Working Paper on Restoration Needs

Habitat Restoration Actions to Double Natural Production of Anadromous Fish in the Central Valley of California

Volume 1

WORKING PAPER ON RESTORATION NEEDS

HABITAT RESTORATION ACTIONS
TO DOUBLE NATURAL PRODUCTION OF ANADROMOUS FISH
IN THE CENTRAL VALLEY OF CALIFORNIA

Volume 1

Prepared for the U.S. Fish and Wildlife Service
under the direction of the
Anadromous Fish Restoration Program Core Group

May 9, 1995

ORGANIZATION OF THIS WORKING PAPER

This is Volume 1 of three volumes that comprise the Anadromous Fish Restoration Program (AFRP) Working Paper on Restoration Needs. The contents of the three volumes are as follows:

> **Volume 1** describes how the WORKING PAPER was developed, explains the process envisioned for completing a final Restoration Plan, and summarizes the production goals, limiting factors, and restoration actions sections developed by the AFRP technical teams. Interested parties should read the letter from Dale Hall and Wayne White that appears at the beginning of Volume 1.
>
> **Volume 2** provides descriptions of Central Valley rivers and streams, summarizes information on historic and existing conditions for anadromous fish, identifies the problems that have led to the decline of anadromous fish populations, and identifies roles and responsibilities of state and federal agencies in managing anadromous fish. It also includes two key documents that were used by the AFRP Core Group and technical teams to develop the WORKING PAPER.
>
> **Volume 3** includes the complete production goals, limiting factors, and restoration actions sections as submitted by the AFRP technical teams and edited by USFWS staff. Volume 3 also includes citations for all three volumes of the WORKING PAPER.

To request copies of this Working Paper, call the AFRP=s information line at (800) 742-9474 or (916) 979-2330 and dial extension 542 after the recorded message begins. You may also obtain copies by calling Roger Dunn, CVPIA Public Outreach, at (916) 979-2760 or by sending e-mail requests to roger_dunn@fws.gov. The Working Paper is available to be viewed and downloaded on the Internet at http://darkstar.dfg.ca.gov/usfws/fws_home.html.

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
SACRAMENTO-SAN JOAQUIN ESTUARY FISHERY RESOURCE OFFICE
4001 N. WILSON WAY, STOCKTON, CA 95205-2486
209-946-6400 (VOICE) 209-946-6355 (FAX)

MEMORANDUM April 14, 1995

To: Dale Hall, ARD,
Ecological Services, Portland

Wayne White
State Supervisor-California

From: Core Group Membership, Anadromous Fish Restoration Program (AFRP)
Central Valley Project Improvement Act (CVPIA)

Subject: Transmittal of working paper describing habitat restoration actions to double production of anadromous fish in the central valley of California

The attached working paper describes the habitat restoration actions the Core Group believes necessary to at least double the production of anadromous fish in the Central Valley, as required by Section 3406(b)(1) of the CVPIA.

We believe that this paper is a necessary technical platform upon which the participating agencies and the public can work cooperatively to achieve a sound, reasonable and implementable program.

This paper was developed by eight technical teams composed of experts possessing specific technical and biological knowledge of Central Valley drainages and anadromous fish stocks. Revisions by the Core Group and Service staff were primarily designed to improve readability and consistency in the document and to assure the restoration actions were justified as fully as possible on technical and biological merits.

The paper is the culmination of the initial phase of Program development. Using this working paper as baseline information, future efforts will evaluate the implementability and reasonableness of the actions described herein and other actions suggested by stakeholders and the interested public to finalize and implement the Anadromous Fish Restoration Program by October 31, 1995. A Preface to the paper describes the process of program development, and explains that reasonableness was not considered in developing the actions needed to double anadromous fish production.

While the Core Group members representing participating state (DFG and DWR) and federal (FWS, USBR, NMFS and EPA) agencies believe the paper provides a sound technical background from which to develop the final program, it does not mean that there is total agreement on the benefits of restoration actions either alone or in combination. Nor is there a commitment by any member or agency to implement any of the restoration actions noted herein.

We envision that each core agency will continue to participate in developing a sound and reasonable habitat restoration program in cooperation with key stakeholders and the interested public.

Martin A. Kjelson
Program Manager

United States Department of the Interior

FISH AND WILDLIFE SERVICE
911 N. E. 11th Avenue
Portland, Oregon 97232

IN REPLY REFER TO:

April 27, 1995

Memorandum

To: Interested Parties

From: Assistant Regional Director, Ecological Services
Region 1, Portland, Oregon

State Supervisor, Ecological Services
Sacramento, California

Subject: The Consideration of "Reasonable Efforts" in Developing the Anadromous Fish Restoration Program (Section 3406(b)(1) of the Central Valley Project Improvement Act)

The purpose of this memorandum is to convey the U.S. Fish and Wildlife Service's position on the reasonableness of actions presented in the attached Anadromous Fish Restoration Program Working Paper (Working Paper) developed by fishery experts from throughout the Central Valley.

The Working Paper represents the best available information on the level of restoration needed to meet the goal of at least doubling natural production of anadromous fishes. No attempt was made by the technical experts to determine if these actions are reasonable or desirable based on the potential social or economic impacts. We are providing this Working Paper as a starting point so we can understand the biological needs as we collectively develop a draft Anadromous Fish Restoration Program (Restoration Program).

As we enter the development phase of the restoration program, the Service is committed to working with stakeholders and the interested public to develop a reasonable, implementable restoration plan that balances the needs of anadromous fish with those of all parties that have an interest in the wise management of California's natural resources.

In our review of the Working Paper we have identified habitat restoration actions that we believe are unreasonable such as: 1) setting fish flow standards that consistently require unimpaired flows; 2) dismantling major water storage reservoirs; and 3) restricting total delta exports to low levels for most of the year. During the development of the draft Restoration Plan, the Service working with the stakeholders may determine other actions to be unreasonable or we may develop additional actions that are reasonable.

It is important to emphasize that the Secretary of the Interior's final decision on which restoration actions should be implemented will be influenced by a variety of factors. These include input and cooperation from the involved public and governmental agencies, results of the programmatic environmental impact statement, the benefit per unit cost, the monetary resources in the restoration fund and the availability of supplemental water for purchase. The fact that actions authorized by the CVPIA are restricted to CVP streams and facilities alone and that other restoration measures will require cooperation from other federal, state and private entities to be implemented will help assure that the final Program will be reasonable.

In summary, this statement is intended to assure all interested parties that the Service is committed to developing a plan that is reasonable and will make significant progress toward doubling natural production of anadromous fish. The CVPIA, in combination with other ongoing restoration activities, offers an unprecedented opportunity to correct the fishery, wildlife, and habitat problems we face in the Central Valley. We invite and encourage your involvement and cooperation to assure successful development and implementation of the Anadromous Fish Restoration Program.

PREFACE

The Central Valley Project Improvement Act (CVPIA), requires the Secretary of the Interior to develop and implement Aa 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 1967-1991@ (Section 3406[b][1]). This program is under development and is known as the Anadromous Fish Restoration Program (AFRP).

This working paper is the culmination of the initial phase of development of a final AFRP plan. The paper presents a package of habitat restoration actions that, if implemented, would achieve the goal of at least doubling natural production. It was developed to provide a platform on which the participating agencies and the public will develop actions to include in the final plan. Reasonableness was not considered in developing this working paper. For the final plan, reasonable actions will be selected from those described in this working paper and additional actions suggested by the public, including stakeholders, other interested parties, and public and private agencies.

This preface describes how the working paper was developed, how the final AFRP plan will be developed, and the process by which Areasonable efforts@ will be identified and included in the final plan.

The final AFRP plan is scheduled for completion by October 31, 1995. The AFRP is proceeding in three general phases: 1) production of the working paper, 2) production of the final AFRP plan, and 3) implementation of the plan.

PRODUCTION OF THE WORKING PAPER

The first phase covers the past efforts up to the release of this working paper. During this period, a coalition of senior fish experts from the U.S. Fish and Wildlife Service, U.S. Bureau of Reclamation, National Marine Fisheries Service, U.S. Environmental Protection Agency, California Department of Fish and Game, and California Department of Water Resources--the ACore Group@--directed the development of the working paper. The Core Group formed eight AFRP technical teams. These teams consisted of experts from state and federal agencies, private industry, and academia with specific knowledge of anadromous fish species in Central Valley rivers and streams. They developed the restoration actions described in this working paper. The AFRP Core Group and USFWS staff then worked with the technical teams to revise the information based on the technical merits of the actions in meeting the restoration goals and to standardize format and improve readability. Additional guidelines used to develop this paper are found in the *CVPIA*, the *Plan of Action for the Central Valley AFRP,* and the *Draft Position Paper for Development of the AFRP.*

To arrive at the most conservative recommendations needed to double natural production of Central Valley anadromous fish stocks, and knowing that reasonableness would be addressed later by a broader group, the Core Group directed the technical team members to consider only the scientific basis for their recommended actions and to recommend actions whose implementation would ensure that production of anadromous fish would at least double.

It was clear early in the process of developing the working paper that predicting the benefits of specific restoration actions would be limited by available data. For example, fish population estimates were developed during the baseline period for other management purposes, and not for developing restoration goals. Despite the limitations, we believe the data, along with management models and the highly respected professional opinions of the many involved fishery experts, provide sound technical bases for the actions contained in this document.

Overall, the package of actions presented in this paper does not yet represent a fully integrated plan (e.g., integration of upstream and Delta actions has not been done in this paper). Most flow recommendations have been screened to ensure that they do not exceed unimpaired runoff or limits imposed by reservoir storage capacity. In some cases, the flow-carryover storage relationships have been evaluated to balance the needs of different fish species or stocks. Coordination with the programmatic environmental impact statement (PEIS) team has been helpful to clarify and resolve these issues. Further integration and balancing are required to develop a comprehensive program that meets the full intent of the CVPIA.

This working paper gives a clear picture of the types and levels of restoration actions necessary to achieve the goal of doubling natural production of Central Valley anadromous fish. By using this working paper as baseline information, future efforts, including public participation, will evaluate the reasonableness of actions.

PRODUCTION OF THE FINAL AFRP PLAN

The second phase begins with release of the working paper and will extend to completion of the final AFRP plan. In this phase, we will prioritize restoration actions and determine what the interested parties and agencies consider reasonable efforts. Determination of reasonableness will rely on public participation and on the independent analyses of social, economic, and environmental impacts conducted by the PEIS team. Reasonable actions will be selected from actions specified in this working paper and additional actions suggested by the public, including stakeholders, other interested parties, and public and private agencies.

Priority will primarily be based on benefits, costs, and feasibility of restoration actions. High priority will be assigned to actions that have the greatest potential to enhance production of anadromous fish at the least cost.

The final AFRP plan will include the habitat restoration actions mandated by the CVPIA in Section 3406 and under the authority of the Secretary of Interior and additional actions deemed reasonable efforts. We believe the mandated actions will improve survival and production of Central Valley anadromous fish but will not double production without implementation of additional actions specified in this paper.

IMPLEMENTATION OF THE PLAN

The third phase covers implementation and monitoring of the restoration actions and is discussed in more detail under the heading AImplementation Considerations@ in Section I, AIntroduction@. This period will extend beyond October 31, 1995. We envision that implementation of the actions authorized by the CVPIA will occur in phases due to limitations of time, resources, knowledge, funding, and the need to address many complex issues surrounding the implementation of the CVPIA. Phased implementation will provide opportunities for the public; private, public, and government agencies; and other interested parties to participate throughout the implementation process.

In addition, the Secretary of Interior has limited authority to implement the actions described in this working paper. Implementation of a comprehensive program will require the support and participation of the public; private, public, and government agencies; and other interested parties who have the authority to implement those actions not under authority of the Secretary. Limited authority reinforces the need for public support to help ensure that the actions in the final AFRP plan will be reasonable.

As implementation of the restoration actions continues, monitoring plans will be designed to assess the biological results and effectiveness of the habitat restoration actions. Results of efforts to monitor the effectiveness of the first actions to be implemented may be used to modify actions that will be implemented later. To avoid duplication and use available resources wisely, monitoring for the AFRP will be coordinated with the Comprehensive Assessment and Monitoring Program 3406 (b)(16) and other efforts to monitor anadromous fish in the Central Valley and Bay/Delta.

REQUEST FOR COMMENT AND PARTICIPATION

We request timely, constructive comment on this paper from those representing the many public and private interests involved with the CVPIA and the AFRP. Many interested parties have already had the opportunity to comment on our *Plan of Action*, *Draft Position Paper*, and the California Department of

Fish and Game's *Book of Numbers* and to participate in public workshops. Your participation is critical to successful development of the final plan.

We have five requests of each reviewer. First, we ask that you review the working paper for technical accuracy. If you observe factual errors, please provide corrections and support for your corrections so that we can use that information in the final AFRP plan. Second, you may find that an alternative set of actions can achieve the same goals as the package of restoration actions described in this working paper. Again, describing such alternatives and the justification to support their validity is important. Third, we are looking for opportunities to better integrate the upstream and Delta actions and invite assistance in this complex process. Fourth, quantifying the benefits of restoration actions is difficult, both individually and in combination. If you have additional information on the efficacy of specific actions, we would find that information useful. Fifth, while not addressed in this working paper, it is important that you convey to us how the implementation of the proposed actions, including criteria for reasonableness, would be most effectively addressed to achieve the goals of the CVPIA. Your suggested approaches to this important process will help all of us in efficiently planning and developing the final plan.

RESPONSIBILITIES

This working paper and the final AFRP plan are the responsibility of the USFWS as lead agency for the AFRP. The USFWS is indebted to the assistance of the technical teams and Core Group members; however, this working paper does not necessarily reflect a commitment by any member's agency or organization to implement any of the restoration actions noted herein. In that light, the reader should view this paper as a reference document whose contents will be modified and improved as we move toward the completion of a final, comprehensive restoration plan. Successful completion of the final plan will depend on the continued guidance of the Core Group and technical team members, participation of the public and interested parties, and support of involved state and federal agencies.

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Core Group

Randy Brown....................DWR
Jim Bybee....................NMFS
Roger Guinee.................... USFWS
Susan Hatfield.................... EPA
Marty Kjelson.................... USFWS
Ken Lentz....................USBR
Terry Mills ....DFG
Larry Puckett....................DFG
Jim Smith.................... USFWS

Mainstem Sacramento River Salmon and Steelhead Technical Team

Serge Birk ....USBR
Frank Fisher ....DFG
Ralph Hinton....................DWR
Rich Johnson.................... USFWS
Keith Marine....................Vogel Environmental Services
Harry Rectenwald ....DFG
Roger Wolcott ....NMFS

Upper Sacramento River Tributaries Salmon and Steelhead Technical Team

Pat Bigelow.................... USFWS
Serge Birk ....USBR
Stacy Cepello ....DWR
Steve Croci.................... USFWS
Ralph Hinton....................DWR
Dave Hoopaugh....................DFG
Spencer Hovekamp ....USBR
Paul Maslin.................... California State University, Chico
Harry Rectenwald ....DFG
Curtis Steitz.................... Pacific Gas & Electric
Paul Ward ....DFG

Lower Sacramento River and Delta Tributaries Salmon and Steelhead Technical Team

Dawne Becker .... DFG
Paul Bratovich .... Beak Consultants Inc.
Mike Bryan .... Beak Consultants Inc.
Dan Castleberry .... USFWS
Roger Guinee .... USFWS
Joe Miyamoto .... East Bay Municipal Utility District
John Nelson .... DFG
Kate Puckett .... USBR
Ted Sommer .... DWR
Nick Villa .... DFG

San Joaquin Basin Salmon and Steelhead Technical Team

Dale Hoffman-Floerke .... DWR
Ken Lentz .... USBR
Bill Loudermilk .... DFG
Carl Mesick .... Carl Mesick Consultants
Mindy Nelson .... Stanislaus River Council
Gary Taylor .... USFWS
John Wullschleger .... USFWS

Sacramento-San Joaquin Delta Salmon and Steelhead Technical Team

Jim Arthur .... USBR
Pat Brandes .... USFWS
Darryl Hayes .... DWR
Bill Kier .... William M. Kier Assoc.

Striped Bass Technical Team

Jim Arthur .... USBR
Loo Botsford .... University of California, Davis
Chuck Hanson .... Hanson Environmental
Dave Kohlhorst .... DFG
Larry Stenger .... Striped Bass Advisory Committee
Don Stevens .... DFG

American Shad Technical Team

Phil Dunn .... Jones & Stokes Associates, Inc.
Roger Guinee .... USFWS
Mike Meinz .... DFG
Dick Painter .... DFG
Ted Sommer .... DWR

Lynn Wixom....DFG
John Wullschleger....USFWS

Sturgeon Technical Team

Kurt Brown....USFWS
Dan Castleberry....USFWS
Jim De Staso....USFWS
Serge Doroshov....University of California, Davis
Patrick Foley....University of California, Davis
Dave Kohlhorst....DFG

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SECTION I. INTRODUCTION TO THE WORKING PAPER

CENTRAL VALLEY PROJECT IMPROVEMENT ACT

This Working Paper discusses habitat restoration actions believed necessary to double the natural production of chinook salmon, steelhead, striped bass, American shad, and white and green sturgeon in the rivers and streams of California's Central Valley. The legal guidelines used to develop this paper can be found in the implementing legislation of the Central Valley Project Improvement Act (CVPIA), which is described below.

On October 30, 1992, the President signed into law the Reclamation Projects Authorization and Adjustment Act of 1992 (Public Law 102-575), including Title XXXIV, the CVPIA. The CVPIA amends the authorization of the Department of the Interior's California Central Valley Project (CVP) to include fish and wildlife protection, restoration, and mitigation as project purposes having equal priority with irrigation and domestic uses and fish and wildlife enhancement as a purpose equal to power generation. The CVPIA identifies several specific measures to meet these new purposes and sets a broad goal of sustaining natural populations of anadromous fishes produced in Central Valley rivers and streams at double their recent average levels. The CVPIA also directs the Secretary of the Interior to operate the CVP consistent with these purposes, to meet the federal trust responsibilities to protect the fishery resources of affected federally recognized Indian tribes, and to meet all requirements of federal and California law.

The Department of the Interior is developing policies and programs to modify the operations, management, and physical facilities of the CVP to comply with the purposes and goals of the CVPIA and the revised purposes of the CVP. These policies and programs will define operational criteria and management and structural priorities for the CVP. The general purposes of the CVPIA, and of the action proposed by the Secretary of the Interior, were identified by Congress in Section 3402:

> (a) to protect, restore, and enhance fish, wildlife, and associated habitats in the Central Valley and Trinity River basins of California;
>
> (b) to address impacts of the CVP on fish, wildlife, and associated habitats;
>
> (c) to improve the operational flexibility of the CVP;
>
> (d) to increase water-related benefits provided by the CVP to the State of California through expanded use of voluntary water transfers and improved water conservation;

(e) to contribute to the State of California's interim and long-term efforts to protect the San Francisco Bay/Sacramento-San Joaquin Delta estuary; and

(f) to achieve a reasonable balance among competing demands for use of CVP water, including the requirements of fish and wildlife, agriculture, municipal and industrial, and power contractors.

In addition, the CVPIA includes several specific and general measures, including the requirement to double natural production of anadromous fish, that, when implemented, will satisfy the purposes of the CVPIA and the revised purposes of the CVP.

These purposes respond to the need to improve the existing water management practices of the CVP. Fish and wildlife populations and the condition and extent of their habitats have declined drastically from historical levels. Construction and operation of the CVP have contributed to these declines and to the decline in water quality and other environmental conditions in the Sacramento-San Joaquin Delta (Delta). In recent years, the pattern of demand for water in California has changed; in particular, municipal and industrial demand has increased. Under previous laws and existing policies, CVP operations have been constrained from fully responding to these changing demands and priorities. As a result, existing operations do not display adequate flexibility or reflect a reasonable balance among competing demands. Despite these adverse effects, CVP facilities offer tremendous opportunities to restore fish populations and their associated habitats in numerous major California waterways. These opportunities are fully embodied in the CVPIA.

SECTION 3406

This document was developed under the authority of HR 429, Title 34 - Central Valley Project Improvement Act, and specifically Section 3406(b)(1):

FISH AND WILDLIFE RESTORATION ACTIVITIES - The Secretary, immediately upon enactment of this title, shall operate the Central Valley Project to meet all obligations under state and federal law, including but not limited to the federal Endangered Species Act, 16 U.S. ' 1531, et seq., and all decisions of the California State Water Resources Control Board establishing conditions on applicable licenses and permits for the project. The Secretary, in consultation with other State and Federal agencies, Indian tribes, and affected interests, is further authorized and directed to:

(1) 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-

1991; Provided, That this goal shall not apply to the San Joaquin River between Friant Dam and the Mendota Pool, for which a separate program is authorized under subsection 3406(c) of this title; Provided further, That the programs and activities authorized by this section shall, when fully implemented, be deemed to meet the mitigation, protection, restoration, and enhancement purposes established by subsection 3406(a) of this title; And provided further, That in the course of developing and implementing this program the Secretary shall make all reasonable efforts consistent with the requirements of this section to address other identified adverse environmental impacts of the Central Valley Project not specifically enumerated in this section.

(A) This program shall 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; 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.

(B) As needed to achieve the goals of this program, the Secretary is authorized and directed to modify Central Valley Project operations to provide flows of suitable quality, quantity, and timing to protect all life stages of anadromous fish, except that such flows shall be provided from the quantity of water dedicated to fish, wildlife, and habitat restoration purposes under paragraph (2) of this subsection; from the water supplies acquired pursuant to paragraph (3) of this subsection; and from other sources which do not conflict with fulfillment of the Secretary's remaining contractual obligations to provide Central Valley Project water for other authorized purposes. Instream flow needs for all Central Valley Project controlled streams and rivers shall be determined by the Secretary based on recommendations of the U.S. Fish and Wildlife Service after consultation with the California Department of Fish and Game.

(C) The Secretary shall cooperate with the State of California to ensure that, to the greatest degree practicable, the specific quantities of yield dedicated to and managed for fish and wildlife purposes under this title are credited against any additional obligations of the Central Valley Project which may be imposed by the State of California following enactment of this title, including but not limited to increased flow and reduced export obligations which may be imposed by the California State Water Resources Control Board in implementing San Francisco Bay/Sacramento-San Joaquin Delta Estuary standards pursuant to the review ordered by the California Court of Appeals in U.S. v. State Water Resources

Control Board, 182 Cal.App.3rd 82 (1986), and that, to the greatest degree practicable, the programs and plans required by this title are developed and implemented in a way that avoids inconsistent or duplicative obligations from being imposed upon Central Valley Project water and power contractors.

(D) Costs associated with this paragraph shall be reimbursable pursuant to existing statutory and regulatory procedures.

IMPLEMENTATION CONSIDERATIONS

Three aspects of implementation are considered here: 1) prioritizing actions, 2) tools available to the Secretary of Interior for implementing actions, and 3) schedule for implementation. The implementation process provides an opportunity to ensure that the restoration actions taken are reasonable.

Prioritizing Actions

Setting priorities for actions will require public participation. Most prioritization should occur before the AFRP plan is completed. To set priorities for actions, criteria for assigning priority to actions must be developed. These criteria should assign high priority to actions that are likely to provide the greatest benefit to production of anadromous fish, especially those actions that protect and restore natural channel and riparian habitat values. Other criteria may include assigning high priority to actions that improve the habitat of species that are endangered, threatened, or of special concern; that improve production of multiple species; that can be implemented rapidly; that and the Secretary has authority or cooperation from others to implement. Actions that are not considered Areasonable efforts@ should not be assigned high priority.

Because not all actions can be implemented simultaneously, an attempt will be made to implement high-priority items first. Monitoring the success of implemented actions will provide information that will help reevaluate priorities for remaining actions. The implementation schedule should be flexible so that unique opportunities to implement actions can be taken advantage of, even if these actions are not the highest priority actions. Because implementation will continue well past the date the AFRP plan is completed, and because public participation will be necessary to implement many actions needed to double production of anadromous fish, participation will continue throughout the implementation process.

Tools Available to the Secretary of Interior for Implementing Actions

Tools in the CVPIA - The USFWS anticipates that the tools available to the Secretary of the Interior for achieving the goals of the AFRP include implementing all sections of the CVPIA. Sections 3406(b)(2) through (21) of the CVPIA authorize and direct the Secretary of Interior to take specific actions. These actions have been categorized as structural modifications, water management modifications, and operational modifications. Two elements do not fit these categories: element (b)(16), the comprehensive monitoring program, and element (b)(19), a reevaluation of carryover storage criteria. A brief description of the elements in each of the three categories is listed below. Further details are provided in the CVPIA.

Structural modifications -

3406(b)(4) - Mitigate for Tracy Pumping Plant operations.

3406(b)(5) - Mitigate for Contra Costa Canal Pumping Plant operations.

3406(b)(6) - Install temperature control device at Shasta Dam.

3406(b)(10) - Minimize fish passage problems at Red Bluff Diversion Dam.

3406(b)(11) - Implement Coleman National Fish Hatchery Plan and modify Keswick Dam Fish Trap.

3406(b)(12) - Improve fish passage and restore habitat in Clear Creek.

3406(b)(13) - Replenish spawning gravel and restore riparian habitat below Shasta, Folsom, and New Melones Reservoirs.

3406(b)(14) - Install new control structures at Delta Cross Channel and Georgiana Slough.

3406(b)(15) - Install barrier at head of Old River.

3406(b)(17) - Resolve fish passage and stranding problems at Anderson-Cottonwood Irrigation District Diversion Dam.

3406(b)(20) - Mitigate for the Glenn-Colusa Irrigation District=s Hamilton City Pumping Plant.

3406(b)(21) - Adequately screen diversions.

Water management modifications -

3406(b)(1)(B) - Modify CVP operations.

3406(b)(2) - Manage 800,000 af of CVP yield for fish, wildlife, and habitat restoration purposes.

3406(b)(3) - Acquire water to supplement the quantity of water dedicated for fish and wildlife water needs under (b)(2), including modifications of CVP operations; water banking; conservation; transfers; conjunctive use; and temporary and permanent land fallowing, including purchase, lease, and option of water, water rights, and associated agricultural land.

3406(b)(7) - Meet flow standards that apply to CVP.

3406(b)(8) - Use pulse flows to increase migratory fish survival.

3406(b)(12) - Provide increased flows in Clear Creek.

3406(b)(18) - Restore striped bass fishery in Bay/Delta.

Operational modifications -

3406(b)(1)(B) - Modify CVP operations.

3406(b)(4) - Mitigate for Tracy Pumping Plant operations.

3406(b)(5) - Mitigate for Contra Costa Canal Pumping Plant operations.

3406(b)(7) - Meet diversion limits that apply to the CVP.

3406(b)(9) - Eliminate fish losses due to flow fluctuations of CVP.

3406(b)(10) - Minimize fish passage problems at Red Bluff Diversion Dam.

3406(b)(14) - Improve operations at Delta Cross Channel and Georgiana Slough.

3406(b)(17) - Resolve fish passage and stranding problems at Anderson-Cottonwood Irrigation District Diversion Dam.

3406(b)(20) - Mitigate for GCID's Hamilton City Pumping Plant.

The CVPIA establishes the ACentral Valley Project Restoration Fund@ and gives the Secretary the authority to use the fund Ato carry out the habitat restoration, improvement and acquisition (from willing sellers) provisions@ of the CVPIA (Section 3407), including the actions listed above.

Tools for use on CVP vs. non-CVP streams - Tools available to the Secretary to implement actions on streams where flows are controlled primarily by CVP structures are greater than the tools available on streams where flows are not controlled by CVP structures. For example, modification of CVP operations and use of the 800,000 acre-feet are limited to CVP-controlled streams. The CVP-controlled streams include the Sacramento, American, Stanislaus, and San Joaquin rivers (although restoration of anadromous fish habitat on the San Joaquin River is limited to that section downstream of Mendota Pool). There are a number of entities involved or affected by the management of water supplies on these rivers.

Non-CVP controlled streams include Battle, Mill, Deer, Butte, Stony, Elder, and Thomas creeks and Feather, Yuba, Bear, Cosumnes, Mokelumne, Calaveras, Tuolumne and Merced rivers, as well as the Delta. Private land owners, public and private irrigation districts, utilities, the State Water Project, and municipalities and industry manage facilities and flows on these streams. The CVPIA does not provide the Secretary with the direct authority to implement actions on these streams.

Cooperation with others - To implement actions on streams or at facilities where the Secretary does not have authority, the Secretary will need the cooperation of the entities with the authority to implement the actions. These entities include SWRCB, the Federal Energy Regulation Commission (FERC), and others that may or do establish diversion restrictions and minimum flow requirements. Other regulatory processes under DFG, EPA, NMFS, the Corps, and other state, federal, county, and local agencies have significant potential to influence the implementation of specific restoration actions in the AFRP. Efficient and timely coordination and strong cooperative efforts with these organizations are essential to implement a comprehensive AFRP.

In addition, the "Principles for Agreement on Bay/Delta Standards between the State of California and the Federal Government", signed on December 15, 1994, has potential to supplement restoration actions in the CVPIA. Category III of the agreement provides for private funding of nonflow actions to improve fish protection. This element of the agreement is to be implemented immediately (1995) and the development of specific actions is currently in progress. Other ongoing restoration or mitigation efforts include the four pumps agreement (DWR and DFG 1986) and DFG efforts described in ARestoring Central Valley Streams: A Plan for Action@ (Reynolds et al. 1993) and the subsequent implementation report (DFG 1995). All of these activities contribute to restoration of anadromous fish habitat in the Central Valley and each of them is implementing actions described in the Working Paper. The challenge for the AFRP is to assist and augment these activities.

Schedule for Implementation

Limitations due to time restrictions, lack of money in the restoration fund, legal and administrative constraints, and the need to balance actions to meet other goals of the CVPIA, among others, will require that actions be implemented in phases. Given these limitations, it is difficult to predict how rapidly we can proceed with implementing actions.

The first restoration actions to be implemented are envisioned to be a combination of those mandated in the CVPIA and other non-CVP actions. Actions requiring structural, water management, and operational modifications are discussed below. For each of these categories, actions for which tools are provided in the CVPIA are discussed first, and actions for which tools other than those provided directly by the CVPIA (those actions that would need to be implemented through other authorities) are discussed second.

Structural modifications - Of the sections of the CVPIA categorized above as structural modifications, most could be implemented soon if given a high priority for use of restoration funds. Several have already been implemented, at least in part, or are being designed. These include mitigating for the Tracy fish facilities (b)(4); constructing the temperature control device at Shasta Dam (b)(6); minimizing fish passage problems at RBDD (b)(10); implementing CNFH Plan (b)(11); replenishing gravel below CVP reservoirs (b)(13); installing a (sound) barrier at Georgiana Slough (b)(14); installing a (temporary) barrier at the head of Old River (b)(15); and mitigating for GCID's Hamilton City Pumping Plant (b)(20). Replenishing gravel below CVP reservoirs (b)(13) will be a continuous process and will take time to significantly restore habitat.

As noted earlier, a major potential to implement structural modifications in the near term may be provided through coordination with the actions carried out under Category III of the principles for agreement on Bay/Delta standards.

Water management modifications - Modifications to CVP operations to provide flows of suitable quality, quantity, and timing to protect all life stages of anadromous fish (b)(1)(B) are currently being implemented although there is potential for improvement with further effort and evaluation of the benefits achieved. These modifications affect CVP-controlled streams and the Delta.

Management of the 800,000 af for fishery and habitat restoration (b)(2) has been ongoing since 1993. This element has been affected by the Bay/Delta Framework Agreement, in that the CVP obligation for Delta flow needs is provided from the 800,000 af. Hence, the remaining portion of the 800,000 af of CVP yield will be available for the needs of the AFRP. The Bay/Delta agreement is to be in effect for the next 3 years.

Some amount of the restoration fund is available to acquire supplemental water supplies (b)(3) for use by the AFRP. This element stipulates the need to define how the Secretary intends to use CVP operational modifications; water banking, conservation, transfer, conjunctive use, and land fallowing. Land fallowing includes purchase and lease of agricultural lands and acquisition of associated water and water rights options. The acquisition of supplemental water would be effective in the Delta and would provide added tributary flows in both CVP and non-CVP Central Valley streams. Success of water acquisition in the near term will be influenced by the availability of restoration funds and the willingness of sellers to provide water for fishery purposes. Acquisition of supplemental water supplies brings in the major stakeholders in the water user community. Success in gaining supplemental water supplies for fishery restoration will depend on how well all parties can work together and cooperate.

Other actions from the CVPIA relate to flow standards required to be met by the CVP (b)(7) and pulse flows to increase migratory fish survival (b)(8). Both are ongoing under the Bay/Delta agreement, which requires the CVP and SWP to meet flow standards, export-to-inflow ratios, pulse flows, and Delta Cross Channel operational criteria. These actions are designed to provide fish protection sufficient for currently listed threatened and endangered species and to avoid additional listings.

Finally, there are ongoing regulatory processes by FERC and the SWRCB that may establish new minimum flow mitigation requirements for the Yuba, Mokelumne, and Tuolumne rivers in the near future. These processes provide improved tributary flows and Delta inflow, further aiding implementation of the restoration actions.

Operational modifications - Most of the operation modification elements of the CVPIA (b)(1[B],4,5,7,9,10,14,17 and 20) are currently being implemented to some extent although there is potential for improvements with further effort and evaluation of the benefits achieved. There is also potential for operational modifications on non-CVP streams that would provide benefits to anadromous fish.

EVALUATION OF FLOW NEEDS

To aid the reader in appreciating the complexity of defining flow needs for anadromous fish restoration, we have provided discussion of several key aspects of this issue.

Relations between Flows and Anadromous Fish Populations

The assumption that there is a relationship between river flow and anadromous fish populations may have initially stemmed from the observation that large rivers maintained large runs of fish, medium-sized rivers held medium-sized runs, and small streams produced relatively few fish, even in very wet years. A common-sense explanation is that there is relationship between the size of a river and the number of fish it will support and the size of a river and the amount of water running through it.

If the CVP is viewed as an experiment testing this assumption, various examples of the relationships between flow and fish can be observed. Flow and temperature changes after the construction of Shasta Dam created cold water habitat for a large population of winter-run chinook salmon in the 1950s and 1960s. This population subsequently declined as flow and flow-related conditions changed and, perhaps, as changing operations in the Delta reduced survival there. New Melones Dam on the Stanislaus River created conditions under which salmon populations were strong in wet years when flow patterns approximated a natural state and neared extinction under dry conditions when a greater proportion of unimpaired winter and spring runoff was retained in reservoirs.

Extirpation of anadromous fish from much of the mainstem San Joaquin River after the severe reduction in flow that followed the completion of Friant Dam provides additional evidence of the relationship between the size of the river and water flow and fish populations. Systemwide, except on the American and Feather rivers where the success of natural populations is very difficult to gauge because of the presence of large hatcheries, strong evidence suggests that reducing winter and spring flows tends to reduce populations of anadromous fish that rear and migrate in winter and spring. In addition to the effects of hatchery production, factors that confound the precise determination of optimum fish flows include differences in life history requirements, water quality problems, land use impacts, altered river and floodplain morphology, and obstruction of access to historical spawning reaches.

Difficulties in Evaluating Flow Needs

The value of a restoration action depends on how effectively it addresses the factors that are actually limiting to the population of a target species. For example, the value of a mechanical device designed to allow the release of warmer reservoir water to draw fish to spawning areas and the later release of cool water to improve egg survival would be diminished if fish were not drawn to spawning areas by warmer water or if overall productivity were primarily controlled by conditions in the estuary.

Identifying the flows needed to restore fish production in regulated streams is controversial because modifying flow regimes to meet the needs of fish may undermine the objectives of the groups who benefit from the existing management scheme. In the Central Valley, the primary objectives of water managers are typically flood control and water storage for later agricultural and urban uses. Consequently, rationales for changing flow patterns are often intensively debated among stakeholders, and close attention is applied to the biological judgments underlying them. Because they are perceived as being less costly, nonflow alternatives are seldom subjected to the same level of scrutiny. However, the degree of uncertainty associated with the benefits of actions such as gravel supplementation and screening is equal to or greater than that associated with modification of flow. For any restoration measure, the key decision is this: does it target a problem that is actually limiting to the target species? Intuitively, the benefits of screening agricultural diversions to prevent entrainment of juvenile fish appear obvious; however, there would be little value in spending limited funds on screening if fish excluded from upstream diversions were subsequently lost in the Delta as a result of direct and indirect effects of exports at the state and federal water projects. Similarly, there would be little value in increasing the quantity of available spawning gravel if the problem that actually limits juvenile production is lack of adequate rearing habitat.

Similar problems surround the evaluation of restoration proposals to improve fish habitat by changing flow regimes. As with most other restoration measures, improvements in fish production resulting from modified flow regimes cannot be quantitatively predicted at this time. CVPIA includes provisions intended to overcome this deficiency, notably Section 3406(b)(16), which requires development of a comprehensive program to assess the biological results and effectiveness of restoration actions, and Section 3406(g), which requires development of biological and water system models to improve scientific understanding of various elements of the Central Valley ecosystem.

Flow evaluation methods - One of the tools available for evaluating fishery flows is the Instream Flow Incremental Methodology (IFIM) developed by USFWS's Instream Flow Group, now the River Systems Management Section of the National Biological Service Mid-continent Ecological Sciences Center. IFIM provides a means of estimating the amounts of fish habitat available at various flows, commonly through PHABSIM, a series of computer programs simulating river hydraulics and fish habitat. Because available habitat can be presented over a range of flows, the methodology provides a means of evaluating tradeoffs between fish habitat and water supply.

The IFIM process for determining relationships between stream flow and habitat is at base simple and direct, consisting of three steps:

1. Observe fish in streams and measure the physical characteristics of the habitat they use.

2. Measure or estimate the amount of similar habitat available in a stream at various flows.

3. Compare the habitat available in the river under various flows to the habitat used by fish. The flow that provides the greatest amount of habitat, modified by macrohabitat constraints such as temperature and water quality, is the optimum flow for a given life stage. This information may then be used in any variety of ways to develop a larger view of the overall biological effect of flows.

The primary physical microhabitat variable addressed through currently applied IFIM methods is water velocity, because the area of river with usable velocity defines the area where fish can live. Substrate quality, an essential element of salmonid spawning habitat, is also usually characterized in a Central Valley IFIM habitat study. Depth is always included in flow studies because it is needed for velocity estimation at unmeasured flows, and because fish need a certain depth of water to swim and breathe. Other variables thought to be important to fish, such as cover and food production, can be included in IFIM microhabitat estimates, but this has not been seriously attempted in any Central Valley study, possibly because evidence of their relationship to long-term flows above a minimal level is inconclusive or difficult to obtain.

For Central Valley chinook salmon and steelhead, important flow-dependent life stages include adult spawning, egg incubation, and juvenile rearing and migration. Because habitat needs change as fish grow from fry to smolts, rearing fish are usually divided into two categories, fry and juveniles above about 50 millimeters (mm) long. Steelhead trout are generally divided into adult, fry, and juvenile life-stages. Useful

IFIM habitat criteria for shad, striped bass, and sturgeon have not been developed in California and probably will not be, given the difficulty of observing these fish in the open water or depths they inhabit.

IFIM techniques are often viewed as limited or deficient in estimating necessary fishery flows. Various criticisms are that PHABSIM processes posit an unreal relationship between habitat and fish production, they do not adequately account for cover or other variables sometimes thought to be flow related, or the relationship between where a fish lives and why it lives there is unclear. Whatever the merit of these criticisms, four main problems are faced by IFIM users in California:

1. No system of estimating proper fishery flows, including IFIM, has been verified by quantification of the relationships between fish habitat and fish production. A 10-year study is underway, however, to test the IFIM and determine whether changes in aquatic habitat caused by changes in the flow produce predictable changes in fish populations (Studley et al. 1993). To achieve this, it will be necessary to determine the numerical relationships between various life stages of fish with different or even conflicting habitat requirements, which has not been attempted in any Central Valley flow study. Such information is expected to be developed under Sections 3406(b)(16) and 3406(g) of the CVPIA, and various specific data needs are described in sections of this report.

2. Because young salmonids are small and comparatively weak, they need low velocities to survive in rivers. Chinook salmon ranging from about 33 to 50 mm long, for example, are most commonly found in still water near stream edges. Absolute areas of this slow water habitat generally increase with decreasing flow, so it is usually possible to interpret flow study results as showing that decreasing flow increases rearing habitat and that maximum fry habitat is provided by no flow at all, when the river becomes a series of still pools. This ignores the importance of flows for food transport, temperature moderation, and habitat diversity, but finding the point on a flow-versus-habitat curve where food transport and habitat diversity become of overriding importance is a matter of interpretation. Because of this, IFIM studies have sometimes become more a focus of debate than a means of resolution, with high-flow proponents rejecting estimated rearing flows and out-of-stream water users defending them.

3. Some Central Valley rivers have had average natural rearing flows reduced an order of magnitude or more so that the flows available for IFIM studies barely approach the lower limit of natural conditions. Most information available on anadromous fish and habitat condition in California is based on study of drastically altered streams, and little is known about the amounts of habitat that unimpaired flows provided. Doubling production implies a return to some approximation of preproject habitat conditions, but flows at preproject rearing-season levels have not been studied on any Central Valley stream. Flow studies have largely evaluated habitat in streams that are being operated like canals. To cite one example, available sampling techniques restricted the Yuba River flow study of 1991 to

measurement of a high flow of 1,035 cubic feet per second (cfs) in reaches where average natural rearing-season flows were well over 6,000 cfs. The resulting habitat estimates have been the basis for flow recommendations but may not include the flows that exploit the full habitat potential of the river.

4. Problems with IFIM methods are most pronounced for early life stages. Juvenile salmonids are small, mobile, and difficult to statistically enumerate in all but the smallest streams; direct knowledge of their behavior and habits in Central Valley streams is sparse, and commonly supplemented with inferences from studies of tagged hatchery fish or fragmentary capture records of variable quality. Consequently, flow studies and flow recommendations have been oriented toward spawning, which is relatively easily quantified; lack of data has sometimes limited consideration of juvenile life stages to providing flows for temperature control or to releasing brief flow pulses that may improve survival during migration.

IFIM has been widely applied, despite its imperfections, partly because no more technically sound yet feasible method is widely available. Some alternatives include rarely used IFIM precursors such as the USFS sag-tape and the PG&E-Waters method; arbitrary setting of flows at a statistical level of unimpaired flow; and, where sufficient flow and population records exist, analysis of historical trends such as the regressions used for San Joaquin tributary streams in this report.

A final and pervasive alternative method of flow evaluation is consideration of available biological data to develop a qualitatively derived flow schedule or to support and modify a flow schedule developed by largely intuitive processes. Most Central Valley flow recommendations, including those in this paper, use this method to some extent and are based substantially on professional judgment. A brief summary of the technical team approach by river system follows.

Approaches Taken by Technical Teams

With these complications in mind and with the legislated goal of determining conditions that would result in a doubling of natural production of anadromous fish, the AFRP technical teams have taken various approaches to developing draft flow recommendations.

Chinook salmon and steelhead - Mainstem Sacramento River recommendations have been constrained by two factors. Several distinct stocks of salmon, each with different habitat requirements, exist in the river; one of these species has been listed under the federal Endangered Species Act and must be given priority. The Sacramento River recommendations therefore call for operations that maintain a storage pool that will enable the delivery of cool water from Shasta Reservoir through spring and summer, when winter-run chinook salmon are in the river. Within this pattern, there has been an attempt to optimize fall- and late fall-run salmon spawning flows and to reduce fluctuations that could affect spawning and rearing success during winter. Although an IFIM study has been conducted on Clear Creek and a Mill Creek IFIM study is in progress, flow recommendations for the other tributaries to the upper Sacramento River are based largely on professional judgment and observation of fish population response to existing and historical flow. In several cases, recommendations are to restore minimal flow levels to reaches that would otherwise be entirely dewatered during periods of the year that are critical for salmon or steelhead. Authors have recommended that existing knowledge be improved by conducting IFIM studies on most of the important tributaries.

Flow recommendations for spawning and rearing in most of the lower Sacramento tributaries rely, at least in part, on conclusions drawn from IFIM studies. However, on the Feather, Yuba, Bear, American, and Mokelumne rivers, flows derived through IFIM have been modified to varying degrees based on knowledge of species= environmental requirements, additional observational data, professional judgment, carryover storage, and other water management imperatives such as flood control. IFIM studies have not been conducted on the Bear or Cosumnes rivers. On the former, fish flows were derived from knowledge of salmon requirements and a flow simulation model; on the latter, flow recommendations reflect the average conditions during baseline period years when production goals (as indicated by escapement) were actually met. Calaveras River flow recommendations are based on a USFWS IFIM study that sought to identify flow needs for a race of winter-run salmon.

Recommendations for the mainstem San Joaquin River are based on a regression of chinook salmon escapement on Vernalis flow and combined state and federal exports during April, May, and June in the year of outmigration. Allocation of total basin outflow between the tributaries and mainstem river was based on the by-year type percentages contributed to total San Joaquin Basin unimpaired runoff from 1922 to 1990. IFIM-based flow recommendations were applied to tributaries in dry year types when unimpaired flow in the reaches that are currently accessible to salmon and steelhead were inadequate for late rearing, spawning, and incubation. On the Merced River, where no IFIM study has been conducted, IFIM flows from a similarly sized drainage were used as a surrogate. DFG has plans to conduct an IFIM study on the Merced River in the near future.

Striped bass, American shad, white and green sturgeon - There are no studies that specifically identify flow requirements for striped bass, American shad, white sturgeon, or green sturgeon. Flow recommendations for striped bass are based on a modification of an existing DFG model that predicts the adult population based on Delta outflow, exports/diversions, and stocking rates. Recommendations for shad and both species of sturgeon reflect average flow during those baseline period years when data indicate that the production goals were actually met. For shad, April-May Delta outflow was related to abundance of juveniles in the DFG fall midwater trawl and was allocated to individual stream on the basis of percent contribution to unimpaired runoff. For sturgeon, flow to production estimates were identified on a river-by-river basis.

SECTION II. SUMMARY OF RESTORATION GOALS

Restoration goals for four races of chinook salmon, steelhead, striped bass, American shad, and white and green sturgeon are presented in the following table. The Core Group defined the restoration goal for anadromous fish to be equal to at least twice the mean estimated natural production for the baseline period (1967-1991). It defined natural production during the baseline period to be that portion of production not produced in hatcheries and defined production to be the number of fish that recruit to adulthood in a given year, including newly recruited fish that are harvested.

Volume 3, Section X, AReports from the Technical Teams,@ provides the details and methods for estimating restoration goals. In Section Xa and appendices A and B, production goal numbers for salmon and steelhead are broken down by stream and race. Methods for adult striped bass are discussed in Section Xf; for American shad in Section Xg; and for white and green sturgeon in Section Xh. Because there are no data to estimate the adult component of the American shad population for any years except 1976 and 1977, young-of-the-year abundance in the California Department of Fish and Game fall midwater trawl was used to estimate our numeric restoration goal.

AFRP goals for anadromous fish production
in Central Valley rivers and streams.

Species	Goal
Chinook salmon, all races	990,000
Fall run	750,000
Late fall run	68,000
Winter run	110,000
Spring run	68,000
Steelhead	13,000
Striped bass	2,500,000
American shad	4,300[a]
White sturgeon	11,000

Species	Goal
Green sturgeon	2,000

[a] The goal for American shad is expressed as the juvenile index as derived from the DFG fall midwater trawl.

SECTION III. SUMMARY OF LIMITING FACTORS

Following are general categories of factors that were identified by the AFRP technical teams as limiting natural production of anadromous fish in Central Valley streams. Not all of these problems affect all species, life stages, or streams. The order in which these items appear in the list is a rough indication of how often they were identified as a problem by the technical teams. For example, inadequate flow was identified as a problem for virtually all species and streams. For more detailed information on the specific factors that affect particular species and streams, readers should refer to the appropriate sections in Volume 3 of this Working Paper.

1. Inadequate timing and/or magnitude of flow to provide suitable conditions for one or more life stage
2. Water temperatures that regularly exceed tolerances of one or more life stage
3. Loss of natural stream habitat
    a. Loss of spawning gravel; lack of spawning gravel recruitment
    b. Sedimentation resulting from riparian and upland land use impacts
    c. Loss of bank and riparian cover
    d. Loss of floodplain and other low-velocity stream habitat
4. Obstacles to fish passage
5. Entrainment of juveniles at riparian and Delta diversions
6. Direct and indirect impacts of Central Valley Project and State Water Project Delta pumping operations
7. Effects of point and nonpoint source discharge of organic pollutants, pesticides, and miscellaneous toxic chemicals
8. Legal and illegal harvest of adult fish

SECTION IV. SUMMARY OF RESTORATION ACTIONS

INTRODUCTION

Section IV summarizes the restoration actions that appear in their complete and original form in Volume 3. For purposes of the summary, organization and presentation has been changed by combining actions for all six anadromous fish species for each river or stream. Information for actions that do not involve modification of flow is limited to a brief, descriptive title, a statement of the objective with respect to improving conditions for anadromous fish, and a list of the species and races for which the action was proposed. Flow requirements for all six species are combined into tables by river, or, where the technical teams have made recommendations for multiple points on a single river, by flow station. Where flow needs for two or more species overlap within a river, or at a flow station, the flows presented in the table are those that would provide the greatest overall benefits for anadromous fish. Water year types are based on the Sacramento River Index and San Joaquin Basin 60-20-20 Index except as otherwise noted. Interested parties who wish to read more detailed descriptions of restoration actions, or would like to review the supporting technical information, can order copies of Volume 3 from the USFWS by calling 1-800-742-9474 or 1-916-979-2330 and dialing 542 after the recorded message begins. Copies may also be obtained by calling Roger Dunn, CVPIA Public Outreach, at 1-916-979-2760 or by sending e-mail requests to roger_dunn@fws.gov.

SACRAMENTO RIVER BASIN

Upper Mainstem Sacramento River

1. Develop and implement an integrated river regulation plan that balances carryover storage needs with instream flow needs based on runoff and storage conditions: Actively regulate river flows and reservoir storage in the upper Sacramento River system to provide necessary habitat for the production of all races of chinook salmon and the anadromous fish they coexist with, consistent with sound ecological management principles.

Minimum recommended Sacramento River flows (cfs)
at Keswick Dam (RM 302), for the period October 1 to April 30[a].

Carryover storage	Keswick Dam release	Carryover storage	Keswick Dam release
1.9	3,250	2.5	4,250
2.0	3,250	2.6	4,500
2.1	3,250	2.7	4,750
2.2	3,500	2.8	5,000
2.3	3,750	2.9	5,250
2.4	4,000	3.0	5,500

[a] Based on October 1 carryover storage (maf) in Shasta Reservoir and critically dry runoff conditions (driest decile runoff of 2.5 maf) to produce a target April 30 Shasta Reservoir storage of 3.0 to 3.2 maf for temperature control.

Species: Fall-, late fall-, winter-, and spring-run chinook salmon; steelhead

2. Implement the Grimes flow schedule: Provide minimum or greater flows to ensure suitable conditions for adult American shad and white and green sturgeon to migrate upstream, spawn, and allow progeny to survive.

Month	Sacramento River flows (cfs) at Grimes (RM 125)				
	Wet	Above normal	Below normal	Dry	Critical
February-March	17,700[a]	17,700[a]	--	--	--
April-May	19,800[b]	17,700[a]	13,200[c]	9,300[c]	5,400[c]

[a] Flows needed for white and green sturgeon spawning. Flows of 15,200 cfs needed for American shad spawning during April-May of above-normal water years.

[b] Flows needed for American shad spawning. Flows of 17,700 cfs needed for white and green sturgeon spawning.

[c] Flows required for American shad spawning.

Species: Fall-, late fall-, winter-, and spring-run chinook salmon; steelhead; American shad; white and green sturgeon

3. Maintain mean monthly flows of 31,000 cfs at Verona from February to May in wet and above-normal years: Provide minimum or greater flows to ensure suitable conditions for adult white and green sturgeon to migrate upstream, spawn, and allow progeny to survive.

Species: White and green sturgeon

4. Develop a flow regime that imitates natural flow changes and avoids dewatering redds or isolating or stranding juveniles on monthly and daily rates of change: Prevent redd dewatering or stranding or isolating adults and juveniles.

Species: Fall-, late fall-, winter-, and spring-run chinook salmon; steelhead

5. Complete an integrated instream flow study (IFIM) to refine a river regulation program that actively balances fishery habitat with the flow regime, including needs for adequate temperature, flushing flows, outmigration, channel maintenance, attraction flows, and maintenance of a riparian corridor: Regulate CVP releases to provide adequate spawning and rearing habitat for salmon and steelhead and to minimize flow fluctuations to avoid dewatering redds and stranding or isolating adult and juvenile fish.

Species: Fall-, late fall-, winter-, and spring-run chinook salmon; steelhead

6. Manage flow to restore riparian vegetation: Consider all features of how flow influences ecosystem.

Species: Fall-, late fall-, winter-, and spring-run chinook salmon; steelhead

7. Maintain water temperatures at or below 56°F from Keswick Dam to Bend Bridge except in extreme water years: Develop a water management plan that will ensure USBR's ability to provide cold water during critical months and budget cold water reserves in reservoirs to maximize survival during critical months.

Species: Fall-, late fall-, winter-, and spring-run chinook salmon; steelhead; American shad; white and green sturgeon

8. Raise RBDD gates for a minimum period from September 15 to June 30: Provide unimpeded adult and juvenile passage past RBDD and decrease juvenile mortality associated with predators.

Species: Fall-, late fall-, winter-, and spring-run chinook salmon; steelhead; white and green sturgeon

9. Complete the process to find final solutions to passage problems at RBDD and improve passage conditions beyond opening the dam gates longer than 8 months: Provide unimpeded adult and juvenile passage and decrease juvenile mortality associated with predators.

Species: Fall-, late fall-, winter-, and spring-run chinook salmon; steelhead; white and green sturgeon

10. Implement structural and operational modifications at ACID to eliminate stranding, toxic discharges, improve screens, and eliminate passage problems for chinook salmon and steelhead: Provide safe passage for adult and juvenile salmon past ACID.

Species: Fall-, late fall-, winter-, and spring-run chinook salmon; steelhead

11. Construct escape channel from stilling basin to the Sacramento River at Keswick Dam: Avoid entrapment of salmonid adults at Keswick Dam stilling basin.

Species: Fall-, late fall-, winter-, and spring-run chinook salmon; steelhead

12. Implement structural and operational modifications to eliminate entrainment at water diversions: Increase survival of outmigrating anadromous fish stocks by reducing entrainment through correcting unscreened or inadequately screened water diversions.

Species: Fall-, late fall-, winter-, and spring-run chinook salmon; steelhead; white and green sturgeon

13. Implement structural and operational modifications to eliminate impingement and entrainment of juvenile salmon at GCID water diversion: Correct problems at the GCID water diversion.

Species: Fall-, late fall-, winter-, and spring-run chinook salmon; steelhead; white and green sturgeon

14. Complete EPA Superfund cleanup of Iron Mountain Mine by 1996: Remedy water quality problems associated with Iron Mountain Mine and other toxic discharges.

Species: Fall-, late fall-, winter-, and spring-run chinook salmon; steelhead; white and green sturgeon

15. Avoid potential competitive displacement of wild, naturally produced juveniles with hatchery-released juveniles by stabilizing hatchery production levels and implementing release strategies

designed to minimize detrimental interactions: Evaluate competitive displacement between hatchery and natural stocks.

Species: Fall-, late fall-, winter-, and spring-run chinook salmon; steelhead

16. Implement specific hatchery spawning protocols and genetic evaluation programs to maintain genetic diversity in hatchery and wild stocks: Maintain genetic diversity in hatchery stocks.

Species: Fall-, late fall-, winter-, and spring-run chinook salmon; steelhead

17. Evaluate transfer of disease between hatchery and natural stocks: Evaluate disease relations between hatchery and natural stocks.

Species: Fall-, late fall-, winter-, and spring-run chinook salmon; steelhead

18. Create a 50,000-acre meander belt from Red Bluff to Chico Landing to provide gravel recruitment, large woody debris, moderate air temperatures, and nutrient input to the lotic system: Restore and preserve riparian forests.

Species: Fall-, late fall-, winter-, and spring-run chinook salmon; steelhead

19. Devise alternative methods other than the Gradient Restoration Facility to increase head differential for the Glenn-Colusa Irrigation District diversion: Facilitate sturgeon passage past GCID.

Species: White and green sturgeon

UPPER SACRAMENTO RIVER TRIBUTARIES

Clear Creek

1. Release 200 cfs of water from Whiskeytown Dam to Clear Creek from October to April and 150 cfs the remainder of the year with variable spring-time releases depending on water year type: Provide adequate instream flows, suitable water temperatures, and channel maintenance flows for all life stages of salmon and steelhead.

Species: Fall-, late fall-, and spring-run chinook salmon; steelhead

2. Maintain water temperatures at or below 65°F during periods of juvenile rearing, at or below 60°F during adult holding and prespawn, and at or below 56°F during egg incubation: Increase salmonid production by providing optimum water temperatures at all critical life stages, especially for spring-run chinook salmon and steelhead.

Species: Fall-, late fall-, and spring-run chinook salmon; steelhead

3. Restrict gravel mining and restore degraded channel: Eliminate the severe adverse effects of gravel mining.

Species: Fall-, late fall-, and spring-run chinook salmon; steelhead

4. Provide effective fish passage above Saeltzer Dam: Provide salmon with access to habitat above McCormick-Saeltzer Dam.

Species: Fall-, late fall-, and spring-run chinook salmon; steelhead

5. Prevent habitat degradation due to sedimentation and urbanization: Develop erosion and stream corridor protection programs.

Species: Fall-, late fall-, winter-, and spring-run chinook salmon; steelhead

6. Restore gravel and spawning habitat: Compensate for lost spawning gravel recruitment and spawning areas blocked by Whiskeytown Dam.

Species: Fall-, late fall-, and spring-run chinook salmon; steelhead

Cow Creek

1. Work with water right holders to obtain an agreement for adequate flows for fall-run salmon migration and spawning and juvenile steelhead: Provide suitable passage and early spawning flows (particularly in dry years) for fall-run chinook salmon adults and adequate flows for juvenile steelhead rearing.

Species: Fall-run chinook salmon; steelhead

2. Effectively screen agricultural diversions: Prevent loss of juvenile steelhead due to entrainment.

Species: Steelhead

3. Improve passage at agricultural diversion dams: Improve passage for adult steelhead and increase steelhead spawning and rearing habitat.

Species: Steelhead

Bear Creek

1. Restore instream flows: Provide adequate instream flows to permit safe passage of juvenile and adult salmon and steelhead at key times of the year.

Species: Fall-run chinook salmon; steelhead

2. Build and operate fish screens on all unscreened diversions: Prevent losses of migrating juvenile fall-run salmon and steelhead into agricultural diversions.

Species: Fall-run chinook salmon; steelhead

Cottonwood Creek

1. Protect and enhance spawning gravel: Increase spawning opportunities.

Species: Fall-, late fall-, and spring-run chinook salmon; steelhead

2. Eliminate attraction flows in Crowley Gulch: Eliminate stranding mortalities.

Species: Fall-, late fall-, and spring-run chinook salmon; steelhead

3. Improve land use practices: Reduce water temperatures to improve holding, spawning, and rearing habitat and reduce siltation and sedimentation of existing spawning gravel.

Species: Fall-, late fall-, and spring-run chinook salmon; steelhead

Battle Creek

1. Treat CNFH water supply: Eliminate the potential for waterborne disease to adversely affect hatchery production.

Species: Fall- and late fall-run chinook salmon; steelhead

2. Allow passage above the CNFH weir: Increase available habitat for all salmonid runs and life stages.

Species: Fall- and late fall-run chinook salmon; steelhead

3. Increase bypass flows at PG&E's hydropower diversions according to the following table: Provide streamflow of sufficient quantity and quality to provide adequate holding, spawning, and rearing habitat.

Diversion	Months	Flow (cfs)
Keswick	All year	30
North Battle Creek Feeder	September-November	40
	January-April	40
	May-August	30
Eagle Canyon	May-November	30
	December-April	50
Wildcat	May-November	30
	December-April	50
South	May-November	20
	December-April	30
Inskip	May-November	30
	December-April	40
Coleman	September-April	50
	May-August	30

The following interim flows will be implemented during the initial phase. Optimum flows, which are listed in the table above, will not be required until the spring-run population numbers are sufficient to utilize all available habitat.

1. **Eagle Canyon Dam** - release 40 cfs at Eagle Canyon Dam from September 1 to April 1, and 30 cfs for the remainder of the year.

2. **Coleman Diversion** - release 50 cfs from Coleman Diversion from October 1 to February 1 and 30 cfs for the remainder of the year.

3. **Wildcat Diversion** - close Wildcat Diversion to allow all the spring-water to remain in the creek and avoid entraining juvenile outmigrants in the power canal.

4. **Coleman Forebay -** deliver canal water to Coleman Hatchery through a bypass pipe.

Species: Fall-, late fall-, winter-, and spring-run chinook salmon; steelhead

4. Construct rack to prevent adult salmon from entering Gover diversion: Prevent loss of spawning adult fall-run chinook.

Species: Fall-, late fall-, winter-, and spring-run chinook salmon; steelhead

5. Screen Orwick diversion: Prevent straying of spawning adult fall-run chinook salmon and prevent entrainment of juvenile salmonids.

Species: Fall-, late fall-, winter-, and spring-run chinook salmon; steelhead

6. Screen tailrace of Coleman Powerhouse: Prevent straying of spawning adult chinook salmon and steelhead.

Species: Fall-, late fall-, winter-, and spring-run chinook salmon; steelhead

7. Construct fish screens at the following PG&E water diversions: Wildcat, Eagle Canyon (only if barrier described in Action 9 is modified), Coleman, North Battle Creek Feeder, Inskip, and South: Minimize loss of both adult and juvenile salmonids.

Species: Fall-, late fall-, winter-, and spring-run chinook salmon; steelhead

8. Evaluate effectiveness of fish ladders at PG&E diversions: Ensure that fish passage is occurring.

Species: Fall-, late fall-, winter-, and spring-run chinook salmon; steelhead

9. Improve fish passage in Eagle Canyon: Facilitate movement of adult salmon and steelhead to habitat in North Battle Creek and above upper Eagle Canyon.

Species: Fall-, late fall-, winter-, and spring-run chinook salmon; steelhead

10. Examine feasibility of establishing a spawning population of winter-run chinook salmon: Increase genetic diversity and current habitat of the endangered Sacramento River winter-run chinook salmon.

Species: Winter-run chinook salmon

Paynes Creek

1. Restore adequate instream flows: Provide minimum instream flows to improve spawning, rearing, and migration opportunities.

Species: Fall-run chinook salmon

2. Restore spawning gravel: Increase spawning potential.

Species: Fall-run chinook salmon

Antelope Creek

1. Restore instream flows: Provide adequate instream flows to permit safe passage of adult salmon at key times of the year.

Species: Fall-, late fall-, and spring-run chinook salmon; steelhead

2. Create defined stream channel: Reduce infiltration losses and maintain flows to the Sacramento River.

Species: Fall-, late fall-, and spring-run chinook salmon; steelhead

Elder Creek

1. Construct a fish passage structure over Corning Canal Siphon: Improve fish passage for chinook salmon and steelhead.

Species: Fall-run chinook salmon; steelhead

2. Adopt an erosion control ordinance to minimize sediment input into Elder Creek: Reduce sediment input into Elder Creek.

Species: Fall-run chinook salmon; steelhead

Mill Creek

1. Improve transportation flows in the valley reach of Mill Creek: Ensure that upstream migrating spring-run chinook and downstream migrating spring and late fall-run chinook and steelhead migrate safely through the lower portion of Mill Creek. Increased flows in fall will also improve spawning conditions for fall-run chinook salmon.

Species: Fall-, late fall-, and spring-run chinook salmon; steelhead

2. Remove Clough Dam: Provide unimpaired passage where an existing structure presently obstructs migrating adults under certain flow conditions.

Species: Fall-, late fall-, and spring-run chinook salmon; steelhead

3. Protect and restore anadromous salmonid fisheries habitat and preserve the long-term productivity of the upper Mill Creek aquatic ecosystem through cooperative watershed management: Identification of restoration priorities and protection of Mill Creek's aquatic ecosystem through cooperative land use management in the upper watershed.

Species: Fall-, late fall-, and spring-run chinook salmon; steelhead

4. Improve salmon spawning areas in lower Mill Creek: Increase available spawning habitat at selected sites in lower Deer Creek to accommodate increased runs of fall- and late fall-run chinook salmon.

Species: Fall-, late fall-, and spring-run chinook salmon; steelhead

5. Maintain and restore riparian habitat along lower reaches of Mill Creek: Help maintain cool water temperatures.

Species: Fall-, late fall-, and spring-run chinook salmon; steelhead

Thomes Creek

1. Modify gravel mining methods: Improve land use practices.

Species: Fall- and spring-run chinook salmon; steelhead

2. Modify timber harvest practices: Improve land use practices.

Species: Fall- and spring-run chinook salmon; steelhead

3. Modify grazing practices: Improve land use practices.

Species: Fall- and spring-run chinook salmon; steelhead

4. Stabilize areas of high erosion: Reduce impacts of previous land use practices and improve habitat.

Species: Fall- and spring-run chinook salmon; steelhead

5. Replace Corning Canal Siphon: Improve fish passage.

Species: Fall- and spring-run chinook salmon; steelhead

6. Minimize diversion barriers usage: Improve fish passage.

Species: Fall- and spring-run chinook salmon; steelhead

7. Develop a release strategy for TCC into Thomes Creek between October and May. Until a strategy is developed, flows of 50 cfs should be released from TCC into Thomes Creek: Improve fish flows in Thomes Creek to ensure survival of all salmonid life stages.

Species: Fall-run chinook salmon; steelhead

8. Conduct regular water quality monitoring: Provide suitable water quality.

Species: Fall-run chinook salmon

Deer Creek

1. Improve transportation flows in the valley reach of Deer Creek: Ensure that upstream migrating spring-run chinook salmon and downstream migrating juvenile spring- and late fall-run chinook and steelhead can migrate safely through the lower 10 miles and pass over three diversion dams in lower Deer Creek. Also, provide improved flows for adult fall-run salmon.

Species: Fall-, late fall-, and spring-run chinook salmon; steelhead

2. Protect and restore chinook salmon and steelhead habitat and preserve the long-term productivity of the upper Deer Creek aquatic ecosystem through cooperative watershed management: Reduce the effects of land use practices.

Species: Fall-, late fall-, and spring-run chinook salmon; steelhead

3. Improve salmon spawning areas in lower Deer Creek: Increase available spawning habitat at selected sites in lower Deer Creek to accommodate increased runs of fall- and possibly late fall-run chinook salmon.

Species: Fall- and late fall-run chinook salmon

4. Maintain and restore riparian habitat along lower reaches of Deer Creek: Help maintain low water temperatures.

Species: Fall-, late fall-, and spring-run chinook salmon; steelhead

5. Conduct flood management activities: Carry out required flood management activities with minimum damage to the fishery resources and riparian habitat in the lower 5 miles of Deer Creek.

Species: Fall-, late fall-, and spring-run chinook salmon; steelhead

Stony Creek

1. Install siphon under Stony Creek for GCID canal: Provide passage for all life stages and prevent entrainment of juvenile salmonids.

Species: Fall- and late fall-run chinook salmon

2. Develop water management release strategy for Black Butte Dam: Provide adequate flows.

Species: Fall- and late fall-run chinook salmon

3. Comply with RBDD mitigation by providing flows between 100 cfs and 500 cfs of water per day to Stony Creek via TCC: Provide adequate flows.

Species: Fall- and late fall-run chinook salmon

4. Modify gravel extraction permits: Provide suitable spawning habitat.

Species: Fall- and late fall-run chinook salmon

5. Add spawning gravel to Stony Creek: Provide suitable spawning habitat.

Species: Fall- and late fall-run chinook salmon

6. Develop a distinct creek channel: Provide suitable spawning habitat.

Species: Fall- and late fall-run chinook salmon

7. Develop plan to establish a riparian corridor: Provide suitable water temperatures.

Species: Fall- and late fall-run chinook salmon

8. Discontinue diversions to the TCC: Alleviate passage problems, ensure adequate flows, and prevent entrainment.

Species: Fall- and late fall-run chinook salmon

9. Correct problems associated with North Diversion Dam: Provide fish passage for all life stages, provide adequate flows past dam, and prevent entrainment.

Species: Fall- and late fall-run chinook salmon

10. Develop plan to assess water quality: Ensure adequate water quality for all life stages.

Species: Fall- and late fall-run chinook salmon

11. Conduct Instream Flow Incremental Methodology (IFIM): Determine preferred water flows for all life stages.

Species: Fall- and late fall-run chinook salmon

Big Chico Creek

1. Substitute an alternative source of irrigation water for that currently supplied by the M&T Ranch Pumps: Prevent loss of juvenile salmonids and permit sufficient attraction flows for adults.

Species: Fall-, late fall-, and spring-run chinook salmon

2. Repair Iron Canyon fish ladder: Facilitate movement of adult spring-run chinook and steelhead to favorable summer holding habitat.

Species: Fall-, late fall-, and spring-run chinook salmon

3. Split low flow between Big Chico Creek and Lindo Channel: Minimize trapping and subsequent loss of both adult and juvenile salmonids from periodic dewatering of Lindo Channel.

Species: Fall-, late fall-, and spring-run chinook salmon

4. Replace spawning gravel in the channels modified for flood control: Improve spawning habitat for fall- and late fall-run chinook.

Species: Fall- and late fall-run chinook salmon; steelhead

5. Repair the Lindo Channel weir and fishway: Facilitate upstream passage of spring chinook and steelhead from Lindo Channel.

Species: Fall-, late fall-, and spring-run chinook salmon

6. Improve cleaning procedure at One-Mile Pool: Reduce siltation of downstream spawning and rearing habitat.

Species: Fall-, late fall-, and spring-run chinook salmon

7. Preserve primary summer holding areas for spring-run chinook salmon: Obtain title or conservation easement on land adjacent to primary summer holding pools for spring-run chinook. This is especially important considering the marginal summer temperatures and possibility of residential development in those areas. Additional disturbance would cause significant mortality.

Species: Fall-, late fall-, and spring-run chinook salmon

8. Revegetate denuded stream reaches, restore and maintain a protected riparian strip: Expand the usable habitat and provide habitat diversity, cover from predators, and shade to keep the water cooler in late spring.

Species: Fall-, late fall-, and spring-run chinook salmon

9. Replace gravel in the flood-diversion reach of Mud Creek: Expand the usable habitat and provide habitat diversity for rearing salmon and their prey.

Species: Fall-, late fall-, and spring-run chinook salmon

Butte Creek

1(a). Obtain rights to approximately 105 cfs of water from Parrott-Phelan diversion: Provide adequate instream flows for all life stages of salmonids.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

1(b). Maintain a minimum 40 cfs instream flow below Centerville Diversion Dam: Provide suitable holding, spawning, and rearing habitat.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

1(c). Purchase existing water rights from diverters: Ensure adequate instream flows.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

2(a). Build new high-volume fish ladder at Durham Mutual Dam: Provide adequate passage for adult salmonids.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

2(b). Install fish screens on both diversions at Durham Mutual Dam: Prevent entrainment of juvenile salmonids.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

3(a)(1). Develop and construct Western Canal Siphon: Eliminate adult passage and juvenile entrainment problems associated with five dams and obtain additional instream flows.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

3(a)(2). Investigate the possibility of consolidation or replacement of additional diversions below the Western Canal Siphon Project: Eliminate adult passage and juvenile entrainment problems and potentially obtain additional instream flows.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

3(a)(3). Acquire water rights as part of the Western Canal Siphon Project: Obtain adequate instream flows.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

3(b)(1). Adjudicate water rights and provide watermaster service or equivalent for entire creek: Ensure adequate instream flows.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

3(b)(2). Remove Western Canal Dam and replace with siphon: Expedite adult passage, eliminate straying of adults, and prevent entrainment of juveniles.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

3(b)(3). Establish operational criteria for Sanborn Slough Bifurcation: Provide better passage for adult salmonids and prevent entrainment of juveniles.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

3(b)(4). Develop operational criteria for, and potential modification to, Butte Slough outfall: Provide sufficient attraction and passage flows for adults and outmigration flows for juveniles.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

4(a)(1). Build new high-volume fish ladder at Adams Dam: Improve adult fish passage.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

4(a)(2). Install fish screens on both diversions at Adams Dam: Prevent entrainment of juvenile salmonids.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

4(a)(3). Build new high-volume fish ladder at Gorrill Dam: Improve adult fish passage.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

4(a)(4). Install fish screens on diversions at McGowan Dam: Prevent entrainment of juvenile salmonids.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

4(a)(5). Install fish screens on three diversions at McPherrin Dam: Prevent entrainment of juvenile salmonids.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

4(b)(1). Install fish screens on both diversions at Western Canal Dam: Prevent entrainment of juvenile salmonids.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

4(b)(2). Build new high-volume fish ladder at Western Canal Dam: Improve adult fish salmonids.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

4(b)(3). Install fish screens on both diversions at Gorrill Dam: Prevent entrainment of juvenile salmonids.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

4(b)(4). Build new high-volume fish ladder at McPherrin Dam: Improve adult fish passage.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

4(c)(1). Build new high-volume fish ladder at McGowan Dam: Improve adult fish passage.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

5(a)(1). Build new high-volume fish ladder at East-West Diversion Weir: Improve adult fish passage.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

5(a)(2). Establish operational criteria for the East and West Barrows: Improve adult fish passage.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

5(a)(3). Establish operational criteria for Sutter Bypass Weir #2: Improve adult fish passage.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

5(a)(4). Establish operational criteria for Nelson Slough: Improve adult fish passage.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

5(a)(5). Establish operational criteria for Sutter Bypass Weir #1: Improve adult fish passage.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

5(a)(6). Install fish screens at Sanborn Slough Bifurcation: Prevent entrainment of juvenile salmonids.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

5(a)(7). Install fish screens at White Mallard Dam: Prevent entrainment of juvenile salmonids.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

5(a)(8). Screen diversions within Sutter Bypass where necessary: Prevent entrainment of juvenile salmonids.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

5(b)(1). Install culvert and riser at White Mallard Duck Club outfall: Prevent straying of adult salmonids.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

5(b)(2). Rebuild and maintain existing culvert and riser at Drumheller Slough outfall: Prevent straying of adult salmonids.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

5(b)(3). Establish operational criteria for Sutter Bypass Weir #5: Improve adult fish passage.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

5(b)(4). Establish operational criteria for Sutter Bypass Weir #3: Improve adult fish passage.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

6(a)(1). Initiate legal action on diverters who are violating water right allocations: Ensure sufficient instream flows.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

6(a)(2). Install high-volume fish ladder on Sutter Bypass Weir #2: Improve adult fish passage.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

6(a)(3). Install high-volume fish ladder on Sutter Bypass Weir #1: Improve adult fish passage.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

6(a)(4). Install fish screens on Little Dry Creek pumps: Prevent entrainment of juvenile salmonids.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

6(a)(5). Increase law enforcement of fishing regulations: Eliminate or reduce poaching.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

6(b)(1). Install high-volume fish ladder on Sutter Bypass Weir #5: Improve adult fish passage.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

6(b)(2). Install high-volume fish ladder on Sutter Bypass Weir #3: Improve adult fish passage.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

7(a)(1). Install high-volume fish ladder at White Mallard Dam: Improve adult fish passage.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

7(a)(2). Develop and enforce land use plans that create buffer zones between the creek and development: Protect existing salmonid habitat from further human development.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

7(a)(3). Develop a watershed management program: Protect existing salmonid habitat while providing for human use of the resources.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

7(b). Enhance fish passage at natural barrier below Centerville Diversion Dam: Increase the amount of available salmonid habitat.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

8(a). Enhance fish passage at PG&E diversion dams: Increase the amount of available salmonid habitat.

Species: Fall- and spring-run chinook salmon; possibly late fall-run chinook salmon and steelhead

Colusa Basin Drain

1. Develop defined migrational routes: Provide direct access to Westside Tributaries

Species: Fall-run chinook salmon

2. Develop defined migrational flows: Provide direct access to Westside Tributaries

Species: Fall-run chinook salmon

3. Reduce water temperatures: Enhance survival in Colusa Drain and Westside Tributaries

Species: Fall-run chinook salmon

Miscellaneous small tributaries

Sacramento River tributaries that typically can provide rearing habitat only for salmonids:

Name	USGS Quad	Side of River
Streams known to support juvenile rearing		
Pine	Ord Ferry	east
Toomes	Vina	east
Dye	Los Molinos	east
Oat	Los Molinos	west
Coyote	Gerber	west
Reeds	Red Bluff East	west
Brewery	Red Bluff East	west
Dibble	Red Bluff East	west
Inks	Bend	east
Anderson	Ball's Ferry	west
Olney	Enterprise	west
Streams presumed to support juvenile rearing		
Burch	Foster Island	west
Jewett	Vina	west

Name	USGS Quad	Side of River
McLure	Vina	west
Red Bank	Red Bluff East	west
Salt	Red Bluff East	east
Ash	Ball=s Ferry	east
Stillwater	Ball=s Ferry	east
Churn	Cottonwood	east
Sulfur	Redding*	east
Streams with potential to support juvenile rearing		
Seven Mile	Red Bluff East	east
Frasier	Bend	west
Spring	Bend	west
Clover	Cottonwood	east
Middle	Redding*	west
Salt	Redding*	west
Jenny	Redding*	west
Rock	Redding*	west

[a] Indicates 15-minute topographic quadrangle map.

1. Revegetate denuded stream reaches and restore and maintain a protected riparian strip in all tributaries: Expand the usable rearing habitat and provide habitat diversity, cover from predators, and shade to keep the water cooler in late spring.

Species: Chinook salmon, runs unknown; steelhead

2. Move pumps to the Sacramento River, where sufficient bypass flow exists, to avoid entrainment of juvenile salmonids (screen pumps): Reduce loss of juveniles to agricultural diversion.

Species: Chinook salmon, runs unknown; steelhead

3. Find alternative sources of water for upstream diversions: Prevent early dewatering of stream reaches used for rearing.

Species: Chinook salmon, runs unknown; steelhead

4. Survey tributaries for toxic materials, follow with cleanup projects as needed; expand enforcement of dumping ordinance: Remove hazards and potential hazards such as car batteries, oil filters, and animal carcasses from streams. Prevent further use of streams for dumps.

Species: Chinook salmon, runs unknown; steelhead

5. Replace bridge/ford combinations with bridges or large culverts: Expand the usable habitat in some tributaries.

Species: Chinook salmon, runs unknown; steelhead

6. Provide siphons to get "beheaded" tributaries streams past irrigation canals: Expand the usable habitat.

Species: Chinook salmon, runs unknown; steelhead

LOWER SACRAMENTO RIVER AND DELTA TRIBUTARIES

Feather River

1. Increase flows in the low-flow channel: Enhance and maintain spawning and rearing habitat.

	Feather River flows (cfs) in the low-flow channel					
	Schedule A[a]					Schedule B[b]
Month	Wet	Above normal	Below normal	Dry	Critical	All year
September-May	2,500	2,500	2,500	1,700	1,700	800
June-August	1,100	1,100	1,100	800	800	800

[a] Schedules A and B are based on two different modeling scenarios presented in a draft IFIM report (Sommer 1994). The modeling scenarios differed in assumptions about depths preferred by spawning

chinook salmon. Schedule A is recommended for adoption and evaluation. If Schedule A results in reduced in spawning habitat, Schedule B flows (or flows derived from subsequent analyses) should be adopted. Flows in warmer months may be contingent on completion of the temperature model. Temperature model likely to require higher flows than specified to supply cold water downstream of Thermalito outlet for spring-run chinook salmon.

Species: Fall- and spring-run chinook salmon; steelhead

2. Consider providing experimental pulse flows: Stimulate outmigration of juvenile chinook salmon.

Species: Fall- and spring-run chinook salmon; steelhead

3. Consider providing experimental high-turbidity pulses: Stimulate outmigration of juvenile chinook salmon.

Species: Fall- and spring-run chinook salmon; steelhead

4. Restore gravel and create spawning habitat: Reduce armoring; increase spawning habitat.

Species: Fall- and spring-run chinook salmon; steelhead

5. Replenish gravel: Reduce spawning habitat degradation.

Species: Fall- and spring-run chinook salmon; steelhead

6. Complete temperature model: Develop a temperature model as a tool for river management.

Species: Fall- and spring-run chinook salmon; steelhead; possibly striped bass; American shad; white and green sturgeon

7. Conduct studies on the hatchery program: Determine distribution of Feather River Fish Hatchery chinook salmon in Central Valley stocks and determine genetic integrity of Feather River spring-run chinook salmon.

Species: Fall- and spring-run chinook salmon

8. Implement the Gridley flow schedule: Enhance and maintain spawning and rearing habitat for chinook salmon, steelhead, American shad, and white and green sturgeon.

Month	Feather River flows (cfs) at Gridley[a]				
	Wet	Above normal	Below normal	Dry	Critical
October-January	2,500[b]	2,500[b]	2,500[b]	1,700[b]	1,700[b]
February-March	7,000[c]	7,000[c]	2,500	1,700[b]	1,700[b]
April-May	7,000[d]	7,000[d]	3,000	2,100	2,100
June-August	1,000	1,000	1,000	1,000	1,000
September	2,500[e]	2,500[e]	2,500[e]	1,400[e]	1,400[e]

[a] Flows proposed on interim basis until completion of DWR=s instream flow study. Flows may be further modified for sturgeon reproduction.

[b] Flows needed for spawning and incubation of salmonids. Initial results from a DWR/DFG instream flow study indicate that spawning habitat in this reach would be maximized in the 750 to 2,750 cfs range (Sommer 1994).

[c] Flows needed for white and green sturgeon spawning. Flows needed for spawning and incubation of salmonids are 2,500 cfs in wet and above-normal years.

[d] Flows needed for white and green sturgeon spawning. Flows needed for spawning and incubation of salmonids are 3,000 cfs in wet and above-normal years.

[e] Flows contingent on completion of the temperature model. Temperature model likely to require flows to come from upstream of Thermalito outlet to meet temperature needs downstream.

Species: Fall- and spring-run chinook salmon; steelhead; white and green sturgeon

9. Implement the Nicolaus flow schedule: Provide adequate flows for spawning and progeny survival for American shad and white and green sturgeon.

Month	Feather River flows (cfs) at Nicolaus				
	Wet	Above normal	Below normal	Dry	Critical
February-March	11,500[a]				
April-May	15,700[b]	12,100[b]	10,500[b]	7,400[b]	4,300[b]

[a] Flows needed for white and green sturgeon spawning.

[b] Flows needed for American shad spawning. Flows needed for sturgeon spawning are 11,500 cfs in wet and above-normal years.

Species: American shad; white and green sturgeon

10. Maintain mean daily water temperatures below 63°F at Gridley and below 68°F throughout the Feather River between February and June for sturgeon spawning; maintain mean daily water temperatures between 61°F and 65°F for at least 1 month between April 1 and June 30 for American shad: Improve American shad and white and green sturgeon spawning success and egg survival by managing pumpback operations at Thermalito Reservoir.

Species: American shad; white and green sturgeon

11. Remove physical and water quality barriers that impede access to spawning habitat: Identify potential physical and water quality barriers, and determine extent of problem. Once barriers are identified, remove or facilitate passage around these barriers.

Species: White and green sturgeon

12. Reduce sturgeon entrainment: Identify extent of sturgeon entrainment. Increase survival of sturgeon larvae and juveniles by reducing or eliminating entrainment.

Species: White and green sturgeon

13. Determine effects of poaching and fishing on spawning stock size: Increase size of spawning stock if significantly reduced by fishing or poaching.

Species: White and green sturgeon

14. Improve water quality: Improve survival and condition of sturgeon.

Species: White and green sturgeon

15. Identify availability of suitable sturgeon spawning habitat: Identify potential sturgeon spawning sites and evaluate availability of such sites to adults. Take corrective actions if suitable spawning habitat is limiting.

Species: White and green sturgeon

Yuba River

1. Implement the Marysville flow schedule: Optimize migration, spawning, incubation, rearing, and outmigration conditions in the lower Yuba River for chinook salmon and American shad.

	Yuba River flows (cfs) at Marysville				
Month	Wet	Above normal	Below normal	Dry	Critical
October-March	700[a]	700[a]	700[a]	700[a]	700[a]
April-May	9,200[b]	7,000[b]	6,100[b]	4,300[b]	2,500[b]
June	1,500[c]	1,500[c]	1,500[c]	1,500[c]	1,500[c]
July-September	450[d]	450[d]	450[d]	450[d]	450[d]

[a] Flows needed for spawning, incubation, and rearing of chinook salmon and steelhead.

[b] Flows needed for American shad spawning. Flows needed for rearing and outmigration of chinook salmon and steelhead spawning were 1,000 cfs in April and 2,000 cfs in May for all water year types.

[c] Flows needed for rearing and outmigration of chinook salmon and steelhead and spawning of steelhead.

[d] Flows needed for steelhead rearing.

Species: Fall-run chinook salmon; steelhead; American shad

2. Evaluate the effectiveness of pulse flows for facilitating successful juvenile salmon outmigration: Optimize outmigration success when water is in short supply (e.g., dry and critically dry water years).

Species: Fall-run chinook salmon; steelhead

3. Reduce and control instream flow ramping rates: Reduce hazards posed to juvenile salmonids when flow rates change rapidly.

Species: Fall-run chinook salmon; steelhead

4. Maintain adequate instream flows for temperature control: Enhance spawning, incubation, rearing, and outmigration conditions.

Species: Fall-run chinook salmon; steelhead; American shad

5. Evaluate and modify (if found to be effective) the water release outlets at Englebright Dam: Assess whether enhancement of control, via shutter configuration, over temperature of water released downstream, and management of the cold water pools, is warranted.

Species: Fall-run chinook salmon; steelhead

6. Improve efficiency of screening devices at Hallwood-Cordua, Brophy-South Yuba, and Browns Valley water diversions: Reduce entrainment and related losses.

Species: Fall-run chinook salmon; steelhead

7. Improve efficiency of fish bypasses at Hallwood-Cordua, Brophy-South Yuba, and Browns Valley water diversions: Reduce entrainment and related losses.

Species: Fall-run chinook salmon; steelhead

8. Exclude piscivores from areas around Hallwood-Cordua, Brophy-South Yuba, and Browns Valley water diversions: Reduce predation losses of juvenile salmonids.

Species: Fall-run chinook salmon; steelhead

9. Maintain a minimum flow of 175 cfs through the critical Simpson Lane reach during the spawning period in dry and critical years: Facilitate passage of spawning adults through the critically shallow portions of the Simpson Lane reach.

Species: Fall-run chinook salmon; steelhead

10. Modify fish ladders at Daguerre Point Dam: Facilitate passage of spawning adults.

Species: Fall-run chinook salmon; steelhead

11. Maintain appropriate flows through ladders at Daguerre Point Dam during the spawning season: Facilitate passage of spawning adults.

Species: Fall-run chinook salmon; steelhead

12. Purchase streambank conservation easements: Improve habitat and instream cover.

Species: Fall-run chinook salmon; steelhead

13. Terminate program to remove woody debris from stream channel: Provide instream cover for juvenile salmonids, especially upstream of Daguerre Point Dam.

Species: Fall-run chinook salmon; steelhead

14. Place large woody debris in stream channel: Provide instream cover for juvenile salmonids.

Species: Fall-run chinook salmon; steelhead

15. Impose stricter harvest regulations on commercial fishers: Increase spawning escapement of naturally produced chinook salmon.

Species: Fall-run chinook salmon; steelhead

16. Conduct weekly on-river patrols in areas where poaching is a concern: Increase spawning escapement.

Species: Fall-run chinook salmon; steelhead

17. Modify the dam face of the Daguerre Point Dam: Reduce juvenile mortality from predation as outmigrants pass over the dam.

Species: Fall-run chinook salmon; steelhead

18. Maintain mean daily water temperatures between 61°F and 65°F for at least 1 month between April 1 and June 30 at Marysville: Improve American shad spawning success and egg survival using multilevel outlets.

Species: American shad

Bear River

1. Implement the Wheatland flow schedule: Provide a sufficient amount of water at preferred temperatures for migration, holding, spawning, incubation, rearing, and outmigration of chinook salmon and spawning of white and green sturgeon.

Month	Bear River flows (cfs) at Wheatland[a]		
	Wet	Above normal	Below normal
October 1-14	100[b]	100[b]	100[b]
October 15-December 31	250[b]	250[b]	250[b]
January	250[c]	250[c]	250[c]
February-March	900[d]	900[d]	250[c,d]
April-May	900[d]	900[d]	250[c]
June	250[e]	250[e]	250[e]
July-September	10[f]	10[f]	10[f]

[a] Salmonid flows apply for wet to below-normal years. Sturgeon flows are for above-normal and wet year types.

[b] Flows needed for spawning, incubation, and rearing of chinook salmon and steelhead.

[c] Flows needed for spawning, incubation, rearing and outmigration of chinook salmon and steelhead. Physical habitat needs alone (depth, velocity, and substrate in PHABSIM analyses) suggest that chinook salmon require at least 190 cfs from January to March and 100 cfs from April to June.

[d] Flows needed for white and green sturgeon spawning. Flows needed for spawning, incubation, and rearing (February-March) and rearing and outmigration (April-May) of chinook salmon and steelhead were 250 cfs in February through May.

[e] Flows needed for rearing and outmigration of chinook salmon and steelhead.

[f] Flows will need to be higher to address temperature requirements of steelhead.

Species: Fall-run chinook salmon; steelhead; white and green sturgeon

2. Conduct an IFIM study to determine instream flow and temperature requirements for all life stages of salmon and steelhead: Ensure that the available water is utilized to its fullest potential to benefit all life stages of salmon and steelhead.

Species: Fall-run chinook salmon; steelhead

3. Implement the Wheatland and Highway 70 water temperature standards: Protect all life stages of juvenile salmonids and white and green sturgeon. Develop operational criteria for Camp Far West and other upstream reservoirs to improve temperature conditions in the lower Bear River.

	Bear River water temperatures (°C)[a] at Wheatland and Highway 70 bridges (temperatures in parentheses are °F).	
Month	Wheatland	Highway 70
October 1-14	15.6 (60)	15.6 (60)
October 15-December 31	14.4 (58)	13.9 (57)
January-March	13.3[b] (56)	13.9[b] (57)
April-June	15.6[b] (60)	15.6[b] (60)
July-September	18.3 (65)	18.3 (65)

[a] Recommended mean daily temperatures to be maintained during wet, above-normal, and below-normal water years.

[b] Water temperatures maintained at or below 63°F for white and green sturgeon spawning, from just downstream of Camp Far West Reservoir to confluence with the Feather River, between February and May in wet and above-normal years.

Species: Fall-run chinook salmon; steelhead; white and green sturgeon

4. Effectively screen all diversions: Reduce loss of production to entrainment.

Species: Fall-run chinook salmon; steelhead; white and green sturgeon

5. Monitor water quality particularly at agricultural return outfalls: Ensure that suitable water quality exists for all life stages of salmonids. Take appropriate action to correct water quality problems.

Species: Fall-run chinook salmon; steelhead; white and green sturgeon

6. Negotiate removal or modification of the culvert crossing at Patterson Sand & Gravel and other physical and chemical barriers impeding anadromous fish migration: Provide uninhibited passage for all life stages of anadromous fish.

Species: Fall-run chinook salmon; steelhead; white and green sturgeon

7. Investigate the extent that poaching and/or fishing reduces adult spawning stock: Increase production by decreasing adult mortality associated with poaching and fishing.

Species: White and green sturgeon

American River

1. Implement the H Street Bridge flow schedule: Optimize migration, spawning, incubation, rearing, and outmigration conditions in the lower American River for chinook salmon, steelhead, and American shad.

Month	American River flows (cfs) at H Street Bridge					
	Wet	Above normal	Below normal	Dry[a]	Critical[a]	Critical relaxation[b]
October[c]	2,500	2,000	2,000	1,750	1,750	800
November-February[c]	2,500	2,000	2,000	1,750	1,750	1,200
March[d]	3,000	3,000	3,000	2,000	2,000	1,500
April-May[e]	11,200	8,600	7,400	5,300	3,100	1,500
June	4,500[d]	3,000[d]	3,000[d]	2,000[d]	2,000[d]	500[f]
July[f]	2,500	2,500	2,500	1,500	1,500	500
August[f]	2,500	2,000	2,000	1,000	1,000	500
September[f]	2,500	1,500	1,500	500	500	500

[a] The dry and critical flow regimes can accommodate all but the most severe drought conditions.

[b] The "critical relaxation" flow regime is intended for application to only the most severe drought years.

[c] Flows needed for chinook salmon spawning and incubation.

[d] Flows needed for salmonid rearing and outmigration.

[e] Flows needed for American shad spawning. Refer to flows in March for salmonid requirements.

[f] Flows for steelhead rearing.

Species: Fall-run chinook salmon; steelhead; American shad

2. Develop water allocation guidelines: Provide, through planning, a reasonable way to divide limited water resources among all appropriate users, including fish.

Species: Fall-run chinook salmon; steelhead

3. Evaluate the effectiveness of pulse flows for facilitating successful juvenile salmonid outmigration: Optimize outmigration success when water is in short supply (e.g., dry and critically dry years).

Species: Fall-run chinook salmon; steelhead

4. Reduce and control instream flow ramping rates and flow fluctuation: Reduce hazards posed to juvenile salmonids when flow rates change quickly.

Species: Fall-run chinook salmon; steelhead

5. Reconfigure Folsom Dam (penstock inlet ports) "shutters": Enhance control over temperature of water released downstream and allow improved management of Folsom Reservoir's cold water pool.

Species: Fall-run chinook salmon; steelhead

6. Replenish spawning gravel and/or restore existing spawning grounds: Enhancement of spawning habitat.

Species: Fall-run chinook salmon; steelhead

7. Improve the fish screen at Fairbairn Water Treatment Plant: Reduce entrainment losses.

Species: Fall-run chinook salmon; steelhead

8. Modify timing and rate of water diverted from the river annually: Reduce entrainment losses. Focus effort toward minimizing the impacts of diversions during periods when juvenile salmonids migrate (e.g., April through June).

Species: Fall-run chinook salmon; steelhead

9. Develop a riparian corridor management plan: Improve and protect riparian habitat and instream cover.

Species: Fall-run chinook salmon; steelhead

10. Terminate current programs that remove woody debris from the river channel: Provide instream cover for juvenile salmonids.

Species: Fall-run chinook salmon; steelhead

11. Impose stricter harvest regulations on both sport and commercial harvesters: Increase spawning escapement of naturally produced chinook salmon.

Species: Fall-run chinook salmon; steelhead

12. Conduct weekly on-river patrols in areas where poaching is a concern: Increase spawning escapement.

Species: Fall-run chinook salmon; steelhead

13. Change hatchery procedures to benefit native stocks: Rebuild native stocks.

Species: Fall-run chinook salmon; steelhead

Mokelumne River

1. Implement the Woodbridge Dam flow schedule: Increase escapement and survival of salmonids and American shad in the lower Mokelumne River.

Month	Mokelumne River flows[a] (cfs) just downstream of Woodbridge Dam				
	Wet	Above normal	Below normal	Dry	Critical
October[b]	300[c]	300[c]	300[c]	200[c]	200[c]
November-December[b]	350[c]	300[c]	300[c]	200[c]	200[c]
January[b]	400[d]	300[d]	300[d]	200[c]	200[c]
February[b]	450[d]	350[d]	350[d]	200[d]	200[d]
March	550[d]	350[d]	350[d]	250[d]	250[d]
April-May	3,700[e]	2,900[e]	2,500[e]	1,800[e]	1,000[e]

Month	Mokelumne River flows[a] (cfs) just downstream of Woodbridge Dam				
	Wet	Above normal	Below normal	Dry	Critical
June	950[d]	500[d]	500[d]	150[d]	150[d]
July	250[d]	100[d]	100[d]	60[f]	60[f]
August-September	60[f]	60[f]	60[f]	60[f]	60[f]

[a] Daily flow fluctuations shall not exceed 10% of the average flow within any 24-hour period, and weekly fluctuations shall not exceed 20% of the average flow within any 7-day period. Flows should not be reduced by more than 300 cfs during any 6-day period.

[b] Should flows exceed 400 cfs for any 7-day period during the peak spawning season (October-December), flows shall not be reduced below 400 cfs for the duration of the spawning/incubation period (October-February).

[c] Flows needed for chinook salmon spawning and incubation.

[d] Flows needed for chinook salmon rearing and outmigration.

[e] Flows needed for American shad spawning. Flows needed for salmon in April are 700 cfs (wet years), 600 cfs (above- and below-normal years) and 350 cfs (dry and critical years). Flows needed for salmon in May are 1,250 cfs (wet years), 900 cfs (above- and below-normal years) and 400 cfs (dry and critical years).

[f] Based on report of an instream barrier near Thornton that will prevent or impair the upstream migration of adult chinook salmon at flows less than 60 cfs (DFG 1991).

Species: Fall-run chinook salmon; steelhead; American shad

2. Provide flows maximizing suitable chinook salmon spawning habitat: Improve quantity of spawning habitat.

Species: Fall-run chinook salmon; steelhead

3. Replenish gravels suitable for salmonid spawning habitat: Improve quantity and quality of habitat.

Species: Fall-run chinook salmon; steelhead

4. Cleanse spawning gravels of fine sediments: Improve the quality of spawning habitat.

Species: Fall-run chinook salmon; steelhead

5. Prevent sedimentation of spawning gravel: Improve the quality of spawning habitat.

Species: Fall-run chinook salmon; steelhead

6. Restrict flow fluctuations and reductions: Prevent redd dewatering and stranding of juvenile salmonids.

Species: Fall-run chinook salmon; steelhead

7. Remove Woodbridge Dam or delay installing dam flashboards until July: Reduce losses of salmon smolts to predation.

Species: Fall-run chinook salmon; steelhead

8. Reduce or eliminate mortality and delays of juvenile salmonids associated with passage past the Woodbridge Irrigation District diversion and Woodbridge Dam: Improve survival of juvenile salmonids past the Woodbridge Irrigation District diversion and Woodbridge Dam.

Species: Fall-run chinook salmon; steelhead

9. Eliminate barriers to efficient and timely migration of adult salmonids: Improve passage conditions at Woodbridge Dam for adult salmonid migration.

Species: Fall-run chinook salmon; steelhead and American shad

10. Screen all diversion in the lower Mokelumne River to DFG standards: Prevent entrainment or loss of juvenile salmonids.

Species: Fall-run chinook salmon; steelhead; American shad

11. Maintain suitable water temperatures for all salmonid life stages: Provide for timely migrations and increased survival of adult and juvenile salmonids.

Species: Fall-run chinook salmon; steelhead

12. Enhance and maintain riparian corridor: Improve streambank and channel rearing for juvenile salmonids.

Species: Fall-run chinook salmon; steelhead

13. Set and enforce water quality standards: Provide optimal water quality for all life stages of salmonid.

Species: Fall-run chinook salmon; steelhead

14. Eliminate adverse effects of poaching and angling on salmonid production: Protect adult salmonid production.

Species: Fall-run chinook salmon; steelhead

15. Evaluate the feasibility of increasing available rearing habitat: Maximize suitable rearing habitat.

Species: Fall-run chinook salmon; steelhead

Cosumnes River

1. Determine and set instream flow requirements: Ensure adequate flows for all life stages of salmonids.

Species: Fall-run chinook salmon; possibly steelhead

2. Restrict water diversions during critical periods for salmonids: Ensure adequate instream flows for all life stages and provide better passage for adults and juveniles.

Species: Fall-run chinook salmon; possibly steelhead

3. Purchase existing water rights: Ensure adequate flows for all life stages of salmonids.

Species: Fall-run chinook salmon; possibly steelhead

4. Evaluate diversion dams and barriers for fish passage problems: Ensure passage problems for adult and juvenile salmonids.

Species: Fall-run chinook salmon; possibly steelhead

5. Remedy passage problems identified in Action 4: Ensure of passage adult and juvenile salmonids.

Species: Fall-run chinook salmon; possibly steelhead

6. Enforce Fish and Game Codes that prohibit construction of unlicensed dams: Ensure unimpeded passage of adult and juvenile salmonids.

Species: Fall-run chinook salmon; possibly steelhead

7. Effectively screen all diversions: Prevent loss of juvenile salmonids to entrainment.

Species: Fall-run chinook salmon; possibly steelhead

8. Establish riparian corridor protection zone: Preserve existing salmonid habitat from incompatible land use and moderate water temperature.

Species: Fall-run chinook salmon; possibly steelhead

9. Rehabilitate damaged areas: Remedy incompatible land use practices that have increased sedimentation of the river and elevate water temperatures.

Species: Fall-run chinook salmon; possibly steelhead

Calaveras River

1. Implement the Calaveras flow schedule: Optimize migration, spawning, incubation, rearing, and outmigration conditions for chinook salmon.

Month	Calaveras River flows (cfs)[a]				
	Wet	Above normal	Below normal	Dry	Critical
February 19-29	225[b]	70	70	50	50

Month	Calaveras River flows (cfs)[a]				
	Wet	Above normal	Below normal	Dry	Critical
March 1-20	225[b]	225[b]	225[b]	225[b]	225[b]
March 21-30	225[b]	225[b]	225[b]	120[c]	120[c]
March 31-September 15	200[c]	160[c]	160[c]	120[c]	120[c]
September 16-October 31	100[d]	100[d]	100[d]	100[d]	100[d]
November 1-February 18	70[e]	70[e]	70[e]	50[e]	50[e]

[a] Flows for spawning and incubation, rearing, and temperature control are needed only to Bellota because most fish remain above where the majority of diversions occur. However, 50 to 70 cfs left instream to tidewater would help maintain the overall health of the river system. Flows are proposed on an interim basis until more complete instream flow studies are conducted.

[b] Flows of 225 cfs are needed for attraction and passage of adults and smolts. Flows are required to mouth of San Joaquin River.

[c] Flows needed for spawning and incubation.

[d] Flows needed for juvenile rearing, including temperature protection.

[e] Flows needed for juvenile rearing.

Species: Winter-run chinook salmon

2. Manage water temperatures for all salmonid life stages, including spawning, incubation, rearing, juvenile outmigration, and adult migration: Provide suitable water temperatures for salmonid survival.

Species: Winter-run chinook salmon

3. Remove migration barriers affecting salmonids: Improve upstream and downstream migration.

Species: Winter-run chinook salmon

4. Evaluate screening needs and install screens as needed on existing diversions that may affect juvenile outmigrants: Protect outmigrants.

Species: Winter-run chinook salmon

5. Monitor sport fishing and regulations: Protect chinook and other salmonids.

SACRAMENTO-SAN JOAQUIN DELTA

1. Provide protection for juvenile salmonids migrating through the Delta from November 1 through June 30, equivalent to protection provided by restricting exports to minimal levels: Increase survival in Delta for all juvenile salmonid life stages (and potentially adults) affected by CVP and SWP exports. This includes juveniles migrating through the Delta using the mainstem rivers, as well as juveniles diverted into the central and southern portions of the Delta and juveniles emigrating from the San Joaquin Basin.

Species: Fall-, late fall-, winter-, and spring-run chinook salmon; steelhead; striped bass

2. Establish a moratorium on net increases in Delta diversions and withdrawals at the Contra Costa Canal: Reduce direct and indirect losses of striped bass resulting from the operation of the pumps and diversions.

Species: Striped bass

3. Close the DCC gates from 1 October through 30 June: Increase the survival of juvenile fish migrating down the mainstem Sacramento River by reducing the number diverted into the central and southern Delta.

Species: Fall-, late fall-, winter-, and spring-run chinook salmon; steelhead; American shad

4. Maintain positive QWEST flows, or an equivalent measure of net seaward flows at Jersey Point, of 1,000 cfs in critical and dry years, 2,000 cfs in below- and above-normal years, and 3,000 cfs in wet years from October 1 through June 30: Increase survival of smolts migrating down the mainstem rivers, decrease the number of smolts diverted into the central Delta, increase the survival of smolts diverted into the central Delta, and provide attraction flows for the San Joaquin Basin adults (October-December).

Species: Fall-, late fall-, winter-, and spring-run chinook salmon; steelhead; striped bass; American shad; white and green sturgeon

5. Increase mean monthly flow at Vernalis to 4,500 cfs, 6,000 cfs, 8,000 cfs, 12,000 cfs, and 21,000 cfs in critical, dry, below-normal, above-normal, and wet year types (60-20-20) during smolt migration period: Increase the survival of smolts migrating through the Delta originating from the San Joaquin Basin.

Species: Fall-, late fall-, winter-, and spring-run chinook salmon; steelhead

6. Implement the Delta outflow schedule: Increase production of striped bass, American shad; white and green sturgeon

Month	Delta outflow (cfs) measured at Chipps Island[a]				
	Wet	Above normal	Below normal	Dry	Critical
October	11,500	7,500	6,500	7,500	7,000
November	29,500	24,000	13,000	13,500	8,000
December	80,500	36,000	24,500	19,500	12,500
January	100,500	85,500	36,500	20,000	18,000
February	103,000	85,500	57,500	40,000	18,000
March	101,000	89,500	51,000	50,500	24,500
April	99,200[b]	76,100[b]	68,000[d]	49,500[d]	27,100[f]
May	99,500[c]	77,500[c]	66,100[e]	46,600[e]	27,100[f]
June	67,500	44,500	36,000	24,000	16,500
July	27,000	16,000	12,000	8,500	6,000
August	11,000	7,000	6,000	5,000	3,500
September	8,000	6,500	5,500	4,500	3,500

[a] Flows needed for striped bass except where noted.

[b] Flows needed for American shad. Flows needed for striped bass are 96,500 cfs and 73,000 cfs in wet and above-normal years, respectively. Flows needed for white and green sturgeon are 25,000 cfs; with minimum daily outflows not less than 20,000 cfs and 15,000 cfs in April and May, respectively.

[c] Flows needed for striped bass. Flows needed for American shad are 99,200 cfs and 76,100 cfs in wet and above-normal water years, respectively. Flows needed for white and green sturgeon are 25,000 cfs with minimum daily outflows not less than 20,000 cfs and 15,000 cfs in April and May, respectively.

[d] Flows needed for striped bass. Flows needed for American shad are 66,100 cfs and 46,500 cfs in below-normal and dry water years.

[e] Flows needed for American shad. Flows of 65,500 cfs, 46,500 cfs needed for striped bass in below-normal and dry water years, respectively.

[f] Flows needed for American shad. Flows needed for striped bass are 25,500 cfs and 27,000 cfs in April and May, respectively.

Species: Fall-, late fall-, winter-, and spring-run chinook salmon; steelhead; striped bass; American shad; white and green sturgeon

7. Reduce predation at and near the SWP and CVP pumps: Improve survival of striped bass eggs, larvae, and juveniles entrained by the SWP and CVP pumps.

Species: Striped bass

8. Improve CVP and SWP salvage operations: Improve survival of eggs, larvae, and juveniles.

Species: Striped bass; white and green sturgeon

9. Minimize loss and/or entrainment of eggs, larvae, and juveniles at the Contra Costa Canal diversion: Improve survival of eggs, larvae, and juveniles as they enter historical nursery areas.

Species: Striped bass; white and green sturgeon

10. Minimize loss and/or entrainment of eggs, larvae, and juveniles at the PG&E power generating plants: Improve survival of eggs, larvae, and juveniles as they enter historical nursery areas.

Species: Striped bass; white and green sturgeon

11. Eliminate, relocate, or reduce Sherman and Twitchell Island diversions: Improve survival of eggs, larvae, and juveniles as they enter historical nursery areas.

Species: Striped bass; white and green sturgeon

12. Minimize loss and/or entrainment of eggs, larvae, and juveniles at private agricultural diversions: Improve survival of eggs, larvae, and juveniles as they enter historical nursery areas.

Species: Striped bass; white and green sturgeon

13. Support measures to prevent development of a water quality barrier to adult striped bass migration in the San Joaquin River near Stockton: Ensure access to spawning areas in the San Joaquin River upstream of Stockton.

Species: Striped bass

14. Reduce toxic chemical and trace metal pollution: Provide better water quality for all life stages of anadromous fish.

Species: Striped bass; white and green sturgeon

15. Eliminate or reduce dredging and dredge spoil contribution to water pollution: Provide better water quality for all life stages of anadromous fish.

Species: Striped bass; white and green sturgeon

16. Reduce or eliminate unnecessary landfill projects: Reduce or eliminate habitat loss due to filling of Bay and Delta tidelands.

Species: Striped bass

17. Reduce or eliminate illegal take and poaching: Reduce impacts of illegal fishing on striped bass populations.

Species: Striped bass

18. Reduce or eliminate the annual summer die-off of adult striped bass: Reduce mortality of adult striped bass.

Species: Striped bass

19. Minimize incidental take of adult striped bass by commercial bay shrimp fishery: Increase young-of-the-year striped bass survival.

Species: Striped bass

20. Reduce or eliminate introduction of exotic aquatic organisms: Reduce impacts that exotic species have on striped bass and their food supply.

Species: Striped bass

SAN JOAQUIN RIVER BASIN

Lower San Joaquin River Tributaries

Merced River -

1. Implement the Merced River flow schedule: Manage flows to benefit all life stages of chinook salmon.

	Merced River flows (cfs) at Crocker-Hoffman Diversion to confluence with the San Joaquin River (flows rounded to nearest 50 cfs)				
Month	Wet[a]	Above normal	Below normal	Dry	Critical
October	350[b]	300[b]	300[b]	250[b]	250[b]
November	350[b]	350[b]	300[b]	300[b]	250[b]
December	600[c]	550[c]	300[b]	300[b]	250[b]
January	1,100[c]	600[c]	300[b]	300[g]	250[g]
February	1,450[c]	1,050[c]	500[g]	300[g]	250[g]
March	1,500[c]	1,050[c]	600[g]	450[g]	400[g]
April	1,800[d]	1,350[d]	1,150[d]	950[d]	750[d]
May	2,950[d]	2,300[d]	1,750[d]	1,200[d]	850[d]
June	2,850[d]	1,450[d]	1,150[d]	650[d]	450[d]
July	1,150[e]	400[e]	250	200[f]	200[f]
August	350[f]	300[f]	25[f]	200[f]	200[f]
September	350[f]	300[f]	25[f]	200[f]	200[f]

[a] Year types based on San Joaquin Basin 60-20-20 Index.

[b] Based on IFIM spawning flow recommendations for similar size drainages (Reynolds 1993) and the assumption that greater than historical flows are needed to compensate for elimination of access to upstream habitat.

[c] Based on historical (1922-1991) percent monthly contribution to total annual unimpaired runoff for the Stanislaus River basin and the assumption that flow should not be reduced between spawning and outmigration to prevent redd dewatering or stranding of rearing juveniles.

[d] Based on Vernalis flow requirement and historical (1922-1990) percent monthly contribution to total annual unimpaired runoff.

[e] Based on historical (1922-1990) percent monthly contribution to total annual unimpaired runoff.

[f] Based on IFIM recommendations for similar size drainages (Reynolds 1993) and the assumption that greater than historical flows are needed to compensate for elimination of access to upstream habitat.

[g] Based on IFIM flow recommendations for similar size drainages and the assumption that flow should not be reduced between spawning and outmigration to prevent redd dewatering or stranding of rearing juveniles.

Species: Fall-run chinook salmon

2. Adjust flow schedule to maintain water temperatures at 56°F between October 15 and February 15, and at 65°F between April 1 and May 31: Maintain water temperature within ranges suitable for chinook salmon spawning, incubation, rearing, and outmigration.

Species: Fall-run chinook salmon

3. Reduce impacts of rapid flow fluctuations: Increase hatching success and juvenile survival by reducing ramping rates and eliminating flow fluctuation during key periods.

Species: Fall-run chinook salmon

4. Restore and protect instream and riparian habitat: Ensure the long-term sustainability of physical, chemical, and biological conditions needed to meet production goals for chinook salmon through restoration and protection of stream ecosystem.

Species: Fall-run chinook salmon

5. Install and maintain fish protection devices at riparian pumps and diversion: Reduce or eliminate loss of juvenile chinook salmon due to entrainment by pumps and diversions.

Species: Fall-run chinook salmon

6. Provide additional law enforcement: Increase spawning success, reduce entrainment, and prevent additional destruction of stream habitat.

Species: Fall-run chinook salmon

7. Provide fish passage around reservoirs: Increase production and minimize impacts on water interests by providing access to additional spawning/rearing habitat upstream of reservoirs.
Species: Fall-run chinook salmon; steelhead

Tuolumne River -

1. Implement the Tuolumne River flow schedule: Manage flows to benefit all life stages of chinook salmon.

Month	Tuolumne River flows (cfs) at LaGrange Dam to confluence with the San Joaquin River (flows rounded to nearest 50 cfs)				
	Wet[a]	Above normal	Below normal	Dry	Critical
October	750[b]	300[b]	300[b]	200[b]	150[b]
November	1250[c]	800[c]	350[b]	300[b]	150[b]
December	1,400[c]	1,050[c]	350[b]	350[b]	200[c]
January	1,700[c]	1,150[c]	500[c]	400[b]	250[c]
February	2,100[c]	1700[c]	950[c]	700[c]	500[c]
March	2,300[c]	1,700[c]	1,300[c]	1,000[c]	900[c]
April	2,950[d]	2,450[d]	2,350[d]	1,900[d]	1,500[d]
May	5,150[d]	4,200[d]	3,350[d]	2,500[d]	1,850[d]
June	5,000[d]	3,250[d]	2,600[d]	1,550[d]	1,000[d]
July	2,150[e]	900[e]	650[e]	250[e]	200[e]

Month	Tuolumne River flows (cfs) at LaGrange Dam to confluence with the San Joaquin River (flows rounded to nearest 50 cfs)				
	Wet[a]	Above normal	Below normal	Dry	Critical
August	450[e]	200[e]	100[f]	100[f]	50[f]
September	350[f]	150[f]	150[f]	100[f]	50[f]

[a] Year type based on San Joaquin Basin 60-20-20 Index.

[b] Based on USFWS IFIM flow recommendations (USFWS unpublished data) and the assumption that greater than historical flows are needed to compensate for elimination of access to upstream habitat.

[c] Based on historical (1922-1990) percent monthly contribution to total annual unimpaired runoff for the Tuolumne River Basin and the assumption that flow should not be reduced between spawning and outmigration to prevent redd dewatering or stranding of rearing juveniles.

[d] Based on Vernalis flow requirement and historical (1922-1990) percent monthly contribution to total annual unimpaired runoff.

[e] Based on historical (1922-1990) percent monthly distribution of total annual unimpaired runoff.

[f] Flow based on USFWS IFIM recommendations.

Species: Fall-run chinook salmon

2. Adjust flow schedule to maintain water temperatures at 56°F between October 15 and February 15 and at 65°F between April 1 and May 31: Maintain water temperature within ranges suitable for chinook salmon spawning, incubation, rearing, and outmigration.

Species: Fall-run chinook salmon

3. Reduce impacts of rapid flow fluctuations: Increase hatching success and juvenile survival by reducing ramping rates and eliminating flow fluctuation during key periods.

Species: Fall-run chinook salmon

4. Restore and protect instream and riparian habitat: Ensure the sustainability of physical, chemical, and biological conditions needed to meet production goals for chinook salmon through restoration and protection of the stream ecosystem.

Species: Fall-run chinook salmon

5. Install and maintain fish protection devices at riparian pumps and diversions: Prevent or eliminate loss of juvenile chinook salmon due to entrainment.

Species: Fall-run chinook salmon

6. Provide additional law enforcement for illegal take of salmon, stream alteration, and water pollution and to ensure adequate protection for juvenile salmon at pumps and diversions: Increase spawning success, reduce entrainment, improve water quality, and prevent additional destruction of stream habitat.

Species: Fall-run chinook salmon

7. Provide fish passage around reservoirs: Increase production and minimize impacts on water impacts by providing access to additional spawning/rearing habitat upstream of reservoirs.

Species: Fall-run chinook salmon

Stanislaus River -

1. Implement the Stanislaus River flow schedule: Manage flows to benefit all life stages of chinook salmon.

Month	Stanislaus River flows (cfs) from Goodwin Dam to confluence with the San Joaquin River (flows rounded to nearest 50 cfs)				
	Wet[a]	Above normal	Below normal	Dry	Critical
October	350[b]	350[b]	300[b]	250[b]	250[b]
November	400[b]	350[b]	300[b]	300[b]	250[b]
December	850[c]	650[c]	300[b]	300[b]	250[b]
January	1,150[c]	800[c]	300[d]	300[d]	250[d]

Month	Stanislaus River flows (cfs) from Goodwin Dam to confluence with the San Joaquin River (flows rounded to nearest 50 cfs)				
	Wet[a]	Above normal	Below normal	Dry	Critical
February	1,450[c]	1,150[c]	700[c]	450[d]	300[d]
March	1,550[c]	1,150[c]	850[c]	650[c]	550[c]
April-May	5,600[e]	4,300[e]	3,800[e]	2,700[e]	1,500[e]
June	2,650[f]	1,600[f]	1,300[f]	700[f]	450[f]
July	900[g]	400[g]	350[h]	200[h]	250[h]
August	350[h]	300[h]	250[h]	200[h]	200[h]
September	350[h]	300[h]	250[h]	200[h]	200[h]

[a] Year types based on San Joaquin Basin 60-20-20 Index.

[b] Flow based on IFIM Recommendations and the assumption that greater than historical flows are needed to compensate for elimination of access to upstream spawning habitat.

[c] Based on historical (1922-1990) percent monthly contribution to total annual unimpaired runoff for the Stanislaus River basin and the assumption that flow should not be reduced between spawning and outmigration to prevent redd dewatering or stranding of rearing juveniles.

[d] Based on USFWS IFIM spawning flow recommendations and the assumption that flow should not be reduced between spawning and outmigration to prevent redd dewatering and stranding of rearing juveniles.

[e] Flows needed for American shad spawning. Flows needed for salmon during April are 2,100 cfs, 1,800 cfs, 1,750 cfs, 1,250 cfs, and 950 cfs in wet, above-normal, below-normal, dry, and critical water years. Flows needed for salmon during May are 3,500 cfs, 2,750 cfs, 2,050 cfs, 1,400 cfs, and 900 cfs in wet, above-normal, below-normal, dry, and critical water years. Stanislaus River contribution to Vernalis flow standard. Based on historical monthly contribution of the Stanislaus River to total unimpaired runoff for the San Joaquin River Basin, 1922-1990.

[f] Stanislaus River contribution to Vernalis flow standard. Based on historical monthly contribution of the Stanislaus River to total unimpaired runoff for the San Joaquin River Basin, 1922-1990.

[g] Based on historical (1922-1990) percent monthly contribution to total annual unimpaired runoff for the Stanislaus River basin.

[h] Based on USFWS IFIM flow and assumption that greater than unimpaired flow is needed to compensate for eliminations of access to upstream habitat.

Species: Fall-run chinook salmon

2. Operate New Melones, Tulloch, and Goodwin reservoirs to maintain water temperatures at 56°F between October 15 and February 15 and at 65°F between April 1 and May 31: Maintain water temperature within ranges suitable for chinook salmon spawning, incubation, rearing, and outmigration.

Species: Fall-run chinook salmon

3. Restore and protect instream and riparian habitat: Ensure the long-term sustainability of physical, chemical, and biological conditions needed to meet production goals for chinook salmon through restoration and protection of the stream ecosystem.

Species: Fall-run chinook salmon

4. Reduce impacts of rapid flow fluctuations: Increase hatching success and juvenile survival by reducing flow fluctuation rates resulting from peaking power and other reservoir operations.

Species: Fall-run chinook salmon

5. Install and maintain fish protection devices at riparian pumps and diversions: Reduce or eliminate loss juvenile chinook salmon due to entrainment by pumps and diversions.

Species: Fall-run chinook salmon

6. Provide additional law enforcement for illegal take of salmon, stream alterations, water pollution and to ensure adequate screening of pumps and diversions: Increase spawning success, reduce entrainment, improve water quality, and prevent additional destruction of stream habitat.

Species: Fall-run chinook salmon

7. Remove or modify of Old Melones Dam: Reduce fall water temperatures in the Stanislaus River.

Species: Fall-run chinook salmon

8. Provide fish passage around reservoirs: Increase production and minimize impacts of anadromous fish restoration on water interests by providing access to additional spawning and rearing habitat upstream of reservoirs.

Species: Fall-run chinook salmon; steelhead

Lower San Joaquin River

1. Implement the Stevinson flow schedule: Manage flows to benefit all life stages of chinook salmon.

Month	San Joaquin flows (cfs)[a] at Stevinson (flows rounded to nearest 50 cfs)				
	Wet[b]	Above normal	Below normal	Dry	Critical
April	5,150	2,650	2,050	1,750	1,250
May	7,000	4,450	3,050	2,300	1,600
June	6,800	3,450	2,600	1,700	1,050

[a] San Joaquin contribution to Vernalis flow standard. Based on Vernalis flow standards and the historical percent contribution of the San Joaquin River to total unimpaired San Joaquin Basin runoff.

[b] Year types based on San Joaquin Basin 60-20-20 Index.

Species: Fall-run chinook salmon

2. Provide mean monthly flows of at least 7,000 cfs at Newman between February and May in wet and above-normal water years: Increase sturgeon production by providing adequate flows for upstream migration, spawning, and progeny survival.

Species: White and green sturgeon

3. Implement the Vernalis flow schedule: Manage flows to benefit all life stages of chinook salmon, American shad, and white and green sturgeon.

Month	San Joaquin River flows (cfs) at Vernalis				
	Wet[a]	Above normal	Below normal	Dry	Critical
October	1,450[b]	950[b]	900[b]	700[b]	650[b]
November	2,000[b]	1,500[b]	950[b]	900[b]	650[b]
December	2,850[b]	2,250[b]	950[b]	950[b]	700[b]
January	3,950[b]	2,550[b]	1,100[b]	1,000[b]	750[b]
February	14,000[c]	14,000[c]	2,150[b]	1,450[b]	1,050[b]
March	14,000[c]	14,000[c]	2,750[b]	2,100[b]	1,850[b]
April	28,400[d]	21,800[d]	18,900[d]	13,500[d]	7,800[d]
May	28,400[d]	21,800[d]	18,900[d]	13,500[d]	7,800[d]
June	17,300[e]	9,750[e]	7,650[e]	4,600[e]	2,950[e]
July	4,200[d]	1,700[d]	1,250[d]	650[d]	650[d]
August	1,150[d]	800[d]	600[d]	500[d]	450[d]
September	1,050[d]	750[d]	650[d]	500[d]	450[d]

[a] Year types based on San Joaquin Basin 60-20-20 Index.

[b] Sum of flow from the Stanislaus, Tuolumne, and Merced rivers.

[c] Flows needed for sturgeon spawning. Flows needed for salmon in February are 5,000 cfs (wet years) and 3,900 cfs (above-normal years). Flows needed for salmon in March are 5,350 cfs (wet years) and 3,900 (above-normal years) in March. Salmon flows are sum of flows from the Stanislaus, Tuolumne, and Merced rivers.

[d] Flows needed for American shad spawning. Flows needed for salmon in April are 12,000 cfs (wet years), 8,250 cfs (above-normal years), 7,300 cfs (below-normal years), 5,850 cfs (dry years), and 4,450 cfs (critical years). Flows needed for salmon in May are 18,600 cfs (wet years), 13,700 cfs (above-normal years), 10,200 cfs (below-normal years), 7,400 cfs (dry years), and 5,200 cfs (critical

years). See footnote [e] for explanation on flow derivation. Flows needed for white and green sturgeon spawning are 14,000 cfs in wet and above-normal water years.

[e] Flow required to meet salmon production goals based on regression relationship:

$$E_{S,T} = (1.820Q_V)-(0.051X_{F,S})-18{,}417.3$$ (Carl Mesick Consultants 1994)

Where, for a given year class, $E_{S,T}$ is the sum of escapement into the Stanislaus and Tuolumne rivers as 2- and 3-year-old fish, Q_V is average San Joaquin River flow (cfs) at Vernalis from April 1 through June 30 in the year of outmigration, and $X_{F,S}$ is total combined monthly exports (af) for the federal (CVP) and state (SWP) water projects, from April 1 through June 30 in the year of outmigration. Flow is allocated between April, May, and June on the basis of historical occurrence of unimpaired runoff.

Species: Fall-run chinook salmon; American shad; white and green sturgeon

4. Install and maintain fish protection devices at Banta-Carbona, West Stanislaus, Patterson, and El Soyo diversions: Reduce or eliminate loss of juvenile chinook salmon resulting from entrainment by the four largest diversions on the San Joaquin River.

Species: Fall-run chinook salmon; depending on mesh aperture could have benefits for striped bass, American shad, juvenile white and green sturgeon

5. Install and maintain fish protection devices at small agricultural diversions: Increase survival of juvenile salmon by reducing or eliminating entrainment.

Species: Fall-run chinook salmon; depending on mesh aperture could have benefits for striped bass, American shad, juvenile white and green sturgeon

6. Continue prohibition on sport harvest of chinook salmon in the San Joaquin Basin upstream of Mossdale; extend closure on the mainstem San Joaquin River downstream to Chipps Island: Increase spawning success by preventing harvest of salmon escaping into San Joaquin River tributaries.

Species: Fall-run chinook salmon

7. Prohibit dredging of Stockton ship channel during critical periods: Prevent dissolved oxygen stage during periods when adult or juvenile salmon are migrating through the lower San Joaquin River and Delta.

Species: Fall-run chinook salmon

8. Operate head of Old River barrier to protect migrating adults and juveniles: Improve water quality for migrating adults, reduce entrainment of outmigrating smolts.

Species: Fall-run chinook salmon; white and green sturgeon

9. Modify reservoir operation to maintain mainstem San Joaquin River water temperatures at 56°F between October 15 and February 15 and at 65°F between April 1 and May 31 for chinook salmon; maintain water temperatures between 61°F and 65°F for 1 month between April 1 and June 30 for American shad; and maintain water temperatures below 63°F in spawning areas and below 68°F throughout the San Joaquin River in wet and above-normal water years between February and May for white and green sturgeon: Prevent delays in adult migration and associated higher rates of egg mortality and increase survival of outmigrating juveniles by reducing stress and mortality associated with high water temperatures. Water temperatures also provide for sturgeon migration, final stages of sexual maturation, spawning, and progeny survival.

Species: Fall-run chinook salmon; American shad; white and green sturgeon

10. Establish a basinwide Conjunctive Water Use Program: Obtain adequate water to meet anadromous fish-flow requirements while minimizing impacts on other water users.

Species: Fall-run chinook salmon

11. Reduce predator populations: Increase survival of juvenile salmon by reducing predator populations.

Species: Fall-run chinook salmon

12. Remove barriers to sturgeon migration: Remove barriers that prevent or slow the migration of sturgeon to areas where sturgeon spawn.

Species: White and green sturgeon

13. Adopt gear restrictions eliminating illegal harvest of white and green sturgeon: Increase size of spawning stock.

Species: White and green sturgeon

14. Improve water quality: Improve survival and condition of sturgeon.

Species: White and green sturgeon