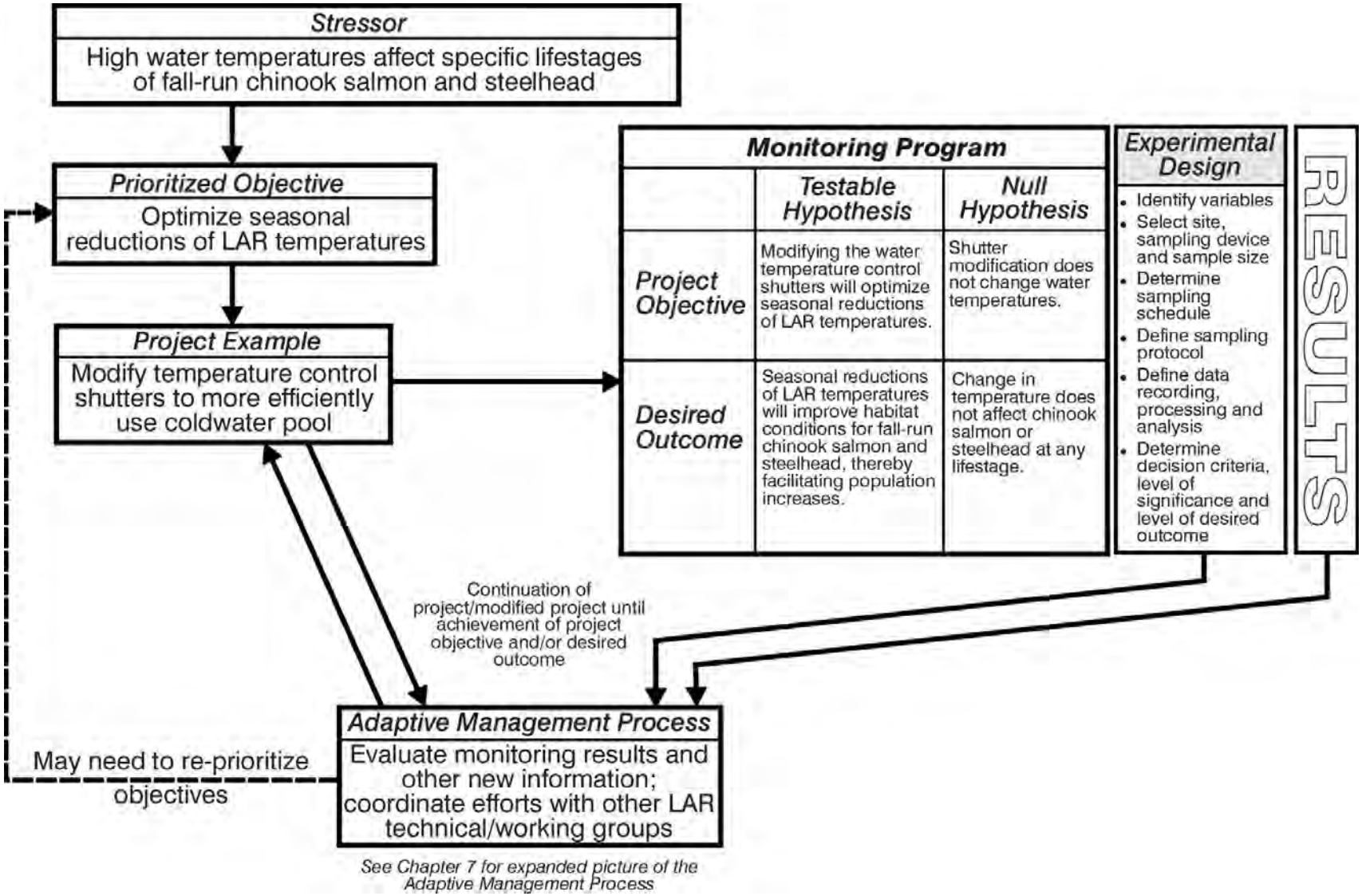


Figure 5-2. Conceptual model and hypotheses for example flow project

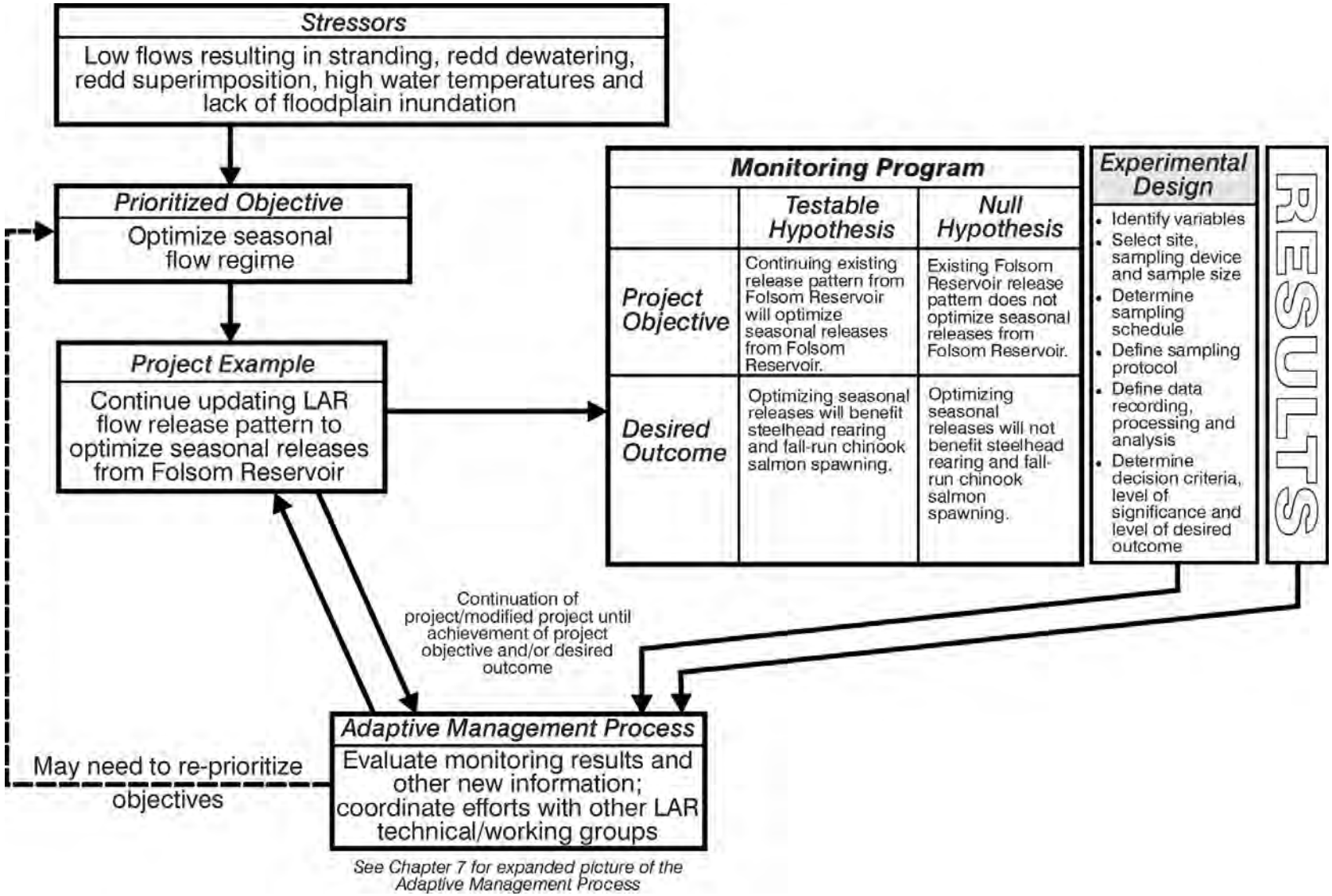


Figure 5-3. Conceptual model and hypotheses for floodplain habitat project

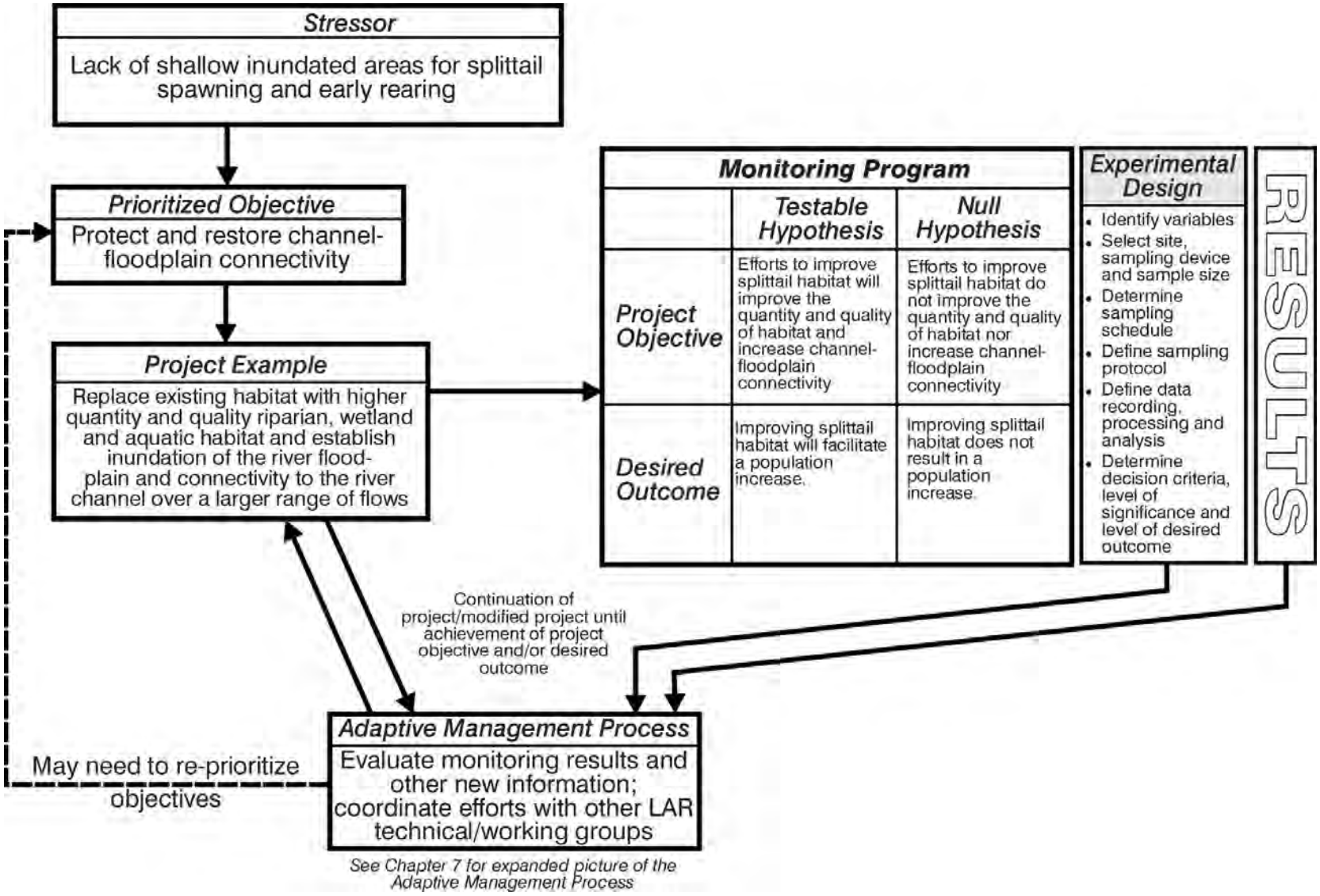


Figure 5-4. Conceptual model and hypotheses for shaded riverine aquatic habitat project

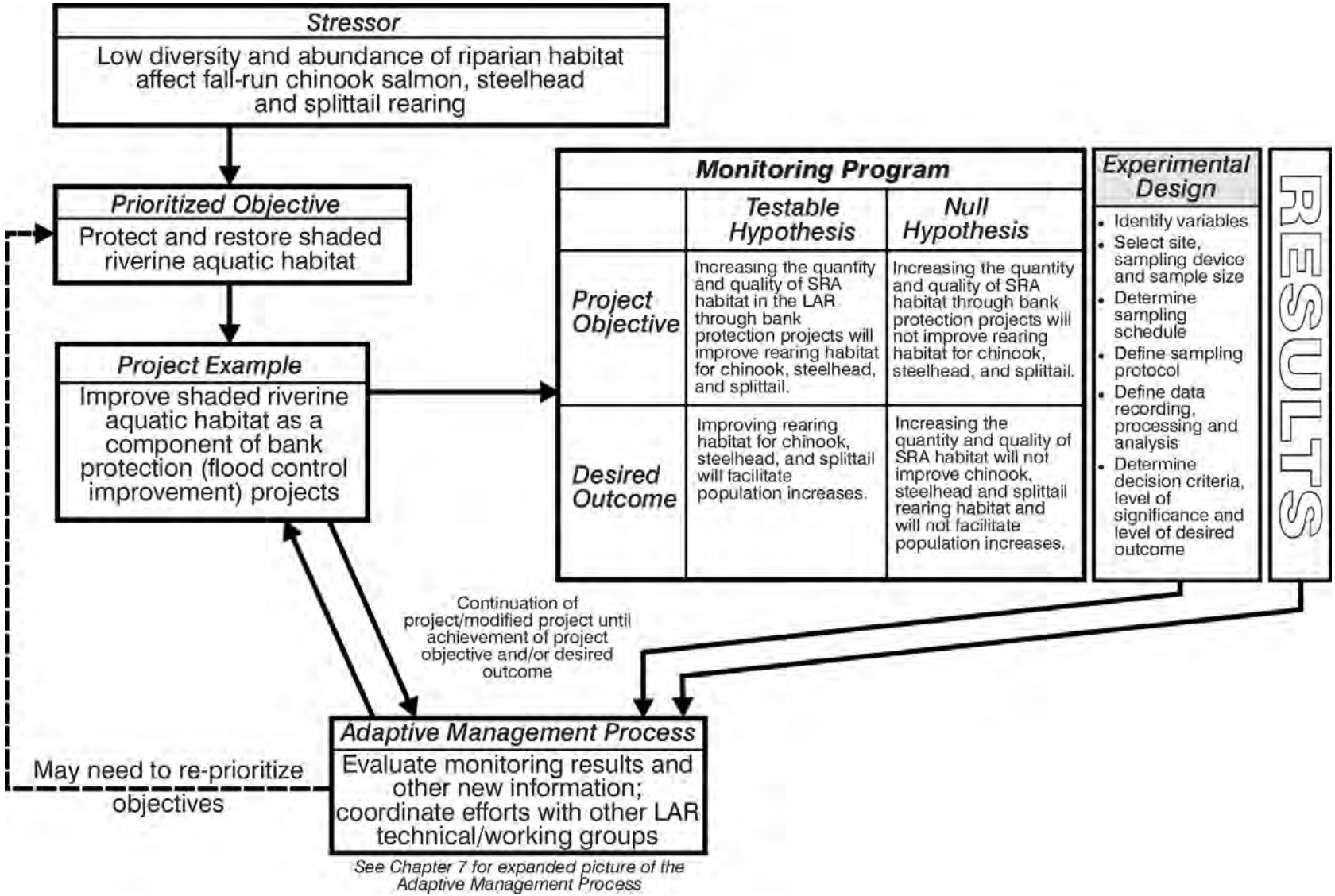


Figure 5-5. Conceptual model and hypotheses for instream habitat project

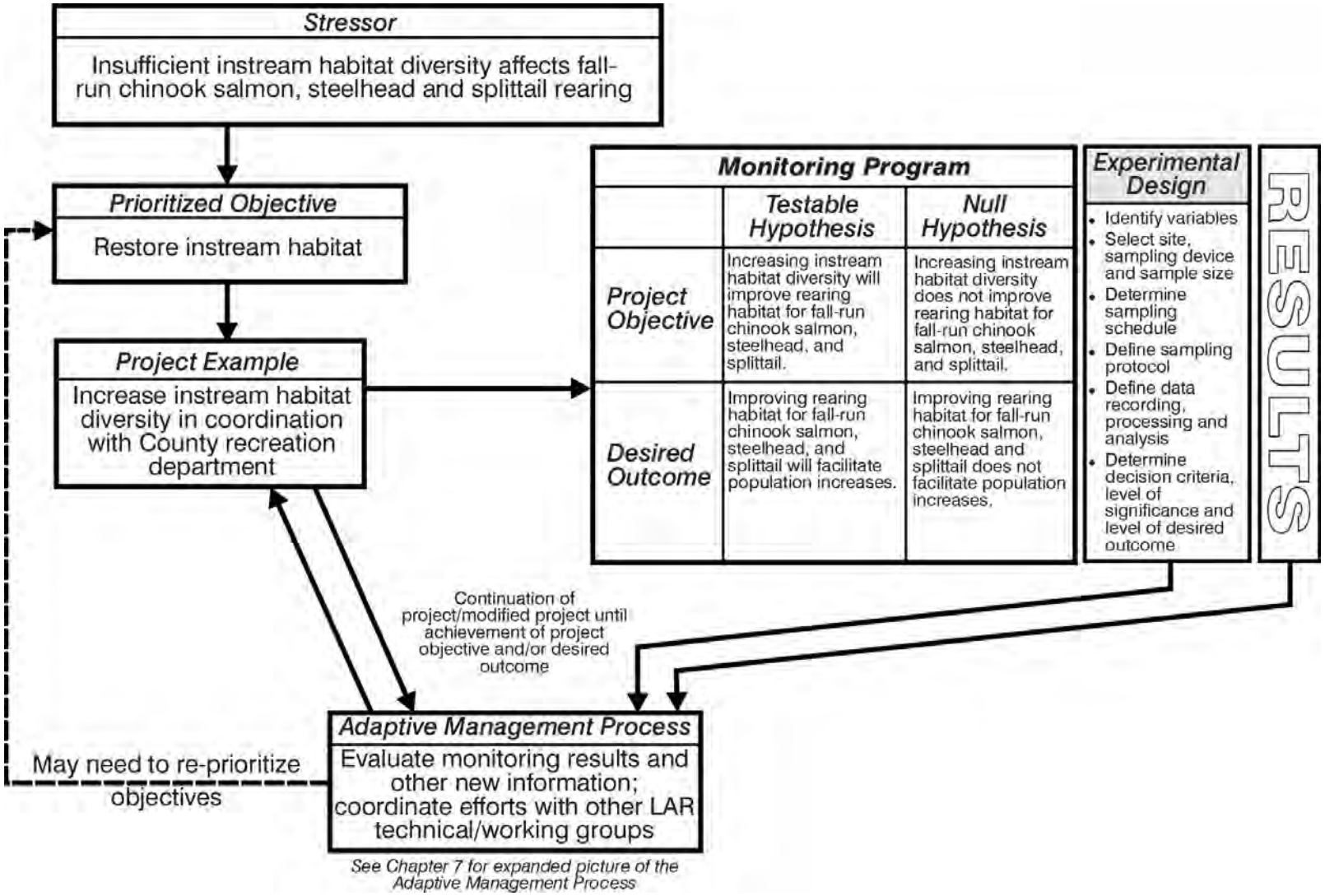
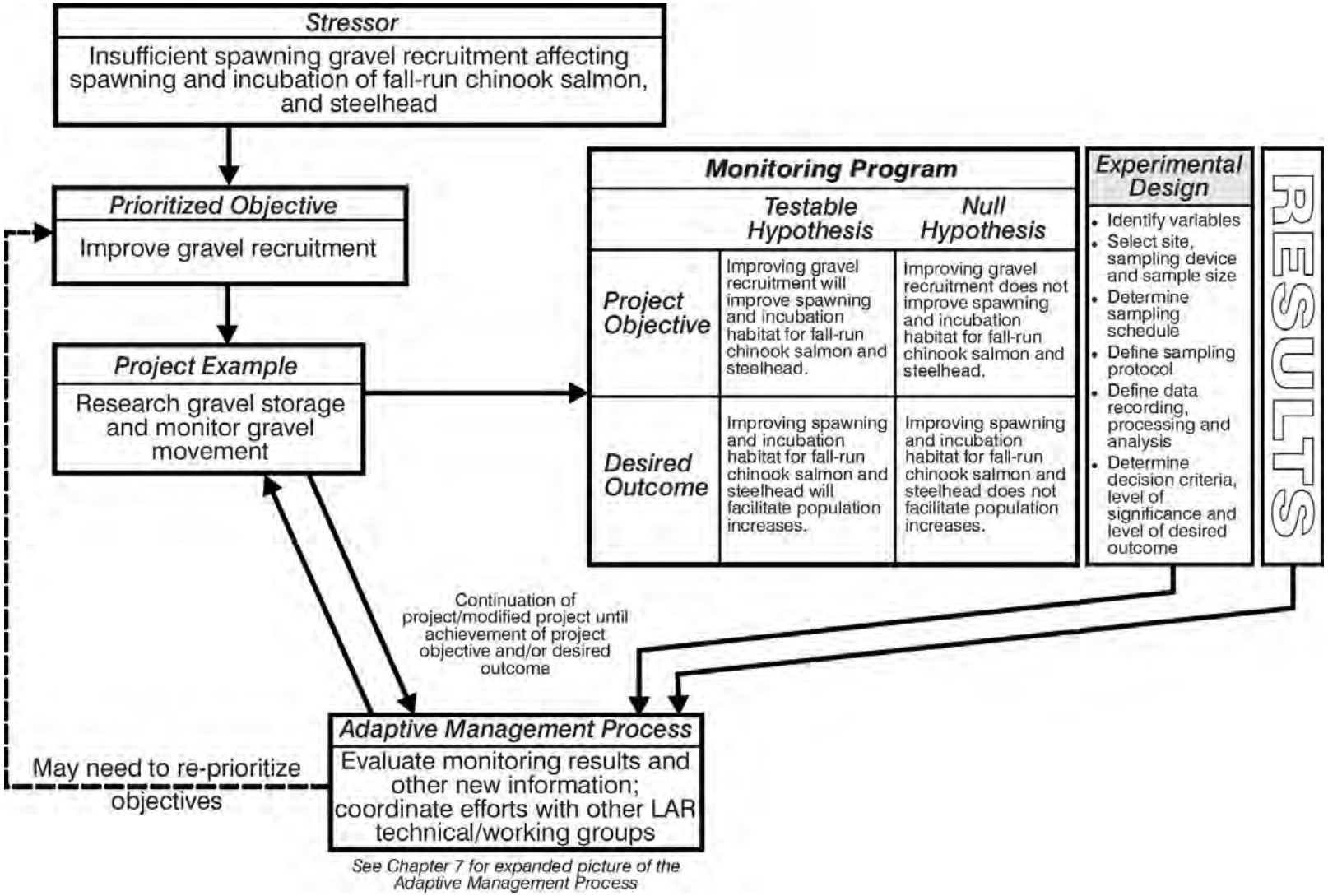


Figure 5-6. Conceptual model and hypotheses for example coarse sediment supply project



Indicators are selected to provide measurable evaluations of important ecological processes, habitats, and species whose status individually and cumulatively provide an assessment of ecological health. Indicators are features or attributes of the ecosystem that are expected to change over time in response to project implementation.

In these models, adaptive management is established as a critical component of each restoration project. Adaptive management relies upon identifying indicators of ecosystem health, comprehensive monitoring of indicators to measure changes over time, testing alternative ways of meeting objectives, and adapting future management actions according to what is learned. The conceptual model depicts how adaptive management would allow the project to evolve, as necessary, based on the monitoring results or, possibly, information external to the project (e.g., recent innovations in bank protection techniques). This new information feeds back into the adaptive management process and supports proposed actions, suggests revisions to actions or restoration processes, and identifies needs for further monitoring and evaluation.

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.

7.0 LOWER AMERICAN RIVER SCIENCE-BASED MANAGEMENT FRAMEWORK

Managing an inherently complex ecosystem such as the lower American River, where many processes and relationships interact, means making management decisions with some degree of uncertainty regarding the consequences or outcomes. The FISH Plan proposes a science-based management framework to reduce uncertainty, and to accomplish the FISH Plan goals and objectives. A comprehensive monitoring plan with reliable data output and thorough evaluation will enable managers to make informed choices and decisions regarding the direction of their programs. In addition, the science-based management framework of the FISH Plan will support management learning through implementation and evaluation of alternative management scenarios - a process of directed selection. As described in this chapter, the science framework incorporates the principles of adaptive management to ensure future resource management actions are adapted according to what has been learned.

The difficulties and uncertainties associated with successful ecosystem restoration call for an implementation strategy that is flexible and can accommodate and adapt to new information. Science is a process for learning about nature in which competing ideas about how the world works are measured against observations (Feynman 1965). Since descriptions of the natural world are often incomplete, and scientists' measurements involve uncertainty and inaccuracy, scientists rely upon statistics for formal tools to help them evaluate the confrontations between ideas (i.e., hypotheses) and data (Hilborn and Mangel 1997).

A widely accepted model describes the scientific process as a learning tree of critical experiments (Platt 1964), whose "branches" or steps can be summarized as:

1. Devising alternative hypotheses;
2. Devising crucial and replicable experiments with alternative possible outcomes that will exclude one or more of the competing hypotheses;
3. Performing the experiments and obtaining "clean" (i.e., unambiguous) results; and
4. Recycling the procedure by devising new sets of alternative subordinate or sequential hypotheses to refine understanding of the process or concept under study.

Platt's (1964) learning tree relies heavily on performing crucial and replicable experiments that will produce unambiguous results. In ecology, such experiments are often difficult to perform. The long time periods involved in many ecological processes, the low expectation for replication of ecological experiments, the inability to control all aspects of an ecological experiment, and the intractability of many populations (e.g., endangered or threatened species) to ecological manipulation, often make ecological experimentation difficult or inadequate. Moreover, when ecological experiments are possible, these same factors tend to obfuscate clear or unambiguous results. Therefore, ecologists must rely on observations (as opposed to experiments), inference, good thinking, and models to guide them through the scientific process (Hilborn and Mangel 1997). Under these conditions, a scientific research program serves to guide ecological research by indicating paths to avoid, and paths to pursue. The remainder of this chapter describes the goals and objectives of the science framework, its four key components, structural considerations, and the adaptive management process.

GOAL AND OBJECTIVES OF THE PROPOSED SCIENCE FRAMEWORK

The overall goal of the science framework is to reduce, to the extent possible, the uncertainties inherent in the management of lower American River fish and aquatic resources. The framework includes the following five proposed objectives to meet this goal:

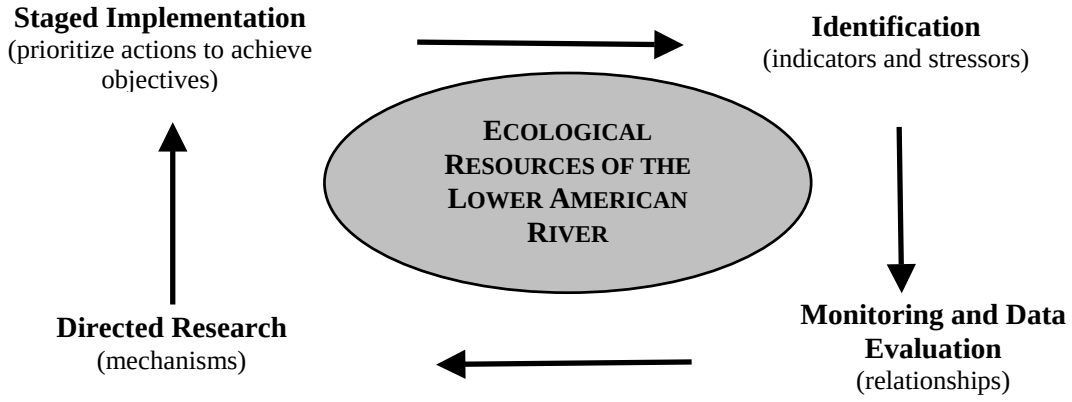
1. **Detect changes** - Serve as an early warning system by detecting project- and ecosystem-induced, short- and long-term changes in the lower American River ecosystem.
2. **Understand system interactions** - Identify causes of change within the lower American River resulting from natural variation, human influences, and their interaction.
3. **Predict trends** - Develop the capacity to predict the status and trends of natural resources for use by resource managers and the public.
4. **Inform interested parties/stakeholders** - Provide information to the public, resource managers, policy makers and others in order to actively manage the ecosystem to meet specified goals and objectives.
5. **Improve resource management** - Develop tools and methods that can help resource managers and regulators improve management of fish and aquatic (riverine) resources and address problems that may arise from human influences (activities).

Three of these objectives - detecting changes, understanding system interactions (identifying causes of change), and predicting trends - rely upon an adaptive management process that includes an effective monitoring plan. The adaptive management and monitoring plan components are described in this chapter.

SCIENCE FRAMEWORK COMPONENTS

Figure 7-1 identifies four necessary components of a successful science framework. These components include: (1) identifying indicators and stressors; (2) monitoring and evaluating information; (3) conducting directed research efforts; and (4) providing a link to the decision-making process and management actions. These components are the minimum required, and are considered part of the interactive process for understanding and managing ecological resources.

Figure 7-1. Components of understanding and managing the ecological resources of the lower American River.



Information generated from monitoring, evaluation, and research activities provides resource managers with the understanding needed to design actions, to detect responses to their actions, to provide the public with information about the success of these actions, and, above all, to improve resource management.

- **Identification of Ecosystem Attributes/Understand Relationships:** Involves identifying measurable and sampling physical, chemical, and biological indicators to evaluate ecosystem processes, habitats, and species.
- **Monitoring and Data Evaluation:** Involves measuring and evaluating the abundance, distribution, change or status of indicators. For example, examining the correlation between the abundance of a fish species and a physical factor, such as river flow.
- **Directed Research:** Involves analysis or experiments to illustrate mechanisms that explain an observed correlation, such as documenting fish abundance and distribution with varying levels of river flow. Allows for the integration of other research activities in a complementary manner.
- **Staged Implementation (Management Actions):** Calls for a logical prioritization of actions to achieve FISH Plan objectives as effectively as possible. The results of monitoring programs are of value to the extent that they provide information for management decisions (actions), and provide early warnings of ecosystem degradation. The link between monitoring and decision-making begins with the formulation of, and agreement on the monitoring program.

SCIENCE FRAMEWORK MANAGEMENT STRUCTURE

The science framework may be used to link FISH Plan decision-making among the resource management agencies to determine how to evaluate results of monitoring and data review collected through FISH Plan management actions and individual projects and in the RCMP. Following the principles of adaptive management, resource managers will adjust FISH Plan goals as necessary to attain the desired program objectives. The science framework will require a management structure to ensure that:

- Goals and objectives have been identified;
- Sampling design is adequate;
- Funds are available;
- Personnel are available;
- Data are managed; and
- Information is made available to the management agencies.

As of this writing, work has just begun to define the science framework for the lower American River. The FISH Plan's adaptive management process, described below, will be a key component of the envisioned science framework, but it is anticipated that the framework will be on the scale of the RCMP. Ideas are being developed further and preliminary contacts with CDFG, CalFed, the U.S. Geological Survey (USGS), California State University, Sacramento (CSUS), and the University of California at Davis (UCD) have been initiated. One concept is to form science partnerships with these parties, relying on an agreed-upon entity, such as a resource agency (e.g., CDFG, USGS) under contract with RCMP entities to provide oversight of the science-based management element. An alternative concept would be to establish an adaptive

management team to oversee and ensure a science-based approach to resource management and implementation of the FISH Plan.

ADAPTIVE MANAGEMENT PROCESS

The adaptive management process is considered an essential component of the lower American River science-based management framework. It is defined as a process that generates, incorporates, evaluates, and responds to new information and conditions in order to achieve the desired objectives. There are several factors that lead to the need for a more clearly articulated, incremental, and science-based approach in the adaptive management process:

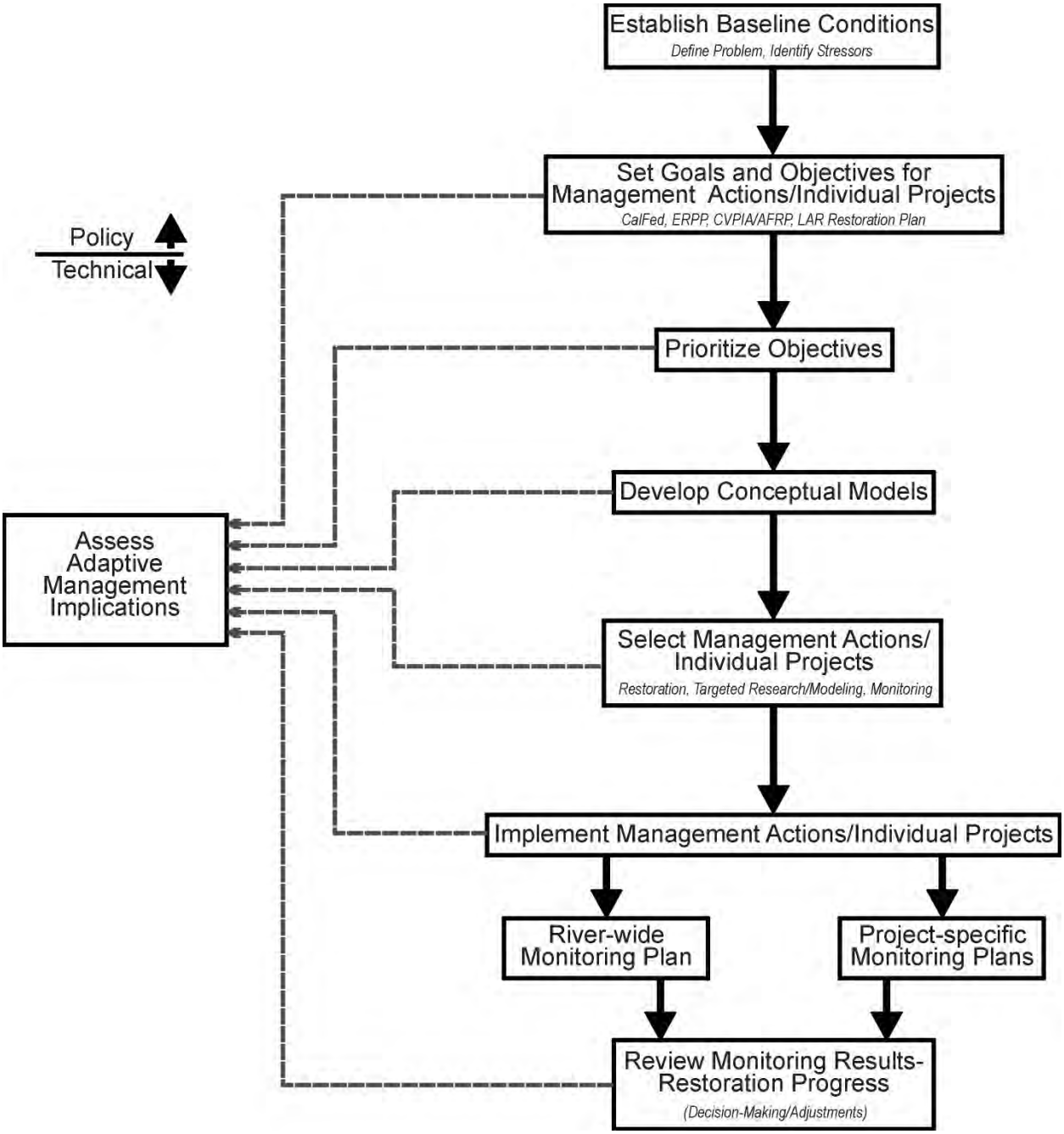
- Multiple competing objectives;
- Complex and uncertain interactions and cause/effect relationships;
- Technical feasibility;
- Limited resources; and
- Multiple individuals and/or organizations responsible and accountable for outcomes.

Adaptive management will be applied to river-wide management actions as well as individual projects within the river corridor. River-wide adaptive management considers the status and trends in fish populations, habitats and processes and more generalized system-wide indicators primarily associated with hydrologic operations and management actions in determining subsequent actions. Project-specific adaptive management focuses on implementing, monitoring and reporting on individual actions within the study area, evaluating the extent to which specific actions meet the objectives of the project and the FISH Plan, and revising subsequent actions accordingly.

The features of a scientifically based, adaptively managed decision-making process, throughout which a high level of disclosure and interaction is critical, are portrayed schematically in **Figure 7-2**. As depicted, the primary steps or actions in the adaptive management process include:

1. Establish quantitative environmental baseline conditions;
2. Set goals and objectives for management actions (or individual projects);
3. Prioritize objectives;
4. Develop conceptual models of ecosystem processes, including natural or created stressors;
5. Evaluate and select potential management actions (or individual projects);
6. Implement the selected management actions (or individual projects);
7. Monitor quantitative variables; and
8. Review and assess the data.

Figure 7-2. Features of the adaptive management process.



Adaptive management relies upon the identification of indicators of ecosystem health, comprehensive monitoring of indicators to measure improvement over time, focused research, and phasing of actions. These principles will be incorporated into the ecological and biological adaptive management process, which includes monitoring and evaluation functions.

The emphasis on the adaptive management process in the FISH Plan reflects the importance of: (1) the scientific basis for a monitoring program; and (2) the feedback of results from the data evaluation into the subsequent round of management decision-making. The model of adaptive management processes has many of the same elements as the CalFed adaptive management

process model (CalFed 2001), including establishing goals, specifying conceptual models, initiating actions, and evaluating data. However, the adaptive management process model portrayed in Figure 7-2 has notable differences in that it: (1) acknowledges the distinction between policy roles and responsibilities and technical roles and responsibilities; and (2) places greater emphasis on management and restoration results than scientific predictability.

The Initial FISH Plan was prepared following this sequence of steps. The river-wide monitoring plan serves as the first-level monitoring plan for the entire FISH Plan. Specific management actions taken to implement the FISH Plan also should follow these adaptive management steps. More specifically, individual projects should identify goals and objectives, develop a conceptual model for demonstrating an understanding of project-related ecosystem processes and stressors, describe the anticipated project results, and provide for adaptive management and monitoring components. Project-specific monitoring results will become part of the knowledge base of information on the lower American River, and, as appropriate, the FISH Plan and management actions will be modified (adapted) according to the results.

The major features of the adaptive management process for the lower American River are discussed briefly in the following sections.

7.1.1. ESTABLISH QUANTITATIVE BASELINE CONDITIONS

A quantitative baseline condition must be established to understand the existing conditions and compare and assess changes in those conditions. The *Baseline Report*, described in Chapter 2 of this report, provides the foundation upon which to build a quantitative baseline for adaptive management purposes.

7.1.2. SET GOALS AND OBJECTIVES FOR MANAGEMENT ACTIONS/ INDIVIDUAL PROJECTS

The river-wide management goals and objectives and priorities reflected in this report were developed through the FISH Plan consensus-building process and informed by various technical committee efforts. A standing technical committee will be required to periodically re-prioritize the list of objectives, as necessary, based on feedback from implementation, monitoring, and guidance from other restoration initiatives (i.e., ERPP, CVPIA, AFRP). Goals and objectives for individual projects also should be derived from the FISH Plan goals and objectives for restoring the fish and aquatic habitat resources of the lower American River. However, since project-specific goals and objectives will be focused on meeting the targeted outcome for the individual project in question, they cannot be detailed at this stage in the process.

7.1.3. PRIORITIZE OBJECTIVES

Prioritization of management objectives and actions/individual projects recommended in the Initial FISH Plan has been done as part of a structured process that involved the following elements:

- A technical subcommittee accountable to a broader stakeholder group;
- A facilitated discussion of objectives;
- Consensus building regarding priorities;

- Documented justification of priorities; and
- Provisions to periodically revisit and re-evaluate priorities.

The above sequence of steps reflects a robust and replicable framework for subsequent review of FISH Plan priorities and recommended actions.

7.1.4. SELECT AND IMPLEMENT MANAGEMENT ACTIONS/INDIVIDUAL PROJECTS

Implementation of the river-wide management actions and individual projects should proceed through a structured process for each action or project, involving:

- Scoping;
- Engineering and feasibility evaluations;
- Budgetary analysis;
- Oversight and review; and
- Reporting.

These steps are the responsibility of individual project proponents.

7.1.5. ECOLOGICAL AND BIOLOGICAL MONITORING AND EVALUATION

One result of the AROG, FWG, and TSC meetings has been to discuss potential monitoring programs, pooling the collective knowledge and experiences of veteran resource managers and balancing the interest of diverse resource stewardship interests in the lower American River. Several related water resource management efforts in the lower American River, including the Lower American River Temperature Improvement Study, the Water Forum Successor Effort, CDFG Stream Evaluation Program, and others, have and will continue to inform and give direction to development of the river-wide and individual project monitoring plans.

These monitoring efforts will gauge and evaluate the response of the lower American River fish and aquatic habitat resources to management actions in a manner that will measure progress toward FISH Plan and individual project goals and objectives. Subsequent re-evaluation and determination of potential new or refined monitoring programs will be accomplished through periodic (annual) review and assessment by a standing technical committee based on data and knowledge produced by the monitoring plan. This information will be shared with resource managers and the general public. The method for distributing this information to members of the general public remains under consideration (i.e., annual report sent to interested parties, web page posting, annual conferences). Identification of potential management actions and changes in monitoring plans should be part of a structured process involving the same elements as listed earlier for prioritizing objectives (Section 7.4.3).

RIVER-WIDE ECOLOGICAL AND BIOLOGICAL MONITORING AND EVALUATION PLAN

The River-wide Ecological and Biological Monitoring and Evaluation Plan (River-wide Monitoring Plan) is an essential part of the lower American River science-based management element and adaptive management process. It will provide the assessment of key physical, chemical, ecological and biological variables required for the testing of present alternative

hypotheses concerning the system indicators and stressors, and measure responses to particular specific management actions. Moreover, it will enhance the available baseline information on the lower American River which will lead to a better understanding of the system dynamics, allow the development of new hypotheses and support appropriate management actions. The River-wide Monitoring Plan will describe the monitoring and evaluation components necessary for adaptive management of lower American River fish and aquatic habitat.

The purpose of the River-wide Monitoring Plan is to provide a detailed framework to support efficient and cost-effective long-term investigations that will provide the basis for the adaptive management of lower American River fish and aquatic habitat. By using the information and lessons learned from prior monitoring efforts and improving on the existing methodologies, where appropriate, the River-wide Monitoring Plan will enable water resource and fisheries resource managers to adaptively manage competing resource demands. The River-wide Monitoring Plan will provide a detailed and comprehensive "roadmap" for the monitoring, evaluation, and reporting of identified river-wide monitoring components (see River-wide Monitoring Plan Annotated Outline in Section 7.5). It is anticipated that the River-wide Monitoring Plan will be implemented in conjunction with the updated flow management plan for the lower American River (under development).

PROJECT-SPECIFIC MONITORING PLAN

The purpose of clarifying monitoring and evaluation plan requirements on an individual project basis is to help individual investigators collectively generate a comprehensive database, using comparable metrics, to facilitate input into the adaptive management decision-making process and to enhance reporting to resource managers regarding project effectiveness. The list of variables that project proponents are encouraged to address in their project-specific monitoring plans should speak to the following questions:

- What did you expect to happen?
- What actually happened?
- What are the adaptive management implications of the actual results?

The level of detail will depend on the nature and status of an individual project, but all projects should provide the information outlined below.

- Overview/summary of project objectives and associated monitoring objectives
  - Primary biological/ecological objectives
  - Questions to be answered
  - Hypotheses and assumptions
  - Conceptual framework/models
- Monitoring approach and design methodology
  - Parameters
  - Duration
  - Frequency
  - Type of equipment
  - Constituents
  - Location, integration with other projects
  - Reference or copies of protocols
- Data sampling procedures

- Number and type of samples
- Sample handling

- Analysis and reporting
  - Report frequency
  - Content and format
  - Evaluation approach
- Peer review
- Data management and format
- Financial assurances (e.g., how monitoring will be funded)

The monitoring plan methodology needs to be developed prior to any data collection, including pre-project field work. The plan may be tentative in the early stages, dependent on early field surveys and evaluations. A feasibility study would present more general statements on methodology. As final project designs are developed, so, too should the project refine final details of the data collection methodology. Project-specific budgets need to include monitoring for mitigation projects, as well as funding for adaptive management efforts that will need to be undertaken if the mitigation projects do not achieve intended goals. Monitoring plans should identify the timeframe over which monitoring will take place.

As discussed in Chapter 5, project monitoring and evaluation plans cannot be specified until projects are proposed and defined. Ultimately, the adaptive management process should be implemented for each project - complete with hypotheses, monitoring plans, and experimental design. Individual fisheries and aquatic habitat enhancement projects, as well as associated statutory and regulatory compliance requirements, will remain the responsibility of individual project proponents.

The relationships between goals, objectives, project selection, implementation, monitoring and assessment for project-specific actions are very similar to those discussed for the river-wide adaptive management process.

7.1.6. DATA REVIEW AND EVALUATION

Data review and evaluation will be part of a structured process involving the same elements as listed earlier for prioritizing objectives (Section 7.4.3). As part of the evaluation process, monitoring results (data) should be reviewed to determine whether the management actions or individual projects are meeting the stated goals of the project and FISH Plan. Based on these results, in instances where stated goals are not being met, management actions or project activities may be adjusted or modified to more closely obtain the desired outcome and meet goals.

7.1.7. PERFORMANCE EVALUATION/FEEDBACK

A crucial element of the adaptive management process is the phase of activity that evaluates the various monitoring data and then translates those results into revised management actions or project activities. Ideally, project-specific conceptual models and hypotheses will guide the modified or newly defined action. If the relationships were clearly understood, then

prescriptions for revisions to the actions could be developed in advance. For some projects, development of these types of protocols may be possible. However, the nature of adaptive management for the lower American River fish and aquatic habitat restoration program is such that it is unlikely that originally intended outcomes will be obtained precisely. Thus, there will be a need to bring together the appropriate technical resources to re-appraise selected management actions given the new knowledge generated by monitoring and data evaluation.

For the lower American River, those resources include the representatives of the agencies and stakeholder community as well as ad hoc input from outside specialists. The effort can be expected to include re-appraising and modifying the conceptual models and the assumptions relative to causal relationships and limiting factors. The group would identify new and/or modified recommended management actions and projects, as well as supportive modeling and/or monitoring approaches. Open exchange and dialogue between the reviewers is critical to ensure technical and restoration progress, and documentation is important to provide future review and feedback. Special meetings of the technical committee will be facilitated to ensure effective exchange and focus within this phase. The focus of meetings may address individual projects, but the discussion must also integrate the findings related to the individual management actions with other watershed and/or regional actions.

ANNOTATED OUTLINE FOR THE RIVER-WIDE ECOLOGICAL AND BIOLOGICAL MONITORING PLAN

The FISH Plan's River-wide Monitoring Plan focuses on five fish species of priority management concern including fall-run chinook salmon, steelhead, splittail, American shad, and striped bass. Special emphasis has been placed upon the first three species to facilitate compliance with ESA and CESA, and to be consistent with state and federal restoration plans, as discussed in Chapter 1. Improvement of habitat conditions for fall-run chinook salmon, steelhead and splittail likely will enhance conditions for American shad and striped bass, as well as for native resident aquatic species.

The River-wide Monitoring Plan includes components developed to answer current hypotheses on the relationships between various stressors, and biological and ecological indicators, primarily as they relate to fall-run chinook salmon and steelhead. The monitoring components outlined in this section use established techniques and observations. Each component has been selected for incorporation into the initial FISH Plan because it meets one or more of the following: (1) encompasses the lower American River study area (i.e., are river-wide); (2) provides opportunity for evaluation of long-term population trends for priority fish species; (3) provides results that relate to the state of the river; or (4) allows for determination of river-wide trends.

The River-wide Monitoring Plan components will be adapted as resource management needs change and in response to the successes or failures of the study. They may, in some form, continue in perpetuity. With this in mind, it is noted that the objectives and actions of individual components may not be the sole responsibility of the LAR Task Force. As the River-wide Monitoring Plan components become more fully developed, entities responsible for funding, implementation, or other aspects of the plan will be identified. The River-wide Monitoring Plan components include:

- Water Temperature Monitoring

- River Hydrology Monitoring
- Adult Chinook Salmon Population Monitoring
- Spawning Gravel Condition Monitoring
- Chinook Salmon Spawning Monitoring (redd surveys)
- Juvenile Chinook Salmon Emigration Monitoring
- Adult Steelhead Spawning Monitoring (creel census and redd surveys, where possible)
- Juvenile Chinook Salmon and Steelhead Rearing Monitoring
- Hatchery Production Monitoring

Each of the monitoring components listed above will be fully developed in the River-wide Monitoring Plan to address the following topics:

- Objectives
- Actions
- Rationale
- Alternative hypotheses
- Experimental design
  - Evaluation approach
  - Survey location
  - Survey period
  - Sampling frequency
  - Survey procedure
  - Sampling controls
  - Data quality control, reporting, and storage
  - Analytical method
  - Equipment
  - Reporting procedure
- Personnel

The following sections provide an annotated outline of the River-wide Monitoring Plan and some detail regarding the objectives and actions associated with each component. The Adult Chinook Salmon Population Monitoring component (see Section 7.5.3) addresses all of the topics identified above to provide an indication of the degree of detail that ultimately can be expected for each of the River-wide Monitoring Plan components.

7.1.8. WATER TEMPERATURE MONITORING

The *Baseline Report* identified water temperature as an essential factor that has influenced and continues to influence lower American River fish species, in particular salmonids, at various stages of their lifecycles. Water temperature has been identified as a main stressor to chinook salmon and steelhead (anadromous salmonids) (see Chapter 4).

Water temperature has been recorded for a ten-year period (1990 to 2000) at eight different locations between RM 0.2 and RM 22.9 along the lower American River. However, although these historic water temperature records are extensive, there are data gaps in the time series of the eight locations. Such discontinuity in water temperature records, if allowed to persist, may hamper the adequate testing of current hypotheses relating water temperature and various biological indicators. It may obstruct a consistent and precise evaluation of responses to management actions and preclude the development of new hypotheses.

OBJECTIVES

Objectives for the Water Temperature Monitoring component are to:

- Make real-time adaptive management decisions to benefit fish resources (particularly species of concern) based on existing conditions including: season, water year type, Folsom Reservoir coldwater pool storage, Folsom Dam shutter configuration, and water demand.
- Develop long-range forecasts of water temperature needs and availability based on existing conditions including: season, water year type, Folsom Reservoir coldwater pool storage, Folsom Dam shutter configuration, and water demand.
- Continue recording lower American River water temperature in a consistent manner.
- Allow for the building of a continuous time series of daily water temperature records at (at least) three locations that are meaningful for the fish resources of the lower American River.
- Provide basic water temperature-related statistics (e.g., daily and monthly averages, variances, maxima and minima) that will serve as explanatory variables in hypothesis testing.
- Develop water temperature profiles for Folsom Reservoir and Lake Natoma.

ACTIONS

The actions listed below have been developed to implement the objectives of the Water Temperature Monitoring component.

- Collect water temperature measurements at a frequency, accuracy, and duration necessary to represent water temperature conditions experienced by fish and other aquatic life throughout the lower American River.
- Collect water temperature profile information from representative locations in Folsom Reservoir and Lake Natoma.
- Model temperature conditions along the lower American River under various combinations of potential conditions represented by different seasons, flow rates, and Folsom Dam shutter configurations.

7.1.9. RIVER HYDROLOGY MONITORING

Flow rates and fluctuations may affect chinook salmon and steelhead populations in various ways, including the timing of spawning and juvenile emigration. Additionally, sudden rapid changes in flow are known to affect egg survival and alevins by exposing redds, and affect the survival of juveniles that become stranded in pools and side channels with inadequate food sources and high competition and predation.

Adequate monitoring of flow rates along the lower American River will provide the basic data to test the influence of flow on spawning and juvenile emigration, as well as on redd dewatering and juvenile stranding.

OBJECTIVES

Objectives for the River Hydrology Monitoring component are to:

- Develop a continuous and accurate record of representative hourly and daily flow rates at USGS gauges (Folsom Dam, Goethe Park, and the north and south forks of the American River).
- Utilize various flow metrics in developing and evaluating biological and ecological functional relationships of the lower American River.

ACTIONS

The actions listed below have been developed to implement the objectives of the River Hydrology Monitoring component.

- Collect accurate and consistent flow rate measurements of necessary frequency, accuracy, and duration at specified locations to represent flow conditions experienced by fish throughout the lower American River.
- Report hourly, daily, weekly, and monthly flow rates for the identified USGS gauges.
- Collect and report flow-stage levels in the lower American River at sufficient sites to further develop and evaluate functional relationships and guide resource management actions.

7.1.10. ADULT CHINOOK SALMON POPULATION MONITORING

Adult abundance, which is referred to as "escapement" for chinook salmon populations, is usually estimated by carcass surveys. The primary purpose of this monitoring is to assess the overall effectiveness of management activities and restoration programs. To accomplish this, accurate escapement estimates are required and the age distribution of the adult fish must be known so that adult abundance can be segregated into broods (i.e., year classes) that correspond to a particular in-river residence period. Current adult monitoring efforts do not entirely meet these requirements.

The accuracy of carcass surveys is of concern as the surveys may not be conducted in a consistent manner and, for safety reasons, cannot be conducted during high flows. Additionally, although samples of fresh carcasses have been collected, often weekly, since 1992, there is concern regarding the extent to which these samples permit a rigorous assessment of the age distribution of spawning adults, sex ratio, rate of successful spawning and pre-spawning mortality.

Although scale samples and often otoliths are collected during carcass surveys, there has not been any up-to-date determination of age distribution of chinook salmon spawning in the lower American River. Instead, either a standard length (e.g., 65 cm) is used to distinguish Age 2 and Age 3+ salmon, or length frequency analyses are used to determine the age of the fish. The standard length method is not consistently accurate and there is uncertainty regarding length-frequency analyses without verification with scales or otoliths. Additionally, males and females of the same age may be different lengths.

Although sex ratio and female spawning rate are currently assessed from samples of fresh carcasses collected during the carcass surveys, there is uncertainty regarding whether these estimates correctly reflect the entirety of the spawning period. For example, weekly carcass samples may not cover the entire spawning period. Moreover, weekly samples occasionally are too small or not proportional to the number of observed fresh carcasses. There also is an unknown degree of imprecision in the visual classification of female carcasses into egg retention classes [“not spawned” (e.g., nearly full ovaries), “partially spawned” (e.g., more than 50 percent egg retention) and “fully spawned” (e.g., few eggs remaining)]. Finally, there is uncertainty regarding the degree to which the ratio of the number of un-spawned females to the number of female carcasses sampled during the survey accurately depicts pre-spawning mortality. In particular, female carcasses have been scarcely sampled during October to early November, when most pre-spawning mortality may occur.

The Adult Chinook Salmon Population Monitoring component would continue carcass surveys in the lower American River through the Spawning Escapement Survey and Carcass Biological Sampling efforts, described in the following sections.

SPAWNING ESCAPEMENT (CARCASS) MONITORING

Knowledge of the dynamics of fish populations is essential for developing appropriate management, restoration and monitoring plans or programs. In the present context of fish management, population dynamics include estimation of the changes in population numbers, composition or biomass. Population size can be estimated by numerous methods. Spawning surveys represent one means of establishing annual spawning run size. Estimating the total annual fall-run chinook salmon population in the lower American River is based on various factors including: (1) extent of spawning below Watt Avenue; (2) extent of spawning above the Nimbus Hatchery training weir; (3) extent of fish passage into the Nimbus Hatchery; (4) amount of angler catch; (5) impingement on the Nimbus Hatchery training weir; and (6) unknown causes of fish disappearance.

Numerous estimation procedures and protocols have been used since 1944 (i.e., expansion of direct counting, Peterson method, Schaefer method, and Jolly-Seber method). Since 1976, CDFG has used fresh carcasses and a modified Schaefer method to estimate annual chinook salmon population size. However, carcasses surveys have not always been implemented with consistency for a representative period, thus a significant degree of uncertainty is associated with the Schaefer estimates of fall-run chinook salmon spawning population and the hypotheses associated with these abundance estimates.

Objectives

Objectives for the Spawning Escapement (Carcass) Monitoring of the Adult Chinook Salmon Population Monitoring component are to:

- Accurately assess the population status of fall-run chinook salmon naturally spawning in the lower American River.
- Provide continuity in the analysis of population trend abundance. In the lower American River, chinook salmon carcasses have been monitored since 1944, and since 1974 the Schaefer method has been utilized to assess escapement.

- Provide potential response variables to assess the impact of various stressors (e.g., lower American River water temperatures and flows) and management actions.
- Assess contribution of hatchery-reared chinook salmon and chinook salmon from other rivers to the population of fall-run chinook salmon naturally spawning in the lower American River.
- Assess the effect of water turbidity on carcass counts and Schaefer escapement estimates.
- Contrast escapement estimates based upon total and fresh carcasses with Schaefer method estimates.
- Evaluate spawning timing and relationship to water temperature.

Actions

The actions listed below have been developed to implement the objectives of the Adult Chinook Salmon Population - Spawning Escapement (Carcass) Monitoring component.

- Estimate total escapement of adults and grilse, by reach, using the Schaefer method.
- Count, record and report all observed fresh and decayed carcasses by date, week, reach and survey.
- Record and report water turbidity by date and sampling site.
- Count carcasses with other marks/tags and record type of mark/tag.
- Remove snout from adipose-clipped carcasses observed and retain in individually labeled plastic bags for later detection, removal and decoding of coded-wire tags.

Rationale

Annual Schaefer estimates of adults and grilse chinook salmon will allow the time series of Schaefer abundance estimates started in 1974 to continue, and avoid the variability that the introduction of a new abundance estimation method might introduce in the analysis of the lower American River fall-run chinook salmon population trend. The counting and recording of all observed fresh and decayed carcasses will provide additional ways to estimate relative abundance and check trends or relationships with stressors detected using only Schaefer abundance estimates. If carcass surveys are performed every year from October 1 to January 31, the cumulative fresh and total carcass counts may provide a consistent way to assess spawning timing. Moreover, weekly estimates of water turbidity at the survey sites will provide a way to quantify effects on tag recovery rate and carcass observations that may influence the accuracy of Schaefer abundance estimates and carcass counts. Recording of all carcasses with foreign marks or tags will aid in assessing hatchery-reared and stray salmon in the fall-run chinook salmon spawning population.

Alternative Hypotheses

Eight alternative hypotheses have been identified for the Spawning Escapement Abundance Monitoring.

Hypothesis A.1: The population of fall-run chinook salmon naturally spawning in the lower American River can be determined.

Hypothesis A.2: Total carcass counts (both fresh and decayed) show the same temporal trend as Schaefer escapement estimates.

Hypothesis A.3: The accuracy of carcass counts and/or Schaefer escapement estimates decreases with water turbidity.

Hypothesis A.4: The accuracy of carcass counts and/or Schaefer escapement estimates decreases with variable water flow rates.

Hypothesis A.5: Weekly carcass counts and/or Schaefer escapement estimates can accurately depict run timing.

Hypothesis A.6: High water temperatures from September through October delay spawning.

Hypothesis A.7: Adult chinook salmon time their upstream spawning migration into the American River in response to high flows rather than in response to major storm events (e.g., declining barometric pressure and air and water temperatures).

Hypothesis A.8: Hatchery-reared salmon as well as strays constitute a significant component of the population of fall-run chinook salmon spawning naturally in the lower American River.

Experimental Design

Survey Location

The lower American River from Sailor Bar (RM 22) to Watt Avenue (RM 9), divided into three reaches:

Reach 1 - Sailor Bar (RM 22) to Rossmoor (RM 18);
Reach 2 - Rossmoor to Goethe Park Footbridge (RM 14.5); and
Reach 3 - Goethe Park Footbridge to Watt Avenue (RM 9).

Survey Period

Every year carcass surveys would start on October 1 and end on January 31. A delayed start or early end of the survey (e.g., hazardous conditions due to high flows, unavoidable logistic problems) would be documented. The lack of observed carcasses in early October does not constitute a cause for delaying the start of the survey because counts of zero observed carcasses are extremely important when assessing spawning timing.

Sampling Frequency

Weekly carcass counting and tag recovery would be performed in each river reach during the entire survey period (18 weeks). Fresh carcass tagging would be performed during the first 16 weeks of the survey period. No tagging would be performed during the last two weeks of the survey period to ensure recovery of all tagged carcasses.

Survey Procedure

The survey procedure would include the following activities:

- Count and tag all fresh carcasses with color-coded hog ring in lower jaw. Fresh carcasses have either one clear eye or pink gills. Carcasses that do not satisfy these conditions are non-fresh or decayed. Tag color-coding may allow identification of tagging week and site (i.e., reach). If, on a particular sampling date, no fresh carcasses are found, the sampling date and site and a count of "zero" would be recorded.
- Return fresh carcasses to flowing water just upstream from where they were collected, and record numbers tags, color code of tag, release date and site (i.e., reach).
- Count and record expected age class (e.g., grilse, adult) of non-fresh carcasses, record observation date and site (i.e., reach) and cut through backbone with machete to remove from future surveys. If on a particular sampling date no decayed carcasses are found, the sampling date and site, and a count of "zero" would be recorded.
- Record water turbidity using a Secchi disc. There would be two measurements per tagging/recovery date and sampling reach. Measurements would be taken at the start and end of the sampling event. Record date, time, site and Secchi-disc depth.
- Record recovered tagged carcasses, age class (grilse or adult), date and site of recovery and color code of tag; cut recovered carcasses through backbone to remove from future surveys.
- Count carcasses with other marks/tags and record numbers recovered, date, site and type of mark/tag.
- Remove snout from adipose-clipped carcasses and retain in individually labeled plastic bags for later detection, removal and decoding of coded-wire tags. Plastic-bag labels should indicate date, site (i.e., reach) of recovery and fork length of carcass.

Data Quality Control, Reporting and Storage

After each sampling week, field and data-entry personnel would check field-recorded data for errors. Survey data would be stored in individual electronic files. Files would contain all raw information and will be in ASCII, comma-separated variable format. The following information would be identified:

- Sampling date;
- Number of adult decayed carcasses counted and chopped by reach (entry of "zero" if no decayed carcass was observed);
- Number of grilse decayed carcasses counted and chopped by reach (entry of "zero" if no decayed carcass was observed);
- Number of fresh carcasses tagged and released by reach (entry of "zero" if no fresh carcass was released);
- Color of tag(s) on released fish;
- Number of fresh carcasses recovered and chopped by reach and color-coding tag;
- Number of carcasses with foreign tags/marks by reach and foreign tag/mark type;
- Number, reach and fork length of recovered, adipose-clipped carcasses whose snouts have been collected;
- Time and value of first Secchi-disc measurement, by reach; and

- Time and value of second Secchi-disc measurement, by reach.

Files would be checked for errors a final time before making them available for analysis. Files would be available no later than three months after the end of the survey (i.e., April 30 if the survey ended on January 31).

Analytical Method

The Schaefer mark-recovery method (Schaefer 1951[1]) as modified by Taylor (1974[2]) would be applied to the tagged and recovered fresh carcasses and total number of carcasses counted (both fresh and decayed) to produce escapement estimates. Escapement would be estimated for the entire survey and for each reach and recovery week.

Equipment

Equipment necessary to perform the surveys includes the following items: drift boat, gaffs, hog rings, pliers, colored surveying tape, machetes, data-recording slates, tape measures, knives, plastic bags, recovery labels for adipose-clipped fish, and Secchi disc.

Reporting Procedure

Every year, CDFG would prepare a final report presenting the results of the annual carcass survey. The report would be prepared no later than six months after the end of the survey (i.e., July 31 if the survey ended on January 31). The report would include the results of the spawning escapement monitoring and the carcass biological sampling.

Report contents corresponding to spawning escapement abundance monitoring would include:

- Brief introduction.
- Description of sampled reaches (including date on which each reach was sampled). Any specific modification made to the sampling protocol would be clearly stated and justified in the report.
- A data table indicating the total number of observed decayed carcasses, tagged fresh carcasses and recovered fresh carcasses by week (date), reach and age class (grilse or adult). If not all observed fresh carcasses were tagged, the observed number would be reported and an explanation of tagging procedure provided.
- Schaefer escapement estimates for the survey and for each reach.
- Periods for which estimates could not be obtained or were generated by means other than Schaefer estimation procedure (e.g., average recovery rates for weeks with no recovery).
- A summary table containing Schaefer model capture-recapture data matrix (e.g., Table 9a in Snider and Reavis 1996[3]).

---

1 Schaefer, M. B. 1951. Estimation of size of animal populations by marking experiments. U.S. Fish and Wildlife, *Fishery Bulletin* 52 (69): 189-203.
2 Taylor, S. N. (ed.) 1974. King (chinook) salmon spawning stocks in California's Central Valley, 1973. California Department of Fish and Game, Rep. No 74-12, 32 pp.
3 Snider, B. and B. Reavis, 1996. Lower American River Chinook Salmon Escapement Survey, October 1995 – January 1996. . California Department of Fish and Game, 17 pp. and 12 figures.

- Table(s) containing fall-run chinook salmon population estimates using Schaefer estimation method (e.g., Table 9b in Snider and Reavis 1996).
- Table(s) containing average flows, water temperatures and water visibility (i.e., average Secchi depths) per survey week. Daily flow discharges (cfs) would be obtained from the USGS gaging station at Fair Oaks (USGS# 11446500) and daily temperatures would be obtained from USGS stations at Hazel Avenue and Watt Avenue bridges.
- Table(s) containing the number of recovered adults and grilse with other marks/tags by survey week.
- Table(s) containing coded-wire tag data from recovered salmon, including coded-wire tag number(s), number of adults/grilse recovered, brood year, number of juveniles planted, release date, release site and hatchery of origin.

Personnel

CDFG would continue to conduct the carcass surveys, data reporting and storage, result reporting and distribution. CDFG also would train field crew on the survey and safety protocols. The field crew would be able to perform survey tasks in a consistent and efficient manner and would be able to differentiate fresh carcasses from decayed ones with the minimum possible error. CDFG also would provide personnel for data-entry and result reporting.

CARCASS BIOLOGICAL SAMPLING

Since 1992, CDFG has conducted biological sampling of fresh carcasses during the carcass surveys that provide Schaeffer escapement estimates. These biological samples have provided initial insight into the distribution of length, gender composition, and females spawning success of fall-run chinook salmon populations in the lower American River. The continuation of this sampling in a consistent manner would facilitate a better understanding of the composition and dynamics of the spawning population and test many of the related hypotheses. The goal would be to intensify the biological sampling of fresh carcasses performed in conjunction with the lower American River carcass surveys.

Objectives

Objectives for the Carcass Biological Sampling of the Adult Chinook Salmon Population Monitoring component are to:

- Assess the annual and weekly sex ratio of the population of fall-run chinook salmon naturally spawning in the lower American River.
- Assess the annual and weekly ratio of successfully spawned females in the population of fall-run chinook salmon naturally spawning in the lower American River.
- Evaluate annual and weekly pre-spawning mortality.
- Assess the length composition of the population of fall-run chinook salmon naturally spawning in the lower American River.
- Assess the age composition of the population of fall-run chinook salmon naturally spawning in the lower American River.
- Estimate adult escapement segregated into broods (i.e., year classes) that correspond to particular periods of in-river residence.

Actions

The actions listed below have been developed to implement the objectives of the Adult Chinook Salmon Population – Carcass Biological Sampling Monitoring component.

- Measure length, determine sex, and record representative samples of the fresh carcasses of fall-run chinook salmon observed during each week of the annual carcass surveys.
- Determine and record the egg-retention status of representative samples of fall-run chinook salmon fresh carcasses observed during each week of the annual carcass surveys.
- Collect representative samples of scales from the fresh carcasses of fall-run chinook salmon observed during each week of the annual carcass surveys.
- Analyze collected scales to determine age.
- Analyze the relationship between the age and length of the fresh carcasses of fall-run chinook salmon spawning in the lower American River.

Rationale

Although sex ratio and female rate of successful spawning have been assessed during past carcass surveys (1992-2000), there is uncertainty regarding whether the samples of fresh carcasses, on which these ratios are based, are representative enough to reflect annual and weekly changes in the ratios as the spawning season progress. It is expected that intensification in the weekly sampling effort will reduce this uncertainty and provide better annual and weekly estimates of sex ratio, as well as rate of successful spawning and pre-spawning mortality, which will allow a more rigorous testing of hypotheses A.1 through A.9 (stated below).

Although scale samples, and often otoliths, have been collected during past carcass surveys, there has not been any up-to-date determination of age distribution of chinook salmon spawning in the lower American River. Thus, any possibility of segregating adult abundance estimates into broods (i.e., year classes) that correspond to particular in-river residence periods has been hindered. The collection of representative scale and otolith samples during annual carcass surveying and an intensification in the age-determination effort is expected to allow the assessment of the age distribution of the population of fall-run chinook salmon spawning in the lower American River. In turn, the assessment of the age distribution of spawning adults will allow testing of hypotheses A.7 to A.10 (listed below), as well as provide key information regarding lower American River fall-run chinook salmon population dynamics.

Alternative Hypotheses

Alternative hypotheses identified for the Carcass Biological Sampling element are listed below.

Hypothesis A.1: Annual pre-spawning mortality from thermal stress can be substantial.

Hypothesis A.2: Annual pre-spawning mortality increases as the duration of elevated water temperature continues or increases.

Hypothesis A.3: Pre-spawning mortality increases as water temperature increases during adult holding, through early November.

Hypothesis A.4: As the spawning season progresses and water temperature decreases, pre-spawning mortality decreases (new fish enter the river population).

Hypothesis A.5: Annual female spawning success ratio is dependent upon the water temperatures encountered from November though January.

Hypothesis A.6: There is no significant change in the annual sex ratio of fall-run chinook salmon naturally spawning in the lower American River.

Hypothesis A.7: As the spawning season progresses, there are significant changes in the weekly sex ratio of fall-run chinook salmon naturally spawning in the lower American River.

Hypothesis A.8: There are no significant changes in the annual contribution of Age 2, Age 3 and Age 4+ to the lower American River fall-run chinook salmon spawning population.

Hypothesis A.9: There is a significant long-term decline in the annual proportion of Age 3 and Age 4+ fall-run chinook salmon that spawn in the lower American River.

Hypothesis A.10: Adult escapement estimates by year-class show a significant relationship to the water temperature and flow conditions experienced by fall-run chinook salmon juveniles during their rearing and outmigration period.

Hypothesis A.11: The variation in adult escapement estimates by year-class responds only to biotic and environmental conditions, and the harvest experienced by the brood outside the lower American River, as opposed to in-river conditions.

Experimental Design

Sampling Location

The lower American River from Sailor Bar (RM 22) to Watt Avenue (RM 9), divided into three reaches:

Reach 1 - Sailor Bar (RM 22) to Rossmoor (RM 18);
Reach 2 - Rossmoor to Goethe Park Footbridge (RM 14.5); and
Reach 3 - Goethe Park Footbridge to Watt Avenue (RM 9).

Sampling Period

The sampling period will extend for 18 weeks, October 1 through January 31.

Sampling Frequency

Fresh carcass samples will be taken weekly from each reach over the course of the entire survey period (18 weeks).

Survey Procedure

The sampling procedure would include the activities described below.

- Measure fork length (to the nearest cm), determine sex, and record all fresh carcasses tagged weekly for the Schaefer mark-recapture method. If the number of fresh carcasses is so large that it would obstruct the Schaefer tagging process, take a random sample of no less than 500 fresh carcasses per week and reach.

- Classify and record all fresh female carcasses into egg-retention classes tagged weekly for the Schaefer mark-recapture method. If the number of fresh carcasses is so large that it would obstruct the Schaefer tagging process, take a random sample of no less than 500 fresh female carcasses per week and reach. Female egg-retention classes include: "not-spawned" (e.g., nearly full ovaries); "partially spawned" (e.g., more than 50 percent egg retention); and "fully spawned" (e.g., few eggs remaining).
- Collect scales from all fresh carcasses tagged weekly for the Schaefer mark-recapture method in individually labeled envelopes. Only if the number of fresh carcasses is as large as to obstruct the Schaefer tagging process, take a random sample of no less than 500 fresh carcasses per week and reach. The labels of the scale-envelopes should indicate date, collection site (i.e., reach), fork length and sex of carcass.
- Collect a random sample of at least 100 ovaries from all female carcasses recovered during the annual Schaefer mark-recapture survey. Keep ovaries in individually perforated labeled bags for later determination of degree of egg retention. Bags will be kept submerged in a plastic container with a mix of ethanol-formaldehyde. Bag labels should indicate date, collection site (i.e., reach), fork length, and egg-retention class assigned in the field to the female carcass.

Data Quality Control, Reporting and Storage

After each sampling week, field and data-entry personnel will check field-recorded data for errors. In particular, the labels of all bags and envelopes will be checked to ensure that all collected ovaries and scales are correctly identified. Data will be stored in individual electronic files. Files will contain all raw information and will be in ASCII, comma-separated variable format. Each row will correspond to a sampled carcass. Columns will identify:

- Sampling date;
- Reach;
- Fork length in cm (cells with missing values will be left blank);
- Sex code (Male = 1, Female = 2, Uncertain = 3, Missing gonads = 4, Not determined = blank);
- Field egg-retention code (Not spawned=0, Partially Spawned=1, Fully Spawned=2, Uncertain=3, Missing gonads=4, Not determined=blank);
- Ovary collected (Yes=1, No=0);
- Laboratory egg-retention percentage (indicate actual percentage of egg retention, if determined, or leave blank);
- Scale collected (Yes=1, No=0);
- First scale age reading (indicate age reading by first reader, otherwise leave blank);
- Second scale age reading (indicate age reading, otherwise leave blank); and
- Confirmed age (indicate age reading, if confirmed, otherwise leave blank).

Files will be checked for errors a final time before making them available for analyses. Age readings must be added at this time. Files will be available no later than six months after the end of the survey (e.g., January 31 if the survey ended on July 31).

Analytical Method

Collected ovaries will be examined in the laboratory using microscopy and commonly used histological procedures to determine the actual percentage of eggs retained in the ovaries.

At least 10 scales per length-class will be selected randomly from the pool of scales collected during the survey for age determination. Two readers will independently count the scale annuli and assess and report the age of each scale. After both readers have read all the selected scales, they will read them together and assign and record an age to each scale. The three readings will be entered in the survey files.

Equipment

Field Work Equipment List: Drift boat, gaffs, hog rings and pliers, colored surveying tape, machetes, data recording slates, tape measures, knife, plastic bags and envelopes for collected ovaries, scales and otoliths, labels for bags and envelopes and plastic container with a mix of ethanol-formaldehyde.

Laboratory Equipment List: Histological microscope and a scale-magnification device.

Reporting Procedure

Every year, CDFG will prepare a final report comprised of the results of the annual carcass survey. The report will be released no later than six months after the end of the survey (i.e., July 31 if the survey ended on January 31). The report will include both the results of the spawning escapement abundance monitoring, as well as the results of the carcass biological sampling.

Report contents corresponding to carcass biological sampling will include:

- Brief introduction.
- Description of sampled reaches detailing the dates on which each reach was sampled during the weekly surveys. Any specific modification to the sampling protocol must be clearly stated and justified. In particular, the sampling description would indicate during which weeks of the survey tagged fresh carcasses were not all sampled, indicating the number(s) sampled instead.
- A table showing the length frequency distribution of sampled fresh carcasses by 1-cm length-class, sex and river reach.
- Average fork length and standard deviation of sampled fresh carcasses per sex and river reach.
- Estimates of sex ratio and pre-spawning mortality for the entire survey.
- A report of any significant temporal trend detected in the weekly data (sex and pre-spawning mortality ratios).
- A table displaying the length frequency distribution of female “not-spawned,” “partially-spawned,” and “fully spawned” sampled females by 1-cm length-class. The table will be based on the classification made in the field. In addition, the table will indicate the number of sampled females that were not classified.

- A table summarizing the percentages of egg retention for the 100 collected ovaries analyzed in the histology laboratory.
- An estimate of the error of the field classification into the three egg-retention categories based on the comparison of the laboratory- and field-assigned egg-retention categories for the 100 collected ovaries.
- Three tables summarizing the length-age matrices based on the three scale-readings.
- Estimates of the total numbers and percentages of ages 2, 3, and 4 for the entire survey based on the length frequency distribution of sampled fresh carcasses and the three length-age matrices.

Personnel

CDFG will continue to conduct the carcass biological sampling, data reporting and storage, result reporting and distribution. CDFG also will train field crew on the survey and safety protocols. The field crew will be able to perform survey tasks in a consistent and efficient manner. They will be trained and able to differentiate fresh carcasses from decayed ones as well as determine female egg-retention categories with the minimum possible error. CDFG also will provide personnel for data entry, histological analysis of chinook female gonads, scale reading (i.e., age determination) and result reporting.

7.1.11. SPAWNING GRAVEL CONDITION MONITORING

Sediment supply is an important watershed attribute that contributes to stream channel meander and maintenance of riparian ecosystems and fish spawning areas. Gravel is an essential element of spawning and rearing habitats for fall-run chinook salmon, steelhead and other native fishes. Lack of sediment recruitment from upstream watersheds, ranging from fine sands to cobbles, may adversely influence the structural characteristics of the stream channel and impair spawning habitat (CalFed 2000).

Folsom and Nimbus dams block gravel recruitment on the lower American River. Although gravel supplies are not thought to currently limit salmonid production in the lower American River, they may become limiting in the near future. The long-term adverse effects of impaired upstream gravel recruitment have not been adequately investigated (CalFed 2000).

Objectives

Objectives for the Spawning Gravel Condition Monitoring component include:

- Develop spawning site preference/suitability criteria.
- Identify the rate at which suitable spawning gravels are depleted.
- Identify the rate at which suitable spawning gravels are replenished.
- Identify flow rates required to transport suitable spawning gravel.

Actions

The actions listed below have been developed to implement the objectives of the Spawning Gravel Condition Monitoring component.

- Conduct chinook salmon spawning activity observations (photograph redds at selected flows with on-the-ground verification).
- Analyze gravel composition and site characteristics of used spawning sites to develop site preference/suitability criteria.
- Identify unsuitable spawning gravels in known spawning areas and physically modify these gravels to mimic suitable spawning gravels.
- Assess spawning gravel storage in banks and monitor erosion rates and erosion composition.
- Survey spawning gravel bed mobility and transport rate.

7.1.12. CHINOOK SALMON SPAWNING MONITORING (REDD SURVEYS)

CDFG has conducted annual redd surveys based on aerial photography and ground reconnaissance surveys during the fall-run chinook salmon spawning period (October-January) since 1991. Aerial surveys were conducted regularly from 1991 to 1996. Survey activity was limited in 1997 and 1998, and was fully resumed in 1999. CDFG redd surveys help to hypothesize lower American River relationships between the temporal and spatial distribution of fall-run chinook salmon spawning activity and water temperature and flow.

Objectives

Objectives for the Chinook Salmon Spawning Monitoring component are to:

- Provide continuity to the analysis of the magnitude of spawning and the temporal and spatial distribution of fall-run chinook salmon spawning in the lower American River.
- Assess inter- and intra-annual trends in the temporal and geographic distribution of fall-run chinook salmon spawning in the lower American River.
- Assess inter- and intra-annual trends in the temporal and geographic distribution of redd superimposition in the lower American River.
- Provide validation to assessments of spawning magnitude and timing based on carcass abundance surveys.
- Test current hypotheses on the relationships between the temporal and spatial distribution of fall-run chinook salmon spawning activity, and water temperature and flow.
- Develop baseline information on the distribution of redds at various tested flows to ascertain redd-dewatering, linked to changes in flow.

Actions

The actions listed below have been developed to implement the objectives of the Chinook Salmon Spawning Monitoring component.

- Conduct weekly aerial photography surveys and ground reconnaissance surveys coinciding with ongoing chinook salmon carcass abundance surveys.
- Enumerate fall-run chinook salmon redds in the lower American River by geographic location, habitat type and river flow.

- Assess redd superimposition weekly and annually.

7.1.13. JUVENILE CHINOOK SALMON EMIGRATION MONITORING

Since 1992, CDFG has conducted juvenile fall-run chinook salmon emigration surveys by rotary screw trapping. The 1992 and 1993 studies dealt primarily with overcoming logistic problems inherent to rotary screw trap surveys. From 1994 to 1997, traps were fished during the chinook salmon emigration period, January through July. Starting in 1998, traps have been fished year-round. For most of these surveys, weekly mark-recapture studies have been conducted during peak emigration periods.

Since 1994, the annual rotary screw trap catch and capture efficiency estimates from the mark-recapture studies have provided the only relative abundance estimate of the fall-run chinook salmon emigration from the lower American River. Therefore, there is a need to continue, and possibly intensify, this monitoring effort.

Objectives

Objectives for the Juvenile Chinook Salmon Emigration Monitoring component are to:

- Continue analysis of fall-run chinook salmon emigration from the American River.
- Provide precise estimates of the annual abundance and timing of emigrating juveniles.
- Assess the size and age composition of the population of emigrating juveniles.
- Assess inter- and intra-annual trends in abundance, size and age composition of emigrating juveniles.
- Assess relationships between the abundance and timing of the emigrating juveniles and lower American River flow rates and water temperatures.
- Assess relationships between the abundance of the emigrating juveniles and the abundance of returning adults for the corresponding broods or year-classes.

Actions

The actions listed below have been developed to implement the objectives of the Juvenile Chinook Salmon Emigration Monitoring component.

- Continue rotary screw trap surveying at least during the fall-run chinook salmon emigration period.
- Conduct consistent daily mark-recapture studies during the fall-run chinook salmon emigration period to allow accurate estimates of rotary screw trap efficiency.
- Evaluate the relationship between rotary screw trap efficiency and daily flow rates.

7.1.14. ADULT STEELHEAD SPAWNING MONITORING (CREEL CENSUS AND REDD SURVEYS)

CDFG conducted steelhead redd counts only in 1991/92 (Snider and McEwan 1993), when flow and water conditions were favorable for visual observations. In that survey, it was reported that steelhead redds were too small to be consistently recognized in aerial photographs, leaving less efficient ground surveys to provide most steelhead redd data. There is a need to develop an efficient survey design for the evaluation of steelhead redds.

Creel census surveys have been conducted in past years to estimate steelhead in-river harvest rates as well as to assess the temporal and geographical distribution of wild and hatchery adult steelhead. Staley (1976) conducted intensive creel census surveys during the 1971-1972 and 1973-1974 steelhead sport fishing seasons, while Meyer (1981-1986) conducted censuses during the 1982-86 sport fishing seasons. Since April 1998, CDFG has continued creel census efforts on the American River. In addition to providing estimates of in-river harvest rates, recent creel census surveys have shown a predominance of steelhead without clipped adipose fins (presumably wild fish) through September. Steelhead with clipped adipose fins, on the other hand, appear to predominate from October through December. Establishing the cause for this observed distribution pattern will require the continuation and intensification of steelhead creel census surveys.

Objectives

Objectives for the Adult Steelhead Spawning Monitoring component are to:

- Develop an efficient survey for the assessment of steelhead redds.
- Initiate and continue full-scale analysis of the magnitude of spawning, and the temporal and spatial distribution of steelhead spawning in the lower American River.
- Assess inter- and intra-annual trends in the temporal and geographic distribution of steelhead spawning in the lower American River.
- Assess inter- and intra-annual trends in the temporal and geographic distribution of redd superimposition in the lower American River.
- Develop and test hypotheses on the relationships between the temporal and spatial distribution of steelhead spawning activity, and water temperature and flow, in the lower American River.
- Develop baseline information on the distribution of redds at various tested flows to ascertain redd-dewatering linked to changes in flow.
- Develop survey method for creek census.
- Assess inter- and intra-annual trends in abundance (creel census survey).

Actions

The actions listed below have been developed to implement the objectives of the Adult Steelhead Spawning Monitoring component.

- Design, conduct and compare weekly aerial photography surveys and ground reconnaissance surveys.
- Develop a method to integrate aerial and terrestrial redd counts in more precise estimates of redd counts.
- Enumerate steelhead redds in the lower American River by geographic location and habitat type.
- Assess redd superimposition weekly and annually.
- Design and implement a comprehensive creel census survey to determine catch per unit effort (CPUE) and develop metric of relative abundance based on these results.

7.1.15. JUVENILE CHINOOK SALMON AND STEELHEAD REARING MONITORING

CDFG has been conducting seining surveys and rotary screw trapping surveys to define the temporal and spatial distribution of salmonids and other fish in the lower American River from 1992 through 1999. CDFG has produced fish community survey reports through 1995. In addition, steelhead captured by seining are reported for 1998/97 in Snider and Titus (2000). Comparison of the catches taken by rotary screw traps and seining efforts suggest that both fishing devices are adequate to broadly represent the temporal distribution of juvenile steelhead.

Unfortunately, rotary screw traps do not appear to provide adequate estimates of juvenile steelhead abundance (Snider et al. 1997b). Results from a seining survey conducted concurrent with the 1994/95 screw trap survey demonstrated the screw trap's inability to capture the majority of steelhead juveniles. Substantially more young-of-the-year steelhead were captured by seining than were caught by the screw traps (1,231 vs. 27 fish), suggesting that few steelhead, if any, actively emigrate as YOY or that the traps did not catch them.

A continuous and simultaneous juvenile chinook salmon and steelhead monitoring effort using rotary screw trapping and other methods (i.e., seining, electrofishing, snorkeling and direct counting) would be required. This effort would enhance current knowledge of the geographical and temporal distribution of juvenile chinook salmon and steelhead rearing timing and the effects of environmental variables (i.e., flow, visibility) on the fishing efficiency of the devices used.

Objectives

Objectives for the Juvenile Chinook Salmon and Steelhead Rearing Monitoring component are to:

- Enhance the knowledge of the geographical and temporal distribution of chinook salmon and steelhead juveniles during rearing periods.
- Assess the relative capture/detection efficiency of various surveying methods (e.g., seining, electrofishing, snorkeling and direct counting, rotary screw trapping).
- Provide the best estimates of the annual abundance and timing of rearing juveniles.
- Assess the size composition and maturity of the population of rearing juveniles.
- Assess inter- and intra-annual trends in abundance, size and age composition of rearing juveniles.
- Assess relationships between the abundance, size and age composition, and timing of the rearing juveniles, and lower American River flow rates and water temperatures.

Actions

The actions listed below have been developed to implement the objectives of the Juvenile Chinook Salmon and Steelhead Rearing Monitoring component.

- Continue rotary screw trap surveying year-round.
- Conduct surveys using methods other than rotary screw trapping (e.g., seining, electrofishing, snorkeling and direct counting)
- Conduct consistent daily mark-recapture studies during the juvenile chinook salmon and steelhead rearing period to estimate relative detection/capture efficiencies for the methods identified in the objectives.
- Evaluate the relationship between relative detection/capture efficiencies and river conditions.

7.1.16. HATCHERY PRODUCTION MONITORING

An accurate determination of the hatchery-reared and released fish contribution to the total lower American River chinook salmon and steelhead spawning population and straying rates is not possible due to the lack of a constant fractional marking program for Central Valley hatcheries. The last constant marking programs implemented in Central Valley hatcheries ended in 1984 (program ran from 1978 to 1984). The absence of an estimate of hatchery-reared and released fish to the total lower American River chinook salmon and steelhead spawning population(s) precludes testing restoration success linked to hatchery releases in the Central Valley.

Objectives

Objectives for the Hatchery Production Monitoring component are to:

- Assess contribution of hatchery-reared and released chinook salmon and steelhead to the naturally spawning adult population.
- Assess survival rates of chinook salmon and steelhead fry relative to the naturally spawning adult population.
- Assess the age composition of the returning population of Nimbus Hatchery-released chinook salmon and steelhead.
- Assess straying rates of Nimbus Hatchery-released chinook salmon and steelhead.

Actions

The actions listed below have been developed to implement the objectives of the Hatchery Production Monitoring component.

- Tag/mark chinook salmon and steelhead reared and released from the Nimbus Hatchery.
- Tag/mark chinook salmon and steelhead reared and released from other hatcheries in the Central Valley.
- Collect, prepare and read scales from Nimbus Hatchery-reared and released chinook salmon and steelhead returning to Nimbus Hatchery.
-

8.0 FISH PLAN IMPLEMENTATION STRATEGY

This chapter describes the manner in which the FWG envisions that the FISH Plan would be carried out. In essence, the FISH Plan articulates a broadly shared understanding regarding the management and restoration actions that are most important to undertake to improve conditions for fall-run chinook salmon, steelhead, and splittail in the lower American River. The FISH Plan is intended to provide a cohesive framework that can: (1) serve as a locus around which public and private entities working in the lower American River can voluntarily coordinate their efforts to responsibly steward lower American River fish and aquatic habitat; and (2) assist funding entities in assessing where habitat enhancement funds might most effectively be invested. However, individual fisheries and aquatic habitat enhancement actions, as well as associated statutory and regulatory compliance requirements, will remain the responsibility of individual project proponents. The FISH Plan is not intended to alter agencies' existing rights or responsibilities (e.g., with regard to policy and fiscal decision-making).

1.1. ADMINISTRATIVE ARRANGEMENTS TO SUPPORT IMPLEMENTATION

Because the FISH Plan will advance many agencies' compatible missions and is being integrated into the LAR Task Force's broader RCMP, the FWG anticipates that the LAR Task Force will be a functional venue through which to coordinate its implementation. This expectation is based on the FISH Working Group continuing to meet, albeit less frequently (perhaps 2 to 4 times per year), to oversee implementation of the FISH Plan (and the analogous portions of the RCMP). This expectation also assumes that the FWG's Technical Subcommittee continues to meet (perhaps 6 to 8 times per year) to guide implementation of these plans in a "hands-on" manner, reviewing monitoring data and developing adaptive management recommendations. It is anticipated that the American River Operations Group (AROG) will continue to meet on a monthly basis to discuss more detailed operational decisions related to lower American River management, but that the efforts of the AROG, TSC, FWG, and LAR Task Force will be complementary to one another.

As FISH Plan and RCMP implementation get underway, the LAR Task Force and its working groups will need to focus on how to implement the recommendations in each of those documents. Some of the recommendations have been initiated already and need little FWG/TSC assistance, while others are at the conceptual stage and will require substantial leadership, guidance, and financial support to bring them to fruition. With this in mind, the FWG and TSC will need to determine which of the recommendations to focus on first, and the most appropriate manner in which to assist project proponents to achieve results that are consistent with FISH Plan goals and objectives (see Section 8.6 for related discussion.)

The Initial FISH Plan is intended to be a living document, in keeping with its adaptive management orientation. The FWG/TSC anticipates that a periodic review of FISH Plan implementation results will be undertaken, generating recommendations regarding adjustments to FISH Plan goals, objectives, conceptual models, recommended actions, priorities, and monitoring provisions. Annual reporting of FISH Plan implementation will be a part of the State of the River Report to be produced by the Water Forum. Throughout the year, the FWG/TSC anticipates:

- Undertaking proactive action planning (including proposal planning) for FISH Plan implementation;
- Providing project-specific feedback on FISH Plan-recommended actions and related projects. Subsets of the FWG/TSC may work together on implementation of FISH Plan recommendations and facilitating associated permitting processes where appropriate;
- Reviewing results and information derived from implementation of FISH Plan recommendations, related projects, and the river-wide monitoring plan;
- Reviewing and commending on drafts of the annual State of the River Report; and
- Interfacing with related initiatives, such as CalFed and other programs.

Should new fisheries and in-stream habitat enhancement opportunities arise, or time-sensitive opportunities to advance second or third priority FISH Plan recommendations, the FWG/TSC is receptive to discussing them as long as first priority FISH Plan recommendations receive their primary focus. The FWG/TSC will make written information available to help project proponents understand the FWG/TSC's functions and how best to avail themselves of opportunities to obtain FWG/TSC feedback on lower American River fisheries and aquatic habitat restoration initiatives.

1.2. Lead Agencies' Roles and Responsibilities

Table 8-1 indicates which organizations would probably need to play key roles in implementing each of the fisheries and aquatic habitat enhancement actions recommended in Chapter 6 (see Column 1).

For those actions where one particular agency clearly would be the appropriate lead agency, that agency's name is underlined (In some cases, it seems appropriate that two or three agencies share the lead.) The fact that an agency is listed in this column reflects the collective perceptions of the FISH Working Group regarding which agencies would have a critical contribution to make towards implementation. However, being listed in this column does not indicate that an agency has agreed to participate in implementing the action, to take the lead in doing so, or to fund implementation of the recommended action.

1.3. Potential Funding Sources

Potential sources of funding for each action are shown in Column 2 of Table 8-1. Again, because an agency or program is listed as a potential source of funding does not mean that that entity has been asked to fund the action in question, nor that it has agreed to do so. The information in Table 8-1 (Column 2) simply reflects the FISH Working Group's ideas about where to begin the effort to obtain funding for the relevant action.

Table 8-1. FISH Plan Recommendations: Implementation Considerations.

Recommended action	1. Key agency(ies)[1]	2. Potential funding source(s)	3. Cost Estimate[2]	4. Time frame	5. Funding status
FIRST PRIORITY RECOMMENDATIONS					
Lower American River Flow/Temperature Regime					
1. Develop and implement an ecologically-based flow management plan for the lower American River, including water temperature management considerations, subject to SWRCB approval.	Water Forum, BAARFS[3], SWRCB, USBR, AROG, City of Sacramento	WFSE, USBR, CalFed, Corps, City of Sacramento	**Development**		
			$1,000,000 to formulate proposal to SWRCB on updated flow management plan (not including implementation, which is to be determined).	Plan development has been initiated. Complete within 2 years.	Partially funded. Approximately $600,000 spent or obligated by City of Sacramento for development of one component (updated flow management plan). This component also has received @ 500 hours of USBR in-kind professional support, @ 170 professional hours of in-kind support per month from AROG member agencies and 30 hours per month from BAARFS member agencies. An additional $50,000-$100,000 is needed to complete this component.[4]
			Implementation, Monitoring, Operations, and Maintenance		
			TBD[5]	TBD	Needed.
2. Develop and implement a comprehensive water temperature monitoring plan for the lower American River.	USBR, CDFG, City of Sacramento, USFWS, NMFS, EID, Water Forum	CalFed, City of Sacramento[6], SAFCA[7], USBR, Water Forum	**Development**		
			Over $1 million for development of comprehensive plan.	Initial steps are underway.	Partially funded by USBR as a component of the function analysis workshop to develop the plan. USBR also has invested @ $195,000 in installation of temperature monitoring equipment in Folsom Reservoir, Lake Natoma, and the lower American River.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	Implement on an ongoing basis. Update plan periodically.	Needed. (USBR spends @$75,000/ year maintaining temperature monitoring stations on the upper and lower American River, and Folsom and Nimbus Reservoirs).

Recommended action	1. Key agency(ies)[1]	2. Potential funding source(s)	3. Cost Estimate[2]	4. Time frame	5. Funding status
3. Develop and implement physical actions and operational and management measures to improve water temperatures in the lower American River.	USBR, CDFG, City of Sacramento, USFWS, NMFS, EID, Water Forum, SAFCA	CalFed, City of Sacramento[6], SAFCA[7], USBR, Water Forum	**Development**		
			TBD	Initial steps are underway.	USBR has invested $2.5 million in design & construction of a TCD for the Folsom Dam M&I intake, $200,000 for the design of a TCD for the EID intake. USBR also spent $100,000 on a value analysis study of lower American River temperature issues, $50,000 on development of related strategies for evaluating study results, and $15,000 for bathymetric surveys of Lake Natoma.[4]
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	Implement on an ongoing basis. Update plan periodically.	Needed. (USBR spends @ $41,000/ year on maintaining temperature monitoring equipment in Folsom Reservoir, Lake Natoma, and the lower American River.)
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.	County of Sacramento (development); Corps, Reclamation Board, CDFG, SAFCA, LAR Task Force, Water Forum (implementation), State Lands Commission	SAFCA, Water Forum, Trout Unlimited, Fish America Foundation, National Fish & Wildlife Foundation, AFRP, Corps	**Development**		
			$100,000 for plan development	Plan development has been initiated. Completion could take 6 months to 3 years.	Needed. (SAFCA has spent $78,000 on the development of planning criteria for woody materials improvements associated with bank protection projects.)
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	Initiate pilot within 3 to 5 years.	Needed.
			$100,00 to $500,000 for evaluation	Initiate evaluation within 1 to 3 years. Complete within 1 to 2 years of start-up.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	If results of evaluation support implementation, implement within 3 to 5 years.	Needed.

Recommended action	1. Key agency(ies)[1]	2. Potential funding source(s)	3. Cost Estimate[2]	4. Time frame	5. Funding status
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.	Corps, Reclamation Board, SAFCA, ARFCD, USFWS, CDFG, NMFS, Water Forum, State Lands Commission	Corps, Reclamation Board, SAFCA, CalFed, Water Forum, Mitigation Funds, Extra-Mural Grants	**Development**		
			$50,000 to $500,000 to identify locations	Initiate within 1 to 3 years. Complete location inventory within 1 to 2 years of start-up.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	Implementation will be ongoing.	Needed.
Artificial Propagation of Fish					
6. Estimate relative proportion of hatchery and naturally produced chinook and steelhead to annual spawning escapement and commercial and sports fisheries to enhance management capabilities.	CDFG, USFWS, NMFS, USBR	CDFG/General Fund, CalFed, USBR, AFRP	**Development**		
			$50,000 to $500,000	Complete within 1 to 3 years.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	May need to be done annually.	Needed.
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.	CDFG, USBR	CDFG, CalFed, USBR, Corps	**Development**		
			$1 to 5 million	Design is underway.	USBR has obligated $350,000 for design of structure, including prototype, & construction of prototype
			Implementation, Monitoring, Operations, and Maintenance		
			$5 million for construction beyond prototype	Expected to be completed in 2003.	Needed.
Stranding					
8. Complete the inventory of areas that pose a stranding threat to juvenile salmonids. Conduct a function analysis workshop to identify measures to reduce or eliminate stranding. Implement measures where appropriate opportunities exist.	CDFG, NMFS, USFWS, Water Forum, USBR, Corps, SAFCA	Corps, USBR, Reclamation Board, SAFCA, CalFed, CVPIA, Water Forum, AFRP, Extra-Mural Grants	**Development**		
			Under $1 million for inventory, V.A. workshop, and pilot	Complete inventory within 2 years.	Partially funded, with $245,000 obligated to CDFG from USBR/CVPIA funds.
			Implementation, Monitoring, Operations, and Maintenance		
			Millions of dollars.	Remedial measures likely to take 2 to 5 years.	Needed.

Recommended action	1. Key agency(ies)[1]	2. Potential funding source(s)	3. Cost Estimate[2]	4. Time frame	5. Funding status
Other Potential Management Actions					
9. Identify the fishery impacts on lower American River priority species caused by meeting Sacramento/San Joaquin Delta WQCP requirements and needs from Folsom Reservoir.	USBR, USFWS, AROG, CDFG, NMFS, Water Forum	Water Forum, CalFed, USBR, Extra-Mural Grants, In-Kind Service	**Development**		
			$5,000 to $50,000 through initial presentation.	Complete within 1 to 3 years.	Needed. (Water Forum has spent approximately 2 days of in-kind support on this as of June, 2001.)
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	Ongoing.	Needed.
10. Improve availability and management of lower American River research data, with attention to quality control.	USBR, CDFG (biological data), USFWS/CAMP, IEP, USGS (physical data), CalFed Science Board, Water Forum (catalyst)	CDFG, Water Forum, SAFCA, CVPIA, National Fish & Wildlife Foundation, AFRP, FWG, RCMP Science Program	**Development**		
			$50,000 to $500,000 initial investment	Initiate within 1 to 3 years. Complete initial effort within 12 to 18 months of start up.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			Approximately $30,000/year on ongoing basis.	Should be ongoing.	Needed.
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.	CDFG, NMFS, USFWS	CalFed, CVPIA, Water Forum, AFRP/IEP	**Development**		
			$65,000 to $500,000	Initiate within 1 to 3 years. Initial determination done within 18 months after start-up.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	Should be ongoing.	Needed.
B. Investigate temporal and spatial distribution of steelhead in the lower American River to strengthen the information base for management decisions.	CDFG, NMFS, USFWS	CalFed, CDFG, CVPIA/USBR, AFRP, NMFS	**Development**		
			$20,000 to $48,000	Underway. Complete initial investigation within 10 to 24 months.	Funded.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	Should be ongoing.	Needed.
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, Water Forum, NMFS, SAFCA (re: long-term re-op)	USBR, CalFed, Water Forum, FWG, CVPIA, SAFCA	**Development**		
			$500,000	Initiate within 1 to 3 years. Likely to take 1 to 5 years to complete model.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	May need to be ongoing.	Needed.

Recommended action	1. Key agency(ies)[1]	2. Potential funding source(s)	3. Cost Estimate[2]	4. Time frame	5. Funding status
SECOND PRIORITY RECOMMENDATIONS					
Aquatic, Riparian and Wetland Habitat					
11. Identify and evaluate opportunities to implement Wetland/Slough Complex restoration, with needs of all priority species in mind.	CDFG, USFWS/AFRP, Water Forum, Corps, State Lands Commission	Corps, CalFed, USBR, AFRP, Other Grants	**Development**		
			$100,000-$500,000 for evaluation	Initiate evaluation within one year. Complete within 1-2 years of start-up	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	If results of evaluation support implementation, implement within 3-5 years.	Needed
Natural Floodplain & 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.	SAFCA (for pilot project), Corps, USFWS, CDFG, NMFS, Water Forum	Corps, SAFCA, Reclamation Board, CalFed, USFWS, Extra-Mural Grants	**Development**		
			$500,000 to $3 million	Initiate within 1 to 3 years. Complete inventory within 2 years of start up.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	Implementation likely to take 1 to 5 years.	Needed
13. Identify opportunities to, and potential benefits of, enhancing or constructing mainstem and side channel habitats that provide salmon and steelhead spawning and rearing habitat, and implement measures where suitable opportunities are available.	USFWS, CDFG, Water Forum, USBR, NMFS, Corps, State Lands Commission	Corps, USBR, CVPIA, CalFed, WFSE, Mitigation Funds, Extra-Mural Grants	**Development**		
			$300,000 to 500,000 for inventory	Complete within 2 years.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			$200 million	Implementation likely to require 3 to 5 years.	Needed.
Harvest of Fish and Wildlife					
14. To assist in protecting and enhancing the 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.	CDFG, USFWS, NMFS,	CDFG, CalFed, WFSE, CVPIA	**Development**		
			Depending on methods used, lower American River cost could range from $500,000 (with otoliths) to millions (with coded wire tagging)	Initiate within 1 to 2 years. Complete within 2 years of start-up.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD. Monitoring will be costly.	Should be ongoing.	Needed.

Recommended action	1. Key agency(ies)[1]	2. Potential funding source(s)	3. Cost Estimate[2]	4. Time frame	5. Funding status
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.	SAFCA, USBR, TSC, AROG, CDFG, DWR, USFWS, NMFS, Corps, Water Forum, SWRCB, State Lands Commission, water interests, environmental organizations	USBR, SAFCA, CalFed, Water Forum, In-Kind Services of TSC & AROG member agencies	**Development**		
			$30,000 to $100,000/ year plus in-kind services	Underway.	Partially funded. At least $300,000 spent or obligated for technical consultation through June, '01.[2] Receives at least 50 hours of professional hours per month of in-kind support from TSC member agencies.[3]
			Implementation, Monitoring, Operations, and Maintenance		
			See above	Should be ongoing.	Partially funded.
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.	Corps, SAFCA, USBR, CDFG	Corps, SAFCA, CalFed, CVPIA	**Development**		
			$50,000 to $150,000 for sensitivity analysis of efforts to date. Up to $500,000 for program development.	Initiate within 2 years. Complete within 1 year from start-up.	Partially funded.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	May be ongoing.	Needed.
17. Assess the need to develop a spawning gravel monitoring and management program for steelhead and fall-run chinook in which intervention would be based on identification of specific sites where intervention would enhance or increase salmonid spawning habitat.	CDFG, USFWS, USBR	CalFed, CDFG, Corps, USBR, CVPIA	**Development**		
			$100,000	Initiate within 1 to 3 years. Complete within 18 months of start-up.	Partially funded ($100,000 in USBR funds to CDFG for experimental program).
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	TBD	Needed.
Artificial Propagation of Fish					
18. Evaluate Nimbus Salmon & Steelhead Hatchery production and stocking practices to identify measures that would promote restoration of native fish species in the lower American River.	CDFG, NMFS	CDFG, CalFed, Water Forum, USBR, Corps, USFWS, CVPIA/AFRP	**Development**		
			Depending on methods, costs could range from under $100,000 to millions	Underway. Complete within 2 years of start-up. May need to be ongoing.	Partially funded.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	TBD	Needed.

Recommended action	1. Key agency(ies)[1]	2. Potential funding source(s)	3. Cost Estimate[2]	4. Time frame	5. Funding status
Other Potential Restoration Actions					
19. Assess feasibility of providing enhanced off-site (e.g., Auburn Ravine, Coon Creek, Dry Creek) steelhead habitat.	USFWS, NMFS, CDFG	CDFG, CalFed, USBR, Corps, AFRP, National Fish & Wildlife Foundation, Mitigation Funds	**Development**		
			$15,000 to $100,000	Initiate within 1 to 3 years. Complete within 6 months of start-up.	Partially funded. USFWS/AFRP spent $36,450 on an existing conditions report on Secret Ravine (a tributary of Dry Cr.) and $40,000 to develop a watershed management plan for Dry Creek (a tributary of the lower American River) with steelhead and chinook salmon needs in mind.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	TBD	Needed.
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.	CDFG, NMFS, USBR	CDFG, Corps, USBR, Water Forum, CalFed, AFRP, NMFS, Fish America, Mitigation Funds	**Development**		
			Under $100,000 to develop. $12,000 to $15,000/year.	Initiate within 1 to 3 years.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	Likely to take 4 months each year, although may not be possible in many years due to flows.	
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, USFWS	NMFS, USFWS, Water Forum, CalFed, AFRP, CDFG	$35,000 to $500,000	Initiate within 3 years. Complete within 1 year of start-up.	Needed.
F. Develop a juvenile steelhead over-summer survival model to assist in understanding factors critical to the well-being of this species.	CDFG, NMFS	Water Forum, CalFed	$100,000 to $500,000	Initiate within 3 years.	Needed.
G. Develop a stock recruitment model for fall-run chinook salmon to guide management decision-making.	CDFG	Water Forum, CDFG, CalFed, AFRP	$10,000	Initiate within 1 to 3 years. Complete within 6 months of start-up.	Needed.
THIRD PRIORITY RECOMMENDATIONS					
20. Identify and characterize the complexity and diversity of aquatic habitats in the lower American River, and implement measures where suitable opportunities are available.	CDFG, NMFS, USFWS	USBR, NMFS, USFWS, CDFG	**Development**		
			$100,000 to 200,000	TBD	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	TBD	Needed.

Recommended action	1. Key agency(ies)[1]	2. Potential funding source(s)	3. Cost Estimate[2]	4. Time frame	5. Funding status
Aquatic, Riparian, and Wetland Habitat					
21. Identify and evaluate suitable locations and benefits of establishing or providing SRA habitat along the lower American River to benefit priority fish species, and implement measures where appropriate opportunities exist.	SAFCA, Corps	Corps, SAFCA, USFWS	**Development**		
			$100,000 to $500,000	Some efforts underway but comprehensive effort should be initiated within 3 years.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	TBD	Needed.
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.	CDFG, NMFS, USFWS, Reclamation Board	Corps, CalFed, AFRP	**Development**		
			$100,000 to $300,000	Initiate within 1 to 3 years. Complete within 1 year of start-up.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	TBD	Needed.
23. Identify and evaluate suitable locations to establish or provide wetland filtration habitat on inflow point source discharges; create such habitat if suitable opportunities can be identified.	Corps, Sacramento County Parks (for pilot project), SAFCA (for pilot project)	EPA, WFSE, Corps, County of Sacramento, Cal Expo, SAFCA (maintenance)	**Development**		
			Under $500,000	Some related efforts underway. Initiate comprehensive inventory within 1 to 3 years.	Needed
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	TBD	Needed.
Contaminants					
24. Develop collaborative guidelines to reduce the application of toxins on lands that have the greatest risk to fish populations, where possible.	SAFCA, CDFG, Regional Board, Water Purveyors under Water Forum Agreement, Sacramento County Parks	EPA, Regional Board, SAFCA, County of Sacramento, Purveyors	**Development**		
			Under $100,000	Should be ongoing.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	TBD	Needed.
Harvest of Fish & Wildlife					
25. To assist with management decision making, ascertain whether in-river illegal harvest of chinook salmon and steelhead is acting as a stressor on those species in the lower American River.	CDFG, NMFS	CDFG, CalFed, AFRP	**Development**		
			$12,000 to $100,000	Initiate within 1 to 3 years. Complete within 6 to 12 months of start-up.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	May need to be ongoing.	Needed.

Recommended action	1. Key agency(ies)[1]	2. Potential funding source(s)	3. Cost Estimate[2]	4. Time frame	5. Funding status
Artificial Propagation of Fish					
26. Evaluate alternative ways for addressing temperature-related issues at the Nimbus and American River Fish Hatcheries which would not jeopardize the needs of in-stream spawning fall-run chinook salmon and steelhead.	CDFG	CDFG, USBR, Corps	**Development**		
			Under $100,000	Initiate within 1 to 3 years.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	Implementation likely to require 3 to 5 years.	Needed.
Other Potential Management Actions					
27. Coordinate the permitting process for lower American River restoration actions through the RCMP, where possible.	SAFCA, Corps, NMFS, USFWS, State Reclamation Board, CDFG, City and County of Sacramento, State Lands Commission	SAFCA, CalFed	**Development**		
			Under $100,000	Initiate within 2 years. Ongoing	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	TBD	Needed.
28. Conduct habitat suitability assessment for steelhead in the mile below Folsom Dam in Lake Natoma.	USFWS, NMFS, CDFG	USFWS, CalFed, USBR, Corps, CDFG, NMFS	**Development**		
			$5,000 to $100,000	Initiate within 2 years. Complete within 1 month of start-up.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	TBD	Needed.
Monitoring and Evaluation Component					
H. Use existing aerial photographs as a baseline for monitoring activities requiring positional accuracy	SAFCA, CDFG, USFWS, USBR, Corps	Water Forum, CalFed, Corps, SAFCA	**Development**		
			Could range from $100,000 to $1,000,000	Initiate within 1 to 3 years. Complete within 2 years of start-up.	Needed
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	May need to be ongoing.	Needed.
I. Evaluate efficacy of installing and operating a fish counting weir to improve estimates of: (a) spawning stock escapement; and (b) juvenile outmigrant population.	NMFS for (a), CDFG for (b), USFWS	CDFG, CalFed, USBR, Corps, FWG	**Development**		
			For (a) $300,000 for construction. For (b), $100,000 for construction assuming temporary weir (April to June only).	Initiate within 3 years.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			For operating (a), $10,000 to 30,000/year For operating (b), $10,000/year.	Ongoing.	Needed.

Recommended action	1. Key agency(ies)[1]	2. Potential funding source(s)	3. Cost Estimate[2]	4. Time frame	5. Funding status

[1] Underlined terms in this column indicate which agencies would be likely to provide leadership for the effort. Others would also play key roles (acronyms are identified on page x.).
[2] Cost estimates are approximate. Further analysis would be needed to verify and refine figures.
[3] BAARFS = Biological Assessment of American River Flow Standard Team. Convened by the Water Forum, members include NMFS, USFWS, CDFG, Corps, USBR, and City of Sacramento.
[4] This recommendation also benefits from the $195,000 USBR spent on water temperature monitoring infrastructure and the $41,000/year that USBR spends to maintain that infrastructure, as described in Recommendation #3.
[5] TBD = To be determined
[6] As mitigation for fish screen modifications on the Fairbairn Water Treatment Plant, the City of Sacramento has committed $500,000 for lower American River temperature enhancements of a type to be determined.
[7] SAFCA has committed $2 million for shutter modifications or other agreed-upon temperature improvements.

The funding sources mentioned in Table 8-1 (Column 2) may be augmented by extra-mural funding from private and public sources, as well as by mitigation funds. As mentioned above, the FISH Plan will be integrated into the LAR Task Force's broader RCMP. The RCMP action plan will receive a certain amount of support from a grant writer cooperatively funded and managed by SAFCA, the Water Forum, and the County and City Parks and Recreation Departments. The grantwriter is developing a fundraising strategy for six Sacramento-area riparian corridors, including the lower American River from the Nimbus Salmon and Steelhead Hatchery downstream to the Sacramento River. The FWG looks forward to working with the grantwriter and managing agencies to assist in securing funds that will help implement the FISH Plan and analogous portions of the RCMP.

1.4. COST ESTIMATES AND FUNDING STATUS

Column 3 of Table 8-1 displays cost estimates for each FISH Plan recommendation. Where appropriate, these cost estimates have been separated into costs associated with the "development" phase of the action and costs associated with the "implementation, monitoring, operations, and maintenance" phase of the action. (The FWG strongly believes that all lower American River fisheries and aquatic habitat enhancement actions should include monitoring components.) Column 5 indicates the funding status of the recommendation in question (e.g., "funded," "partially funded," or funding needed"); this column also includes notes regarding the extent to which resources have been invested to date in beginning implementation of the recommendation or in related efforts.

1.5. TIMELINE FOR RESTORATION AND MANAGEMENT ACTIONS

The suggested timeline for implementing the fisheries and aquatic habitat enhancement actions recommended in Chapter 6 is specific to each recommended action (see Table 8-1, Column 4). As mentioned above, some of the recommended actions have already been initiated. Of these, some are expected to be completed within a year, while others are envisioned as activities that should be ongoing for the foreseeable future. However, most of the recommended actions are envisioned as being initiated within the next year and being wrapped up within 2 to 5 years.

1.6. TECHNICAL ASSISTANCE NEEDED TO DEVELOP, UPDATE, ADMINISTER AND IMPLEMENT THE PLAN AND MONITOR RESULTS

Development and implementation of measures to enhance conditions for steelhead, chinook salmon and other aquatic resources of the lower American River should be based on a fuller understanding of resource needs and restoration opportunities. The FWG envisions that on-going, long-term consultation and technical assistance provided by its Technical Subcommittee will continue to play a significant role in increasing this understanding as the FWG and TSC guide implementation of the FISH Plan.

As mentioned in Chapter 6, the FWG has recommended that technical assistance be used to improve the availability and management of lower American River research data, with attention

to quality control. 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 exists in various formats and resides with numerous entities and individuals. These 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.

In addition, 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, temperature, and other restoration actions on target fish populations.

1.7. OVERCOMING POTENTIAL CHALLENGES TO IMPLEMENTATION

The FWG anticipates that there will, indeed, be challenges to overcome in implementing the FISH Plan and analogous portions of the RCMP. This section lists some of the challenges that may be encountered, as well as strategies for overcoming them.

8.1.1 NEED TO MORE FULLY INTEGRATE SCIENCE AND MANAGEMENT

An organized, science-based management program is needed to provide the framework for FISH Plan and RCMP implementation. Such a program would describe what we are doing, why, the likelihood of success, how we will know if the actions are successful, how we will learn from our efforts, and how lessons learned will be linked to management decision-making processes. It should be based on both ecosystem and project-specific monitoring. It should take data and translate it into "information," making it available to decision-makers. In response to this challenge, the following two efforts are underway:

- Development of monitoring and adaptive management programs for the FISH Plan; and
- Development of a proposed, RCMP-level "Science-Based Management Program."

8.1.2 NEED TO EFFECTIVELY FIELD QUESTIONS ABOUT FISH PLAN RECOMMENDATIONS

Interested parties who did not participate directly in negotiations may have questions or initial concerns about FISH Plan and RCMP recommendations. To ensure the recommendations are implemented, Task Force and working group members need to be able to respond effectively to such questions or concerns. There are three strategies for doing this, as follows:

- At the RCMP level, the RCMP Roll-out Committee is organizing briefings for elected officials and other interested parties, and a workshop for the public;

- As the Lower American River Science-Based Management Program is developed, opportunities are likely to emerge for those with stakes in RCMP implementation to participate directly in that program; and
- RCMP and FISH Plan implementation is expected to involve many teams with different leaders, but overlapping membership; this approach is expected to help develop broad ownership in the RCMP.

8.1.3 NEED TO OBTAIN IMPLEMENTATION FUNDS

A number of FISH Plan recommendations have some funding, or would build on and leverage past investments. However, substantial funding is needed to fully implement FISH Plan recommendations. Anticipated strategies for obtaining needed funds include:

- Cooperative agreements between participating agencies;
- Obtaining fundraising assistance from the grantwriter whose services have been retained by SAFCA, the Water Forum, County Parks, and City Parks to develop a fundraising strategy that encompasses the lower American River as well as half a dozen other riparian corridors in the Sacramento region.

8.1.4 NEED FOR SYSTEMATIC APPROACH TO IMPLEMENTATION

In FISH Plan implementation, a balance needs to be found between taking advantage of time-sensitive project implementation opportunities and a more systematic and measured approach (e.g., such as that used to develop the FISH Plan). While there are action-oriented opportunities that should not be missed, there is also a real need to undertake selected studies to ensure that we chart a wise course in lower American River management. Strategies to assist in achieving this balance include:

- Ongoing dialogue within the LAR Task Force, FWG and TSC regarding how to implement the RCMP and FISH Plan;
- Formulation of clear descriptions of specific expectations associated with each recommendation;
- Development of shared protocols where appropriate; and
- Where possible, allowing a comfortable amount of time for deliberations on implementation strategies and decisions.

8.1.5 NEED FOR MORE TIMELY PERMITTING PROCESS FOR RESTORATION PROJECTS

There is a widely-held perception that it is difficult to obtain the permits necessary to undertake projects in the lower American River, even for those specifically intended to benefit lower American River fish and aquatic habitat. This is believed to be due to staffing shortages within the Endangered Species offices of USFWS and NMFS. Strategies proposed to address this challenge include:

- Seeking an expedited ESA review and permitting process for actions included in the FISH Plan; and
- Developing the above-referenced Lower American River Science-Based Management Element, closely involving CalFed in that effort.

8.1.6 POSSIBLE NEED FOR MORE FORMAL RIVER CORRIDOR MANAGEMENT PLAN ADMINISTRATIVE STRUCTURES

As discussed in Section 8.6.1. above, the primary administrative structures anticipated to support FISH Plan and RCMP implementation for the duration of the RCMP's 3-year action plan remain the LAR Task Force and its working groups. It has been suggested that more formal administrative arrangements (e.g., establishment of a watershed conservancy, joint powers agency, etc.) may be needed to support the most effective possible form of integrated management for the lower American River.

This subject is expected to be fully discussed during the update of the American River Parkway Plan. Addressing it in that venue and timeframe will allow for: (a) a thorough exploration of various options for administrative structures that could be used; and (b) the participation of state and local elected officials in determining the most appropriate administrative arrangements for coordinated management of the lower American River.

8.0 FISH PLAN IMPLEMENTATION STRATEGY

This chapter describes the manner in which the FWG envisions that the FISH Plan would be carried out. In essence, the FISH Plan articulates a broadly shared understanding regarding the management and restoration actions that are most important to undertake to improve conditions for fall-run chinook salmon, steelhead, and splittail in the lower American River. The FISH Plan is intended to provide a cohesive framework that can: (1) serve as a locus around which public and private entities working in the lower American River can voluntarily coordinate their efforts to responsibly steward lower American River fish and aquatic habitat; and (2) assist funding entities in assessing where habitat enhancement funds might most effectively be invested. However, individual fisheries and aquatic habitat enhancement actions, as well as associated statutory and regulatory compliance requirements, will remain the responsibility of individual project proponents. The FISH Plan is not intended to alter agencies' existing rights or responsibilities (e.g., with regard to policy and fiscal decision-making).

1.1. ADMINISTRATIVE ARRANGEMENTS TO SUPPORT IMPLEMENTATION

Because the FISH Plan will advance many agencies' compatible missions and is being integrated into the LAR Task Force's broader RCMP, the FWG anticipates that the LAR Task Force will be a functional venue through which to coordinate its implementation. This expectation is based on the FISH Working Group continuing to meet, albeit less frequently (perhaps 2 to 4 times per year), to oversee implementation of the FISH Plan (and the analogous portions of the RCMP). This expectation also assumes that the FWG's Technical Subcommittee continues to meet (perhaps 6 to 8 times per year) to guide implementation of these plans in a "hands-on" manner, reviewing monitoring data and developing adaptive management recommendations. It is anticipated that the American River Operations Group (AROG) will continue to meet on a monthly basis to discuss more detailed operational decisions related to lower American River management, but that the efforts of the AROG, TSC, FWG, and LAR Task Force will be complementary to one another.

As FISH Plan and RCMP implementation get underway, the LAR Task Force and its working groups will need to focus on how to implement the recommendations in each of those documents. Some of the recommendations have been initiated already and need little FWG/TSC assistance, while others are at the conceptual stage and will require substantial leadership, guidance, and financial support to bring them to fruition. With this in mind, the FWG and TSC will need to determine which of the recommendations to focus on first, and the most appropriate manner in which to assist project proponents to achieve results that are consistent with FISH Plan goals and objectives (see Section 8.6 for related discussion.)

The Initial FISH Plan is intended to be a living document, in keeping with its adaptive management orientation. The FWG/TSC anticipates that a periodic review of FISH Plan implementation results will be undertaken, generating recommendations regarding adjustments to FISH Plan goals, objectives, conceptual models, recommended actions, priorities, and monitoring provisions. Annual reporting of FISH Plan implementation will be a part of the State of the River Report to be produced by the Water Forum. Throughout the year, the FWG/TSC anticipates:

- Undertaking proactive action planning (including proposal planning) for FISH Plan implementation;
- Providing project-specific feedback on FISH Plan-recommended actions and related projects. Subsets of the FWG/TSC may work together on implementation of FISH Plan recommendations and facilitating associated permitting processes where appropriate;
- Reviewing results and information derived from implementation of FISH Plan recommendations, related projects, and the river-wide monitoring plan;
- Reviewing and commending on drafts of the annual State of the River Report; and
- Interfacing with related initiatives, such as CalFed and other programs.

Should new fisheries and in-stream habitat enhancement opportunities arise, or time-sensitive opportunities to advance second or third priority FISH Plan recommendations, the FWG/TSC is receptive to discussing them as long as first priority FISH Plan recommendations receive their primary focus. The FWG/TSC will make written information available to help project proponents understand the FWG/TSC's functions and how best to avail themselves of opportunities to obtain FWG/TSC feedback on lower American River fisheries and aquatic habitat restoration initiatives.

1.2. Lead Agencies' Roles and Responsibilities

Table 8-1 indicates which organizations would probably need to play key roles in implementing each of the fisheries and aquatic habitat enhancement actions recommended in Chapter 6 (see Column 1).

For those actions where one particular agency clearly would be the appropriate lead agency, that agency's name is underlined (In some cases, it seems appropriate that two or three agencies share the lead.) The fact that an agency is listed in this column reflects the collective perceptions of the FISH Working Group regarding which agencies would have a critical contribution to make towards implementation. However, being listed in this column does not indicate that an agency has agreed to participate in implementing the action, to take the lead in doing so, or to fund implementation of the recommended action.

1.3. Potential Funding Sources

Potential sources of funding for each action are shown in Column 2 of Table 8-1. Again, because an agency or program is listed as a potential source of funding does not mean that that entity has been asked to fund the action in question, nor that it has agreed to do so. The information in Table 8-1 (Column 2) simply reflects the FISH Working Group's ideas about where to begin the effort to obtain funding for the relevant action.

Table 8-1. FISH Plan Recommendations: Implementation Considerations.

Recommended action	1. Key agency(ies)[1]	2. Potential funding source(s)	3. Cost Estimate[2]	4. Time frame	5. Funding status
FIRST PRIORITY RECOMMENDATIONS					
Lower American River Flow/Temperature Regime					
1. Develop and implement an ecologically-based flow management plan for the lower American River, including water temperature management considerations, subject to SWRCB approval.	Water Forum, BAARFS[3], SWRCB, USBR, AROG, City of Sacramento	WFSE, USBR, CalFed, Corps, City of Sacramento	**Development**		
			$1,000,000 to formulate proposal to SWRCB on updated flow management plan (not including implementation, which is to be determined).	Plan development has been initiated. Complete within 2 years.	Partially funded. Approximately $600,000 spent or obligated by City of Sacramento for development of one component (updated flow management plan). This component also has received @ 500 hours of USBR in-kind professional support, @ 170 professional hours of in-kind support per month from AROG member agencies and 30 hours per month from BAARFS member agencies. An additional $50,000-$100,000 is needed to complete this component.[4]
			Implementation, Monitoring, Operations, and Maintenance		
			TBD[5]	TBD	Needed.
2. Develop and implement a comprehensive water temperature monitoring plan for the lower American River.	USBR, CDFG, City of Sacramento, USFWS, NMFS, EID, Water Forum	CalFed, City of Sacramento[6], SAFCA[7], USBR, Water Forum	**Development**		
			Over $1 million for development of comprehensive plan.	Initial steps are underway.	Partially funded by USBR as a component of the function analysis workshop to develop the plan. USBR also has invested @ $195,000 in installation of temperature monitoring equipment in Folsom Reservoir, Lake Natoma, and the lower American River.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	Implement on an ongoing basis. Update plan periodically.	Needed. (USBR spends @$75,000/ year maintaining temperature monitoring stations on the upper and lower American River, and Folsom and Nimbus Reservoirs).

Recommended action	1. Key agency(ies)[1]	2. Potential funding source(s)	3. Cost Estimate[2]	4. Time frame	5. Funding status
3. Develop and implement physical actions and operational and management measures to improve water temperatures in the lower American River.	USBR, CDFG, City of Sacramento, USFWS, NMFS, EID, Water Forum, SAFCA	CalFed, City of Sacramento[6], SAFCA[7], USBR, Water Forum	**Development**		
			TBD	Initial steps are underway.	USBR has invested $2.5 million in design & construction of a TCD for the Folsom Dam M&I intake, $200,000 for the design of a TCD for the EID intake. USBR also spent $100,000 on a value analysis study of lower American River temperature issues, $50,000 on development of related strategies for evaluating study results, and $15,000 for bathymetric surveys of Lake Natoma.[4]
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	Implement on an ongoing basis. Update plan periodically.	Needed. (USBR spends @ $41,000/ year on maintaining temperature monitoring equipment in Folsom Reservoir, Lake Natoma, and the lower American River.)
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.	County of Sacramento (development); Corps, Reclamation Board, CDFG, SAFCA, LAR Task Force, Water Forum (implementation), State Lands Commission	SAFCA, Water Forum, Trout Unlimited, Fish America Foundation, National Fish & Wildlife Foundation, AFRP, Corps	**Development**		
			$100,000 for plan development	Plan development has been initiated. Completion could take 6 months to 3 years.	Needed. (SAFCA has spent $78,000 on the development of planning criteria for woody materials improvements associated with bank protection projects.)
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	Initiate pilot within 3 to 5 years.	Needed.
			$100,00 to $500,000 for evaluation	Initiate evaluation within 1 to 3 years. Complete within 1 to 2 years of start-up.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	If results of evaluation support implementation, implement within 3 to 5 years.	Needed.

Recommended action	1. Key agency(ies)[1]	2. Potential funding source(s)	3. Cost Estimate[2]	4. Time frame	5. Funding status
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.	Corps, Reclamation Board, SAFCA, ARFCD, USFWS, CDFG, NMFS, Water Forum, State Lands Commission	Corps, Reclamation Board, SAFCA, CalFed, Water Forum, Mitigation Funds, Extra-Mural Grants	**Development**		
			$50,000 to $500,000 to identify locations	Initiate within 1 to 3 years. Complete location inventory within 1 to 2 years of start-up.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	Implementation will be ongoing.	Needed.
Artificial Propagation of Fish					
6. Estimate relative proportion of hatchery and naturally produced chinook and steelhead to annual spawning escapement and commercial and sports fisheries to enhance management capabilities.	CDFG, USFWS, NMFS, USBR	CDFG/General Fund, CalFed, USBR, AFRP	**Development**		
			$50,000 to $500,000	Complete within 1 to 3 years.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	May need to be done annually.	Needed.
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.	CDFG, USBR	CDFG, CalFed, USBR, Corps	**Development**		
			$1 to 5 million	Design is underway.	USBR has obligated $350,000 for design of structure, including prototype, & construction of prototype
			Implementation, Monitoring, Operations, and Maintenance		
			$5 million for construction beyond prototype	Expected to be completed in 2003.	Needed.
Stranding					
8. Complete the inventory of areas that pose a stranding threat to juvenile salmonids. Conduct a function analysis workshop to identify measures to reduce or eliminate stranding. Implement measures where appropriate opportunities exist.	CDFG, NMFS, USFWS, Water Forum, USBR, Corps, SAFCA	Corps, USBR, Reclamation Board, SAFCA, CalFed, CVPIA, Water Forum, AFRP, Extra-Mural Grants	**Development**		
			Under $1 million for inventory, V.A. workshop, and pilot	Complete inventory within 2 years.	Partially funded, with $245,000 obligated to CDFG from USBR/CVPIA funds.
			Implementation, Monitoring, Operations, and Maintenance		
			Millions of dollars.	Remedial measures likely to take 2 to 5 years.	Needed.

Recommended action	1. Key agency(ies)[1]	2. Potential funding source(s)	3. Cost Estimate[2]	4. Time frame	5. Funding status
Other Potential Management Actions					
9. Identify the fishery impacts on lower American River priority species caused by meeting Sacramento/San Joaquin Delta WQCP requirements and needs from Folsom Reservoir.	USBR, USFWS, AROG, CDFG, NMFS, Water Forum	Water Forum, CalFed, USBR, Extra-Mural Grants, In-Kind Service	**Development**		
			$5,000 to $50,000 through initial presentation.	Complete within 1 to 3 years.	Needed. (Water Forum has spent approximately 2 days of in-kind support on this as of June, 2001.)
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	Ongoing.	Needed.
10. Improve availability and management of lower American River research data, with attention to quality control.	USBR, CDFG (biological data), USFWS/CAMP, IEP, USGS (physical data), CalFed Science Board, Water Forum (catalyst)	CDFG, Water Forum, SAFCA, CVPIA, National Fish & Wildlife Foundation, AFRP, FWG, RCMP Science Program	**Development**		
			$50,000 to $500,000 initial investment	Initiate within 1 to 3 years. Complete initial effort within 12 to 18 months of start up.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			Approximately $30,000/year on ongoing basis.	Should be ongoing.	Needed.
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.	CDFG, NMFS, USFWS	CalFed, CVPIA, Water Forum, AFRP/IEP	**Development**		
			$65,000 to $500,000	Initiate within 1 to 3 years. Initial determination done within 18 months after start-up.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	Should be ongoing.	Needed.
B. Investigate temporal and spatial distribution of steelhead in the lower American River to strengthen the information base for management decisions.	CDFG, NMFS, USFWS	CalFed, CDFG, CVPIA/USBR, AFRP, NMFS	**Development**		
			$20,000 to $48,000	Underway. Complete initial investigation within 10 to 24 months.	Funded.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	Should be ongoing.	Needed.
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, Water Forum, NMFS, SAFCA (re: long-term re-op)	USBR, CalFed, Water Forum, FWG, CVPIA, SAFCA	**Development**		
			$500,000	Initiate within 1 to 3 years. Likely to take 1 to 5 years to complete model.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	May need to be ongoing.	Needed.

Recommended action	1. Key agency(ies)[1]	2. Potential funding source(s)	3. Cost Estimate[2]	4. Time frame	5. Funding status
SECOND PRIORITY RECOMMENDATIONS					
Aquatic, Riparian and Wetland Habitat					
11. Identify and evaluate opportunities to implement Wetland/Slough Complex restoration, with needs of all priority species in mind.	CDFG, USFWS/AFRP, Water Forum, Corps, State Lands Commission	Corps, CalFed, USBR, AFRP, Other Grants	**Development**		
			$100,000-$500,000 for evaluation	Initiate evaluation within one year. Complete within 1-2 years of start-up	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	If results of evaluation support implementation, implement within 3-5 years.	Needed
Natural Floodplain & 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.	SAFCA (for pilot project), Corps, USFWS, CDFG, NMFS, Water Forum	Corps, SAFCA, Reclamation Board, CalFed, USFWS, Extra-Mural Grants	**Development**		
			$500,000 to $3 million	Initiate within 1 to 3 years. Complete inventory within 2 years of start up.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	Implementation likely to take 1 to 5 years.	Needed
13. Identify opportunities to, and potential benefits of, enhancing or constructing mainstem and side channel habitats that provide salmon and steelhead spawning and rearing habitat, and implement measures where suitable opportunities are available.	USFWS, CDFG, Water Forum, USBR, NMFS, Corps, State Lands Commission	Corps, USBR, CVPIA, CalFed, WFSE, Mitigation Funds, Extra-Mural Grants	**Development**		
			$300,000 to 500,000 for inventory	Complete within 2 years.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			$200 million	Implementation likely to require 3 to 5 years.	Needed.
Harvest of Fish and Wildlife					
14. To assist in protecting and enhancing the 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.	CDFG, USFWS, NMFS,	CDFG, CalFed, WFSE, CVPIA	**Development**		
			Depending on methods used, lower American River cost could range from $500,000 (with otoliths) to millions (with coded wire tagging)	Initiate within 1 to 2 years. Complete within 2 years of start-up.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD. Monitoring will be costly.	Should be ongoing.	Needed.

Recommended action	1. Key agency(ies)[1]	2. Potential funding source(s)	3. Cost Estimate[2]	4. Time frame	5. Funding status
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.	SAFCA, USBR, TSC, AROG, CDFG, DWR, USFWS, NMFS, Corps, Water Forum, SWRCB, State Lands Commission, water interests, environmental organizations	USBR, SAFCA, CalFed, Water Forum, In-Kind Services of TSC & AROG member agencies	**Development**		
			$30,000 to $100,000/ year plus in-kind services	Underway.	Partially funded. At least $300,000 spent or obligated for technical consultation through June, '01.[2] Receives at least 50 hours of professional hours per month of in-kind support from TSC member agencies.[3]
			Implementation, Monitoring, Operations, and Maintenance		
			See above	Should be ongoing.	Partially funded.
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.	Corps, SAFCA, USBR, CDFG	Corps, SAFCA, CalFed, CVPIA	**Development**		
			$50,000 to $150,000 for sensitivity analysis of efforts to date. Up to $500,000 for program development.	Initiate within 2 years. Complete within 1 year from start-up.	Partially funded.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	May be ongoing.	Needed.
17. Assess the need to develop a spawning gravel monitoring and management program for steelhead and fall-run chinook in which intervention would be based on identification of specific sites where intervention would enhance or increase salmonid spawning habitat.	CDFG, USFWS, USBR	CalFed, CDFG, Corps, USBR, CVPIA	**Development**		
			$100,000	Initiate within 1 to 3 years. Complete within 18 months of start-up.	Partially funded ($100,000 in USBR funds to CDFG for experimental program).
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	TBD	Needed.
Artificial Propagation of Fish					
18. Evaluate Nimbus Salmon & Steelhead Hatchery production and stocking practices to identify measures that would promote restoration of native fish species in the lower American River.	CDFG, NMFS	CDFG, CalFed, Water Forum, USBR, Corps, USFWS, CVPIA/AFRP	**Development**		
			Depending on methods, costs could range from under $100,000 to millions	Underway. Complete within 2 years of start-up. May need to be ongoing.	Partially funded.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	TBD	Needed.

Recommended action	1. Key agency(ies)[1]	2. Potential funding source(s)	3. Cost Estimate[2]	4. Time frame	5. Funding status
Other Potential Restoration Actions					
19. Assess feasibility of providing enhanced off-site (e.g., Auburn Ravine, Coon Creek, Dry Creek) steelhead habitat.	USFWS, NMFS, CDFG	CDFG, CalFed, USBR, Corps, AFRP, National Fish & Wildlife Foundation, Mitigation Funds	**Development**		
			$15,000 to $100,000	Initiate within 1 to 3 years. Complete within 6 months of start-up.	Partially funded. USFWS/AFRP spent $36,450 on an existing conditions report on Secret Ravine (a tributary of Dry Cr.) and $40,000 to develop a watershed management plan for Dry Creek (a tributary of the lower American River) with steelhead and chinook salmon needs in mind.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	TBD	Needed.
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.	CDFG, NMFS, USBR	CDFG, Corps, USBR, Water Forum, CalFed, AFRP, NMFS, Fish America, Mitigation Funds	**Development**		
			Under $100,000 to develop. $12,000 to $15,000/year.	Initiate within 1 to 3 years.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	Likely to take 4 months each year, although may not be possible in many years due to flows.	
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, USFWS	NMFS, USFWS, Water Forum, CalFed, AFRP, CDFG	$35,000 to $500,000	Initiate within 3 years. Complete within 1 year of start-up.	Needed.
F. Develop a juvenile steelhead over-summer survival model to assist in understanding factors critical to the well-being of this species.	CDFG, NMFS	Water Forum, CalFed	$100,000 to $500,000	Initiate within 3 years.	Needed.
G. Develop a stock recruitment model for fall-run chinook salmon to guide management decision-making.	CDFG	Water Forum, CDFG, CalFed, AFRP	$10,000	Initiate within 1 to 3 years. Complete within 6 months of start-up.	Needed.
THIRD PRIORITY RECOMMENDATIONS					
20. Identify and characterize the complexity and diversity of aquatic habitats in the lower American River, and implement measures where suitable opportunities are available.	CDFG, NMFS, USFWS	USBR, NMFS, USFWS, CDFG	**Development**		
			$100,000 to 200,000	TBD	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	TBD	Needed.

Recommended action	1. Key agency(ies)[1]	2. Potential funding source(s)	3. Cost Estimate[2]	4. Time frame	5. Funding status
Aquatic, Riparian, and Wetland Habitat					
21. Identify and evaluate suitable locations and benefits of establishing or providing SRA habitat along the lower American River to benefit priority fish species, and implement measures where appropriate opportunities exist.	SAFCA, Corps	Corps, SAFCA, USFWS	**Development**		
			$100,000 to $500,000	Some efforts underway but comprehensive effort should be initiated within 3 years.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	TBD	Needed.
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.	CDFG, NMFS, USFWS, Reclamation Board	Corps, CalFed, AFRP	**Development**		
			$100,000 to $300,000	Initiate within 1 to 3 years. Complete within 1 year of start-up.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	TBD	Needed.
23. Identify and evaluate suitable locations to establish or provide wetland filtration habitat on inflow point source discharges; create such habitat if suitable opportunities can be identified.	Corps, Sacramento County Parks (for pilot project), SAFCA (for pilot project)	EPA, WFSE, Corps, County of Sacramento, Cal Expo, SAFCA (maintenance)	**Development**		
			Under $500,000	Some related efforts underway. Initiate comprehensive inventory within 1 to 3 years.	Needed
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	TBD	Needed.
Contaminants					
24. Develop collaborative guidelines to reduce the application of toxins on lands that have the greatest risk to fish populations, where possible.	SAFCA, CDFG, Regional Board, Water Purveyors under Water Forum Agreement, Sacramento County Parks	EPA, Regional Board, SAFCA, County of Sacramento, Purveyors	**Development**		
			Under $100,000	Should be ongoing.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	TBD	Needed.
Harvest of Fish & Wildlife					
25. To assist with management decision making, ascertain whether in-river illegal harvest of chinook salmon and steelhead is acting as a stressor on those species in the lower American River.	CDFG, NMFS	CDFG, CalFed, AFRP	**Development**		
			$12,000 to $100,000	Initiate within 1 to 3 years. Complete within 6 to 12 months of start-up.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	May need to be ongoing.	Needed.

Recommended action	1. Key agency(ies)[1]	2. Potential funding source(s)	3. Cost Estimate[2]	4. Time frame	5. Funding status
Artificial Propagation of Fish					
26. Evaluate alternative ways for addressing temperature-related issues at the Nimbus and American River Fish Hatcheries which would not jeopardize the needs of in-stream spawning fall-run chinook salmon and steelhead.	CDFG	CDFG, USBR, Corps	**Development**		
			Under $100,000	Initiate within 1 to 3 years.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	Implementation likely to require 3 to 5 years.	Needed.
Other Potential Management Actions					
27. Coordinate the permitting process for lower American River restoration actions through the RCMP, where possible.	SAFCA, Corps, NMFS, USFWS, State Reclamation Board, CDFG, City and County of Sacramento, State Lands Commission	SAFCA, CalFed	**Development**		
			Under $100,000	Initiate within 2 years. Ongoing	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	TBD	Needed.
28. Conduct habitat suitability assessment for steelhead in the mile below Folsom Dam in Lake Natoma.	USFWS, NMFS, CDFG	USFWS, CalFed, USBR, Corps, CDFG, NMFS	**Development**		
			$5,000 to $100,000	Initiate within 2 years. Complete within 1 month of start-up.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	TBD	Needed.
Monitoring and Evaluation Component					
H. Use existing aerial photographs as a baseline for monitoring activities requiring positional accuracy	SAFCA, CDFG, USFWS, USBR, Corps	Water Forum, CalFed, Corps, SAFCA	**Development**		
			Could range from $100,000 to $1,000,000	Initiate within 1 to 3 years. Complete within 2 years of start-up.	Needed
			Implementation, Monitoring, Operations, and Maintenance		
			TBD	May need to be ongoing.	Needed.
I. Evaluate efficacy of installing and operating a fish counting weir to improve estimates of: (a) spawning stock escapement; and (b) juvenile outmigrant population.	NMFS for (a), CDFG for (b), USFWS	CDFG, CalFed, USBR, Corps, FWG	**Development**		
			For (a) $300,000 for construction. For (b), $100,000 for construction assuming temporary weir (April to June only).	Initiate within 3 years.	Needed.
			Implementation, Monitoring, Operations, and Maintenance		
			For operating (a), $10,000 to 30,000/year For operating (b), $10,000/year.	Ongoing.	Needed.

Recommended action	1. Key agency(ies)[1]	2. Potential funding source(s)	3. Cost Estimate[2]	4. Time frame	5. Funding status

[1] Underlined terms in this column indicate which agencies would be likely to provide leadership for the effort. Others would also play key roles (acronyms are identified on page x.).
[2] Cost estimates are approximate. Further analysis would be needed to verify and refine figures.
[3] BAARFS = Biological Assessment of American River Flow Standard Team. Convened by the Water Forum, members include NMFS, USFWS, CDFG, Corps, USBR, and City of Sacramento.
[4] This recommendation also benefits from the $195,000 USBR spent on water temperature monitoring infrastructure and the $41,000/year that USBR spends to maintain that infrastructure, as described in Recommendation #3.
[5] TBD = To be determined
[6] As mitigation for fish screen modifications on the Fairbairn Water Treatment Plant, the City of Sacramento has committed $500,000 for lower American River temperature enhancements of a type to be determined.
[7] SAFCA has committed $2 million for shutter modifications or other agreed-upon temperature improvements.

The funding sources mentioned in Table 8-1 (Column 2) may be augmented by extra-mural funding from private and public sources, as well as by mitigation funds. As mentioned above, the FISH Plan will be integrated into the LAR Task Force's broader RCMP. The RCMP action plan will receive a certain amount of support from a grant writer cooperatively funded and managed by SAFCA, the Water Forum, and the County and City Parks and Recreation Departments. The grantwriter is developing a fundraising strategy for six Sacramento-area riparian corridors, including the lower American River from the Nimbus Salmon and Steelhead Hatchery downstream to the Sacramento River. The FWG looks forward to working with the grantwriter and managing agencies to assist in securing funds that will help implement the FISH Plan and analogous portions of the RCMP.

1.4. COST ESTIMATES AND FUNDING STATUS

Column 3 of Table 8-1 displays cost estimates for each FISH Plan recommendation. Where appropriate, these cost estimates have been separated into costs associated with the "development" phase of the action and costs associated with the "implementation, monitoring, operations, and maintenance" phase of the action. (The FWG strongly believes that all lower American River fisheries and aquatic habitat enhancement actions should include monitoring components.) Column 5 indicates the funding status of the recommendation in question (e.g., "funded," "partially funded," or funding needed"); this column also includes notes regarding the extent to which resources have been invested to date in beginning implementation of the recommendation or in related efforts.

1.5. TIMELINE FOR RESTORATION AND MANAGEMENT ACTIONS

The suggested timeline for implementing the fisheries and aquatic habitat enhancement actions recommended in Chapter 6 is specific to each recommended action (see Table 8-1, Column 4). As mentioned above, some of the recommended actions have already been initiated. Of these, some are expected to be completed within a year, while others are envisioned as activities that should be ongoing for the foreseeable future. However, most of the recommended actions are envisioned as being initiated within the next year and being wrapped up within 2 to 5 years.

1.6. TECHNICAL ASSISTANCE NEEDED TO DEVELOP, UPDATE, ADMINISTER AND IMPLEMENT THE PLAN AND MONITOR RESULTS

Development and implementation of measures to enhance conditions for steelhead, chinook salmon and other aquatic resources of the lower American River should be based on a fuller understanding of resource needs and restoration opportunities. The FWG envisions that on-going, long-term consultation and technical assistance provided by its Technical Subcommittee will continue to play a significant role in increasing this understanding as the FWG and TSC guide implementation of the FISH Plan.

As mentioned in Chapter 6, the FWG has recommended that technical assistance be used to improve the availability and management of lower American River research data, with attention

to quality control. 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 exists in various formats and resides with numerous entities and individuals. These 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.

In addition, 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, temperature, and other restoration actions on target fish populations.

1.7. OVERCOMING POTENTIAL CHALLENGES TO IMPLEMENTATION

The FWG anticipates that there will, indeed, be challenges to overcome in implementing the FISH Plan and analogous portions of the RCMP. This section lists some of the challenges that may be encountered, as well as strategies for overcoming them.

8.1.1 NEED TO MORE FULLY INTEGRATE SCIENCE AND MANAGEMENT

An organized, science-based management program is needed to provide the framework for FISH Plan and RCMP implementation. Such a program would describe what we are doing, why, the likelihood of success, how we will know if the actions are successful, how we will learn from our efforts, and how lessons learned will be linked to management decision-making processes. It should be based on both ecosystem and project-specific monitoring. It should take data and translate it into "information," making it available to decision-makers. In response to this challenge, the following two efforts are underway:

- Development of monitoring and adaptive management programs for the FISH Plan; and
- Development of a proposed, RCMP-level "Science-Based Management Program."

8.1.2 NEED TO EFFECTIVELY FIELD QUESTIONS ABOUT FISH PLAN RECOMMENDATIONS

Interested parties who did not participate directly in negotiations may have questions or initial concerns about FISH Plan and RCMP recommendations. To ensure the recommendations are implemented, Task Force and working group members need to be able to respond effectively to such questions or concerns. There are three strategies for doing this, as follows:

- At the RCMP level, the RCMP Roll-out Committee is organizing briefings for elected officials and other interested parties, and a workshop for the public;

- As the Lower American River Science-Based Management Program is developed, opportunities are likely to emerge for those with stakes in RCMP implementation to participate directly in that program; and
- RCMP and FISH Plan implementation is expected to involve many teams with different leaders, but overlapping membership; this approach is expected to help develop broad ownership in the RCMP.

8.1.3 NEED TO OBTAIN IMPLEMENTATION FUNDS

A number of FISH Plan recommendations have some funding, or would build on and leverage past investments. However, substantial funding is needed to fully implement FISH Plan recommendations. Anticipated strategies for obtaining needed funds include:

- Cooperative agreements between participating agencies;
- Obtaining fundraising assistance from the grantwriter whose services have been retained by SAFCA, the Water Forum, County Parks, and City Parks to develop a fundraising strategy that encompasses the lower American River as well as half a dozen other riparian corridors in the Sacramento region.

8.1.4 NEED FOR SYSTEMATIC APPROACH TO IMPLEMENTATION

In FISH Plan implementation, a balance needs to be found between taking advantage of time-sensitive project implementation opportunities and a more systematic and measured approach (e.g., such as that used to develop the FISH Plan). While there are action-oriented opportunities that should not be missed, there is also a real need to undertake selected studies to ensure that we chart a wise course in lower American River management. Strategies to assist in achieving this balance include:

- Ongoing dialogue within the LAR Task Force, FWG and TSC regarding how to implement the RCMP and FISH Plan;
- Formulation of clear descriptions of specific expectations associated with each recommendation;
- Development of shared protocols where appropriate; and
- Where possible, allowing a comfortable amount of time for deliberations on implementation strategies and decisions.

8.1.5 NEED FOR MORE TIMELY PERMITTING PROCESS FOR RESTORATION PROJECTS

There is a widely-held perception that it is difficult to obtain the permits necessary to undertake projects in the lower American River, even for those specifically intended to benefit lower American River fish and aquatic habitat. This is believed to be due to staffing shortages within the Endangered Species offices of USFWS and NMFS. Strategies proposed to address this challenge include:

- Seeking an expedited ESA review and permitting process for actions included in the FISH Plan; and
- Developing the above-referenced Lower American River Science-Based Management Element, closely involving CalFed in that effort.

8.1.6 POSSIBLE NEED FOR MORE FORMAL RIVER CORRIDOR MANAGEMENT PLAN ADMINISTRATIVE STRUCTURES

As discussed in Section 8.6.1. above, the primary administrative structures anticipated to support FISH Plan and RCMP implementation for the duration of the RCMP's 3-year action plan remain the LAR Task Force and its working groups. It has been suggested that more formal administrative arrangements (e.g., establishment of a watershed conservancy, joint powers agency, etc.) may be needed to support the most effective possible form of integrated management for the lower American River.

This subject is expected to be fully discussed during the update of the American River Parkway Plan. Addressing it in that venue and timeframe will allow for: (a) a thorough exploration of various options for administrative structures that could be used; and (b) the participation of state and local elected officials in determining the most appropriate administrative arrangements for coordinated management of the lower American River.

9.0 LITERATURE CITED

Ayres Associates. 2001. Two Dimensional Modeling and Analysis of Spawning Bed Mobilization, LAR.

_____. 1997. Geomorphic, Sediment Engineering, and Channel Stability Analyses. American and Sacramento River, California Project. Final Report. Prepared for U.S. Army Corps of Engineers, Sacramento District. December 1997.

Briggs, J.C. 1953. The behavior and reproduction of salmonid fishes in a small coastal stream. California Fish and Game Fish Bulletin. 94. 62 pp.

Brown, L.R., P. B. Moyle, and C. D. Vanicek. 1992. American River Studies: Intensive Fish Surveys, March-June 1991. Department of Wildlife and Fisheries Biology, University of California, Davis, and Department of Biology, California State University Sacramento. April 1992.

CalFed Bay-Delta Program. 2000. Ecosystem Restoration Program Plan, Strategic Plan for Ecosystem Restoration. Programmatic Environmental Impact Statement/Environmental Impact Report Technical Appendix. Prepared for the United States Bureau of Reclamation, United States Fish and Wildlife Service, National Marine Fisheries Service, United States Environmental Protection Agency, Natural Resources Conservation Service, United States Army Corps of Engineers, and California Resources Agency.

_____. 1997. American River Technical Team Meeting Report. Prepared for CalFed Bay-Delta Program Ecosystem Roundtable, Water Forum, and Lower American River Task Force. April 4, 1997.

California Department of Fish and Game. 2000. Lower American River Pilot Salmon and Steelhead Spawning Habitat Improvement Project, Quarterly Status Report July 1999-March 2000. Prepared for U.S. Fish and Wildlife Service Central Valley Anadromous Fish Restoration Program. USFWS Agreement #: 14-48-0002-93720.

_____. 1996. Steelhead Restoration and Management Plan for California.

City of Sacramento and County of Sacramento. 2000. Habitat Management Element of the Water Forum Agreement: A Component of a Multi-Agency, Lower American River Habitat Management Program. Prepared for Sacramento City-County Office of Metropolitan Water Planning.

DuPraw, M.E. 2000. Development of a Fisheries and Aquatic Habitat Management Plan for the Lower American River. Draft Convening Report. California Center for Public Dispute Resolution. February 14, 2000.

Feynman, R. P. 1965. The character of physical law. MIT Press, Massachusetts Institute of Technology, Cambridge, Massachusetts.

Hilborn, R. and M. Mangel 1997. The ecological detective: Confronting models with data. Princeton University Press, Princeton, New Jersey.

Jones & Stokes Associates, Incorporated. 2001. River Corridor Management Plan. Draft Report. Prepared for the Sacramento Area Flood Control Agency.

_____. 1998. Floodway Management Plan for the Lower American River. Prepared for the Sacramento Area Flood Control Agency. November 1998.

McEwan, D. and T. A. Jackson. 1996. Steelhead restoration and management plan for California. California Department of Fish and Game. February 1996.

McEwan, D. and Nelson, J. 1991. Steelhead Restoration Plan for the American River. State of California Department of Fish and Game. 1991.

Platt, J. R. 1964. Strong inference. Science 146: 347-53.

Reynolds, F., T.J. Mills, R. Benthin, and A. Low. 1993. Restoring Central Valley Streams: A Plan for Action. California Department of Fish and Game, Inland Fisheries Division. November 1993.

Snider, B. and D. McEwan. 1993. Fish community survey, lower American River, February-July 1992. Department of Fish and Game, Stream Evaluation Program, Environmental Services Division. 94 pp. January 1993.

Snider B. and K. Vyverberg. 1995. Chinook Salmon Redd Survey, Lower American River, Fall 1993. California Department of Fish and Game, Environmental Services Division, Stream Flow and Habitat Evaluation Program. February 1995.

Snider, B., K. Urquart, D. McEwan, and M. Munos. 1993. Chinook Salmon Redd Survey, Lower American River, Fall 1992. Department of Fish and Game, Environmental Services Division, Stream Evaluation Program. 1993

Surface Water Resources, Inc. 2001. Aquatic Resources of the Lower American River: Baseline Report. Draft Report. Prepared for the Lower American River Fisheries And Instream Habitat Working Group.

USBR. 2001. Draft Function Analysis Workshop Report. Lower American River Temperature Improvement Study. January 8-12, 2001.

USFWS. 2000. Final Restoration Plan for the Anadromous Fish Restoration Project.

_____. 1999. Effect of Water Temperatures in Early-Life Survival of Sacramento River Fall- and Winter-run Salmon. Final Report. U.S. Fish and Wildlife Service Northern Central Valley Fish and Wildlife Office.

_____. 1995. Working Paper on Restoration Needs. Habitat Restoration Actions to Double Natural Production of anadromous Fish in the Central Valley of California. Volume 3. May 9, 1995

_____. 1994. Effects of the Central Valley Project and State Water Project on Delta Smelt and Sacramento Splittail. Biological Assessment. Prepared by California Department of Water Resources and United States Bureau of Reclamation. August 1994.

_____. 1985. Final report on the 1981 lower American River flow study. Flow needs of chinook salmon in the lower American River: United States Fish and Wildlife Service, Division of Ecological Services. Prepared for the United Stated Bureau of Recreation, Mid-Pacific Region.

Appendix A

CRITERIA FOR "FIRST SORT" OF POTENTIAL RESTORATION ACTIONS

Instructions:

- To be categorized as "Include," a candidate project would need to meet all of Criteria (1) – (4) below.
- If it is unclear whether the candidate project meets the requirements for the "Include" category, it would be categorized as "Maybe Include." (Projects for which currently available information is insufficient to assess the fit with FISH Plan goals would be put in this category.)
- If it is clear that the candidate project does not meet the requirements for the "Include" category, it would be categorized as "Omit." However, TSC doubts regarding whether or not the candidate project meets Criteria #4 by itself is not sufficient to prevent its inclusion in the "Maybe Include" category. If the potential project is valuable from a scientific perspective, broader input regarding implementability should be elicited.
- Fish species "of priority management concern" are steelhead, fall-run chinook salmon, and splittail. Fish species "of management concern" include these as well as American shad, striped bass, and other native fish.

Criteria:

1. **Addresses Needs/Stressors of Priority Species**. Reviewers conclude that the project is likely to benefit LAR fish species of highest priority management concern. Projects can demonstrate this characteristic by:
   (a) Reducing one or more variables causing considerable stress to LAR fish species of priority management concern (or being part of an inter-related set of actions that collectively do so); and/or
   (b) Restoring or protecting natural processes, functions, or conditions of importance to priority fish species. This includes preventing relatively irreversible disruptive changes to the habitat of priority fish species and/or halting or avoiding negative impacts associated with the status quo. Generally, recommended projects should not preclude other key habitat enhancement opportunities.
2. **High Scientific Merit / Data Benefits/Learning Potential**. An explicitly-articulated conceptual model[1] indicates that the proposed project is likely to make a significant contribution to the scientific understanding and/or management of LAR aquatic habitat and/or LAR fish species of priority management concern.
3. **Geographic Scope.** Proposed action falls within the RCMP's geographic scope.[2]
4. **Public Support/Implementability/Ripeness.** Reviewers believe that the proposed action would enjoy broad public support and would be relatively manageable to implement, given regulatory, political considerations.

[1] In this context, "conceptual model" refers to a basic explanation for why the proposed action is expected to produce benefits (e.g., the relationship of the proposed action to a particular stressor affecting a particular life stage of a particular species of fish). The conceptual model may be only a few sentences, but describes what is expected to result from the proposed action and why. It provides a reference point for learning and adaptive management based on the results obtained from carrying out the proposed action.

[2] FISH Plan recommendations may include a section discussing/acknowledging potential actions outside the RCMP's geographic scope if the TSC believes they would have high positive impacts on LAR fish species of priority management concern.

Appendix B

CRITERIA FOR DETAILED SCORING OF POTENTIAL RESTORATION ACTIONS

Instructions:

- Each "Yes" or "Maybe" candidate project should be assessed with respect to each of the 9 detailed scoring criteria below.
- For each of the detailed scoring criteria, please assign a score between 0 (low) and 2 (high) for the candidate project based on available information. The items listed in bulleted form beneath each of the detailed scoring criteria represent some of the ways that a potential project might demonstrate that it met the criteria in question. These bulleted items should be considered by TSC members in assigning a score to the project regarding that particular criteria.
- Results will be used to inform TSC discussion, but will not be used as the sole determination of priorities.
- Following the scoring exercise, TSC professional judgment will be sought regarding whether the results are well-founded, based on the professional knowledge and experience of TSC members. The TSC recommendation subsequently will be submitted to the FWG for further discussion, drawing upon the professional knowledge and experience of FWG members (particularly with regard to implementability).
- Fish species "of priority management concern" are steelhead, fall-run chinook salmon, and splittail. Fish species "of management concern" include these as well as American shad, striped bass, and other native fish.

Criteria:

1. Addresses Needs of Priority Species. **Score: ____ (0-2)**

- Project is likely to increase/preserve salmonid rearing habitat.
- Project is likely to increase salmonid spawning habitat quantity.
- Project is likely to increase salmonid spawning habitat quality and incubation success.
- Project is likely to promote/preserve genetic integrity of salmonid populations.
- Project is likely to improve salmonid outmigrant success.
- Project is likely to significantly reduce or eliminate predator impacts on fish species of priority management concern.
- Project is likely to increase splittail spawning habitat.
- Project is likely to increase splittail rearing habitat.
- Project is expected to assist in the recovery of listed species.
- Project is unlikely to adversely affect listed species.

2. Addresses Major Stressor. **Score: ____ (0-2)**

- Project is likely to reduce temperature-related stressors on priority fish species (steelhead, fall-run chinook and/or splittail).
- Project is likely to reduce flow-related stressors on priority fish species.
- Project is likely to reduce physical habitat-related stressors on priority fish species.

3. High Species Conservation Value. **Score: ____ (0-2)**

- Without the project, impacts to LAR fish species of priority management concern are expected to be significant.
- Pursuit of this project would not preclude other key habitat enhancement opportunities.

4. High Habitat Enhancement/Management Value. **Score: ____ (0-2)**

- Project is likely to have high management value for priority fish species.
- Project is likely to have beneficial habitat values for priority fish species.

5. High Scientific Merit. **Score: ____ (0-2)**

- There is a strong scientific basis for anticipating that the project will have positive impacts on LAR fish species of priority management concern and/or their habitat (e.g., a high probability of success).

6. <u>High Data Benefits/Learning Potential</u>. **Score: ____ (0-2)**

- Project is likely to make a significant contribution to scientific understanding of LAR aquatic habitat and/or LAR fish species of priority management concern.
- Project is likely to make a significant contribution to management of LAR aquatic habitat and/or fish species of priority management concern.
- Project is likely to make a significant contribution that can be used to inform management decisions in a relatively short timeframe.

7. <u>Multiple and/or Leveraged Benefits</u>. **Score: ____ (0-2)**

- Project is likely to benefit multiple LAR fish species of management concern.
- Project is likely to leverage benefits to LAR aquatic habitat, fish species of priority management concern, and/or LAR ecosystem as a whole through linkages with other past, current, or anticipated restoration actions.

8. <u>Durability/Sustainability</u>. **Score: ____ (0-2)**

- Project is likely to be self-sustaining/self-maintaining at all anticipated flows.
- Project is likely to provide sustained benefits.
- Project is likely to provide systemic benefits.

9. <u>Project Implementation Criteria</u>. **Score: ____ (0-2)**

- Project is likely to enjoy broad public support (including the support of relevant landowners/entities with jurisdiction over affected resources).
- Project implementation would be manageable, given regulatory and political considerations.
- Project effectiveness can be monitored and evaluated.
- Project site is readily accessible.

Appendix C

Disposition of Brainstormed Suggestions for lower American River Fisheries & Aquatic Habitat Enhancement

No.	Suggestions*	Status**
1.1	**Flow Management Plan**	
1.1.1	Update the lower American River flow management plan.	In Recommendation #1.
1.1.2	Develop and implement a river management plan that meets AFRP flow objectives	Recommendation #1 addresses desired characteristics of an LAR stream flow regulation plan.
1.1.3	Develop and implement appropriate flow fluctuation criteria.	In Recommendation #1.
1.1.4	Reduce and control instream flow ramping rates and flow fluctuations.	In Recommendation #1.
1.1.5	Evaluate the effectiveness of pulse flows for facilitating successful juvenile salmonid outmigration	Recommendation #I.
1.1.6	Implement dry year pulse flow augmentation.	Addressed in Recommendation #I.
1.1.7	Minimize dewatering of salmon and steelhead redds by maintaining flows exceeding 2,500 cfs after the onset of chinook salmon spawning until April 30.	Recommendation #1.
1.1.8	Develop water allocation guidelines.	Addressed in Recommendation #1 and by Water Forum Agreement.
1.1.9	Enter into agreements with landowners and water districts to limit diversion of natural flows from creeks to improve streamflows.	Addressed in Recommendation #1 and by Water Forum Agreement.
1.1.10	Provide target flows by 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 determined by the water temperature objective (65°F from June 1 through September 30 in the lower American River between Nimbus Dam and Watt Avenue).	In Recommendation #1.
1.1.11	Acquire water from willing sellers to augment river flow during dry years to provide fishery benefits.	In Recommendation #1.
1.1.12	Develop and implement an ecologically-based flow management plan for the lower American River. Recommended flows and temperature targets for the lower American River should be met, and its operations should be coordinated with flows that occur naturally in the Sacramento Valley and with storage releases from Shasta and Oroville Reservoirs.	Recommendation #1.
1.1.13	Increase flows for American shad migration, spawning, incubation and rearing From April to June, by modifying CVP operations, by using dedicated water, and by acquiring water from willing sellers, consistent with actions to protect chinook salmon and steelhead and when hydrologic conditions are adequate to minimize adverse effects to water supply operations.	Recommendation #1.

No.	Suggestions*	Status**
1.2	**Water Temperature Regimes**	
1.2.1	Maintain suitable lower American River water temperatures during critical lifestage periods.	Recommendation #2.
1.2.2	Maintain suitable mean daily temperatures during critical lifestages.	Recommendation #2.
1.2.3	Implement Folsom Dam target temperature releases.	Recommendation #2.
1.2.4	Construct a Folsom Dam Temperature Control Device (TCD).	Recommendation #3.
1.2.5	Implement Folsom Reservoir coldwater pool management.	Recommendation #2.
1.2.6	Coordinate techniques and tools to optimize use of coldwater pool.	Recommendation #2.
1.2.7	Evaluate the potential for creating thermal refuges for juvenile steelhead over-summer rearing in the lower American River.	Incorporated into Recommendation B.
1.2.8	Evaluate options to reduce releases of warmer surface waters of Lake Natoma through the turbines at Nimbus Dam into the lower American River.	Recommendation #2.
1.2.9	Evaluate operations of Nimbus Dam during occasional spill events to minimize the release of warm surface water from Lake Natoma.	Recommendation #2.
1.2.10	Determine and implement reservoir storage levels and releases at Folsom Reservoir necessary to maintain preferred temperatures for steelhead during summer and fall.	Recommendation #1.
1.3	**Coarse Sediment Supply**	
1.3.1	Replenish and/or restore spawning gravel in existing spawning grounds.	Incorporated into Recommendation #17.
1.3.2	Monitor spawning gravel conditions in the lower American River and identify specific sites where mechanical cleaning or gravel introductions would be beneficial to enhance or increase gravel spawning habitat.	Incorporated into Recommendation #17.
1.3.3	Develop a collaborative program to investigate erosion, bedload movement, sediment transport, and depositional processes and their relationship to the formation of point bars and riparian regeneration in the lower American River.	Recommendation #16.
1.3.4	Maintain, improve, or supplement gravel recruitment and natural sediment transport in the lower American River to maintain natural ecological processes linked to stream channel maintenance, erosion and deposition, maintenance of fish spawning areas, and the regeneration of riparian vegetation.	Incorporated into Recommendation #17.
1.3.5	Implement a spawning gravel management program.	Incorporated into Recommendation #17.
1.4	**Natural Floodplain and Flood Processes**	
1.4.1	Maintain and enhance floodplain overflow areas.	Incorporated into Recommendation #12.
1.4.2	Protect existing overflow areas from future reclamation.	Recommendation #12.

No.	Suggestions*	Status**
1.4.3	Expand existing floodplain overflow basins by obtaining easements of titles from willing sellers of floodplain lands.	Omitted. Outside FWG scope. Should be referred to ARPP update.
1.4.4	Maintain the existing stream meander configuration along the lower American River by working with involved parties to develop a floodplain management program consistent with flood control needs. These parties could include the Corps, California State Reclamation Board, Sacramento Area Flood Control Agency, Lower American River Task Force, and the Sacramento Area Water Forum.	Omitted. Vague. Underway as RCMP.
1.4.5	Enter into agreements with willing landowners and irrigation districts to set back levees and allow floodplain processes such as stream meander belts.	Omitted. Vague. Lacked sufficient information about suggestion to act on it.
1.4.6	Maintain mainstem and side channel habitats typical of a natural river that provide salmon and steelhead spawning and rearing habitat.	Recommendation #13.
1.4.7	Reduce or eliminate gravel mining from active stream channels.	Omitted. Non-responsive. TSC is unaware of current mining operations in LAR.
1.4.8	Excavate, reshape and plant riverbank.	Incorporated into Recommendation #8.
1.4.9	Maintain and monitor riparian plants.	Omitted. Outside FWG scope. BPWG lead.
1.4.10	Maintain and monitor riverbank revegetation and old rip-rap.	Omitted. Outside FWG scope. BPWG lead.
1.5	**Aquatic, Riparian and Wetland Habitat**	
1.5.1	Develop and implement a comprehensive watershed management plan for the lower American River to protect the channel (e.g., maintain flood control capacity and reduce bank erosion) and preserve and restore the riparian corridor.	Underway as RCMP for lower American River.
1.5.2	Establish and/or maintain a sustainable continuous corridor of riparian habitat along the lower American River.	Incorporated into Recommendation #21.
1.5.3	Develop riparian corridor restoration and management plan.	Underway as RCMP.
1.5.4	Enhance shaded riverine aquatic (SRA) habitat.	Recommendation #21.
1.5.5	Terminate or modify current programs that remove woody debris from the river and creek channels.	Incorporated into Recommendation #4.
1.5.6	Develop plan or policy for large woody debris.	Recommendation #4.
1.5.7	Achieve and enhance shoreline habitat consisting of instream cover (typically partially submerged large trees, and clusters of rocks), bank vegetation (typically large riparian trees that extend over the shoreline), and fine soil banks.	Incorporated into Recommendations # 6, 12, 20, 21, and 23.
1.5.8	Implement a spawning habitat management program.	Incorporated into Recommendations # 1, 12, 13, 17, H, 27, and 29.
1.5.9	Implement a Wetland/Slough Complex restoration.	Recommendation #11.
1.5.10	Improve levee management practices to protect and enhance riparian and SRA habitat.	Recommendation #5.

No.	Suggestions*	Status**
1.5.11	Restore side channels along the lower American River to provide additional riparian corridors for increasing fish and wildlife habitat.	Incorporated into Recommendation #13.
1.5.12	Fix gravel imbeddedness.	Incorporated into Recommendation #17.
1.5.13	Increase habitat complexity.	Recommendation #20.
1.5.14	Use structures to modify flow dynamics to create greater diversity of instream habitat; monitor progress.	Recommendation #22.
1.5.15	Create wetland filtration habitat on inflow point source discharges.	Recommendation #23.
1.5.16	Maintain and monitor plants in constructed seasonal wetland (Discovery Park).	Omitted. Outside FWG scope. BPWG lead.
1.6	**Water Diversions**	
1.6.1	Reduce losses of juvenile salmon and steelhead in the lower American River due to entrainment at water intake structures.	Already underway.
1.6.2	Evaluate the efficacy and modify the timing and rate of water diverted annually, if appropriate, considering flows and the maintenance and/or restoration of riparian and riverine aquatic habitats.	Omitted. Outside FWG scope. FMWG and Carmichael Water District lead.
1.6.3	Reduce chinook salmon and steelhead mortality due to municipal and industrial consumptive use diversions.	Incorporated into Recommendation #1.
1.6.4	Monitor effectiveness of existing and proposed fish screens.	Already underway.
1.6.5	Remove old water intake structures.	Incorporated into Recommendation #1.
1.7	**Levees and Bank Protection**	
1.7.1	Identify locations in the lower American River where existing revetments could be modified to incorporate habitat features such as scalloped embayments and associated hard points, multi-stage bench areas, SRA habitat and other features to aid in preservation and/or reestablishment of both berm and bank vegetation.	Recommendation #5.
1.7.2	For continuing and future bank protection projects, incorporate habitat features such as scalloped embayments and associated hard point, multi-stage bench areas, SRA habitat and other features.	Recommendation #5.
1.8	**Invasive Riparian and Marsh Plant Species**	
1.8.1	Reduce populations of invasive non-native plant species that compete with the establishment and succession of native riparian vegetation along the lower American River.	Omitted. Outside FWG scope. FMWG lead.
1.8.2	Develop a cooperative program to monitor the distribution and abundance of non-native plants and develop cooperative control programs as needed.	Omitted. Outside FWG scope. FMWG lead.
1.8.3	Herbicide giant reed regrowth.	Omitted. Non-responsive.

No.	Suggestions*	Status**
1.9	**Harvest of Fish and Wildlife**	
1.9.1	Control illegal harvest of chinook salmon and steelhead by increasing enforcement efforts.	Incorporated into Recommendation #25.
1.9.2	Further limit sport and commercial harvests of naturally-produced fish.	Incorporated into Recommendation #25.
1.9.3	Develop harvest management strategies for chinook salmon and steelhead populations of naturally-spawned fish to attain levels that fully use existing and restored habitat.	Omitted. Beyond FWG scope.
1.9.4	Develop harvest management plans for chinook salmon and steelhead with commercial and recreational fishery organizations, resource management agencies, and other stakeholders to meet target escapement and production goals for the lower American River.	Omitted. Beyond FWG scope.
1.9.5	Evaluate the efficacy of marking and selective harvest program for lower American River chinook salmon.	Recommendation #14.
1.10	**Artificial Propagation of Fish**	
1.10.1	Change hatchery procedures to benefit native stocks of salmonids.	Incorporated into Recommendation #18.
1.10.2	Evaluate hatchery production and stocking practices at the Nimbus and Feather River hatcheries that affect the lower American River to reduce the proportion of returning, hatchery-origin chinook salmon and steelhead that stray into non-natal streams.	Incorporated into Recommendation #18.
1.10.3	Adopt methods for selecting spawning adults for the hatchery production from an appropriate cross-section of the returning adult population available to the hatchery.	Incorporated into Recommendation #18.
1.10.4	Investigate replacing the Nimbus steelhead broodstock with the most genetically appropriate steelhead stock.	Incorporated into Recommendation #18.
1.10.5	Discontinue stocking fish produced from adults taken from other rivers that are genetically distinct from the native stock.	Incorporated into Recommendation #18.
1.10.6	Introduce steelhead above Nimbus and Folsom dams.	Omitted. Outside FWG scope.
1.10.7	Introduce spring-run chinook salmon above Nimbus and Folsom dams.	Omitted. Outside FWG scope.
1.10.8	Introduce fall-run chinook salmon above Nimbus and Folsom dams.	Omitted. Outside FWG scope.
1.10.9	Develop a hatchery temperature control program.	Incorporated into Recommendation #26.
1.10.10	Develop a collaborative program to coded-wire tag a representative proportion of fall-run chinook salmon produced at the Nimbus Hatchery.	Incorporated into Recommendations # 6 and 14.
1.10.11	Reduce reliance on stocking programs for meeting angler demands.	Incorporated into Recommendations #6 and 14.
1.10.12	Fix the training weir at the Nimbus Salmon and Steelhead Hatchery.	Recommendation #7.
1.10.13	Undertake a program to mark all, or a constant fractional number of hatchery produced steelhead.	Incorporated into Recommendation #14.

No.	Suggestions*	Status**
1.10.14	Provide a more direct supply of cold water to Nimbus Hatchery.	Incorporated into Recommendation #26.
1.11	**Contaminants**	
1.11.1	Reduce the application of herbicides, pesticides, fumigants, and other agents toxic to fish and wildlife on agricultural lands that have the greatest risk to fish and wildlife populations.	Recommendation #24.
1.11.2	Enter into conservation easements with willing landowners to modify agricultural practices in ways to reduce loads and concentrations of contaminants.	Incorporated into Recommendation #24.
1.11.3	Provide incentives to landowners to modify agricultural or other land use practices that contribute to the input of contaminants into waterways.	Incorporated into Recommendation #24.
1.11.4	Treat or increase treatment of urban runoff.	Incorporated into Recommendation #24.
1.12	**Stranding**	
1.12.1	Reduce or eliminate the stranding of juvenile salmonids on floodplains, shallow ponds, and levee borrow areas.	Recommendation #8.
1.12.2	Reduce or eliminate exposure/desiccation of salmonid redds.	Incorporated into Recommendation #1.
2.0	**Systems Operations and Management Actions**	
2.1	**Folsom Dam and Reservoir**	
2.1.1	Fix leaks in the power penstock inlet port, shutters, and guidance structure at Folsom Dam.	Incorporated into Recommendation #3.
2.1.2	Construct curtains at tributary inflows to Folsom Lake forcing cold water to lake bottom.	Incorporated into Recommendation #3.
2.1.3	Develop cold water isolation/pump back system.	Omitted – lacked sufficient information about this suggestion to act on it.
2.1.4	Evaluate current operations.	Incorporated into Recommendation #2.
2.1.5	Improve short-term management of shutter operations until permanent improvements are made	Incorporated into Recommendation #2.
2.1.6	Access low elevation coldwater pool with hydroelectric power generation — economically utilize coldwater pool below penstock intakes.	Incorporated into Recommendation #2.
2.1.7	Purchase water from upstream reservoirs.	Incorporated into Recommendation #1.
2.1.8	Raise or lower Folsom Dam.	Omitted. Outside FWG scope.
2.1.9	Recommend change in USBR standard operating practice regarding operation of Folsom Dam to release from the spillway gates first.	Incorporated into Recommendation #2.
2.1.10	Change Folsom Dam complex operations from peak to base-loading.	Omitted. Non-responsive.
2.1.11	Access cold water between the lower river outlet works and the penstocks.	Incorporated into Recommendation #3.

No.	Suggestions*	Status**
2.1.12	Install chillers in Folsom Dam.	Omitted. Lacked sufficient information about this suggestion to act on it.
2.1.13	Install and operate a fish counting weir.	Recommendation I.
2.1.14	Remove Folsom Dam.	Omitted. Outside FWG scope.
2.2	**Nimbus Dam and Lake Natoma**	
2.2.1	Remove Nimbus Dam.	Omitted. Outside FWG scope.
2.2.2	Construct a temperature control device for Nimbus Dam spillway bay(s).	Incorporated into Recommendation #3.
2.2.3	Install temperature curtain at plunge zone of Lake Natoma.	Incorporated into Recommendation #3.
2.2.4	Install temperature curtain around the Nimbus Dam powerplant intake.	Incorporated into Recommendation #3.
2.2.5	Modify channel in Lake Natoma, as needed.	Incorporated into Recommendation #3.
2.2.6	Move Natoma power powerplant and outlet to opposite side with TCD.	Omitted. Non-responsive.
2.2.7	Place cold water barrier in front of Folsom South Canal.	Omitted. Non-responsive.
2.2.8	Install a Pipe from Folsom tailrace to Nimbus Outlet.	Omitted. Might be a last resort. Would need to be a flexible bladder due to peaking.
2.2.9	Remove all, or part of, concrete debris wall in front of Nimbus powerplant.	Incorporated into Recommendation #3.
2.2.10	Change Nimbus Dam complex operations from peak to base-loading.	Omitted. Nimbus Dam already is a base-loading operation.
2.2.11	Improve efficiency of water transport through Lake Natoma.	Incorporated into Recommendation #2.
2.2.12	Install conduit from Nimbus Dam to upstream of Rainbow Bridge.	Omitted. Last resort. Would need to be a flexible bladder due to peaking.
2.2.13	Construct fish ladder at Nimbus Dam to make seasonal use of historic spawning habitat between Nimbus and Folsom dams.	Recommendation #28.
3.0	**Other Potential Management and/or Restoration Actions**	
3.1	**Management Actions**	
3.1.1	Provide ongoing long-term consultation/technical assistance.	Recommendation #15.
3.1.2	Establish mitigation/enhancement monitoring plan.	Underway as RCMP.
3.1.3	Construct Roseville reclamation pipeline.	Omitted due to feasibility considerations.
3.1.4	Develop an improved fire management plan.	Omitted. Outside FWG scope. BPWG or FMWG lead.
3.1.5	Re-evaluate statewide water supply policy.	Incorporated into Recommendation #9.
3.1.6	Increase the American River voice in Statewide water policies for meeting Delta needs.	Incorporated into Recommendation #9.

No.	Suggestions*	Status**
3.1.7	Effectively manage growth in Sacramento and Placer counties.	Omitted. Outside FWG scope.
3.1.8	Review zoning/land use plans to assess potential management opportunities.	Omitted. Outside FWG scope.
3.1.9	Install concrete boat ramp at Howe and Watt avenue access points.	Omitted. Underway or done.
3.1.10	Trench and install a tunnel for water main crossing (under the American River and through Discovery Park).	Omitted. Underway or done.
3.1.11	Develop and implement educational program that explains the natural history of the lower American River, as well as current and foreseeable management and restoration actions.	Omitted. Outside FWG scope. RWG lead.
3.2	**Restoration Actions**	
3.2.1	Identify off-site mitigation opportunities.	Omitted. Lacked sufficient information about this suggestion to act on it.
3.2.2	Build off-site habitat downstream of Nimbus Dam for steelhead.	Recommendation #19.
3.2.3	Establish areas where riparian vegetation is likely to occur naturally, and therefore should be managed by studying historic hydrographs regarding river stage elevation.	Incorporated into Recommendation #21.
4.0	**Studies in Progress**	
4.1	**Surveys**	
4.1.1	Conduct adult chinook salmon stock escapement estimation.	Incorporated into Recommendation I.
4.1.2	Conduct chinook salmon aerial redd surveys	Incorporated into Recommendation H.
4.2	**Monitoring and Evaluation**	
4.2.1	Monitor water temperature of the lower American River, and develop a comprehensive basin-wide monitoring program.	Recommendation #2.
4.2.2	Evaluate flow fluctuations and develop ramping criteria for the lower American River.	Incorporated into Recommendation #1.
4.2.3	Evaluate current monitoring practices and temperature monitoring program.	Incorporated into Recommendation #2.
5.0	**Research Actions**	
5.1	**Studies and Analyses**	
5.1.1	Evaluate tailrace habitat utilization.	Recommendation #28.
5.1.2	Conduct feasibility and cost/benefit analysis of all potential actions.	Omitted. Expected to occur at project-specific level, vs. in FISH Plan.
5.1.3	Conduct watershed optimization analysis.	Incorporated into Recommendation #2.
5.1.4	Conduct a temperature sensitive, radio transmitter tag study of juvenile fall-run chinook salmon to study rearing habitat and thermal history in relation to growth.	Incorporated into Recommendation B.
5.1.5	Radio tag juvenile steelhead to determine their fate below Watt Avenue.	Incorporated into Recommendations #14 and 18.

No.	Suggestions*	Status**
5.1.6	Investigate impact of nitrogen inflow on production.	Incorporated into Recommendation #2.
5.1.7	Evaluate splittail habitat availability.	Incorporated into Recommendations #12.
5.1.8	Investigate stranding impact on populations of fall-run chinook salmon and steelhead.	Incorporated into Recommendation #8.
5.1.9	Investigate impact of flow on invertebrates.	Omitted. Non-responsive.
5.1.10	Conduct a bathymetric thermal sink survey of Lake Natoma.	Incorporated into Recommendation #2.
5.1.11	Conduct a topographical survey of Lake Natoma.	Incorporated into Recommendation #2.
5.1.12	Conduct a limnologic survey of Lake Natoma.	Incorporated into Recommendation #1.
5.1.13	Investigate impact of enlarging outlets.	
5.1.14	Identify limiting factors to habitat and prioritize opportunity for enhancement.	Omitted. Underway as FISH Plan.
5.1.15	Investigate the potential for the toxic plume from Aerojet Corporation to infiltrate the lower American River.	Omitted. Done.
5.1.16	Investigate impact of “first flush” urban runoff events to riverine water quality.	Incorporated into Recommendation #23.
5.1.17	Study the impact of motorboat use on water quality.	Omitted. Done in Baseline Report.
5.1.18	Explore other methods of studying fall-run chinook salmon.	Underway and incorporated into draft FISH Plan recommendations throughout.
5.1.19	Conduct a temperature mapping study of the lower American River.	Incorporated into Recommendation D.
5.1.20	Evaluate impacts on listed species of using Folsom Reservoir preferentially to meet Delta water quality standards and export demands.	Incorporated into Recommendation #9.
5.1.21	Determine contribution of estuary reared fish to the total spawning population.	Recommendation #18.
5.1.22	Conduct watershed optimization analysis.	Incorporated into Recommendation #2.
5.1.23	Evaluate production demands on lower American River water supply needs for urban/municipal use.	Omitted. Non-responsive.
5.1.24	Examine ways to increase yield from American River watershed.	Omitted. Outside FWG scope because key opportunity to increase yield resides in groundwater.
5.1.25	Conduct a cost/benefit and feasibility study on the reintroduction of anadromous fish above Nimbus and Folsom dams.	Omitted. Outside FWG scope.
5.1.26	Conduct a thermal refugia utilization study.	Incorporated into Recommendation B.
5.1.27	Undertake study to determine in what month are flows likely to be most closely correlated with juvenile emigrant population size.	Omitted. Done in Baseline Report.
5.1.28	Undertake a rigorous analysis of confidence intervals and estimations of error in current methodologies.	Omitted. Will be done in FISH Plan’s Monitoring Strategy.

No.	Suggestions*	Status**
5.1.29	Evaluate alternative study methodologies: ▪ Monitor in-river production rather than escapement as a measure of the lower ▪ American River fall-run chinook salmon fishery health; ▪ Use of a fish weir or counting gate system to quantify escapement populations; ▪ Conduct hydro-acoustic sampling; and ▪ Separate hatchery influences from in-river production measurements.	Omitted. Will be done in FISH Plan's Monitoring Strategy.
5.1.30	Conduct a rigorous (perhaps 100%) coded wire tag program for fall-run chinook salmon to track contribution of hatchery reared fish to in-river spawning populations. Methods for recovering tagged fish need to be investigated (i.e., creel survey, seining).	Omitted. Will be done in FISH Plan's Monitoring Strategy.
5.1.31	Conduct an emergence study controlling gravel and water temperatures. The emergence study conducted on the Tuolumne River should be consulted.	Incorporated into Recommendation #17.
5.1.32	Investigate the eventual fate of fish entrained in screw traps and subsequent comparison of emigration timing and screw trap counts to escapement population size. Estuarine/Delta rearing may be the key factor determining the number of returning adults.	Omitted. Done in Baseline Report.
5.1.33	Evaluate suggested alternative methods of estimating outmigrant population (e.g., use of egg deposition numbers, number of fish spawning, and sex ratios, in conjunction with an emergence survival model).	Underway, but also incorporated into Recommendations E and I.
5.1.34	Estimate striped bass abundance in the lower American River and effects on steelhead and chinook salmon populations.	Incorporated into Recommendation E, assuming that E includes development of a relative habitat suitability index for striped bass.
5.1.35	Estimate American shad abundance in the lower American River and effects on juvenile steelhead and chinook salmon populations.	Omitted. Non-responsive.
5.1.36	Make annual estimates of the number of steelhead spawning in the American River below Nimbus Dam.	Incorporated into Recommendation #6.
5.2	**Model Development**	
5.2.1	Develop automated temperature selection model for Folsom Dam.	Incorporated into Recommendation #2.
5.2.2	Establish database of lower American River research to support model development.	Incorporated into Recommendation #11.
5.2.3	Develop in-river production model.	Incorporated into Recommendation E.
5.2.4	Develop fish health index.	Incorporated into Recommendation B.
5.2.5	Create steelhead mortality model.	Incorporated into Recommendation F.
5.2.6	Create multi-point water temperature model with daily forecasting capabilities.	Recommendation C.
5.2.7	Develop a rigorous analysis of error and confidence intervals associated with population estimations (spawning stock escapement and emigrant juvenile).	Omitted. Done in Baseline Report.

No.	Suggestions*	Status**
5.2.8	Establish relationship between storm event and incidence of contamination. Use data gathered at Fairbairn Water Treatment Plant.	Omitted. Addressed in Baseline Report. County has related effort underway.
5.2.9	Establish the role of the lower American River regarding salmonid life history, particularly in the ocean (e.g., through creel surveys and/or scale analysis).	Omitted. Outside FWG scope.

* Recommendations in this column refer to the numbering system in the "sorting matrix form" used at 3/7/01 TSC meeting.
** Recommendation numbers in this column refer to numbering system used in the September 2001 draft FISH Plan recommendations (Chapter 6).