CALFED BAY-DELTA PROGRAM
SACRAMENTO RIVER AND TRIBUTARIES
TECHNICAL TEAM MEETING REPORT

Prepared for

CALFED Bay-Delta Program
Ecosystem Roundtable

9 April 1997

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1. INTRODUCTION

The CALFED Bay-Delta Program was established in May 1995 as a cooperative effort among seven state and federal agencies with management and regulatory responsibilities in the Bay-Delta. The program is aimed at developing a long-term solution to problems affecting the San Francisco Bay/Sacramento-San Joaquin Delta estuary in Northern California, with a focus on ecosystem quality, water quality, water supply, and system reliability. The Ecosystem Roundtable was formed as an advisory stakeholder group to CALFED to provide guidance regarding implementation of ecosystem restoration projects in the next three-to-five years. CALFED is soliciting input from technical experts in a variety of disciplines and geographical areas to aid in identifying and prioritizing ecosystem problems and restoration actions.

The Sacramento River and tributaries technical team was formed to provide input to CALFED on restoration actions in the basin that would benefit priority species and habitats identified in the "Implementation Strategy to Identify Priorities for Bay-Delta Ecosystem Restoration." The technical team is one of five geographically defined teams that are providing input to CALFED for development of a workplan that will guide funding of near-term restoration actions.

1.1 Technical Team Meeting

On March 4-6, 1997, the CALFED Bay-Delta Program held a meeting at the Red Lion Inn in Redding. The primary purpose of the meeting was to involve technical representatives from agencies and stakeholder groups in developing a package of priority fish and habitat restoration actions to be implemented in the near-term. These actions were focused on the Sacramento River between Shasta Dam and the legal Delta (I Street Bridge), including all tributaries except the American River (which is being addressed by another technical team).

Based on the Implementation Strategy, the priority species for the Sacramento River and tributaries included chinook salmon (particularly winter run, late fall run, and spring run, although fall run are included as well), steelhead, green sturgeon, and splittail. Species of secondary priority include striped bass and migratory birds. This list includes species that are listed or in decline, important commercial or recreational species that have declined, and species which are dependent on the Delta during some part of their life cycle. Local threatened or endangered species which are not directly connected to problems in the Delta were not included as a priority for CALFED funded projects. They may, however, be addressed by restoration actions funded by other sources.

Priority habitats for restoration actions in the Sacramento River system include seasonal wetlands (floodplain), shaded riverine aquatic habitat, and instream aquatic habitat because of their relationship to the priority species.

1.2 Meeting Overview

A copy of the meeting agenda and attendee list is provided in Appendix A. The meeting began with selected background presentations on geomorphic processes, fish populations, and geographical and structural aspects of the Sacramento River system. The CALFED planning process, time line, and program coordination effort was presented. There was general discussion of the geographic scope for the technical team, the priority species and habitats that should be considered for restoration actions, and the relationships between stressors, physical processes, biological benefits, and restoration actions.

Two geographic subgroups were formed (mainstem and tributaries) to discuss system stressors and potential restoration actions in different portions of the Sacramento watershed. The subgroups met for one day, then reconvened in a general session on the last day of the meeting to review and comment on each subgroup's positions and respective conclusions.

1.3 General Session Presentations

The first general session began with a presentation by Eric Larsen of U.C. Davis on fluvial processes in rivers. Dr. Larsen described a number of the mechanisms behind river meandering, including the associated erosion and deposition processes and the importance of water velocities in channel migration. He described a predictive model for river meander that can be used for river management decision making. The model can depict associated aquatic and terrestrial habitat changes within the floodplain caused by channel profile and hydraulic changes resulting from river meandering. An abstract of the presentation is included as Appendix B.

Steve Greco of U.C. Davis gave a presentation on management concepts and opportunities for increasing the ecological potential of riverine/riparian ecosystems on the Sacramento River for fish and wildlife. He described the river continuum concept and the associated floodplain and channel relationships, and noted that structural modifications and other development factors have resulted in serial discontinuities throughout the river system. The importance of the flood pulse concept was introduced as a driving variable in the ecology of a riverine system. The influence of interrelationships between riparian zone habitat, floodplain and gravel bar development, and juvenile salmonid habitat was emphasized, along with the connection between these factors and the river meander process described earlier by Eric Larsen. Steve concluded by proposing development of a model for floodplain inundation that can be used to facilitate passive development of riparian forest through flow prescriptions. An abstract of Steve Greco's presentation is included in Appendix B.

Stacy Cepello of the Department of Water Resources (DWR) Northern District gave a slide show presentation on the Sacramento River from Keswick Dam down to the Delta, generally describing the current condition of the river. Several SB 1086 projects on the Sacramento River were presented, providing an indication of the types of restoration activities that are already in progress. A status report and description of SB 1086 projects on the Sacramento River is included in Appendix C.

Paul Ward of the Department of Fish and Game (CDFG) gave a presentation on the timing and distribution of various salmon runs in the Sacramento River, both past and present. He noted historic run sizes of up to 200K winter run, 500-600K spring run, and 200-500K fall run salmon. He mentioned that Deer Creek, Mill Creek, and Butte Creek are now the primary spring run habitat. A number of key fish species in the Sacramento River system were reviewed, along with their distribution.

Harry Rectenwald of CDFG reviewed a number of the structural changes that have occurred on the Sacramento River, and their implications for fisheries management. These changes include construction of Shasta Dam, and the resulting barrier, flow, and water temperature related effects on the system. Other major features include Iron Mountain Mine, which has considerable effect on downstream water quality, and Red Bluff Diversion Dam, which poses a passage and predation problem for anadromous fish. Other structural changes with implications for anadromous fish include the Anderson-Cottonwood Irrigation District (ACID) diversion dam, and the hydroelectric plants and Coleman Hatchery on Battle Creek.

1.4 CALFED Planning Process Overview and Introductory Comments

Kate Hansel of CALFED gave a presentation on the integrated planning process being implemented by the CALFED Bay-Delta Program (see Appendix D). She emphasized that the current activities are focused on development of a work plan and implementation of near-term actions. Near-term actions will be guided by identification of high priority restoration categories in each of the different geographical areas where technical teams have been convened. An "umbrella team" is being convened to help integrate and balance various restoration actions between different geographical areas.

The time line for the current planning process was reviewed (Appendix D), noting that the current schedule calls for decisions on project funding this summer. The coordination of restoration activities between a variety of different programs was discussed, and the current coordination process presented on an overhead slide (Appendix D).

David Bernard, one of the meeting's facilitators, reviewed the process for setting goals and making decisions about priority actions. Goal setting was noted as important to establish a direction for guidance of restoration actions. General restoration goals identified by the CALFED Bay-Delta Program as part of the Ecosystem Restoration Program Plan (ERPP) and the Central Valley Project Improvement Act (CVPIA) Anadromous Fish Restoration Program (AFRP) were cited by the group as being pertinent to the current development and prioritization of restoration actions for the Sacramento River and tributaries. The specific goals of each of these programs were not discussed.

David reviewed the concepts of stressors and physical processes in the river system, and how projects and programs can be directed at stressors and processes to yield biological benefits. Adaptive management can be applied to evaluate the results of the projects and programs, and adjustments can be made in subsequent actions to improve the biological benefits. Example stressors and physical processes identified by the San Joaquin River technical team were included in the meeting packet, for use in developing similar information for the Sacramento River system. In addition, David stated it was expected that participants use their expert judgement in decision making about priority stressors and restoration actions, since available data will always be limited.

2. STRESSOR CATEGORIES

Categories of stressors were identified from the CALFED Ecosystem Restoration Program Plan (ERPP), previous technical team efforts, the spring run workshop in 1996, the SB 1086 Program (Riparian Habitat Committee), and other sources. These stressor categories included the following.

1. Degraded Instream Riverine Habitat Conditions
2. Lack of Shaded Riverine Aquatic (SRA) Habitat
3. Lack of Floodplain and Riparian Woodland Habitat
4. Passage Problems
5. Lack of Food Supply
6. Toxicity/Water Quality
7. Diversions
8. Straying
9. Erosion/Sediment Input/Geomorphic Factors
10. Predation
11. Fish Population Management
12. Land Use Actions

Each of these stressor categories are briefly discussed below (in no particular order of importance).

Degraded Instream Riverine Habitat Conditions

Degradation of instream riverine habitat conditions is related to gravel quantity or quality, flows, availability of cover, water quality and temperature, entrainment, channel configuration, and other factors. Instream habitat degradation has developed as a result of flood control and water development activities, diversions, land use changes, and many other causes. Degraded habitat conditions can preclude successful spawning, rearing, holding, and migration by populations of native fish, including anadromous species.

Lack of Shaded Riverine Aquatic (SRA) Habitat

Shaded riverine aquatic habitat exists along river margins and backwaters where riparian vegetation overhangs the water. This type of habitat is has been significantly reduced due to flood control, water conveyance, and land use activities. Shaded riverine aquatic habitat provides important cover and food for juvenile salmon, spawning substrate for other fish such as Sacramento splittail, and refuge for juvenile fish during periods of high water. In addition, SRA habitat typically provides nutrients and allochthonous material that supports nutrient cycling, and helps maintain the foodweb needed to support quality aquatic foraging conditions. The vegetation also provides habitat for wildlife species, and helps maintain cooler water temperatures for aquatic species. Loss of SRA habitat due to levee maintenance, land use practices such as grazing, or flood control activities can result in higher water temperatures and increases in other juvenile salmon mortality factors.

Lack of Floodplain and Riparian Woodland Habitat

Floodplains and riparian woodlands are essential components of a dynamic riverine ecosystem that provides numerous benefits for fish and wildlife species. Floodplains provide important aquatic habitat during high flow periods, along with gravel and organic input to the system that are critical to life stages of salmonids and other species. River meander processes that occur within the floodplain are critical to gravel recruitment and creation of habitat for a variety of fish and wildlife species.

Riparian woodlands are a source of SRA habitat, and provide terrestrial habitat to migratory birds and other species. Many special status species are dependent on or closely associated with riparian habitats, and aquatic species benefit from the enhanced nutrient cycling and foodweb support functions of riparian areas.

Passage Problems

Restrictions on upstream or downstream movement of migrating fish species is a stressor because it may affect the physical condition (e.g., mechanical injury due to diversions, screens, dams, etc.), physiological condition (e.g., spawning readiness, smolting, etc.), and/or ecological status (e.g., predation risk, run timing, outmigrant survival, etc.) of anadromous fish. Upstream and downstream passage can be impaired by serial discontinuities in the river system such as dams, diversions, areas of poor water quality, and other factors. Barriers to upstream movement may result in the elimination of many miles of upstream spawning habitat, and delays in upstream migration can increase predation risks and decrease spawning success. Downstream migration may be affected by many of these same barriers, which are added to other downstream migration risks resulting from stranding due to flow changes, increased predation due to longer travel times, or increased water temperatures during the late spring or summer.

Lack of Food Supply

Successful outmigration of fry and smolts requires adequate rearing habitat and food resources to maximize survival to the ocean. Lack of food supply can decrease the fitness of outmigrants, subjecting them to higher predation rates, greater disease susceptibility, and other mortality factors. A highly productive foodweb is necessary to provide an adequate food supply and support sustainable native fish and wildlife populations. High quality instream habitat, an adequate floodplain, and developed SRA habitat and riparian woodlands are important factors in maintaining a productive foodweb. Native plant species are an important part of the foodweb, since invasive non-native species frequently fail to provide the cover, structure, or food production necessary for native fish and wildlife populations.

Toxicity/Water Quality

Introduction of toxic compounds from agricultural or urban runoff, or from point sources such as Iron Mountain Mine, can have an acute or chronic toxicity effect on fish and wildlife in the Sacramento River system. This degradation of water quality may have negative cumulative effects on salmon production, particularly for younger life stages of salmon that may have longer exposure and higher sensitivity to toxic compounds. The success of a variety of restoration projects could be limited if underlying water quality problems are not identified and addressed.

Diversions

Numerous diversions along the mainstem of the Sacramento River and its tributaries present an entrainment or impingement risk to anadromous and other fish species. Entrainment of salmon fry and smolts can be a significant source of direct mortality.

Straying

Potential salmonid production can be lost when adults stray from their natal spawning streams, since conditions in other areas may not be as suitable for successful spawning. Providing access to the natal streams is important for maintaining the highest possible levels of production, and sustaining the genetic integrity of the stock.

Straying by hatchery fish into non-natal streams may threaten the genetic integrity of the wild stock. The hatchery fish may compete with the wild population for spawning sites, and they interject a genetic component into the population that is not specifically adapted to the conditions of the watershed.

Erosion/Sediment Input/Geomorphic Factors

Spawning areas in the Sacramento River and tributaries can be adversely affected by increased fine sediment loads, decreased recruitment of approprately sized spawning gravels, and other changes related to altered sediment budgets. Increased fine sediment loads result from accelerated erosion processes higher in the watershed and result in decreased gravel permeability, which has a negative effect on dissolved oxygen concentration and metabolite removal rates in the redds. Spawning gravels can be "cemented" into the streambed by accumulation of fine material in the intersticial spaces during low flow periods, thus reducing their suitability for redd construction. Altered sediment budgets are caused by upstream dams that trap larger sediments and change the flow regime, and also by watershed processes that may accelerate erosion and fine sediment loading.

Gravel mining is another stressor that is prevalent in many tributary streams. Adverse effects due to gravel mining include removal of spawning gravel and the associated changes in channel configuration, riparian vegetation, sediment budget, habitat conditions, and other factors.

Predation

Predation is a natural mortality factor that can have an unnaturally significant effect on the salmon population when it is intensified by introduced species, habitat changes that favor the predator, or other changes that increase the vulnerability of the prey. Within the Sacramento River system, substantial predation losses have been reported at RBDD due to high concentrations of predators immediately downstream of the structure. Heavy predation losses are also suspected in slow moving portions of the river (such as deep oxbows) that result in long exposure times of salmon fry and smolts to good habitat for introduced predators such as striped bass.

In the tributaries, poaching can be a significant predation factor on spawning salmon, particularly on spring run fish that hold over during the summer.

Fish Population Management

Hatchery production of salmon smolts can have a beneficial effect on overall salmon production in a river system, but it may also have a deleterious effect on wild salmon fry, smolts, and spawners. Release of large numbers of smolts into the river could affect the migratory behavior of wild fry and smolts, and may affect food supply in localized areas. The genetic integrity of the wild salmon population can be adversely affected and result in decreased fitness, changes in run timing, loss of adaptability to changing environmental conditions, and lower reproductive success.

Land Use Actions

Land use impacts in a watershed may result from development of roads and urban areas, grazing, changes in runoff patterns and sediment transport, agricultural activity, and other factors. Land uses within a watershed can adversely affect anadromous fish and other aquatic resources by causing changes in sediment budgets, increased fine sediment input, water quality changes, riparian corridor degradation, and other habitat changes.

3. SACRAMENTO RIVER MAINSTEM SUBGROUP

The subgroup for the Sacramento River mainstem included:

David Bernard (facilitator)
Serge Birk
Analena Bronson
John Carlon
Stacy Cepello
Scott Clemons
Steve Greco
Tom Griggs
Andrew Hamilton
Kate Hansel (coordinator)
Diana Jacobs
Jeff Jaraczeski (observer)
John Siperek
Jim Smith
Russell Smith
Nick Villa
Dave Vogel
Scott Wilcox (recorder)
Ramon Vega
Rod Fujita
Bruce Herbold
Eric Larsen

The subgroup began by delineating distinct reaches of the river that would be addressed independently for purposes of identifying stressors and desirable restoration actions. Four reach definitions were proposed, consistent with the reach definitions used in prior years for the Category III spring run salmon workshop and other activities. The reaches were:

- Keswick Dam to Red Bluff Diversion Dam (RBDD)
- RBDD to Chico Landing
- Chico Landing to Colusa
- Colusa to the Delta

3.1 Mainstem Stressors

The Sacramento mainstem subgroup selected stressor categories from a SB 1086 Riparian Habitat Committee document. The SB 1086 document (Appendix E) was developed to provide input into the CALFED ERPP. Ten stressor categories generally identified in the SB 1086 document included:

1. Degraded Instream Riverine Habitat Conditions
2. Lack of Shaded Riverine Aquatic (SRA) Habitat
3. Lack of Floodplain and Riparian Woodland Habitat
4. Passage Problems (Lack of Upstream/Downstream Movement)
5. Lack of Food Supply
6. Toxicity/Water Quality
7. Diversions
8. Straying
9. Erosion/Sediment Input/Geomorphic Factors
10. Predation

Each of these stressor categories were discussed by the subgroup, and possible restoration actions to address the stressors were identified.

3.2 Mainstem Restoration Actions and Ranking

Restoration actions under each stressor category for the Sacramento mainstem are briefly described in the following paragraphs. The specificity of the restoration actions varied, depending on the stressor and status of any ongoing projects or programs. A matrix was developed to identify the river reach, species, and program status for each action item (Table 1).

Within each stressor category, restoration actions were ranked for their relative importance. It was emphasized that the rankings DO NOT represent the overall importance of the action item for the Sacramento River mainstem, but merely the relative importance of the action WITHIN a restoration category. There was no consensus among the group regarding ranking BETWEEN restoration categories. Thus, an action ranked high in one category is not necessarily of greater importance or priority than an action ranked low in some other category.

Since the subgroup prioritized restoration actions within each stressor category, but not between categories, the actions will need additional prioritization by the Umbrella Team before they can be fully integrated into the overall workplan. This prioritization will facilitate comparisons between actions (and their associated level of effort) in the Sacramento River watershed, as well as actions in other watersheds within CALFED's study area.

Degraded Instream Riverine Habitat Conditions

Many of the actions discussed by the mainstem subgroup dealt with channel conditions and the associated gravel recruitment and cover complexity components. Protecting sources of gravel recruitment, and supplementing gravel supplies where they are currently inadequate was considered an important action. Protecting the mainstem meander belt was cited as a method for maintaining gravel recruitment, as well as a source of woody debris that provides necessary structural habitat complexity. If the river is allowed to meander, many instream habitat conditions will "passively" improve due to associated riparian growth, gravel recruitment, woody debris recruitment, and increases in channel complexity and diversity. Gravel replacement or restoration projects may also help restore fundamental geomorphic processes that benefit other species through changes in invertebrate productivity and riparian zone dynamics.

Lack of Shaded Riverine Aquatic (SRA) Habitat

Actions which increase the amount of SRA habitat would provide benefits to both terrestrial and aquatic species. Recommended actions included the protection, restoration and re-establishment of SRA habitat through a combination of habitat improvements on existing levees and maintenance or expansion of meander belts. Existing levee improvements include revegetation actions and re-evaluation of floodplain protection strategies. Meander belts provide a number of instream habitat

Table 1. Sacramento River Mainstem Stressor Categories and Restoration Actions

		Reach				Species/Run										Implementation							
Stressor Categories	**Restoration Actions**	Keswick to RBDD	RBDD to Chico Landing	Chico Landing to Colusa	Colusa to Delta	Fall run	Late fall run	Winter run	Spring run	Steelhead	Splittail	Striped bass	Green sturgeon	Migratory birds	Others	Program	Project	Pilot	Feasibility Study	Research	(E)xisting or (N)ew Actions	Rank within category	**Notes**
Degraded Instream Riverine Habitat Conditions	Replenish riverine gravels, monitor gravel movement, and schedule Keswick flow for gravel submergence and redistribution.	■				✓	✓	✓	✓	✓							●			●	N,E	3	Gravel submergence is an existing program, gravel redistribution is new.
	Take actions to protect gravel sources in tributaries.	■	■			✓	✓	✓	✓	✓						●					N,E	2	Existing project in Clear Creek.
	Protect mainstream meander belt as a source of gravel.	■	■			✓	✓	✓	✓	✓				✓	✓	●					E	1	
	Improve rearing habitat by increasing structural complexity.	■	■	■		✓	✓	✓	✓	✓						●					E	4	
	Provide adequate flow (> minimum) for spawning habitat and rearing.		■			✓	✓	✓	✓	✓						●					E	5	
Lack of Shaded Riverine Aquatic Habitat (SRA)	Protect, restore, and re-establish SRA where possible.	■	■	■		✓	✓	✓	✓	✓						●					E	2,3	Lower ranking in Colusa to Delta reach.
	Maintain meander belt where presently active.	■	■	■		✓	✓	✓	✓	✓						●					E	1	
	Allow wider meander belt where possible (by land acquisition or discontinuing levee armoring).	■	■	■		✓	✓	✓	✓	✓												1	
	Conduct feasibility study on revegetation of project levees or rocked levees.			■	■	✓	✓	✓	✓	✓													
	Endorse/partner with ACOE and Rec. Bd. study on re-evaluation of floodplain protection strategy.				■	?	?	?	?	?						?					E?	3	
Lack of Floodplain and Riparian Woodland Habitat	Protect/restore riparian forest habitats.	■	■			✓	✓	✓	✓	✓	✓			✓	✓	●					E	1	
	Reclaim historic floodplain within current flow context.	■	■	■		?	?	?	?	?						●					E	2	Passive action in lower reaches, by not rocking or rebuilding.
	Restore floodplain function by moving/removing private levees.	■	■			✓	✓	✓	✓	✓		✓		✓	✓			●	●			2	
	Conduct project levee or other rock removal/relocation projects.			■	■	✓	✓	✓	✓	✓									●		E	3	Existing ACOE, DWR, and Category III feasibility study
	Conduct Yolo Bypass feasibility of establishing floodplain-like conditions at a lower flow split between the bypass and the river.				■					✓									●			4	
	Manage hydrograph to allow maximum overbank flooding within flow peak potential.		■			✓	✓	✓	✓	✓					✓	●					E	2	
	Initiate land acquisition in floodplain.		■			✓	✓	✓	✓	✓				✓	✓	●					E	1	
	Revise floodplain management.		■			✓	✓	✓	✓	✓				✓	✓	●					E	1	
	Obtain floodplain easements.		■			✓	✓	✓	✓	✓				✓	✓	●					E	1	
Passage Problems	Structure and operation of ACID.	■				✓	✓	✓	✓	✓						●					E	2	
	Options for passage and reduction of predation at RBDD.		■			✓	✓	✓	✓	✓						●					E	1	
Lack of Food Supply	Remove non-native plants from the riparian zone, re-establish natives.	■	■	■	■	✓	✓	✓	✓	✓	✓	✓				●			●		N	1	
Toxicity	Non-point source agricultural runoff: use BMPs, expand riparian buffer zone.		■	■	■	✓	✓	✓	✓	✓						●		●			E	1	Existing pilot program completed. Possibly fund implementation. Copper is a constituent of concern.
	Colusa Drain.				■																E		Being addressed by Category III
Diversions	Conduct screen rehabilitation.	■			■	✓	✓	✓	✓	✓						●					E	1	
	Install new screens.	■	■	■	■	✓	✓	✓	✓	✓						●					N,E	1	New program for Chico Landing to Colusa. Issue RFPs for high priority sites, based on inventory.
	Conduct screen options feasibility study (consolidate diversions, construct in-gravel wells).		■	■	■	✓	✓	✓	✓	✓								●	●		N	3	
	Conduct winter rice flooding and waterfowl pilot project to assess priority locations and flow needs.				■									✓	✓			●				2	Design a pilot study.
Straying	Eliminate inappropriate attraction flow.	■	■			✓	✓	✓	✓	✓						●					E	2	ACID, Orick Diversion
	Hatchery operation modification.	■	■			✓	✓	✓	✓										●			1	Modification of operations
Erosion/Sediment Input/Geomorphic Factors	Increase tributary sediment control.	■	■			✓	✓	✓	✓	✓						●			●	●	E	1	Feasibility and research for RBDD to Chico Landing.
Predation	Decrease predation.		■	■	■	✓	✓	✓	✓	✓						●				●	E	1	

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benefits (discussed previously), and also provide SRA habitat for invertebrate production and terrestrial species.

Lack of Floodplain and Riparian Woodland Habitat

Many of the floodplain related actions discussed by the subgroup dealt with reclaiming the current floodplain, within the context of current flows, by relocating or removing levees. Land acquisition would be necessary within the floodplain, and the hydrograph would need to be managed to facilitate floodplain inundation in a manner that would mimic the natural system and provide maximum benefit to aquatic species. Floodplain easements and modifications to existing bypass facilities (such as the Yolo Bypass) to facilitate more natural floodplain processes and functions were identified as actions that would help restore both aquatic and riparian woodland habitats.

Passage Problems

Actions to facilitate upstream and downstream movement of fish focused on the diversion dam at ACID, and Red Bluff Diversion Dam (RBDD). The problems at the ACID dam could be improved with changes in the structure and operation of the facility. Passage problems and associated predation at RBDD could be addressed through changes in the structure and operation of the facility.

Lack of Food Supply

Lack of food supply is a stressor that can be addressed by a number of different restoration actions. Increases in SRA habitat and instream habitat restoration will naturally increase invertebrate production and enhance the related food web processes that support anadromous fish. In addition, control of non-native plants in the riparian zones can facilitate re-establishment of the native flora that provides a more food production for native species.

Toxicity/Water Quality

Iron Mountain Mine was identified as the major source of toxins in the Sacramento River, but remediation of the site is being addressed by EPA and there is no need for actions or additional funding. Other sources of toxins include non-point source agricultural runoff, and Colusa Drain. Actions to address these stressors include use of Best Management Practices (BMPs) and expansion of riparian zone buffers to improve water quality. A research and monitoring plan is being developed for the Colusa Drain as part of a previously funded Category III project.

Continued and expanded monitoring of water quality and assessment of its potential effect on salmon populations is a necessary component of an overall restoration strategy, and an adaptive management tool that can help target future restoration actions.

Diversions

Screening of diversions is a near-term, documented restoration action that can further reduce entrainment and contribute to increased production of salmon from the Sacramento River system. The primary restoration actions related to diversions are to install new screens, conduct screen rehabilitation, and conduct feasibility studies related to screening options such as diversion consolidation or in-gravel wells. An inventory of diversions on the Sacramento River has been conducted, and the diversions could be prioritized in different reaches of the river to determine where the greatest benefits would result from new screen installation.

In addition to new screens, other water diversion related restoration actions could include altering the timing, duration, location, and/or magnitude of diversion to decrease the salmon losses.

Straying

Actions to reduce straying and the associated loss of spawners to the reproductive population were focused on eliminating inappropriate attraction flows at the ACID diversion, and modifying hatchery operations to limit attraction of wild salmon into Coleman Hatchery. These actions would facilitate return of spawners to their natal streams, and subsequent production of wild salmon smolts.

Erosion/Sediment Input/Geomorphic Factors

Many restoration actions related to sediment input and geomorphic factors were discussed earlier under headings of Degraded Instream Habitat Conditions and Lack of Floodplain and Riparian Woodland Habitat. Additional actions discussed by the mainstem subgroup included control of fine sediment input to the Sacramento River from its tributaries. Specific actions that could be taken in the tributaries were addressed separately by the tributary subgroup. Control of fine sediment input can improve the quality of spawning gravels in the mainstem, and thereby address a potentially key stressor on the salmon life cycle in the Sacramento River system.

Predation

A primary action to consider in reducing predation is related to structural or operational changes at RBDD, which was cited earlier. Other predation related actions include consideration of the implications of increased oxbow formation associated with channel restoration activities. Deep, slow moving oxbows may provide prime habitat for introduced predatory species that can adversely affect salmon outmigrant populations. No specific restoration actions related to predation effects, beyond those associated with RBDD, were proposed by the subgroup.

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4. SACRAMENTO RIVER TRIBUTARIES SUBGROUP

The subgroup for the Sacramento River tributaries included:

Bob Baiocchi
Cindy Darling (coordinator)
Leon Davies
Joan Florsheim
Elise Holland
Buford Holt
John Icanberry
Eugenia Laychak (facilitator)
Michael Kossow
Bill Mitchell
John Nelson
Bob Nuzum
Tricia Parker
Harry Rectenwald
Pete Rhoads
Paul Ward

The subgroup began by listing each of the tributaries to the Sacramento River and prioritizing them for restoration actions based on the following criteria.

- Does the stream support threatened or endangered species that have a high probability of extinction?

- Does the stream consistently provide the type of habitat required by the priority species?

- Does the stream have enough production capacity to support sustainable populations of the species of interest?

- Does the stream have sufficient flow to maintain base flows, provide characteristics of a natural flow regime, and maintain sediment transport capacity?

Other considerations for prioritization of streams included the following.

- Can floodplain and channel related actions be integrated?
- Is there geographic diversification among the priority streams?
- Does the stream have any existing restoration plan?
- Are priority streams more degraded than others?
- Should there be less emphasis on streams that have existing restoration actions?
- Is there a high level of agreement on restoration actions?

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Based on the use of these four criteria as well as the other considerations, the following streams were selected as having the highest priority for restoration actions.

- Clear Creek
- Battle Creek
- Mill Creek
- Deer Creek
- Butte Creek
- Yuba River

The next tier of streams included the following.

- Feather River
- Antelope Creek
- Cow Creek
- Big Chico Creek

The remaining tributaries were grouped together by the species and life stages they support or could support. These included the following.

- Cottonwood and Little Chico creeks (these creeks could periodically provide spawning habitat).
- Thomes, Stony, Bear, Paynes, and Elder creeks, and Bear River (these creeks support very small spawning populations and provide non-natal rearing habitat).
- Other tributaries which provide non-natal rearing habitat, and the Colusa Drain.

4.1 Tributary Stressors

Following prioritization of the tributaries, the subgroup identified specific problems for each tributary that could be addressed by various restoration actions. These problems, or stressors, and the tributaries to which they apply are itemized in Table 2. Stressor categories identified by the tributary subgroup generally parallel those of the mainstem subgroup (with the addition of land use actions and fish population management), and included the following.

- Toxicity/Water Quality
- Passage Problems
- Instream Habitat/Flow
- Predation
- Erosion/Sediment Input/Geomorphic Factors
- Land Use Actions
- Fish Population Management

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TABLE 2. STRESSORS IN SACRAMENTO RIVER TRIBUTARIES

Stressor Categories	Individual Stressors	Highest Priority Tributaries: Mill Creek	Deer Creek	Yuba River	Clear Creek	Butte Creek	Battle Creek	Notes
Water Quality	High temperatures.	■		■[6]	■	■[14]		6) Yuba: Spring and early fall are problem periods. 14) Butte: High temperatures in pools and lower reaches (from agriculture runoff).
	Problems due to forest management.		■					
	Herbicide use (e.g. PG&E and golf course).					■		
	Urbanization: non-point source pollution.					■		
	Fish pathogens at aquaculture facilities, control is needed.						■[21]	21) Funding for ozone treatment facility may be needed.
Passage	Insufficient flow over riffles.	■	■[3]	■	■	■[10]		3) Deer: Passage insufficient for adults and juveniles. 10) Butte: General insufficient flows over stream length.
	Barriers to passage.	■	■[4]	■[7]	■[8]	■[11]	■	4) Deer: ____? 7)Yuba: Engelbright dam on the South Fork Yuba blocks summer holding habitat. 8) Clear: Saeltzer Dam. 11) Butte: Many actions already underway.
	Entrainment at diversions (unscreened).			■		■	■	
Flow	Impacts from lack of flows.	■		■	■	■[13]	■[19]	13) Butte: Lots of politics/negotiations between DFG and PG&E (and insufficient flows in Little Butte Creek). 19) Battle Creek: May not be a problem in a year.
	Insufficient flow for channel maintenance.			■				
	Juvenile stranding due to flow reductions.			■		■[16]		16) Butte Creek: Stranding (of many spp.) in Sutter bypass.
	Impacts from flood management practices.					■		
	Impacts from water management.					■[17]	■	17) Butte Creek: Many "old boy" management schemes used for water facility operations, possible adjudication.
Predation	Impacts from predation.		?	■				
	Impacts from poaching.	■[31]	■	■[5]	■[9]	■	■	31) Limited poaching impacts at Mill Creek. 5) Yuba: Poaching at Daguerre Point Dam (covered under AFRP under "Central Valley Wide"). 9) Clear: Poaching below Saeltzer Dam, will be remedied after removal.
Geomorphic Factors	Impacts from accelerated erosion: roads, hillsides, banks.	■	■[2]		■	■[15]	■	2) Deer: Actions to address erosion are already included in the AFRP (from agriculture runoff). 15) Butte: Flume failures cause acute sedimentation problems.
	Insufficient presence of gravel.				■			
	Lack of channel integrity due to gravel mining.				■			
	Modifications to channel morphology.					■		

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TABLE 2. STRESSORS IN SACRAMENTO RIVER TRIBUTARIES

Stressor Categories	Individual Stressors	Highest Priority Tributaries: Mill Creek	Deer Creek	Yuba River	Clear Creek	Butte Creek	Battle Creek	Notes
Habitat and Land Use Impacts	Lack of riparian vegetation.	■	■	■		■[12]		12) Butte: Valley reach - above Butte sink.
	Lack of floodplain/side channel habitat.			■				
	Impacts from grazing.	■[1]						1) Mill: Watershed conservancy is working on this issue.
	Land use impacts associated with livestock.		■					
Population Management	Potential for hybridization of spring and fall run populations.			■			■[20]	20) Could be a problem at all tributaries, needs to be worked on.
	Straying of adults into gold fields.			■				
	Need protection for spring run holding areas.					■[18]		18) Future land-use practices.
	Potential need for winter/spring run spawning population initiation.						■[37]	37) Winter run.
	Excessive hatchery production on lower reach (potential straying of mainstem fish).						■	
	Incidental mortality of spring run in hatchery.						■	
	Inadequate fishing regulations.						■[22]	22) Fishing regulations need to be made similar to those on Deer and Mill.

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TABLE 2. STRESSORS IN SACRAMENTO RIVER TRIBUTARIES

Stressor Categories	Individual Stressors	Tributaries: Big Chico Creek	Feather River	Antelope, Cottonwood Cow & Little Chico Creeks*	Thomes, Stony, Bear, Paynes, & Elder Creeks, Bear River	Miscellaneous**	Colusa Drain	Notes
Water Quality	High temperatures.	■	■	■	■	■	■	
	Problems due to forest management.	■						
	Herbicide use (e.g. PG&E and golf course).	■					■	
	Urbanization: non-point source pollution.	■[27]		■?		■		27) Major non-pont source pollution impacts for Big Chico Creek.
	Fish pathogens at aquaculture facilities, control is needed.							
Passage	Insufficient flow over riffles.	■[23]		■	■		■	23) Big Chico: flow problems due to flow split. DFG working on this issue.
	Barriers to passage.	■	■[24]	■	■		■	24) Passage at Oroville Dam could be explored (adults and juveniles). Fish could be restored above dam. Needs to be debated/studied. All problems on the Feather need to be delineated as to above or below dam.
	Entrainment at diversions (unscreened).		■[25]	■[28]				25) Feather River: includes Sunset pumps, Hyatt and Thermalito. 28) Entrainment impacts for Antelope Creek.
Flow	Impacts from lack of flows.	■[23]	■	■	■	■		23) Big Chico: flow problems due to flow split. DFG working on this issue.
	Insufficient flow for channel maintenance.	■[29]						29) Possible flow impacts for Big Chico Creek - fall run is a problem below flood diversion.
	Juvenile stranding due to flow reductions.	■[30]		■				30) Possible juvenile stranding impacts at Big Chico Creek.
	Impacts from flood management practices.	■	■			■		
	Impacts from water management.		■	■		■		
Predation	Impacts from predation.							
	Impacts from poaching.	■	■					
Geomorphic Factors	Impacts from accelerated erosion: roads, hillsides, banks.	■	■	■		■		
	Insufficient presence of gravel.	■	■	■[26]	■[26]	■[26]		26) Insufficient gravel due to mining
	Lack of channel integrity due to gravel mining.							
	Modifications to channel morphology.	■[32]	■	■		■		32) Potential channel morphology modification impacts for Big Chico Creek.

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TABLE 2. STRESSORS IN SACRAMENTO RIVER TRIBUTARIES

Stressor Categories	Individual Stressors	Tributaries: Big Chico Creek	Feather River	Antelope, Cottonwood Cow & Little Chico Creeks*	Thomes, Stony, Bear, Paynes, & Elder Creeks, Bear River	Miscellaneous**	Colusa Drain	Notes
Habitat and Land Use Impacts	Lack of riparian vegetation.	■[33]	■	■		■		33) Minor lack of riparian vegetation impacts at Big Chico Creek.
	Lack of floodplain/side channel habitat.	■[34]						34) Minor lack of floodplain/side channel habitat impacts at Big Chico Creek.
	Impacts from grazing.		■	■				
	Land use impacts associated with livestock.			■				
Population Management	Potential for hybridization of spring and fall run populations.		■					20) Could be a problem at all tributaries, needs to be worked on.
	Straying of adults into gold fields.							
	Need protection for spring run holding areas.	■[35]						35) Some spring run holding area concern for Big Chico Creek.
	Potential need for *winter/spring run spawning* population initiation.			■[37]				37) Spring run.
	Excessive hatchery production on lower reach (potential straying of mainstem fish).						■	
	Incidental mortality of spring run in hatchery.							
	Inadequate fishing regulations.							

*These creeks were considered to have spring run salmon potential.

* *Miscellaneous includes all the smaller tributaries not listed individually. These tributaries are important because they can provide non-natal rearing habitat, and also because they can contribute to gravel recruitment in the Sacramento River. *They may also contribute to water quality problems.*

4.2 Tributary Restoration Actions

Once the stressors listed in Table 2 had been identified for the different tributaries, the group reviewed the 1996 spring run workshop report prepared for Category III. Section 3 of that report from pages 4 to 7 identified limiting factors and restoration actions for Deer, Mill, Butte, Battle, Big Chico, Clear, and Antelope creeks and for the Feather and Yuba rivers. The group reviewed last year's recommendations and added actions where needed based on new information or on the expanded priorities beyond spring run. These previously identified and new actions are listed in Table 3.

4.3 Other Issues

Some tributary problems or issues identified by the subgroup were not addressed in detail at the meeting, either because there were considerable differences of opinion or the issues were tangential to the primary focus of the meeting. These items included the following.

- Scientific uncertainty regarding hybridization of spring run salmon in the tributaries was cited as an overarching concern for all of the spring run streams.

- Accelerated erosion on all creeks due to development was another overarching concern.

- Migration barrier problems associated with Shasta and Oroville dams were an unresolved issue. Some participants wanted to pursue reintroduction of anadromous fish above the reservoirs. Other participants felt the technical feasibility of this was so unlikely and the potential costs so high that they could not recommend pursuing this action.

- Criteria for RFP responses and guidance on priorities for project implementation was cited as a task to be addressed later in the CALFED process.

- Sacramento River mainstem dam and reservoir operation, flow releases, and habitat quality must be addressed to ensure that restoration actions taken in the tributaries are effective.

- The need for system wide study of green sturgeon life history was another issue of overarching concern for many of the tributaries.

- Floodplain restoration feasibility should be evaluated before any floodplain restoration actions are pursued.

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TABLE 3. STRESSORS AND POTENTIAL RESTORATION ACTIONS FOR SACRAMENTO RIVER TRIBUTARIES.

Stream	Stressor	Potential Restoration Action
Deer Creek	Erosion, Sediment Input, Geomorphic Factors	Resolve erosion problems.
		Implement road related fixes for erosion problems.
		Restore riparian vegetation.
	Poaching, Predation	Implement a programmatic level increase in law enforcement to reduce poaching.
	Land Use, Forest Management	Encourage USFS, CDF, and BLM to be part of the overall CALFED effort on a programmatic level.
		Improve agency and public education on forestry issues on a programmatic level.
		Coordinate forestry agency management plans with other agencies and conservancies.
		Fund the Deer Creek watershed conservancy.
	Instream Habitat, Flow	Evaluate additional water exchange to ensure passage during critical migration periods.
	Toxicity, Water Quality	Develop a Highway 32 toxic spill contingency plan
		Convert pumps used in water exchange program from diesel to electrical power source.

Stream	Stressor	Potential Restoration Action
Mill Creek	Erosion, Sediment Input, Geomorphic Factors	Resolve erosion problems.
		Implement road related fixes for erosion problems.
		Restore riparian vegetation.
	Predation, Poaching	Implement a programmatic level increase in law enforcement to reduce poaching.
	Land Use, Forest Management	Encourage USFS, CDF, and BLM to be part of the overall CALFED effort on a programmatic level.
		Improve agency and public education on forestry issues on a programmatic level.
		Coordinate forestry agency management plans with other agencies and conservancies.
		Fund the Mill Creek watershed conservancy.
	Instream Habitat, Flow	Evaluate additional water exchange to ensure passage during critical migration periods.
		Real time flow monitoring
		Convert pumps used in water exchange program from diesel to electrical power source.
	Passage Problems	Modification to Clough Dam

Stream	Stressor	Potential Restoration Action
Butte Creek	Land Use	Fund the Butte Creek Conservancy.
		Encourage continued outreach activities with agricultural interest.
		Continue to fund site specific actions.
		Fund Nature Conservancy and other projects specific to barriers and diversions.
		Fund watershed plan and conservation easements.
	Floodplain and Riparian Woodland Habitat, Flood Management	Encourage fish compatible project responses to flood damage.
		Evaluate feasibility of reestablishing an interaction between the river and the floodplain.
		Evaluate feasibility of easements and buffer zones in the upper canyons above Hwy. 99.
	Passage Problems	Complete fish screens and ladder at Durham-Mutual Dam
		Complete fish screen and ladder at Adams Dam
		Complete fish screen and ladder at Gorrill Dam
		Site survey and engineering analysis for remaining diversion structures along lower Butte Creek (including White Mallard fish screen and ladder, and Drumheller Slough outfall culvert reconstruction).
		Purchase screened portable pumps as alternative to Little Dry Creek Diversion.
	Instream Habitat, Flow	Evaluate habitat above Barrier Falls at Chimney Rock..

Stream	Stressor	Potential Restoration Action
Battle Creek	Population Management	Evaluate need to establish founding population of spring run.
		Evaluate options to provide an isolated water supply for Coleman National Fish Hatchery.
		Evaluate Battle Creek plan (AFRP).
	Erosion, Sediment Input, Geomorphic Factors	Fund recommendations coming out of the local watershed groups.
		Identify sources of erosion and develop projects and actions for decreasing erosion.
		Restore and replenish spawning gravel in North Fork.
	Water Quality	Evaluate need to fund pathogen control for private aquacultural facilities. Review status with CVPIA programs.
	Instream Habitat, Flows	Extend and expand flow agreement with PG&E.
	Passage Problems	Fish screen and ladder at Eagle Canyon Diversion.
		Options and feasibility analysis for additional fish screens, ladders, and a flow allocation methodology above Eagle Canyon
Big Chico Creek	Population Management	Provide input to genetic monitoring of the fish population.
	Erosion, Sediment Input, Geomorphic Factors	Evaluate flood management practices in Lindo Channel
		Reestablish and revegetate riparian areas.
		Develop a watershed plan.
	Predation, Poaching	Focus law enforcement efforts on the creek during critical times for salmon.
	Passage Problems	Replace fish ladder at Iron Canyon.
		Install discharge bypass at One Mile Recreation Area.
		Replace fish ladder at One Mile Pool.

Stream	Stressor	Potential Restoration Action
Clear Creek	Population Management	Evaluate need for founding population of spring run chinook.
	Erosion, Sediment Input, Geomorphic Factors	Reestablish channel maintenance flows
		Reestablish channel integrity
		Provide assistance to local watershed groups.
		Erosion control projects.
	Land Use	Encourage coordination between local groups, Park Service, BLM, and USFS.
	Passage Problems	Improve fish passage at Saeltzer Dam.
	Toxicity, Water Quality	Pilot flow study for water temperature.
Antelope, Cow, Cottonwood, Little Chico Creeks	Erosion, Sediment Input, Land Use	Fund all or parts of watershed analyses.
		Include implementation actions in watershed analyses.
		Encourage consolidation of local efforts when reasonable.
	Passage Problems	Conduct an options, feasibility, and engineering analysis of fish passage problems and habitat restoration opportunities on Antelope Creek.
Feather River	Population Management	Evaluate hatchery practices at Feather River Hatchery.
	Passage Problems	Screen unscreened diversions.
	Predation, Poaching	Implement a programmatic level increase in law enforcement to reduce poaching.
	Land Use	Restore riparian vegetation.

Stream	Stressor	Potential Restoration Action
Yuba River	Population Management	Evaluate potential for creating more separation of fall and spring-run spawning habitat to reduce or eliminate hybridization.
	Passage Problems	Implement the Daguerre Point Dam Project listed in the spring run chinook report (fish screen, fish ladder, and dam modifications).
		Screen unscreened diversions.
	Water Quality	Evaluate the effect of a water temperature control device at Englebright Dam.
		Evaluate operation of Englebright Dam and Reservoir.
	Erosion, Sediment Input, Geomorphic Factors	Evaluate feasibility of off-channel and sidechannel restoration.
	Predation, Poaching	Implement a programmatic level increase in law enforcement to reduce poaching.
	Land Use	Restore riparian vegetation.

5. CONCLUDING COMMENTS

5.1 Summary of Subgroup Activities

The reconvened group briefly reviewed the activities and process of each subgroup. The mainstem subgroup presented the stressor categories that it defined, restoration actions that could be taken, and ranking of restoration actions within categories. The tributaries subgroup presented their prioritization of streams, and the problems and restoration actions identified for each tributary.

5.2 Prioritization and Ecosystem Perspective

The reconvened group discussed several issues and potential methods related to David Bernard's question about how a group might prioritize actions in cases where there are insufficient funds to support all desired projects and programs. Suggestions included the following.

- CALFED could provide decision analysis tools developed by other disciplines to help prioritize restoration actions.
- Identify high value, high consensus actions as priority items, such as preventing irreparable damage to habitats.
- Prioritize by watershed according to its capacity for production and meeting Endangered Species Act needs.
- Assign highest priorities to projects that are assured to be successful.
- Prioritize by the level of scientific agreement.
- Prioritize based on the existence of partnerships for the project, and a high level of leveraging potential for project funds.
- Assign priorities with consideration of local watershed group support.
- Prioritize from an overall ecosystem perspective.
- Identify projects that have multiple options for addressing individual problems.
- Assign a small, carefully balanced group to prioritize actions.

Since restoration actions discussed by the group frequently raised the issue of how to facilitate an ecosystem perspective on restoration, David asked the group for suggestions on this topic. The need to look at long term benefits was cited as one aid to taking an ecosystem perspective, as well as a need to view actions from a more global perspective that may require thinking "higher on the organizational ladder." Focusing on biodiversity was cited as another method to encourage an ecosystem perspective.

In order to effectively take an ecosystem perspective, it was noted that there needs to be a common understanding and agreement on goals, so that a common vision of what the ecosystem might look like can be achieved. In the process of approaching restoration from an ecosystem perspective, Aldo Leopold's advice was paraphrased regarding "...keeping every cog and wheel as the first precaution of intelligent tinkering."

5.3 Suggestions for Future Meetings

The following suggestions were made by the group to facilitate productive future meetings.

- Identify which restoration activities were related to the broader ecosystem, and which are related to a particular species.
- Propose a model for addressing issues at the beginning of the meeting.
- Go through the background material at the beginning of the meeting.
- Send out the mailing of background material further in advance.
- Use a consistent list of species and habitats from one year to the next, in order to address a "consistent universe."
- Use smaller meeting rooms.
- Have facilitators switch subgroups part way through, in order to help maintain a common track for each group.
- Address the potential problem of objectivity of the experts attending the meeting, since they are frequently stakeholders as well.
- Indicate that monitoring is to be a part of any project funded through CALFED.

APPENDIX A

Workshop Agenda and Attendee List

Sacramento River and Tributaries Technical Team Meeting
Redding, CA March 4-6, 1997

Attendee List

Name	Affiliation	Phone Number
Bob Baiocchi	RCRC	(916) 836-1115
David Bernard	CALFED (ESSA Technologies)	(604) 733-2996
Serge Birk	CVPWA	(916) 529-4334
Analena Bronson	DWR	(916) 327-1534
John Carlon	The Nature Conservancy	(916) 342-0396
Stacy Cepello	DWR	(916)
Scott Clemons	WCB	(916) 445-1072
Cindy Darling	CALFED	(916) 653-5950
Leon Davies	WFCB, U.C.Davis	(916) 752-7699
Joan Florsheim	Phillip Williams & Assoc.	(415) 981-8363
Rod Fujita	Environmental Defense Fund	
Steve Greco	U. C. Davis	(916) 752-9199
Tom Griggs	The Nature Conservancy	(916) 826-0947
Andrew Hamilton	USFWS	(916) 979-2760
Kate Hansel	CALFED	(916) 653-1103
Dennis Heiman	RWQCB	(916) 224-4851
Bruce Herbold	EPA	(415) 744-1992
Elise Holland	The Bay Institute	(415) 221-7680
Buford Holt	Bureau of Reclamation	(916) 275-1554
John Icanberry	USFWS	(209) 946-6400
Diana Jacobs	State Lands Commission	(916) 574-1877
Jeff Jaraczeski	NCWA	(916) 442-8333

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Michael Kossow	RCRC	(916) 284-7277
Eric Larsen	U.C. Davis	(916) 752-8336
Bill Mitchell	Jones & Stokes Assoc.	(916) 737-3000
Gary Nakamura	UC Cooperative Extension	(916) 224-4902
John Nelson	CDFG	(916) 358-2944
Bob Nuzum	EBMUD	(510) 287-0407
Tricia Parker	USFWS	(916) 527-3043
Harry Rectenwald	CDFG	(916) 225-2368
Pete Rhoads	MWDSC	(916) 650-2620
John Siperek	CDFG	(916) 225-2312
Russell Smith	Bureau of Reclamation	(916) 275-1554
Jim Smith	USFWS	(916) 527-3043
Jeff Souza	Western Shasta Res. Con. Dist.	(916) 246-5299
Ramon Vega	USFWS	
Nick Villa	CDFG	(916) 358-2943
Dave Vogel	NRS, Inc.	(916) 527-9587 ext. 11
Paul Ward	CDFG	
Scott Wilcox	CALFED (EA)	(916) 924-7450

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APPENDIX B

General Session Presentations
by

Eric Larsen
Steve Greco

NUMERICALLY MODELING MEANDER MIGRATION: UPPER SACRAMENTO RIVER

Presentation by Eric Larsen, Post Doctoral Researcher, U.C. Davis

The Upper Sacramento River has historically had extensive unconfined alluvial reaches that experienced meander migration. Lateral channel migration is a fundamental process that determines riparian vegetation and wildlife evolution in the actively migrating zone of a river. The evolution of the physical structure of the stream channel also determines the continually evolving structure of the aquatic ecosystem. Because the dynamic functioning of the river channel planform provides the basic structure of riparian and aquatic ecosystem, it is critical to understand how the meandering planform of the river evolves over time.

Empirical methods of predicting future migration use long term historical records to predict future patterns. These methods generally predict future migration by using observed migration rates and projecting them perpendicularly to the channel planform. However, channel migration has other important components that are not well predicted empirically. Predicting channel migration based on the fundamental laws of fluid mechanics and sediment transport (i.e. numerical modeling) has the potential to be more accurate, and to be a powerful and practical tool.

A numerical model of meander migration has been developed and tested for use on the Upper Sacramento River by the Department of Water Resources, where it has been shown to be of value in examining important resource issues. For example, we have demonstrated that the numerical model can be used to show the geomorphic influence of bank revetment on the river channel planform. Model analyses demonstrate that riprap leads to significant long-term changes, including decreases in channel length and sinuosity, and increases in channel slope. These changes may have important, unanticipated impacts on current and future land use activities. The model is also being used to model riparian vegetation succession that occurs due to channel migration.

Management concepts and opportunities for increasing the ecological potential of riverine/riparian ecosystems on the Sacramento River for fish and wildlife

Presentation by Steven E. Greco, Research Scientist, U.C. Davis

The Sacramento River between Red Bluff and Colusa is a low-gradient meandering river that hosts a series of salmonid runs each year and has forest remnants distributed along several river reaches that support a wide variety and abundance of wildlife. The historical extent of the riparian forests of the Sacramento River has been reduced dramatically over the past century (Roberts, Howe, and Major 1977; Katibah et al. 1984; Scott and Marquiss 1984). The existing riparian forest in the alluvial floodplain is a dynamic and resilient community adapted to fluvial system cycles of flooding, drawdown, erosion and deposition. The fish and wildlife species of the Sacramento River are also adapted to take advantage of flooding cycles and there is evidence from other large river ecosystems that fish biomass (or yield) is positively correlated with flooding into the floodplain (see Roux and Copp 1996; Bayley and Petrere 1989; Ward and Stanford 1989) as is avian species diversity for riparian cover (Hehnke and Stone 1978). Petts and others (1989) examined 81 studies on causes for salmonid population changes in regulated river systems and while they found that 59% of the studies reported declines in fish populations due to negative effects, 18% of the studies reported increased fish populations or no change due to alterations of the hydrologic regime. Through carefully planned and seasonally timed prescription flow releases in combination with natural channel migration processes the life cycles of salmonid fisheries and riparian forest wildlife species could potentially be managed for greater productivity.

River ecosystem ecology is a relatively new field of theory that is being refined and tested with case study research and application. It has emerged from a combination of hydrology, geomorphology, aquatic ecology, limnology, wetland and terrestrial plant ecology. When the river is looked at as a system in the landscape there are evident patterns that suggest an interdependence between upstream reaches and downstream reaches. From this observation an ecosystem theory was proposed in the early 1980's called the "river continuum concept" or RCC, that proposed rivers are highly directional systems and continuous gradients of energy and nutrients are created from headwaters to estuary (Vannote et al. 1980). This continuum can also be envisioned as a longitudinal cross-sectional view from headwaters to estuary showing a shift from coarse particulate organic matter (CPOM) in the upper reaches to fine particulate organic matter (FPOM) in the lower reaches and the corresponding shift in biological processing from shredders to decomposers to detritivorous organisms. Many of these aquatic insects and microorganisms depend on external input of organic materials such as wood and other litter (known as allochthonous inputs) that are also important food types to many of the life cycle stages of salmonid species who feed upon the aquatic insects (Maser and Sedell 1994).

However, when ecologists tried to apply the RCC to large rivers it did not hold up entirely (Sedell, Richey and Swanson 1989). First, large rivers are often no longer continuous from headwaters to estuary due to dams and other diversion structures that create discontinuities within the fluvial system. In addition the RCC did not consider that the floodplain system behaves much differently than higher order mountain stream systems. Nutrient cycling in the floodplain of large river systems is separated from the main channel for much of the year except when there is overbank flow during flooding events and then nutrients rapidly cycle and intermix with the main channel (Brinson et al. 1983). This mixing can lead to locally high plant productivity and produce many aquatic insects that salmonids feed upon. The diversity of aquatic and terrestrial insect is high in the floodplain and are nutritious for fry and juveniles. The floodplain during overbank flow also provides a great deal of cover for juvenile salmonids among plant species such as willow and grasses that slow water and create eddies that create backwaters.

The dynamics of flood water elevation within the channel and onto the floodplain is known as the "flood pulse concept" proposed by Junk, Bayley and Sparks (1989). The flood pulse concept can be used to evaluate the processes of floodplain productivity of riparian forests and salmonid fisheries. Central to the concept is the aquatic/terrestrial transition zone (ATTZ) which is the interaction area between the aquatic zone flood waters and the terrestrial zone of the floodplain above mean low water and below the 100-year flood event. Floodplain dynamics are characterized by intermittent and recurrent inundation for durations that vary seasonally and by storm events or by dam releases. The relationship between riverine and riparian habitats and how their flooding regimes vary according to cross-section topography relative to the position of the channel is important to understanding their dynamics and managing their productivity.

The Sacramento River has a channel morphology shaped by fluvial processes creating channel beds, channel bars, channel shelves, floodplains, and flood terraces. There are vegetation communities also associated with these topo/hydrographic zones as documented by several ecologists (see Conard et al. 1977, Strahan 1984, and McBride and Strahan 1984). The fluvial processes create a diverse mosaic of vegetation age and size classes providing a diversity of habitat areas. The Sacramento River ecosystem has the following wetland types according to the Cowardin et al. (1979) wetland classification system: 1) riverine, lower perennial; 2) riverine, intermittent; 3) lacustrine, limnetic; 4) lacustrine, littoral; and, 5) palustrine. This classification system, however, does not explicitly include the riparian zone beyond the channel shelf.

The riparian zone influences the quality of fish habitat in many ways. Shade lowers backwater and side channel water temperatures and vegetation litter inputs create microbial populations that spurn invertebrate populations that provide abundant prey for salmonid species. Submerged and partially submerged wood within the channel riparian zone also greatly contribute to aquatic insect diversity (Maser and Sedell 1995). The physical processes of channel migration form important fish habitats and is influenced by riparian vegetation by slowing water velocity and stabilizing banks as well as influencing deposition patterns often causing backwaters to form. The backwaters are valuable salmonid habitats often used as rearing areas. The channel form of a meandering river contains a variety of fish habitats formed through the processes of fluvial geomorphology and in particular the motions of helical flow and bedload transport. The helical flow influences the channel bed form and creates deep pools at the inside of the bends and deposits sediment on point bars. Riffles are formed between the successive bends that provide spawning and feeding areas for adult salmonids. Backwater areas formed from point bar deposition or meander scrolls are often created in flood flows and are influenced by the presence of riparian vegetation.

Fishes need a mosaic and diversity of feeding, refuge and spawning habitat types during their life cycle. Opportunities for movements between these habitats are important to reducing mortality and increasing reproductive success (Schlosser and Angermeier 1995). Studies now being completed on the recent Colorado River prescription flow released from Hoover Dam report that backwater habitats were increased by 20% for spawning fish (Stevens 1997). The flow was 45,000 cfs for a duration of one week.

In conclusion, a better scientific understanding of the processes that shape and form the critical habitats important to fish and wildlife on the Sacramento River is needed to guide a comprehensive ecosystem-scale approach to restoring biotic productivity. A framework to study the complexities of river floodplain ecology should include evaluations of historical data to measure trends through time and geographically explicit ecosystem models to explore alternative ecological successions and productivity strategies. An examination of the physical flooding processes needs to be undertaken to better understand and harness the link between the aquatic and terrestrial systems. Riparian forests should be studied to reveal relationships between floodplain productivity and fish and wildlife productivity by quantifying and modeling habitat quality (see for example Mayer and Laudenslayer 1988 for terrestrial vertebrates in California). Research that provides strategic management information to increase fish and wildlife productivity is greatly needed.

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APPENDIX C

Status of SB 1086 Implementation

STATUS OF SB 1086 IMPLEMENTATION

General Comments

The Upper Sacramento River Fisheries and Riparian Habitat Management Plan (Resources Agency, 1989) is a consensus-based plan that includes 22 restoration proposals (Action Items); the first two deal with protection and restoration of riparian habitat on the main stem and its tributaries, and the other 20 deal with actions to resolve fishery problems on the main stem and its tributaries.

The riparian habitat proposals recommend several means of protecting, restoring, and increasing riparian habitat along the river, while addressing the concerns of landowners who want protection from floods, streambank erosion, and trespassing. The riparian habitat restoration plan will protect and restore riparian vegetation along critical reaches of the river and along major tributaries, and will help to assure preservation of several rare, threatened, and endangered species of plants and animals dependent on the diverse vegetation that accompanies a dynamic (meandering) river system. The social and economic values of riparian habitat are considered to be very important, although difficult to quantify.

The fisheries proposals range from a Superfund cleanup of the Iron Mountain Mine near Redding and a major reconstruction of the Coleman National Fish Hatchery on Battle Creek to construction of fish ladders and screens on tributary streams, such as Clear, Butte, and Big Chico Creeks. When completed, the fishery restoration program will be instrumental in re-establishing a fishery valued at more than $100 million annually. Federal funding is now available through the Central Valley Project Improvement Act (CVPIA), and State-Federal funding from the CALFED Bay-Delta Program. However, major State and local cost-sharing is also required, and $90 million will be provided by a general obligation bond act authorized by Proposition 204.

The 1989 management plan estimated total initial costs for this program of $240 million with annual costs of about $10 million. However, in the past seven years alternatives to many of the specific actions have been identified and new technologies have been developed. Generally, the restoration actions taken so far have been more comprehensive than those originally envisioned. It is now obvious that the total program cost will be considerably more than originally thought, but the solutions will also be much more comprehensive and presumably much more effective. Because of these changes it is no longer appropriate to use the costs defined in the 1989 plan and it is impossible to accurately estimate costs for projects not yet fully defined, so costs are not included in this update.

RIPARIAN HABITAT RESTORATION PLAN

1. Comprehensive Management Plan for the Sacramento River Riparian System

Purpose: To preserve the remaining riparian habitat and re-establish a continuous riparian ecosystem along the Sacramento River between the mouth of the Feather River and Keswick Dam.

Solutions: Develop a consensus plan to create, implement, and manage a Sacramento River Riparian Conservation Area from Keswick Dam to Verona.

Benefits: Would increase the acreage and variety of riparian habitats along the river and reverse the decline in wildlife, fishery, and human use values.

Status: Habitat acquisition by several Federal and State agencies and private groups is underway. Planning for a Sacramento River Riparian Conservation Area is nearing completion. Issues of management responsibility, economic incentives, meander zone boundaries, socio-economics, and public access are being resolved. Development of a Sacramento River Geographic Information System is nearly complete.

2. Riparian Habitat Preservation on Sacramento River Tributary Streams

Purpose: To preserve the remaining riparian habitat and restore high-quality riparian ecological systems on Sacramento Valley tributary streams.

Solutions: Prepare an inventory of riparian habitats on the valley floor. Encourage riparian habitat conservation and improvement through a program of local government planning, economic incentives to private landowners, conservation easements, and direct purchase.

Benefits: Preserve remaining riparian vegetation along tributaries, restore degraded riparian areas, and restore some previously developed lands which will benefit fish and wildlife, including some threatened and endangered species.

Status: A Waterway Corridor Protection Program for the Redding Basin is complete. Mapping of stream corridors in Tehama County is complete and mapping in Butte and Glenn Counties is underway. Additional funding to complete an inventory of riparian habitats on the valley floor is being sought. Property owner groups have recently formed Conservancies on Mill, Deer, and Battle Creeks to work with agencies, environmental groups and others to better manage the tributary watersheds.

FISHERIES RESTORATION PLAN

1. Red Bluff Diversion Dam

Purpose: To reduce delay or blockage of upstream migrant adult salmon and the mortality of downstream migrant juveniles at the RBDD.

Solutions: Construct new fish screen and bypass in headworks to Tehama-Colusa Canal; enlarge existing fish ladders; construct new left bank ladder; develop and implement predator control; monitor and evaluate measures.

Benefits: If all problems are corrected, this measure potentially could increase salmon and steelhead runs by more than 100,000 fish.

Status: New fish screen and bypass was completed in 1991; enlarged ladders, fish bypass, and Archimedes pump alternatives are under study. Research pumping plant began in full operation in July 1996.

2. Temperature and Turbidity

Purpose: Increase fish production by maintaining suitable temperatures in the upper Sacramento River and by minimizing turbidity discharged from Shasta Dam.

Solutions: Install a large curtain in Whiskeytown Reservoir to reduce the temperature of water diverted to the spring Creek powerhouse. Design and modify Shasta Dam outlets to permit selective withdrawal of water.

Benefits: Reverse or reduce the loss of winter- and early fall-run chinook salmon eggs and juvenile fish in poor water years. This loss represents the production of thousands of salmon, perhaps 50,000-100,000.

Status: A temperature curtain was installed in Whiskeytown Reservoir in 1994. A massive water temperature control device is being constructed at Shasta Dam to provide better control of river temperatures. The construction activities are nearly finished with an anticipated completion date in late 1996.

3. Spawning Gravel Restoration

Purpose: Restore spawning and rearing habitat in the Sacramento River below Keswick Dam to levels which existed prior to construction of Shasta Dam.

Solutions: Replace large amounts of spawning gravels; engineer side-channel spawning sites; rip armored areas, monitor and evaluate results.

Benefits: Provide suitable spawning habitat for more than 70,000 salmon.

Status: About 165,000 cubic yards of spawning gravel have been placed in the Upper Sacramento River since 1978; this represents more than 15 percent of the total amount needed.

4. Sacramento River Flows

Purpose: To increase anadromous fish production currently limited by inadequate flows which reduce habitat, dewater redds, and strand juvenile fish.

Solutions: Evaluate instream flow needs study conducted by DFG and DWR several years ago. Negotiate with USBR to modify flow releases from Keswick Dam as needed.

Benefits: Increased fish production in the Sacramento River.

Status: The instream flow needs study is complete, but the data should be evaluated to determine if additional information is needed and negotiations to determine revised flow releases have not yet begun. The National Biological Survey is reviewing these data and may initiate the next step.

5. Coleman National Fish Hatchery

Purpose: Restore Coleman National Fish Hatchery to meet its original long-term fish production goals.

Solutions: Staged rehabilitation of the entire facility as described in the "Station Development Plan" prepared by the USFWS.

Benefits: Coleman Hatchery is the primary remaining feature of the "fish salvage program", which was intended to mitigate for the fishery losses caused by construction of Shasta Dam. Restoration would allow the hatchery to meet production goals which often have not been met in recent years due to deterioration of the facility.

Status: About half of the station rehabilitation has been completed. Construction will continue in phases over several years. In FY 1995 rehabilitation of 50-year old rearing ponds, a new primary water line for the ponds, and Phase I water treatment facilities were completed. Work is underway on an ozonation plant which will completely treat the inflow to the hatchery.

6. Heavy Metals - Iron Mt. Mine

Purpose: To protect fisheries from toxicity caused by heavy metals in acid mine drainage from the Iron Mountain Mine near Redding. This is a long-standing pollution problem affecting the fishery for nearly 100 years.

Solutions: Generally, treat and neutralize mine drainage, cap the mine area, plug the mine shafts, divert streams flowing through the mine wastes, and possibly construct a debris dam on Slick Rock Creek. This is a high-priority EPA Superfund cleanup project.

Benefits: Would keep heavy metals in the Sacramento River at safe levels in all years and would eliminate massive fish kills that occur periodically.

Status: About two-thirds of the clean-up plan is complete with a 75 percent reduction in heavy metal loading. The mountain is partially capped, most of the effluent is collected in a new treatment plant, and upper Spring Creek is diverted away from the contaminated area. In 1995, work focused on treatment of old tailing piles. The next steps include feasibility studies of ways to remove contaminated sediment in Keswick Reservoir and to collect effluent in Slick Rock Creek. These steps will make the clean-up about 95 percent effective.

7. Mill Creek

Purpose: To restore the salmon and steelhead fishery in Mill Creek.

Solutions: Construct wells and install pumps; rip and clean spawning riffles; construct spawning areas; restore riparian habitat; revise diversion system and modify or remove Clough Dam, if owner agrees.

Benefits: Objective is to restore spring- and fall-run salmon and steelhead populations to historical levels (about 8,000 salmon and 2,000 steelhead).

Status: Two wells are operated as needed to facilitate fish passage during critical migration periods. Negotiations with a private water right holder for additional flow in lower Mill Creek are complete. Funding for long-term operation is being secured.

8. GCID Diversion

Purpose: To substantially reduce mortality of downstream migrant salmon at the GCID diversion.

Solutions: Construct new fish screens and restore original river level at diversion, if necessary.

Benefits: Annual losses at GCID are thought to be up to 20 percent of the downstream migrant salmon. Reversing this loss could result in an increase of up to 70,000 adult salmon. Dredging the intake channel to provide positive bypass flows and installation of an interim flat-plate screen have significantly improved fish passage at the site, so remaining benefits are somewhat less.

Status: Engineering feasibility report is complete and Draft EIR/EIS is in process with release of public review document scheduled for Spring 1997.

9. Deer Creek

Purpose: To restore the salmon and steelhead fishery in Deer Creek.

Solutions: Improve fish passage; rip and clean riffles; construct spawning areas; restore riparian habitat; include habitat restoration in flood maintenance work.

Benefits: Objective is to restore spring- and fall-run salmon and steelhead populations to historical levels (about 10,000 salmon and 1,000 steelhead).

Status: Negotiations are underway with Water Districts to provide ground water in exchange for leaving natural flows in the creek. A funding proposal was approved by the Delta Pumps Committee. The water users are voluntarily providing needed flows on an interim basis until the agreements are finalized.

10. Unscreened Diversions

Purpose: To significantly reduce mortality of downstream migrant salmon and steelhead at more than 400 unscreened diversions along the upper Sacramento River.

Solutions: Conduct studies to inventory diversions, determine priority, and construct new screens as needed.

Benefits: Not specifically known, but losses could exceed 10 million downstream migrants annually, representing 100,000 adult salmon and steelhead.

Status: DFG has prepared an Unscreened Diversion Plan and has set priorities for screening the largest unscreened diversions. USBR has funding for feasibility studies of several interim screening projects and has hired a project manager to prepare a long-term screening plan. Several new screening technologies are being tested and evaluated in demonstration projects.

11. Clear Creek

Purpose: Improve the Clear Creek salmon and steelhead fishery.

Solutions: Increase flows from Whiskeytown Dam; construct new fish ladder and screen; acquire land to permit spawning gravel restoration; rip and clean gravel; construct instream structures.

Benefits: Potential increase of up to 13,000 salmon and a similar number of steelhead.

Status: New fish ladder and screen constructed in 1992; engineering work complete on sediment removal and spawning gravel restoration project. Project funding is waiting for completion of purchase of fee title or easements on critical stream habitat. A larger and more effective fish ladder is under consideration.

12. ACID Diversion Dam

Purpose: Improve fish passage at ACID Diversion Dam and eliminate flow fluctuations required to install, remove, and/or adjust the dam flash boards.

Solutions: Interim ladder improvements; followed by construction of a new fishway and trap, and a new structure to install or remove the diversion dam boards safely without major changes in flow.

Benefits: Improved fish passage, especially for threatened winter-run salmon; improved fish trapping capability closer to Coleman National Fish Hatchery; reduced stranding of fish and dewatering of redds due to flow fluctuations.

Status: New left bank fishway has been installed by DFG; a new system for installing and adjusting the diversion dam so flows do not have to be reduced so drastically will be constructed by Spring 1997. USBR and ACID have signed a letter of agreement to minimize fish stranding and dewatering problems due to large changes in flow related to diversion dam installation and removal.

13. Butte Creek

Purpose: To restore the salmon and steelhead fishery in Butte Creek.

Solutions: Evaluate water rights and alternative supplies; conduct instream flow needs study; construct fish ladders, fish screens, and/or traps as needed; improve fish passage and habitat.

Benefits: Restore spring- and fall-run salmon populations to historical levels (about 6,000 salmon).

Status: DFG has purchased one water right which will increase instream flows and Point Four Dam has been removed. A state-of-the-art fish screen and ladder were installed on the Parrott Phelan Diversion Dam in 1995. Federal and State agencies are working with Western Canal Water District on a variety of proposals to remove several more dams on lower Butte Creek and modify ladders and install screens on the remaining dams. The water users; M&T Ranch, Parrott Investment Company, DFG, and USFWS have signed a water exchange agreement that leaves 40 cfs in Butte Creek nine months a year (about 22,000 acre-feet annually).

14. Big Chico Creek

Purpose: To restore the salmon and steelhead fishery in Big Chico Creek.

Solutions: Relocate and screen the M&T/Parrott pumps; develop a fishery management plan; modify control structures, dams, and fish ladders on Chico Creek and Lindo Channel as needed; revegetate Lindo Channel.

Benefits: Restore spring- and fall-run salmon and steelhead to historical levels (about 1,000 salmon and 500 steelhead).

Status: Development of fishery management plan continues; task force has developed a Big Chico Creek Action Plan. Several actions are currently being implemented, including improvements to the Iron Canyon fish ladder, a flow bypass for cleaning the One-mile swimming area, and Lindo Channel improvements. Relocation of the M&T pumps is underway.

15. Sacramento River Hatchery

Purpose: To help compensate for unmitigated losses of salmon and steelhead resulting from loss of natural habitat by the construction of the CVP (Shasta, Keswick, Whiskeytown, and Red Bluff Diversion Dams, and the Tehama-Colusa Canal).

Solutions: Construct a new hatchery on the Sacramento River below Keswick Dam with a capacity up to 33,000 adult salmon and 5,000 steelhead. Based on the experience at Coleman Hatchery, this would require production up to 22 million salmon smolts and 3.3 million steelhead smolts.

Benefits: A Sacramento River Hatchery could contribute about 110,000 adult salmon and 16,500 steelhead to the commercial and sport fisheries.

Status: No progress on this action to date.

16. Tehama-Colusa Fish Facility

Purpose: TCFF ceased operation on October 31, 1988. This Action Item would define ways to resolve the fishery mitigation and enhancement issues associated with closing the TCFF.

Solutions: Restore main stem Sacramento River spawning habitat to support 24,000 adult salmon and construct a new fish hatchery below Keswick Dam to maintain 33,000 adult salmon.

Benefits: Generally, replace the fishery production originally planned for the TCFF, about 57,000 adult salmon.

Status: No progress on this action to date.

17. Sacramento River Bank Stabilization

Purpose: To restore habitat for juvenile salmon at areas impacted by bank stabilization.

Solutions: Develop and evaluate mitigation measures; evaluate the Palisades approach; conduct research on the importance of rearing habitat; develop and implement the "Comprehensive Management Plan"; incorporate mitigation measures into bank protection projects.

Benefits: Cannot be defined specifically, generally would improve rearing habitat in the river.

Status: The USCE has developed and implemented a comprehensive package of mitigation measures and standards for bank protection projects. A reconnaissance report proposing to restore 10 sites along the Upper Sacramento River is now complete.

18. Battle Creek

Purpose: Restore naturally spawning salmon populations in Battle Creek upstream from Coleman National Fish Hatchery and Coleman Powerhouse.

Solutions: Complete flow study and restoration plan for Battle Creek; increase flows; improve ladders and screens as needed.

Benefits: Potentially create habitat for several thousand spring-, winter-, and/or fall-run salmon.

Status: Flow study and restoration plan for Battle Creek are complete, but implementation awaits formal agreement with PG&E and completion of the water treatment facilities at Coleman National Fish Hatchery. Meanwhile, PG&E has increased flows ten-fold creating 17 miles of new habitat in lower Battle Creek. Spring-run chinook are now being allowed to migrate above the Coleman Hatchery barrier dam to reestablish a spawning population. The need for new screens and ladders on PG&E diversions is being evaluated.

19. Cottonwood Creek

Purpose: Improve salmon and steelhead production in Cottonwood Creek.

Solutions: Rip and clean spawning riffles; construct spawning areas; implement regulations to control gravel mining.

Benefits: The objective is to restore fall and spring-run salmon and steelhead populations to historical levels (4,000 salmon and 1,000 steelhead).

Status: No progress on this action to date, although for several years gravel operators were required to set aside part of the spawning-sized gravel for fish restoration work. Now, they have agreed to remove gravel by skimming rather than digging deep pits to reduce damage to the stream system.

20. Lower Sacramento River - Colusa Drain

Purpose: To increase survival of downstream migrating salmon smolts in the lower Sacramento River and Delta by decreasing water temperatures in late spring months.

Solutions: Conduct feasibility study; construct enlarged Ridge Cut and Bypass Channel, if feasible.

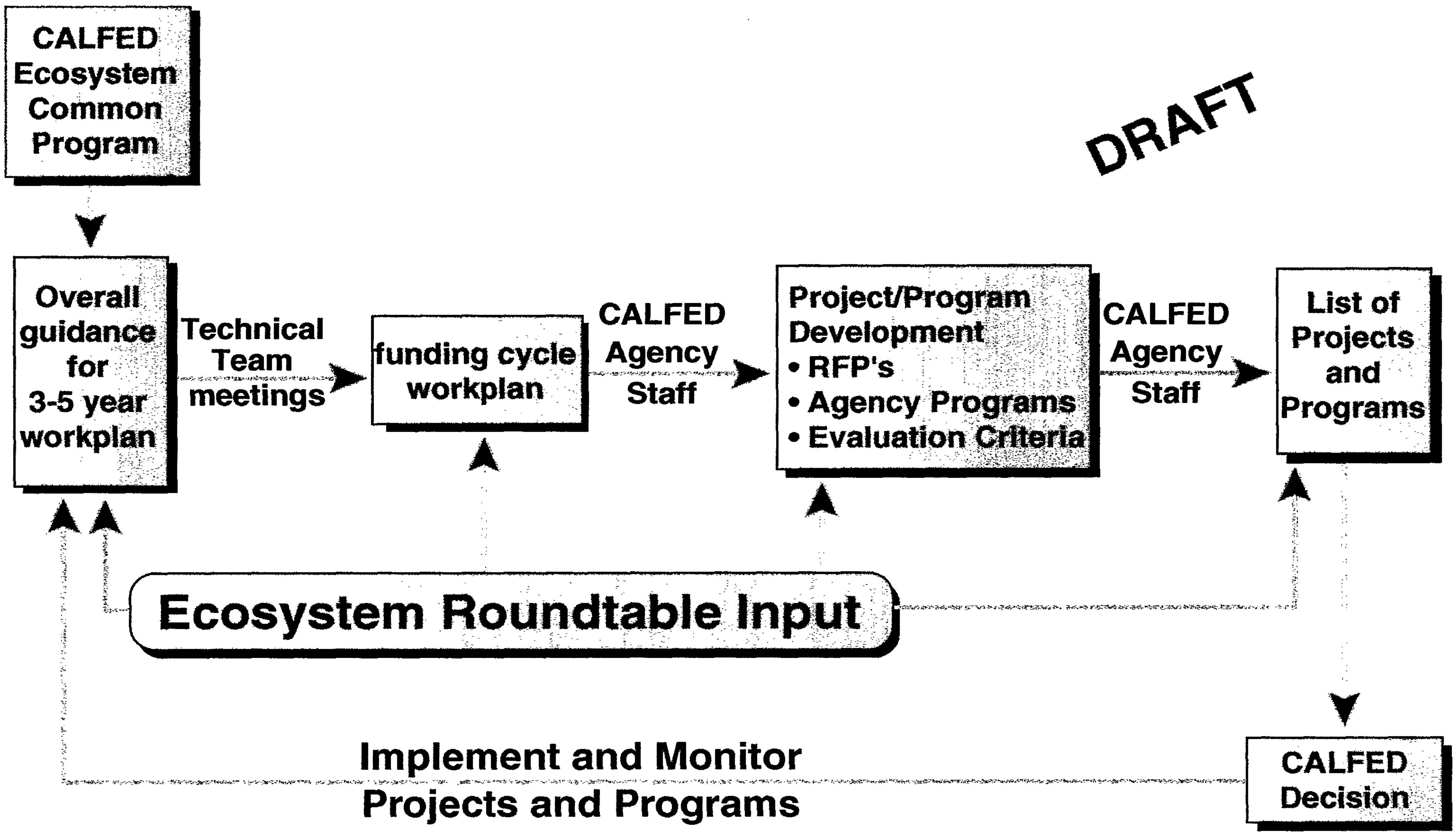
Benefits: Not specifically known without study; generally, this action would reduce temperature-related mortality of salmon smolts in the Sacramento River below Knights Landing.

Status: No progress on this action to date.

APPENDIX D

CALFED Planning Process, Time Line, and Program Coordination

Integrated Planning Process

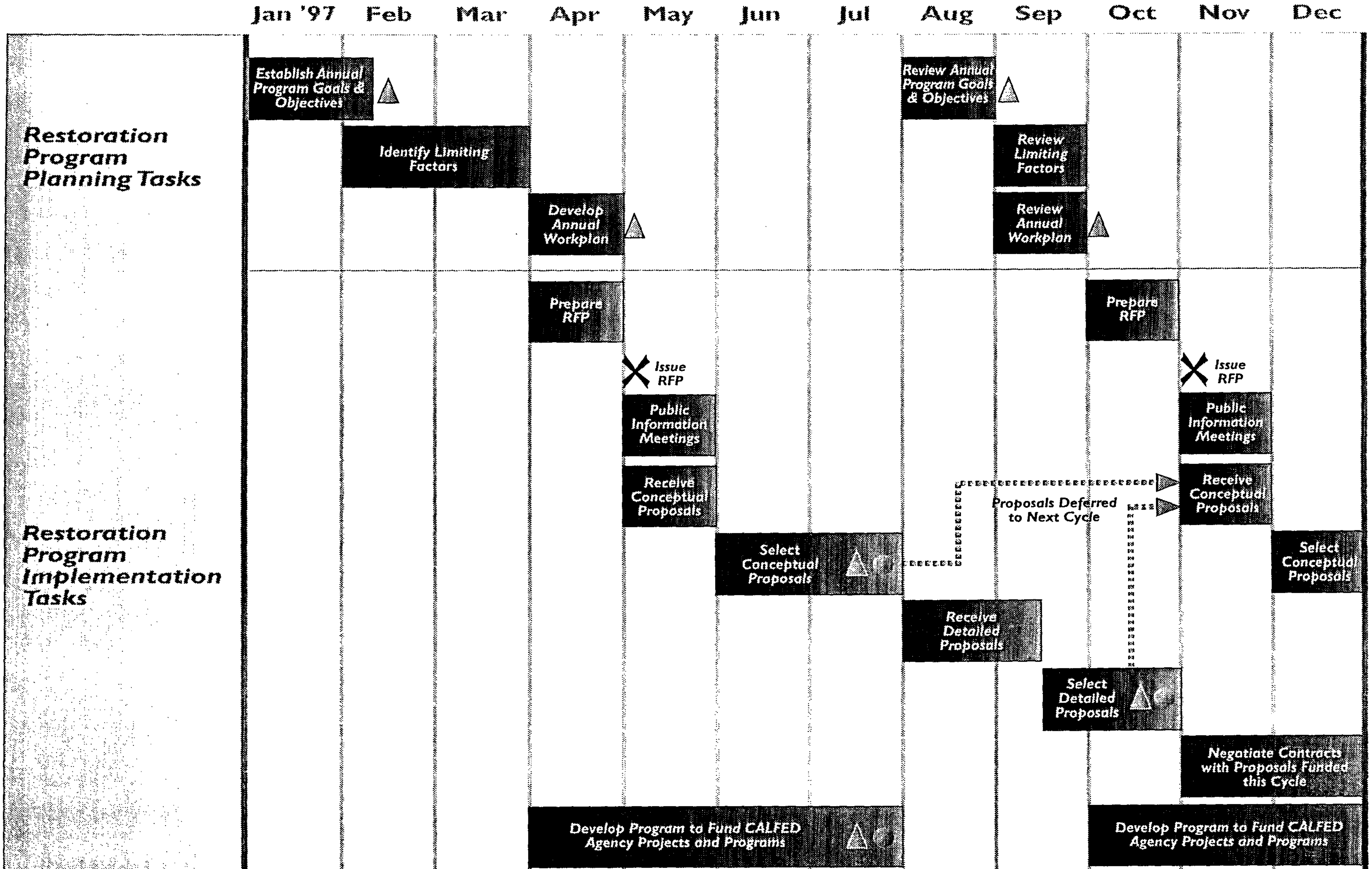


DRAFT

CALFED BAY-DELTA PROGRAM

CALFED Ecosystem Roundtable Planning Process
(Alternative Two Step Process)

DRAFT



139875.ZZ.ZZ 2-Step Process 3-13-97sbm

Revision: 03-13-97

△ = Roundtable Recommendations ● = CALFED Decision Point

DRAFT

Restoration Coordination

Method of Coordination	CALFED Near Term Restoration Program	Other Bay-Delta Programs/ Funds	Other Restoration Programs/ Funds
Jointly identify priority problems and actions Consolidate stakeholder input into process Adopt common RFP process Jointly review & rank funding proposals Jointly fund projects/programs Coordiante project/program development Coordinate project/program implementation	Cat III (Prop 204 and Stakeholder Funds)	• CVPIA (Restoration Fund) • Prop 204 related sections • 4 Pumps/ Tracy Mitigation Funds • Flood Emergency Funding	• NRCS (Farm Bill) • US Army Corps Sec 1135 • CWA Grant Funds • Other Fed/State Funds • Local Govt Funds • Private/ Nonprofit Funds

APPENDIX E

SB 1086 Document Excerpt
Used for Sacramento River Mainstem Stressor Identification

D. Improve and maintain the health and integrity of Sacramento Valley resources that provide direct support to the Delta ecosystem.

1. Improve and increase aquatic habitats so they can support sustainable production and survival of fisheries in the Delta.

(1) a. Increase the amount of high-quality instream riverine ~~edge~~ habitat to allow spawning and rearing by sustainable populations of native fish.

Implementation Objective: Maintain high quality holding, spawning, rearing and migration habitat for key aquatic species.

Target: Provide sufficient flow to transport sediment and distribute new spawning gravels.

Target: Increase gravel supplies and recruitment to the main stem river.

Target: Restore degraded channel sections.

Target: Control excessive silt discharges to protect spawning gravels in the mainstem by protecting watersheds in the Sacramento River Basin.

Implementation Objective: Provide high quality water in sufficient quantities to maintain important holding, spawning, rearing, and migration habitats for key aquatic species.

Target: Implement a river flow regulation plan that balances carryover storage needs with instream flow needs based on runoff and storage conditions.

Implementation Objective: Maintain water temperatures at levels to sustain all life stages of anadromous and native fish species, and other species dependent on the aquatic environment.

Target: Attain the following target temperatures for salmon

Juvenile rearing - 65°F
Holding of prespawning adults - 60°F
Egg incubation - 56°F

Implementation Objective: Maintain and restore opportunities for natural processes of channel meander, sediment transport, and gravel recruitment.

Target: Develop and implement a plan to protect all natural sources of spawning gravel in the high water channels and along the flood plains of the Sacramento River and its tributaries.

(2) b. Increase the amount of high quality shaded riverine aquatic habitat and riparian woodland habitat to provide localized temperature reduction and allow production of terrestrial food to maintain sustainable populations of Delta fisheries.

Implementation Objective: Maintain and restore a viable continuous riparian ecosystem that provides a near continuous corridor of streamside vegetation.

Target: Evaluate and implement opportunities to incorporate flows to restore riparian vegetation from Keswick Dam to Sacramento that are consistent with the overall river regulation plan.

Target: Preserve and restore riparian habitats and meander belts along the Sacramento River between Keswick Dam and Colusa.

Implementation Objective: Maintain or reestablish natural geomorphic and fluvial processes in artificially confined channel reaches.

Target: Evaluate opportunities to relocate, or modify artificial constrictions such as levees, bridges, and bank protection and implement changes where it is feasible to do so.

Target: Promote and support relocating water diversions and research alternate methodologies of supplying water from the Sacramento River that protect fish but also minimize conflict with maintaining dynamic fluvial river processes.

(4) c. Reestablish or maintain appropriate upstream and downstream movement of anadromous fish in the ~~tributaries~~ mainstem.

Implementation Objectives: Increase monitoring of fish outmigration and flows in tributary streams.

Target: Real time assessment of outmigration conditions.

Implementation Objectives: Maintain or improve connectivity of upstream holding and spawning habitats on tributaries to the mainstem Sacramento River.

Target: Unimpaired outmigration for all anadromous species.

(5) d. Improve the productivity of the foodweb to support sustainable native fish and wildlife populations by reducing the effects of nonnative species.

Implementation Objective: Reduce populations of harmful introduced plants.

Target: Reduce and systematically control populations of invasive exotic plant species that compete with the establishment and succession of native riparian vegetation.

(6) e. Reduce concentrations of toxic constituents and other pollutants to eliminate their adverse effects on Delta populations of fish and wildlife species.

Implementation Objective: Reduce loss of juvenile anadromous and resident fish and other aquatic organisms due to inorganic compounds.

Target: Reduce the loss of aquatic organisms to toxic chemicals.

Implementation Objective: Reduce loss of juvenile anadromous and resident fish and other aquatic organisms due to organic compounds.

(3b.) 2. Increase the amount of high-quality riparian woodland habitat to reduce fragmentation and increase conductivity to better support sustainable native fish and wildlife population in the Delta.

Implementation Objective: Maintain and where feasible reestablish a continuous riparian corridor along the Sacramento River between Keswick Dam and Sacramento.

Target: In coordination with the Upper Sacramento Advisory Council, develop a Sacramento River Riparian Conservation Area Plan.

Target: Establish a Sacramento River Riparian Conservation Area from Verona to Keswick.

Target: Maintain and restore opportunities for natural riparian successional process to occur along major rivers.

Target: Protect and restore riparian corridor along tributary streams.

Implementation Objectives: Maintain or restore natural input to nutrient/carbon cycle.

Target: Maintain and restore healthy riparian ecosystems along the Sacramento River and its tributaries.

Target: Maintain and restore connectivity between the river and stream channels to their floodplain through overbank flooding.

Implementation Objectives: Increase the quality and quantity of wetland habitats adjacent to mainstem rivers.

Target: Allow for the natural process of river meandering which creates oxbows and other wetland features along mainstem rivers.

Implementation Objective: Maintain and restore a continuous viable riparian ecosystem adjacent to mainstem channels and major tributaries.

Target: Revegetate denuded areas.

Target: Obtain streambank or riparian zone conservation easements.

Target: Avoid any loss or additional fragmentation of the riparian habitat in acreage, lineal coverage, or habitat value.

Target: Preserve and restore riparian habitats and meanderbelts along the Sacramento River between Keswick Dam and Colusa.

Implementation Objective: Restore natural channel process to more closely approximate historic conditions in major tributaries.

Implementation Objective: Establish buffer zones around important habitat areas to protect these habitats from incompatible land uses.

Implementation Objective: Protect and increase the areal extent of riparian habitats and restore and enhance degraded habitat areas.

Implementation Objective: Protect and increase the areal extent of valley-oak woodland and enhance degraded valley-oak woodlands.

Implementation Objective: Increase the area of perennial grasslands.

3a. 3. Increase floodplains and associated riparian habitat to improve diversity and abundance of fish and wildlife.

Implementation Objective: Maintain or restore hydrologic connectivity between flood plains and tributary and mainstem channels.

Implementation Objectives: Restore natural floodplain configurations associated with rivers and tributaries.

Target: Preserve floodplain areas where natural sedimentation and vegetation succession can occur unimpeded, and as a source of riverine and estuarine nutrients and allochthonous material.

4. Contribute to the recovery of threatened and endangered species or species of special concern and also increase populations of economically important species in the Delta.

1. Contribute to the recovery of threatened, endangered or species of special concern.

Implementation Objectives: Restore and maintain splittail at levels which will fully utilize existing habitat.

Target: Maintain a population growth rate greater than 1.0.

Implementation Objective: Improve the survival of juvenile winter-run chinook salmon in their rearing and emigration habitats.

(7) Target: Install positive barrier fish screens to screen 50% (by volume) of the water diverted from the Sacramento River.

Implementation Objective: Improve the survival of juvenile steelhead in their rearing and emigration habitats.

Target: Install positive barrier fish screens to screen 50% (by volume) of the water diverted from the Sacramento River.

2. Increase populations of economically important species.

Implementation Objective: Restore and maintain green sturgeon at levels which will fully utilize existing habitat.

Target: Maintain a population growth rate greater than 1.0.

Implementation Objective: Restore and maintain white sturgeon at levels which will fully utilize existing habitat.

Target: Maintain a population growth rate greater than 1.0.

Implementation Objective: Restore and maintain striped bass at levels which will fully utilize existing habitat.

Target: Maintain a population growth rate greater than 1.0.

Implementation Objective: Restore and maintain American shad at levels which will fully utilize existing habitat.

Target: Maintain a population growth rate greater than 1.0.

Implementation Objective: Improve the survival of economically important juvenile fish in their rearing and emigration habitats.

Target: Install positive barrier fish screens to screen 50% (by volume) of the water diverted from the Sacramento River.

3. Increase populations of prey or food species.

Implementation Objective: Restore and maintain native fish communities.

Target: Maintain existing species diversity and abundance levels.

Implementation Objective: Restore and maintain native amphibian populations.

Target: Maintain existing species diversity and abundance levels.

Implementation Objective: Restore and maintain lower trophic organisms such as invertebrate, bacterial, and algal species.

Target: Maintain existing species diversity and abundance levels.

Implementation Objective: Restore and maintain Pacific lamprey at levels which will fully utilize existing habitat.

Target: Maintain a population growth rate greater than 1.0.

(8) Implementation Objective: Reduce loss of adult fish due to straying.

Target: Provide positive outflow for Big Chico Creek. Refer to Implementation Objectives and Targets for Big Chico Creek Ecological Unit.

(9) Implementation Objective: Reduce degradation of aquatic habitat due to erosion and sediment input.

Target: Control excessive silt discharges to protect spawning gravels in the mainstem by protecting watersheds in the Sacramento River Basin.

(10) Implementation Objective: Reduce loss of juvenile anadromous and resident fish and other aquatic organisms due to predation.

Target: Eliminate predator habitat by redesigning bridge pilings and abutments, water diversion structures, and other structures along the banks of the Sacramento River.