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# Upper Sacramento River
## Fisheries and Riparian Habitat Management Plan

January 1989
Prepared for The Resources Agency
State of California

C—051695

C-051695

# FOREWORD

California's premier river, the Sacramento, provides a wide range of recreation and water-related benefits that enrich the entire State.

But the Sacramento, the State's number one producer of salmon, has problems that must be addressed soon: its salmon runs are declining and less than 5 percent of its riparian habitat remains.

To help reverse these trends, the State passed a law in 1986 that calls for a management plan to protect, restore, and enhance the fish and riparian habitat and associated wildlife of the upper Sacramento River. The law evolved from two separate bills, one introduced by Assemblyman Robert Campbell to inventory riparian habitat, and the second by Senator Jim Nielsen to develop an Upper Sacramento River Fisheries and Riparian Habitat Management Plan. The bill that emerged combined these two objectives. The act, Senate Bill 1086, requires the management plan to establish a series of priority actions with specified time frames, estimated costs and benefits, and proposed funding sources.

SB 1086 appropriated $250,000 from the California Environmental License Plate Fund, with $150,000 going to the Wildlife Conservation Board for an inventory of riparian lands prepared in 1987, and $100,000 to The Resources Agency to prepare this management plan.

As stipulated in SB 1086, this plan was prepared by an advisory council and an action team of people representing a wide range of federal, State, and local agencies and private interests concerned with protecting the health of the upper Sacramento River system. The upper Sacramento River system is defined as that portion of the river and its tributaries between the Feather River and Keswick Dam, or essentially from Verona just north of Sacramento to Redding in Shasta County, a distance of 222 river miles.

Most of this plan is devoted to describing specific actions that will help restore the Sacramento River fishery to its optimum state and protect and restore riparian habitat. These actions should be pursued aggressively by the State of California, in concert with federal and local governments and interested organizations and individuals. The plan was developed in a spirit of cooperation and consensus among the participating agencies and individuals, continuing the process that produced the original legislation. However, the plan's conclusions and recommendations do not bind any of the participating agencies or groups to any specific position, policy, or funding commitment.

Bob Bosworth
Advisory Council Chairman



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Many of the problems facing salmon and steelhead in the Sacramento River started with the construction of Shasta and Keswick Dams in the 1940s, which resulted in the loss of about 50 percent of the river's historic spawning area. These projects blocked off hundreds of miles of spawning area and eliminated all spawning gravel recruitment above the dams, causing sharp declines in the numbers of spawning salmon. Further losses resulted from building Red Bluff Diversion Dam in the 1960s.

However, dams are not the only problem. California's burgeoning population has caused many changes that have adversely affected fish, wildlife, and riparian habitat. Diversions of water for farms, factories, and homes reduce streamflow and kill millions of juvenile salmon and steelhead. Land management practices damage fish and wildlife habitat, and gravel mining activities reduce recruitment of spawning gravels.

Numerous actions have been undertaken over the years to stop the decline, but until now, there has been no unified effort to put together an overall plan to solve the myriad fishery problems in the watershed.

Mitigation measures have been insufficient and often unsuccessful. For example, Coleman National Fish Hatchery, built in 1942 to mitigate the loss of habitat caused by Shasta Dam, is old and inefficient and is presently unable to meet its mitigation goals. Plans for renovating Coleman are already developed and are incorporated as a high priority item in this report.

The plan presented herein identifies 22 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, 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 that are dependent on the diverse vegetation that accompanies a live, mobile (meandering) stream system. The social and economic values of riparian habitat are generally considered to be very important.

The fisheries proposals range from a $68-million cleanup of the Iron Mountain Mine near Redding and a $24-million reconstruction of the Coleman National Fish Hatchery on Battle Creek, to construction of fish ladders and screens on tributary streams, such as Butte and Big Chico Creeks. When completed, the fishery restoration program will be instrumental in reestablishing a fishery valued at more than $100 million annually.

The actions recommended in the report have been endorsed by the Advisory Council. The Council therefore supports legislation to implement these actions.

## Previous Studies

The Sacramento River is a priceless resource that has been increasingly called on to supply California's growing needs for water, flood control, power, and all the related benefits a great river can provide. Many planning studies have been conducted during the past 100 years and projects constructed to meet these needs. Unfortunately, the river's fish and wildlife resources and riparian habitat were not given the same attention as other beneficial uses and have suffered greatly as a result.

This plan presents a program for protecting and restoring these neglected resources. It should be recognized that the plan focuses only on fish and riparian habitat, and does not attempt to develop a comprehensive program for all beneficial uses of water.



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While the plan draws heavily on previous studies, it does not attempt to reproduce them, nor does it attempt to provide specific information on hydrology, geology, water quality, and water supply. However, this information can be obtained from previous reports identified in Appendix C, which presents a list of references used to develop this plan.

We recognize that all potential actions that might be taken to improve fish populations and protect riparian vegetation are not contained in this plan. Nonetheless, we believe that implementation of the recommended actions contained in this report will provide the basis for restoring fish populations and riparian habitat to acceptable numbers.

## Planning Considerations

In developing this management plan, the Advisory Council was guided by the following definitions, goals, and policies.

## Definitions

Wild: fish that have maintained their populations entirely by natural spawning, with no introduction of artificial propagation at any time within their historic life cycle.

Natural: fish that may have originated from wild, natural, or hatchery stocks, but that were spawned naturally in streams or rivers.

Artificial: fish that originated from wild, natural, or hatchery stocks that are spawned, incubated, and reared to fry or smolts in a hatchery or other artificially developed environment.

## Goals and Policies

1. Riparian Habitat Protection

Short-term: Protect and maintain existing riparian habitat from further loss or deterioration.

Long-term: Reestablish a continuous riparian ecosystem along the river between Chico and Redding, and reestablish riparian vegetation along the river from Verona to Chico, consistent with the Sacramento River Flood Control Project.

2. Fisheries

It is the intent of this fishery restoration plan that actions to protect, restore, and enhance wild strains of salmon and steelhead will be given the highest priority.

Actions that will maximize habitat restoration for naturally spawning salmon and steelhead will be given second priority. Natural production is intended to be limited only by the carrying capacity of the natural ecosystem.

Artificial production will be limited to actions that will fully compensate for fish populations that existed at the time their historic habitat was permanently lost due to blockage by dams or other human causes.

The Council recognizes that hatcheries have the capability to support a higher catch-to-escapement ratio than can be sustained through management of natural production. It is the policy of the Council that the upper Sacramento River system be managed to optimize (restore/enhance) natural and wild fish populations, even though this policy may result in "surplus" populations of returning hatchery fish.



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It is the intent of the Advisory Council that this plan provide measures necessary to minimize fish losses due to entrainment, predation, and other hazards associated with diversion of water from the upper Sacramento River and its tributaries. Such measures may include fish screens, reducing diversions during critical periods, or relocating diversion points to avoid conflicts with fish populations. The Council supports public funding to construct fish screens and other fish protection measures when the owner of the diversion is not responsible for costs. When existing State laws require the owner of a diversion to help pay for these measures, the owner will be expected to participate.

3. Public Trust Considerations

The Public Trust Doctrine, which protects the public's right to use the State's tidelands, submerged lands, and navigable waterways, is a legal concept rooted in Roman and English law. This doctrine reflects an interest which arises principally from the State's ownership of the riverbed at the time of statehood. The interest takes these general forms: (1) fee ownership of areas which are, or were, below the mean low-water mark in nontidal waters, and (2) an easement for public trust purposes on lands which are, or were, between the mean low- and high–water marks. Historically, the Public Trust Doctrine has protected the public's right to engage in commerce, navigation, and fisheries activities in the State's navigable bodies of water. Later court decisions, such as *Marks v. Whitney* (6 C.3d 251), in 1971 broadened uses under the Public Trust Doctrine to include: ". . .preservation of those lands in their natural state, so that they may serve as ecological units for scientific study, as open space, and as environments which provide food and habitat for birds and marine life, and which favorably affect the scenery and climate of the area."

In several specific cases where potential public trust conflicts exist between instream water uses for recreation, fish and habitat preservation, and appropriative uses for agriculture, the Council has relied on cooperative efforts of landowners, water rights holders, and appropriate government and public interests, as reflected herein, to restore fisheries and habitat values in the Sacramento River watershed. This means that public funds will be recommended for, but not limited to, the development of emergency alternative water supplies or implementation of other measures needed to restore these resources, with the participation and cooperation of affected parties. In doing so, the Advisory Council recognizes that the Public Trust Doctrine plays an important role in helping to create a long–term balance between all competing interests which use, or are affected by, the State's navigable waterways.

## Management Plan

The management plan was developed by the Action Team and approved by the Advisory Council. It contains a compilation of actions needed to restore fish and riparian habitat in the Sacramento River system. Two of these actions deal with restoring riparian vegetation or reducing losses of native vegetation, and comprise a Riparian Habitat Restoration Plan. The other 20 deal with proposed solutions to fisheries problems on the main stem Sacramento and its tributaries, and collectively are called a Fisheries Restoration Plan.

The individual restoration proposals are listed in order of priority, although collectively the riparian habitat proposals and the fishery proposals are considered to be equal in importance. When the selection of a recommended solution required a choice among alternative solutions, the rejected alternatives are included in the action item, along with an explanation of why they were rejected. The following three–part map shows the general area of study.



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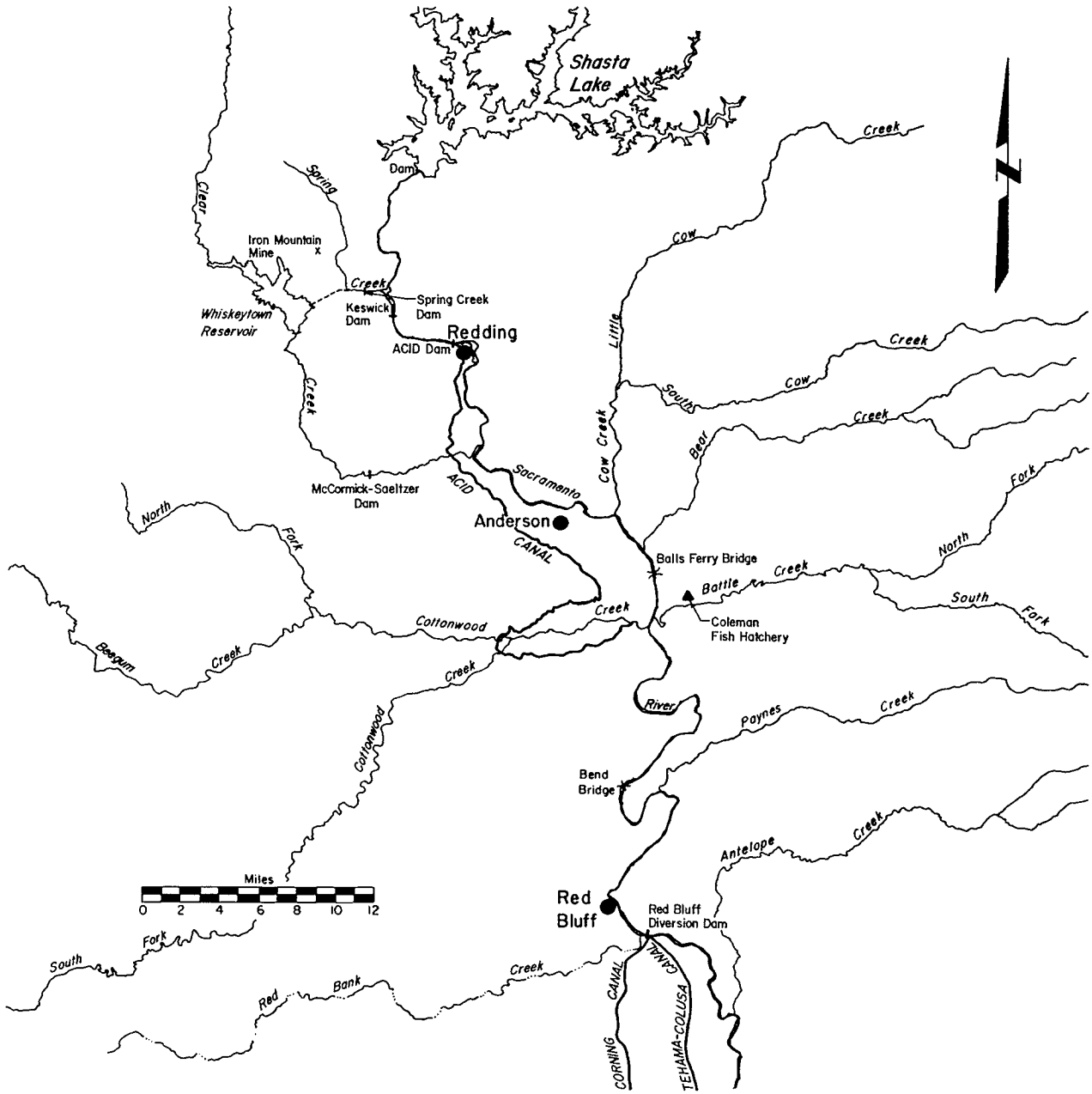
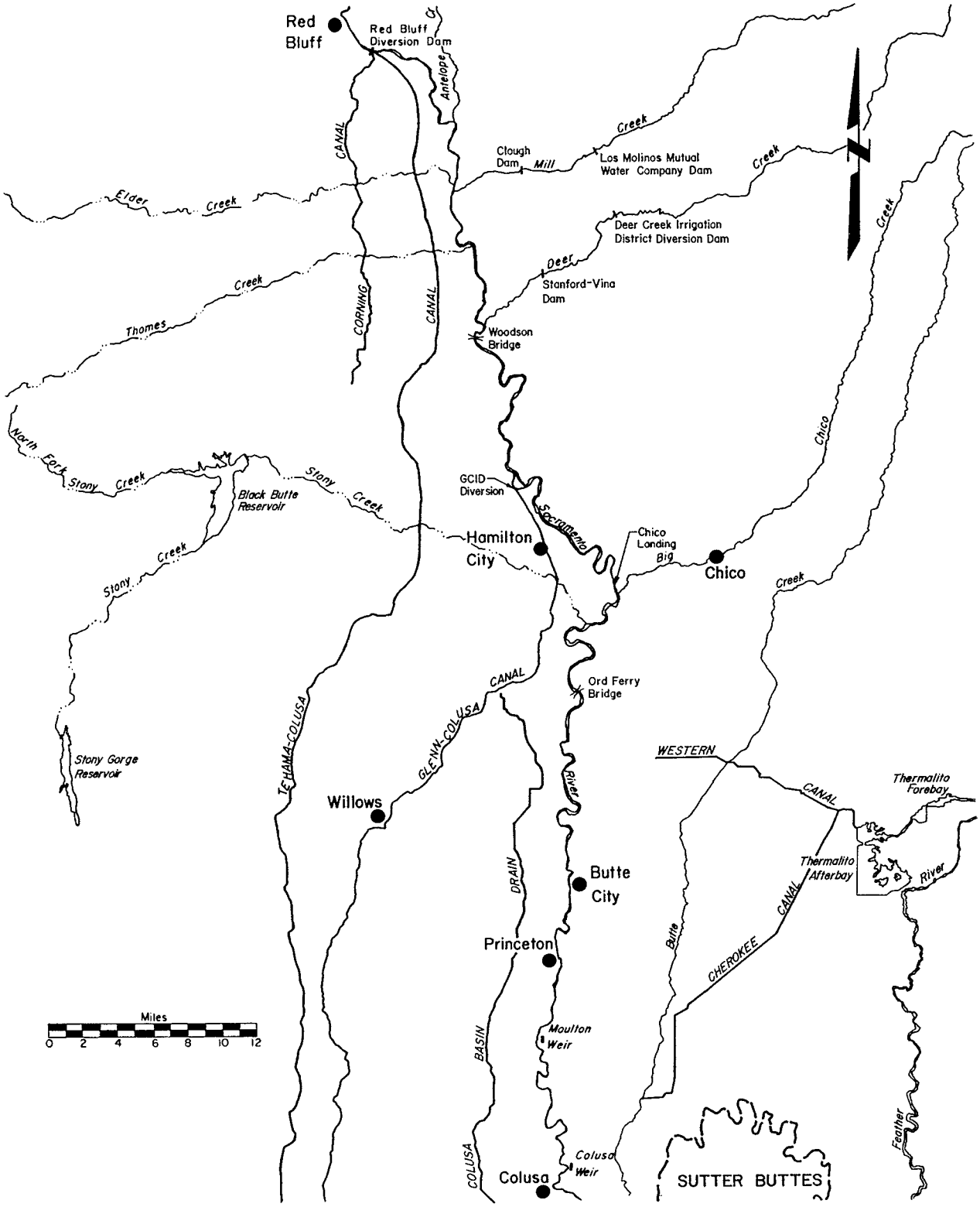
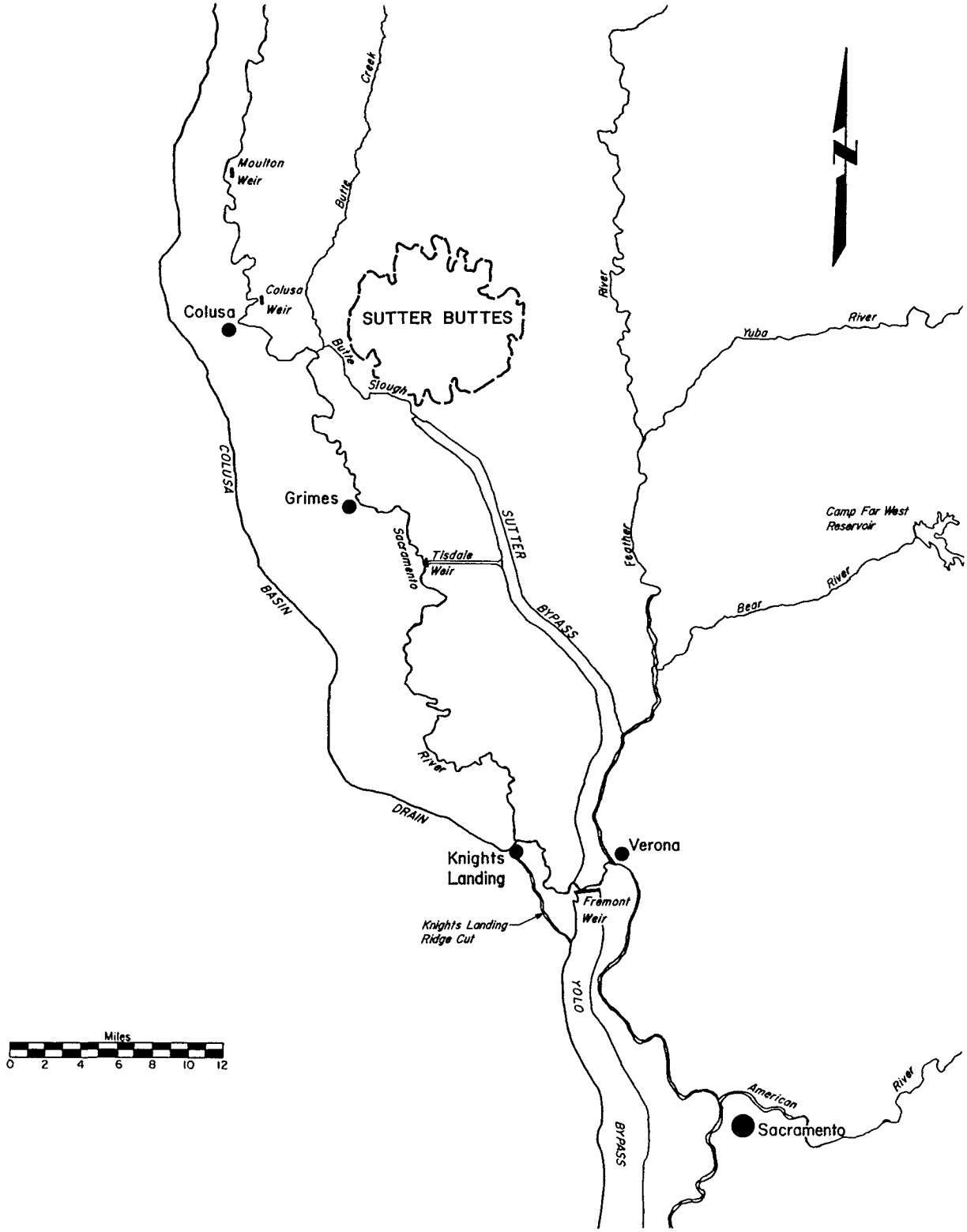



SACRAMENTO RIVER
Keswick to Red Bluff




SACRAMENTO RIVER
Red Bluff to Colusa




SACRAMENTO RIVER
Colusa to Verona



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Riparian Habitat Restoration Plan

This section of the restoration plan contains two actions needed to comprehensively manage stream and riverside riparian habitat in the upper Sacramento Valley. These proposals are "A Comprehensive Management Plan for the Sacramento River Riparian System" and "Riparian Habitat Preservation on Sacramento River Tributary Streams." These actions evolved from several identified problems and proposed actions to resolve both the short-term protection of existing habitat, and long-term reestablishment of a continuous riparian ecosystem along the Sacramento River and its major tributary streams.

An inventory of riparian habitat, "Sacramento River Riparian Atlas – Verona to Redding," was completed by the Wildlife Conservation Board in 1988, and is published separately (see Appendix D). This atlas provides the maps and basic data needed to develop the riparian habitat plans. The Comprehensive Management Plan recommends establishment of a Sacramento River Riparian Conservation Area, which incorporates elements related to habitat preservation, management, erosion control, flood control, river dynamics, land use, ecology, restoration, public access, and taxes to local government. The plan emphasizes voluntary landowner participation through sale of riparian lands or easements, transfer of development rights, lease agreements, or tax incentives.

Recommendations for the tributary streams include the need for an inventory of riparian habitat with emphasis on incentives for riparian conservation and promotion of land stewardship.

Fisheries Restoration Plan

Implementation of the fisheries restoration plan for the upper Sacramento River will help restore and enhance the salmon and steelhead fisheries in the upper river system. Each proposed action begins with a statement of purpose and includes sections on background, discussion, recommendations, estimated costs, benefits, potential conflicts, implementation, and special funding sources.

Each fishery action is presented in priority order, with the priority based on the necessity for the action and with natural (wild) populations given preference over artificial propagation (hatcheries).



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# CONCLUSIONS AND RECOMMENDATIONS

## Conclusions

- The Sacramento River system is the most important river in California for anadromous fish; it also contains important remnant riparian habitat.
- Anadromous fish runs, especially winter–run and spring–run chinook salmon and steelhead, are at dangerously depressed levels and must be protected and restored.
- Less than 5 percent of the historic riparian habitat of the Sacramento River system remains in existence in 1988.
- The restoration measures contained in the management plan, when implemented, can restore the anadromous fishery to acceptable numbers; they can also protect and restore habitat necessary for several threatened and endangered species of plants, birds, animals, and fish.
- Restoration of fish populations and riparian habitat in the upper Sacramento River system will require a major commitment of federal, State, and local funding.
- Responsibility for fish and riparian habitat losses are estimated to be 75 percent federal and 25 percent State and local.

## Recommendations

- State and federal legislation should be enacted as soon as possible to provide authority and funding needed to implement the actions contained in this management plan.
- The State of California should commit the necessary funding from a combination of Proposition 70, Proposition 99, and other sources to meet the State's share of the costs.
- The fishery and riparian habitat measures contained herein should be implemented in general conformance with the priorities indicated (see table on page 12).
- State and federal legislation should be enacted to authorize an Upper Sacramento River Advisory Council to facilitate implementation of the management plan.



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*The fisheries restoration plan for the upper Sacramento River will restore and enhance the salmon and steelhead fisheries.*

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# IMPLEMENTATION PROGRAM

The actions recommended in this plan are not necessarily new proposals. Rather, they are a composite of solutions to problems identified by various sources and in various stages of consideration, some of which have been considered for many years and are already completed or under way. For example, the problems caused by the toxic drainage in Spring Creek from Iron Mountain Mine is a high priority item already the focus of a clean-up plan developed by the Environmental Protection Agency. The action item in this plan supports and recommends implementation of the EPA proposal.

## Funding Responsibility

Capital costs of implementing this plan total about $240 million, with annual costs of about $9 million. However, about $100 million of this total is already funded, authorized, or otherwise committed by the federal government. Examples of federal commitments include (1) the EPA plan to clean up the Iron Mountain Mine toxic waste problem ($68 million), (2) modifications to the Tehama-Colusa Canal headworks and fish screen at the Red Bluff Diversion Dam funded by the U.S. Bureau of Reclamation ($15 million), (3) USBR authorization for design and construction of Shasta Dam modifications to control water temperatures ($6 million), (4) USBR-funded spawning gravel restoration in the upper Sacramento River ($250,000), and (5) U. S. Fish and Wildlife Service funding to protect riparian habitat in a Middle Sacramento River Wildlife Refuge ($3 million committed to date).

The Advisory Council recognizes that the decline in the fish and riparian-related resources in the upper Sacramento River system is attributable to a combination of factors associated with federal, State, and local activities. Consequently, funding of the action items described in the plan should be shared between the federal government, the State government, and local agencies. However, precise types of payment (i.e., cash transfers, in-kind services, etc.), sources of funding (i.e., federal treasury, Central Valley Project water users, State general fund, State Water Project users, etc.), and the proportions of payment between the participating entities should be determined independent of this report.

Examples of cost sharing between federal, State, and local governments are contained in the Suisun Marsh Preservation Agreement (dated March 21, 1987), Public Law 99-546 governing implementation of the Coordinated Operation Agreement and the Suisun Marsh Preservation Agreement (dated October 27, 1986), and Public Law 98-541 governing the Trinity River Basin Fish and Wildlife Management Program (dated October 24, 1984).

Estimated costs and funding responsibility for the action items included in the Riparian Habitat and Fishery Restoration Plans are listed in order of priority in the following table. Capital costs for the two major elements of the Riparian Habitat Restoration Plan would be about $35 million, with annual costs of about $4 million. Total initial costs for the 20 fishery actions would be about $205 million, with annual costs of about $5 million.



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## PROPOSED PRIORITY AND FUNDING RESPONSIBILITY FOR FISHERY ACTION ITEMS
### *SB 1086 Management Plan*

| Priority | Action Items | Funding Responsibility | Total Initial Costs[1] | Annual Costs |
|---|---|---|---|---|
| Riparian Habitat Restoration Plan | | | | |
| 1 | Comprehensive Management Plan (Main Stem Sacramento River) | Federal & State | $33,000,000 | $4,125,000 |
| 2 | Riparian Habitat Preservation on Tributary Streams | Federal & State | 500,000 | NA |
| | Subtotal of Riparian Habitat Restoration Costs | | $33,500,000 | $4,125,000 |
| Fisheries Restoration Plan | | | | |
| 1 | Red Bluff Diversion Dam | Federal (USBR) | $23,000,000[2] | $300,000 |
| 2 | Temperature & Turbidity | Federal (USBR) | 6,400,000[3] | Unknown |
| 3 | Spawning Gravel Restoration | Federal (USBR) & State (DFG) | 12,000,000 | 500,000 |
| 4 | Sacramento River Flows | Federal (USBR) & State (DFG & DWR) | 1,100,000 | Unknown |
| 5 | Coleman Fish Hatchery | Federal (USFWS & USBR) | 24,450,000[4] | 900,000 |
| 6 | Heavy Metals-Iron Mt. Mine | Federal (EPA) | 68,000,000[5] | Unknown |
| 7 | Mill Creek | State (DWR & DFG) | 1,550,000 | 50,000 |
| 8 | GCID Diversion | Federal (USCE), State (DWR) & Local (GCID) | 25,100,000 | 80,000 |
| 9 | Deer Creek | State (DWR & DFG) | 1,400,000 | 50,000 |
| 10 | Unscreened Diversions | Federal (USCE), State (DFG) & Local | 7,150,000 | 300,000 |
| 11 | Clear Creek | Federal (USBR) & State (DFG) | 2,000,000 | 800,000 |
| 12 | ACID Diversion Dam | State (DFG) & Local (ACID) | 1,000,000 | Unknown |
| 13 | Butte Creek | State (DWR & DFG) & Local | 1,600,000 | 100,000 |
| 14 | Big Chico Creek | State (DWR & DFG) & Local | 1,400,000 | 40,000 |
| 15 | Sacramento River Hatchery | Federal (USBR & USFWS) | 25,000,000 | 1,500,000 |
| 16 | Tehama-Colusa Fish Facility | Federal (USBR) NA[6] | NA | |
| 17 | Bank Stabilization | Federal (USCE) | 180,000 | 20,000 |
| 18 | Battle Creek | State (DFG) & Local (PG&E) | 2,000,000 | Unknown |
| 19 | Cottonwood Creek | State (DFG & DWR) | 400,000 | Unknown |
| 20 | Colusa Drain | Federal (USCE), State (DWR) & Local | 3,300,000 | Unknown |
| | Subtotal of Fisheries Restoration Costs | | $207,030,000 | $4,640,000 |
| | Total Sacramento River Management Plan Costs | | $240,530,000 | $8,765,000 |

[1] When the management plan defines a range of possible costs, this summary includes the highest estimate for comparative purposes.

[2] Includes $15,000,000 for fish screen and bypass and trash deflector wall now under construction.

[3] Includes $800,000 already allocated to design Shasta Dam modifications.

[4] Includes $2,100,000 for winter-run salmon holding ponds now under construction.

[5] Includes $4,150,000 already allocated to cap ground above ore bodies and determine how to seal mine.

[6] Implementation of the Action Items on Sacramento River Hatchery and Spawning Gravel Restoration would be required to fully replace TCFF mitigation and enhancement production.

NA = Not Applicable



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## Plan Implementation

The Council believes that a potential mechanism for conflict resolution should be established if this plan is to be successfully implemented. State and federal agencies will require specific authority by legislative and/or administrative means to carry out many of the proposed actions, and a mechanism or institution should be established to permit maximum cooperation between the various agencies, private landowners, and others with a stake in conserving and utilizing the resources of the river and its riparian habitat.

Therefore, it is recommended that any State or federal legislation and/or directives issued to put this plan into effect recognize a multidiscipline Upper Sacramento River Advisory Council. The Council will review progress on the overall plan as it is implemented and make annual recommendations on priorities and schedules to the State Legislature and the Congress as project actions are undertaken. The Council should consist of representatives from the following agencies or groups:

U. S. Army Corps of Engineers
U. S. Fish and Wildlife Service
U. S. Forest Service
U. S. Bureau of Land Management
U. S. Bureau of Reclamation
U. S. Soil Conservation Service
National Marine Fisheries Service
California Department of Fish and Game
California Department of Food and Agriculture
California Department of Forestry and Fire Protection
California Department of Water Resources
California Water Commission
California State Lands Commission
California State Reclamation Board
California State Water Resources Control Board
California Wildlife Conservation Board
Sacramento River Water Contractors' Association
Sacramento Valley Landowners Association
One member from each of the Boards of Supervisors from Butte, Colusa, Glenn, Shasta, Sutter, and Tehama Counties and three persons who shall represent, respectively, commercial fishermen, recreational fishermen, and general wildlife and conservation interests.

Meetings of the Advisory Council will be public, and persons having an interest in managing the river, its resources, and riparian habitat will be encouraged to attend and participate.



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*The management plan consists of 20 actions to restore the fisheries of the Upper Sacramento River Basin and two actions that deal with preserving and restoring riparian vegetation.*

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# FUNDING SOURCES

Funding for these actions may be available from a number of sources. New congressional authority and appropriations would be required for most of the federal actions, except those previously mentioned that are already approved or under way. Existing sources of funding (mostly bond acts) probably are adequate to cover the State's share of the capital costs of the proposed actions. However, specific authorization or approval would be required from the Legislature or an administering agency to use the funds for these purposes. On the other hand, existing funding sources could not be used for ongoing annual operation, maintenance, or replacement costs, which are likely to exceed $9 million. Some of the annual costs are partly covered by existing budgets--e.g., Coleman National Fish Hatchery--but most would require new federal and State authority and appropriations.

## Existing Funding Sources

1. 1984 Fish and Wildlife Habitat Enhancement Bond (Proposition 19)

Administered by the Wildlife Conservation Board, provides funding for interior wetlands, rare or endangered species habitat acquisition, and stream improvement. The WCB does not anticipate funding any significant new programs from the remaining appropriation.

2. California Wildlife, Coastal and Parks Initiative (Proposition 70)

Provides the WCB with $4 million for acquisition of riparian habitat along the Sacramento River from Shasta Dam to Collinsville.

WCB will also receive statewide Habitat Conservation Program funding. Funding categories under which Sacramento River projects may qualify include: (1) acquisition, enhancement, restoration, or protection of critical wild trout or steelhead nursery and spawning areas; and (2) acquisition, enhancement, restoration, or protection of lands providing habitat for threatened, endangered, or fully protected species.

Statewide, $10 million is available to DFG for restoration and enhancement of salmon streams in accordance with the recommendations of the Commercial Salmon Stamp Advisory Committee and the Advisory Committee on Salmon and Steelhead Trout and $6 million for restoration and enhancement of wild trout and native steelhead habitat and related projects.

3. Fish and Game - Fisheries Restoration (AB 1705)

This bill authorized $5 million for fishery-related projects; however, only $1,250,000 was appropriated in the first year of this two-year bill. Funding for the upcoming second year is uncertain at this time.

4. Salmon Stamp Funds

Funds administered through the Commercial Salmon Stamp Advisory Committee vary from about $200,000 to $1,000,000 annually, depending on the year's catch.

5. Environmental License Plate Fund

This fund provides variable amounts ($0-$3 million annually) for acquisition of rare and endangered species habitat.



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6. Urban Stream Restoration Program

This program, administered by DWR, can supply grants (up to $300,000) for local stream restoration projects. Several Sacramento River tributaries would be eligible.

7. Delta Pumps Fish Protection Agreement

Under an agreement between the Department of Water Resources and the Department of Fish and Game, the State Water Project, in 1986, set aside $15 million to begin a program to restore the fish populations of the Sacramento–San Joaquin Delta. Additional funds are also provided each year to compensate for continuing losses of striped bass, chinook salmon, and steelhead at the Harvey O. Banks Delta Pumping Plant.

A variety of fishery restoration and enhancement projects included in the Upper Sacramento River Fisheries and Riparian Habitat Management Plan would be eligible for funding under this agreement.

8. Federal Aid in Sport Fish Restoration Program

California Dingell–Johnson/Wallop–Breaux Projects are administered by the California Department of Fish and Game and evaluated and approved by the U. S. Fish and Wildlife Service. In the 1987–88 fiscal year, approximately $10 million (75 percent federal and 25 percent State funded) was expended on projects in California. The program collects a "user fee" on anglers and boaters through fishing tackle excise taxes, motor boat fuel taxes, and import duties on tackle and boats. These monies are allocated the year following collection to the State fishery agency for sport fisheries and boating access projects. A substantial portion of funding is directed to sport fishery restoration and enhancement programs within the Department of Fish and Game. Funding is also apportioned for boating access (at least 10 percent) and aquatic resources education (up to 10 percent) under guidelines included under 1984 Wallop–Breaux amendments to the program.

9. Cigarette and Tobacco Tax Benefit Fund Initiative (Proposition 99)

Provides an estimated $15 million per year to a Public Resources Account which can be appropriated in equal amounts for programs to (1) protect, restore, enhance, or maintain fish; (2) protect, restore, enhance, or maintain waterfowl and wildlife habitat; and (3) enhance State and local park and recreation resources.

## Potential New Funding Sources

1. Legislative or Congressional Appropriation

New congressional authority and appropriations would be required for most of the proposed federal actions. Continuing new appropriations would also be needed for the annual costs of most of the proposed actions. Annual operations, maintenance, and restoration would be either a federal or State cost, depending on responsibility for the capital cost of the action. Specific new State legislative authority would be required for certain actions such as the "set–aside agreement," the "riparian tax incentive," and the "tax reimbursement to local government" programs described in the Comprehensive Management Plan for the Sacramento River Riparian System.

2. New Bond Acts

New bond acts, patterned after Proposition 19 (Fish and Wildlife Habitat Enhancement Bond) or Proposition 70 (California Wildlife, Coastal, and Parks Initiative), could be proposed by legislative action or voter initiative for the specific purpose of implementing certain of the proposals in this management plan.



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3. Energy Surcharge

Federal legislation could be passed that authorizes use of a small part of the hydroelectric power revenues to implement the Upper Sacramento River Fisheries and Riparian Habitat Management Plan. A similar approach has already been used on the Columbia River to restore depleted fisheries. There, Congress made the Bonneville Power Administration the custodian of a fund resulting from a 0.05 cent per kilowatt hour set-aside from BPA power revenues. The annual additions to the fund are spent based on priorities set by a multiagency council. For example, if a similar amount was set aside from upper Sacramento River basin hydroelectric power revenues, several million dollars would be available each year for implementation of the Sacramento River Management Plan.



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*The riparian plant community has a significant influence on the stream environment and supports a wide variety of wildlife species.*



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# RIPARIAN HABITAT RESTORATION PLAN



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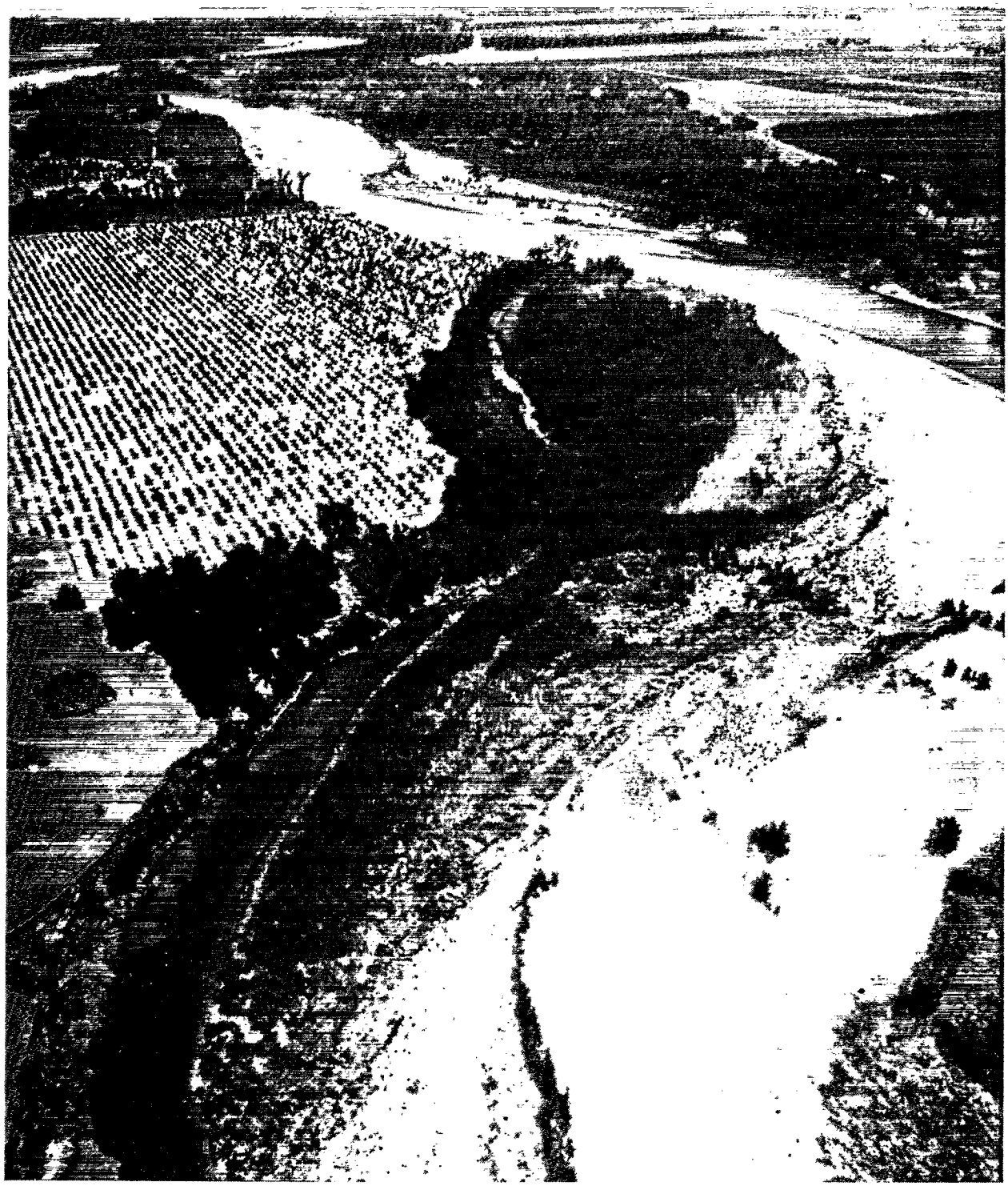

*Once bountiful riparian forests along the Sacramento River have been greatly diminished to the extent that less than 5 percent of the original acreage remains today.*



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# A Comprehensive Management Plan for the Sacramento River Riparian System

## Purpose

The purpose of this management plan is to preserve remaining riparian habitat and reestablish a continuous riparian ecosystem along the Sacramento River between the mouth of the Feather River and Keswick Dam.

## Background

The riparian zone comprises many important natural elements contributing to a system rich in species diversity. These include water access, maximum habitat edge, and a complex productive food web. Essential to the system is a rich vegetative diversity.

Establishment of riparian vegetation in alluvial floodplain areas takes place sequentially as one plant community over time replaces another. This biological process (succession) is dependent on the processes of erosion and deposition. The process typically starts where cottonwood and willow seeds germinate at the water's edge of a newly formed sandbar, resulting in a band of young trees. Once the stand is established, growth is rapid. Eventually, as this process is repeated year after year, the emerging forest develops a gradient in height and age, sometimes referred to as a gallery forest.

Increase in soil depth due to accelerated deposition results in a decreased availability of subsurface moisture. Within the first 10 years, sycamore, box elder, and other species tolerant of this drier condition and dense shade become established. As soil depths continue to increase and the cottonwood-dominated forest matures (20 to 30 years), black walnut and Oregon ash begin to appear.

As the cottonwoods age and begin to die out, valley oaks may become established, although their presence is irregular. Under the proper conditions, the mature black walnut/sycamore woodland slowly gives way to a climax oak woodland.

As a result of the processes of erosion, deposition, and plant community succession, a mosaic of habitat types of different ages, species compositions, and vegetative structures are continually renewed within the alluvial floodplain. For this to occur, however, the natural erosion-deposition-regrowth cycle must be allowed sufficient breadth and time.

Riparian lands provide a highly suitable and often critical habitat for a wide array of birds, mammals, and other wildlife. State and/or federal threatened or endangered species include the bald eagle, western yellow-billed cuckoo, Swainson's hawk, and the valley elderberry beetle, which is endemic to the Central Valley of California. Species of special concern include the bank swallow and the California hibiscus. The area also provides habitat for raptors, migratory birds, wood ducks, and other waterfowl.

Historically, the Sacramento River was bordered by up to 500,000 acres of riparian forest, with bands of vegetation spreading four to five miles wide. In the last 150 years, agricultural conversion has been the primary factor eliminating riparian habitat. Other land use activities--such as timber and fuel harvesting, channelization, dam and levee construction, bank protection, and streamflow regulation--have altered the riparian system and contributed to vegetation loss. Conversion of riparian



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woodlands by agriculture and urbanization has reduced the present habitat to less than 5 percent of the original acreage. In addition, less than one-half of the original river edge vegetation beneficial to resident and anadromous fisheries production remains.

Several water development and flood control projects have dramatically altered the river's natural flow regime and sediment transport characteristics. These projects have also had major impacts on the lower reaches of the river and its associated riparian habitat. The Central Valley Project includes Shasta, Keswick, and Whiskeytown Dams and the Red Bluff Diversion Dam. The Sacramento River Flood Control Project extends 280 miles south from Chico Landing and includes a series of levees, weirs, and overflow areas. The Sacramento River Bank Protection Project was designed to protect the flood control system between Chico Landing and Collinsville. The Chico Landing to Red Bluff Comprehensive Bank Stabilization Project, designed to control lateral migration (meandering) in this reach, is about 54 percent complete but has not been worked on since 1984.

The quality and extent of riparian vegetation varies with the geology, morphological characteristics, and development along the river. The river can be characterized by four major reaches between Verona and Keswick, discussed below:

| | River Reach | River Mile (RM) |
|---|---|---|
| A. | Verona to Colusa Bridge | RM 80–143 |
| B. | Colusa Bridge to Chico Landing | RM 143–194 |
| C. | Chico Landing to Red Bluff | RM 194–243 |
| D. | Red Bluff to Keswick | RM 243–302 |

A. Verona to Colusa Bridge is highly regulated by a series of weirs and bypasses. Levees are generally constructed near the river's edges, defining a relatively narrow river corridor. This reach represents the most extreme area of riparian habitat loss. A narrow berm supports riparian vegetation in places, but levee maintenance has kept much of this reach devoid of riparian habitat. Infrequently, a small land area occurs between the levees. Some of these lands contain riparian habitat (often degraded), but many have been cleared for agriculture or other uses. Nearly all of the land outside of the levees is farmed. Remnants, usually old oxbow lakes, occur rarely.

B. Colusa Bridge to Chico Landing is bordered on each side by setback levees up to river mile 176, creating wide berms which are characteristic of this reach of the river. Upstream of river mile 176, only one project levee of about 8 miles occurs along the right bank. In 1978, the consulting firm of Murray, Burns, and Kienlen (MBK) identified 38 riparian vegetation sites, mostly within the Colusa Bridge to Chico Landing reach, that were classified as desirable areas for retention of riparian vegetation for flood control. MBK also identified additional sites that should be cleared and managed solely for flood control. Lands between the levees are a mixture of agriculture and riparian habitat. Although farmland accounts for the majority of acreage between the levees, this reach contains substantial remnants of Sacramento Valley riparian forest.

During the 1960s and early 1970s, bank protection (riprap) was constructed only where erosion had advanced across the berms to the point where the project levees were threatened. During the past decade, bank protection work has also been done to protect berms before erosion approaches the levee toe—which also preserves riparian vegetation on the berms. The purpose of bank protection from river mile 176 to 194 is to prevent river cutoffs (to maintain channel length and hydraulic gradient). This helps maintain the water surface elevations during flood events to ensure adequate overflow from the river into Butte Basin. It is critically important to the proper



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functioning of the Sacramento River Flood Control Project to maintain the existing division of flows between the Butte Basin overflow area and the river so that design capacities of the downstream leveed reach are not exceeded. In addition, the bank protection in the Butte Basin area will provide protection for four of the MBK sites identified for retention of vegetation.

C. The Chico Landing to Red Bluff river reach, with a few exceptions, is generally unleveed and contains significant and substantial remnants of the Sacramento Valley's riparian forest. The floodplain shows a long history of erosion, deposition, and channel migration. The river has meandered in deep alluvial soils throughout this reach during recent times.

D. The Red Bluff to Keswick reach is generally unleveed and can be considered stable. Red Bluff to Balls Ferry is a geologically stable corridor containing Iron Canyon and generally nonerodible riverbanks throughout. The river's riparian zone from Balls Ferry to Keswick, especially in the Anderson and Redding areas, is subject to urban encroachment in floodplain areas. River flows in the segment above Cottonwood Creek are highly regulated, and little bank erosion has occurred since Shasta Dam was built. However, a limited amount of riprap has been placed on the riverbank to protect urban structures and roads in recent years.

Those areas of native vegetation that remain between Verona and Keswick Dam (22,000+ acres) occur in parcels from a few acres to several hundred acres in size, primarily between Colusa and Red Bluff. Nearly 3,000 acres have been acquired by public agencies and private conservation groups. Of particular concern is the continuing loss of mature valley oak woodland which occurs in remnant stands on high terrace lands. Both riparian and agricultural high terrace lands are consistently being lost through erosion. Because of the long period of time required for reestablishment of oaks on the newly emerging high terrace lands, the past conversion of these lands to agriculture has precluded the natural pattern of oak woodland regeneration and replacement.

The occurrence of the remaining riparian habitat in fragmented blocks greatly diminishes its ability to support viable wildlife populations. In addition, this remaining habitat is being further degraded by human activity and adverse land uses. The combined loss, fragmentation, and deterioration of riparian habitat has caused, or is leading to, the extinction or elimination of several wildlife species. The drastic decline of the Swainson's hawk, once one of California's most abundant raptors, is in part due to the loss of riparian nesting areas. In 1987, surveys produced such a low number of yellow-billed cuckoos that the species appeared to be in danger of immediate extirpation. The elimination of the bank swallow appears likely if bank protection work continues, and if mitigation measures are unsuccessful. A number of other animal species, as well as some plant species including the California hibiscus, have population viability problems as a result of adverse human impacts on riparian habitat.

## Discussion

In reaches of the river containing a bedrock geomorphology (above Red Bluff), or where the river system has been so altered by flow regulation and levee construction so as to nearly preclude natural physical and biological process from occurring (Verona to Colusa), preserving existing riparian habitat and reestablishing a continuous band of riparian vegetation along the river is a reasonable goal. When feasible, reestablishment of riparian vegetation in remaining floodplain areas should also be pursued. This could include preserving and, if possible, incorporating old oxbows and wetlands that have been cut off from the river into a continuous vegetation corridor.

The most significant area of remaining riparian habitat, as well as the most feasible location for reestablishing a functional Sacramento River riparian ecosystem, is in the Chico Landing to Red Bluff reach.



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Between Chico Landing and Red Bluff, riparian vegetation has an influence on erosion and deposition within the flood plain. In turn, the diversity of streamside vegetation and its overall condition are dependent on these same dynamic river processes. Riparian vegetation effectively creates a buffer to decrease local flood velocities. This increases the deposition of suspended materials derived from eroding banks. It is this erosion–deposition process that builds the mid–terrace and eventually the high terrace lands that support high terrace climax forest and agriculture. Overbank flooding is essential for the continued health of the riparian system. As silt and seeds are deposited during these overbank waterflow events, the native vegetation is rejuvenated.

Within the Butte Basin reach (Colusa to Chico Landing), opportunities for retaining an active meander belt are limited. The Sacramento River Flood Control Project and Sacramento River Bank Stabilization Project will effectively freeze much of the remaining unleveed reach in place. Nevertheless, there are significant habitats adjacent to the river that are in need of long–term protection, including the majority of Murray, Burns and Kienlen sites.

A. What needs to be accomplished.

1) Preserve remaining riparian habitat.

2) Reestablish a continuous riparian ecosystem along the Sacramento River.

   a) Restoration of the riparian system must be accomplished, giving full consideration to local, State, and federally sponsored flood control and bank stabilization programs.

   b) Landowner, public, and local government concerns must be taken into account.

   c) Long–term preservation of the system will require a cooperative comprehensive management program.

B. How these goals can be accomplished.

Develop a Sacramento River Riparian Conservation Plan that will guide the restoration and long–term conservation of a continuous riparian ecosystem consistent with federal and State flood control and bank stabilization projects, and that also has the support and cooperation of affected landowners and local governments.

The Riparian Conservation Plan must include:

1) Management zones and boundaries that take into account natural geomorphologic processes, riparian system dynamics, societal and economical constraints, present and potential future land uses, and the property rights of private landowners.

2) A means of preserving and fostering conservation of existing riparian vegetation and restoring a continuous ecosystem along the river.

3) Appropriate land use policies and management.

## Recommended Solutions

Develop legislation to create, implement, and manage a Sacramento River Riparian Conservation Area from Keswick Dam to Verona.

A. Develop a Sacramento River Riparian Conservation Area Plan

The first step in creating a Riparian Conservation Area is to establish an inner river zone. Delineation of this zone would take into account the river's natural geologic controls and effects on erosion, riparian ecosystem dynamics, existing land uses including agriculture, and structures such as buildings, bridges, and levees that must be protected from bank erosion. Within this zone, the natural river processes of erosion and deposition would be allowed to occur for the most part unhindered by human intervention.

The next step would be to establish an outer boundary which would define the Riparian Conservation Area perimeter. Generally, all lands inside the Riparian Conservation Area would be managed as riparian habitat, but river migration would be allowed only within the inner river zone. When the limits of the inner boundary are reached by lateral river migration, bank stabilization or other previously agreed-upon actions would be implemented (see following map).

The Corps of Engineers, U. S. Fish and Wildlife Service, and Department of Fish and Game, along with other involved agencies and interest groups, should work with landowners in developing the extent of the two management areas. Landowners, agencies, and conservation organizations involved in the development of a Riparian Conservation Plan for the Sacramento River under Senate Bill 1086 have made substantial progress in drafting mutually agreed-upon boundaries.

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

There are a variety of ways to establish the Riparian Conservation Area. Acquisition through direct purchase, conservation easements, and transferring development rights are commonly used by federal and State agencies for the protection of critical habitat areas. However, since some landowners would rather maintain ownership or an unrestricted title to their lands in the Conservation Area, two new programs, a "set-aside" agreement, and tax incentives are included in the conservation plan.

The total area of the Riparian Conservation Area is estimated at approximately 30,000 acres. Based on the 1988 Sacramento River Riparian Atlas, this would be 27,000 acres of existing riparian habitat (State and federal lands included), including native vegetation and exposed gravel bars, and 3,000 acres of agricultural and other lands, including fallow areas and levees.

All of the following implementation options are based upon voluntary landowner cooperation.

1) Set aside agreements between the State and riparian landowners based on an annual per acre payment.

In general, landowners would agree to not develop their riparian lands within the Conservation Area. Land management provisions would be similar to those contained in conservation easements. In some instances, landowners would reserve the right to conduct agricultural related non-commercial activities such as gravel removal for on-farm needs. Landowners would allow deposition and plant growth to take place with a minimum of interference and may choose to actively manage their lands within the Riparian Conservation Area to enhance wildlife habitat in a manner consistent with the comprehensive plan. Landowners would provide access to appropriate individuals as necessary to monitor habitat conditions.



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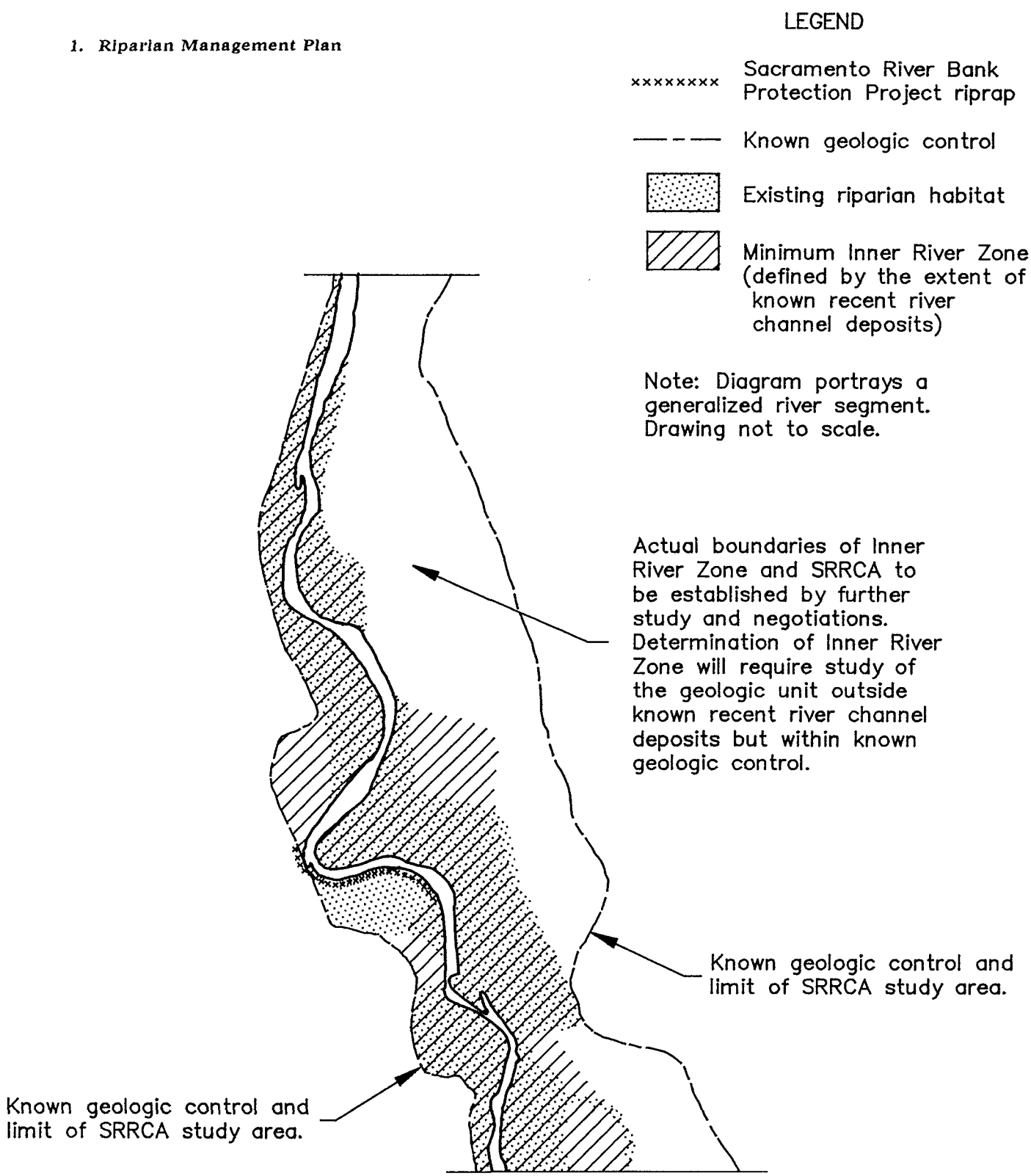


Conceptual Map of the Sacramento River Riparian Conservation Area (SRRCA)

Participation in the agreement by landowners would be voluntary. The minimum participation period would be five years with automatic renewal. To withdraw from participation in the Conservation Area, a landowner must give notice for five consecutive years. Annual per acre payment would be based on a percentage of the appraised fair market valuation of adjoining agricultural land. In the event of change of ownership, participation would vest with the land. The original number of acres included in the set-aside agreement by a landowner would not change with erosion or deposition. If the landowner chooses to sell or transfer the subject property during the set–aside agreement period, the State or a designated land conservation organization shall have a first right of refusal.

2) Seek legislation to encourage riparian conservation and riparian habitat improvement by private landowners through a program of economic incentives that could reduce or eliminate property taxes on riparian lands that are not developed.

Legislation similar to the Oregon riparian tax incentive program, but modified and improved to be more effective and pertinent to California, should be developed as a means of preserving riparian habitat within the Conservation Area. Legislation could be written for a California riparian tax incentive program, using the Oregon program.

The Oregon riparian tax incentive program, created by passage of Oregon Senate Bill (OSB) 397, was enacted to encourage the protection and rehabilitation of privately owned riparian zones. The program is administered by the Oregon Department of Fish and Wildlife (ODFW) and contains two different mechanisms to encourage the maintenance or rehabilitation of riparian areas on privately owned lands. First, OSB 397 provides landowners a property tax exemption for riparian lands that are left undisturbed and protected, and/or enhanced. Landowners who make an agreement with ODFW to preserve riparian areas on their parcel are eligible for a complete property tax exemption on those lands left protected. Second, OSB 397 grants landowners a personal or corporate income tax credit for costs incurred in riparian habitat improvement projects.

To make legislation similar to Oregon SB 397 more effective in California, the economic rewards offered to the landowner must be increased and greater amounts of land should be made eligible for enrollment in the program. The Oregon program can be improved in the following ways for implementation in California:

a) The possibility of property tax relief for landowners who preserve riparian areas in excess of the current taxation rate for those riparian lands should be investigated. For example, landowners who agree to preserve riparian land on their parcel might receive a property tax exemption equal to an equivalent acreage of orchard land.

b) Landowners should be granted a personal or corporate income tax credit for costs incurred in riparian habitat improvement projects.

c) The full extent of riparian lands existing on a parcel should be eligible for enrollment. There should be no restriction on the total amount of riparian eligible for enrollment on a parcel, as currently practiced under the Oregon program.

d) All parcels containing riparian lands should be eligible for enrollment regardless of their zoning designation.

e) There should be no restriction on the number of stream miles enrolled per county per year.



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3) Fee title purchase of parcels from willing sellers.

Acquisition of parcels within the Riparian Conservation Area by federal, State, or private conservation organizations is the most direct method of insuring long-term preservation of existing riparian areas. Results from a "willing seller" questionnaire completed by the Wildlife Conservation Board in 1988 indicate that 62 percent of 109 landowners adjacent to the Sacramento River would be willing to convey a conservation easement or sell their land if the purchase price and conditions of sale are at least fair.

In addition to traditional real estate mechanisms, other innovative approaches are possible. For example, a program is under development by a private resource protection organization which would provide long-term arrangements for acquisition of riparian lands.

4) Protect and restore privately owned riparian lands through conservation easements from willing sellers.

A conservation easement is a nonpossessory interest in real property conveyed by a landowner to another party. The conservation easement usually is a transfer of development rights by the landowner to a qualified government agency or charitable organization. The title to the property remains in the landowner's name and the land may be sold on the open market, subject to the terms and restrictions contained in the easement. The recipient of the easement has the right to enforce compliance with the terms of the easement.

A conservation easement does not necessarily allow any public access; landowners may continue to prevent and prosecute trespass. Additionally, landowners, must continue to pay property taxes on the lands covered by the conservation easement. Conservation easements purchased by the Wildlife Conservation Board or other public agencies are typically less than 50 percent of a parcel's appraised value.

5) Transfer of development rights.

Transfer of development rights (TDR) is a method of transferring potential development from a location where local government wishes to limit development to a location where local government is willing to see increased development. TDRs have been most widely used in California for regulating residential and commercial development activities.

Counties which have significant riparian areas along the Sacramento River system could develop planning policies that include TDRs as a means of regulating development in riparian zones. TDRs could be utilized by local government to relieve development pressures from riparian zones by offering riparian zone landowners development rights in another part of the county. Under a TDR program, a landowner is allowed to sell "development credits" assigned to his or her land by local government. These credits may be purchased and used by a landowner in an area where local government is prepared to allow development at increased densities over what would otherwise be permissible. Counties may realize a net tax increase by participating in a TDR program.

C. Implement a Sacramento River Riparian Conservation Area Management Plan

The Sacramento River Riparian Conservation Area would be a legislated district managed by a governing board created and funded by Congress and the Legislature. The Board will include a balanced representation of participating landowners and public interest groups. The California



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Department of Fish and Game, Department of Water Resources, U. S. Army Corps of Engineers, U. S. Fish and Wildlife Service, other agencies, and local governments would serve in an advisory capacity to the Board, as necessary. A major function of the Board will be to coordinate the various agencies and private organizations to meet the goals of the Riparian Conservation Plan.

The Board would be responsible for the following:

- Protection of existing riparian lands.
- Reestablishment of a continuous riparian corridor along the Sacramento River.
- Management and monitoring of the Conservation Area for the long-term preservation of a viable riparian ecosystem.

The governing board will implement a management plan for the Riparian Conservation Area guided by the following policies and plan elements:

1) The Sacramento River Riparian Conservation Area is for the protection, preservation, and enhancement of riparian vegetation and its wildlife, including rare, threatened, and endangered species.

a) Provide for the recovery of threatened and endangered species.

b) Manage from an ecosystem perspective, taking into account and balancing human-imposed constraints as necessary.

c) Recovery of threatened and endangered species should result in less restrictive regulations related to pesticide use for the protection of these species. The governing board and agencies should work toward exempting agricultural lands outside the Riparian Conservation Area from restrictive spraying regulations aimed at endangered species protection where an adequate buffer zone exists.

2) Reimbursement of Taxes to Local Government

a) Payments in-lieu of taxes should be paid for all land acquisitions. No county or local government should lose revenues by virtue of an increase in public land.

b) Any reduction in revenues to local government that results from landowners maintaining riparian areas should be reimbursed.

3) Public Access

Limit and control access onto public lands. The Riparian Conservation Area is primarily for the preservation of riparian habitat for wildlife. Human activities must be directed to those areas where they will incur the least environmental impact. Trespass could be minimized by:

a) Providing adequate law enforcement personnel to patrol public lands.

b) Public education.

c) Developing a recreation plan for the Sacramento River.



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4) Construct and maintain bank stabilization as required by the Sacramento River Riparian Conservation Area Plan.

Construction of bank protection projects has resulted in a loss of riparian habitat along the Sacramento River and its tributaries during the past 20 years. Almost all bank protection work along the Sacramento River has been done with rock riprap and has resulted in the direct loss of riparian vegetation and its associated wildlife values. Most bank protection projects consist of clearing vegetation from a strip of land wide enough to allow the bank to be excavated to a slope of 1 foot vertical to 2 feet horizontal or flatter in order to ensure stability of the bank protection. The bank is sloped to the channel thalweg (lowest point), which requires that a strip of land approximately 75 feet wide be cleared (assuming a 25-foot-high eroded bank) to allow construction.

a) Where the need for bank stabilization is identified in the Riparian Conservation Plan, the use of the least environmentally damaging technique shall be required. Bank stabilizations should be constructed with techniques found to be engineeringly, environmentally, and economically feasible. Alternatives should be selected to reduce the direct construction impacts to riparian areas and which could lead to the creation of new areas to be vegetated with native plant species. The alternative methods would be determined on a site-specific basis and could be either a palisade type, a form of biotechnical construction method, riprap placement from water access rather than land access, or other methods.

b) Encourage and promote further research and evaluation of palisade and biotechnical methodologies. Mitigation efforts by agencies affecting riparian resources need to be consistent and coordinated in an overall comprehensive river management plan.

Past revegetation of project sites and associated easements have failed, primarily due to inadequate maintenance of plants. Other reasons include: lack of contractor supervision, lack of protection for new plantings, poor species choice, environmental easements remaining unmarked and unsigned, and a lack of communication between the maintenance agencies, the landowners, and reclamation district. An interagency Mitigation Task Force, established in 1987, is attempting to resolve these and other problems related to bank stabilization projects. The following mitigation guidelines should apply to the Conservation Area:

- Mitigation is, under both State and federal law, an integral part of any bank stabilization project and shall therefore be authorized and funded as part of the project.

- Project impacts shall be minimized to the greatest extent possible. This can, in large part, be accomplished through careful planning. Unavoidable adverse impacts to riparian areas must require on-site replacement, with no net loss in habitat value or acreage of riparian habitat. Off-site mitigation should be considered only if on-site mitigation is physically impossible. Off-site mitigation should be provided in advance of construction.

- Construction agencies shall provide mitigation to compensate for construction activities completed prior to enactment of NEPA/CEQA. Construction agencies shall reevaluate completed projects to determine whether mitigation was provided for, adequate, or successful. Additional authority and funding may be required to rectify the present situation.



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- o Agencies responsible for conducting emergency bank stabilization activities need to make sure that work is done in the most environmentally sensitive manner possible. Mitigation to offset lost habitat shall be provided in the same manner as for normal project mitigation.

5) Revegetation

Remaining riparian lands or abandoned agricultural lands suitable for restoration were identified and prioritized under the Fish and Wildlife Service's Sacramento River Refuge Plan and under the Riparian Atlas authorized by SB 1086. Additionally, opportunities exist for revegetation of levees and revetted areas where present maintenance activities discourage the growth of almost all vines, shrubs, and trees. Revegetation and vegetation maintenance policies within the Riparian Conservation Area should include the following:

a) Allow for natural revegetation within the Riparian Conservation Area where the river's influence and adjacent seed sources will allow revegetation to occur within a reasonable period of time. Implement an aggressive revegetation plan to reestablish valley oak woodlands on high terrace lands and to reconnect fragmented riparian habitats.

b) The Corps of Engineers should revise their nationwide maintenance practice regulations (Title 33) specifically for the Sacramento system and adopt the Reclamation Board's less restrictive "Interim Guide for Vegetation on Flood Control Levees Under Reclamation Board Authority." Alternatively, the Corps could write a supplement to the Operation and Maintenance Manual that is specific to the Sacramento River, incorporating information from the Reclamation Board's guide. The Corps will require completion of ongoing studies before revisions are undertaken.

c) Encourage an integrated management approach to vegetation control that makes use of selective applications of herbicides and fire, combined with hand clearing and mechanical work. Prohibit the practice of indiscriminate control of vegetation by burning and herbicides, which often result in the unnecessary destruction of vegetation. Additionally, a range of maintenance standards should be developed, depending on the land use adjacent to the river and the risk associated with structural failure at a specific site.

6) Conservation and management of privately owned riparian lands through grants, education, and technical assistance.

a) The board should administer a Riparian Lands Restoration Program, similar to the Urban Streams Restoration Program, encouraging landowners to apply for available grant money for riparian restoration and enhancement on their riparian properties.

The objective of this program would be to assist riparian land owners, through monetary grants and technical assistance, with riparian restoration and enhancement work on their property. The Riparian Lands Restoration Program would be operated similar to the Urban Streams Restoration Program presently administered by the Department of Water Resources. Landowner-initiated projects receiving funding through the program might include fencing or irrigating riparian areas, revegetation work, and floodplain management. Project proposals demonstrating a strong sense of land stewardship and management on the part of the landowner would be encouraged.



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b) Riparian conservation concepts and proper management techniques should be actively promoted by the University of California Cooperative Extension Program, the U. S. Soil Conservation Service, relevant State and federal agencies, the Farm Bureau, and conservation organizations.

The University of California Cooperative Extension Program should work with the Soil Conservation Service, the Farm Bureau, and other appropriate agencies to develop an educational and technical assistance program to conserve privately owned riparian areas. The Department of Water Resources and the Department of Fish and Game could provide technical assistance in the program. These programs could assist local government in riparian zone management plans and policies. These programs would also be available to individual riparian landowners seeking assistance and advice on riparian land management methods and techniques. The University of California Cooperative Extension Program should encourage the community college system to offer courses on riparian zone land management techniques and other appropriate means of land stewardship to conserve riparian vegetation.

## Estimated Costs

| | Costs |
|---|---|
| A. Develop the Sacramento River Riparian Conservation Area Plan. | |
| Conduct studies necessary to establish inner river zone and Conservation Area boundaries. Complete planning necessary to identify boundaries, estimate costs, and develop legislation needed to implement the Sacramento River Riparian Conservation Area Plan. | $500,000 |
| B. Establish a Sacramento River Riparian Conservation Area from Verona to Keswick by direct purchase, conservation easements, transfer of development rights, set-aside agreements, tax incentives. | |
| Current riparian habitat land values on the upper Sacramento River are between $500 and $2,000 an acre. Variations in price are primarily based on accessibility and feasibility of agricultural development. Much higher figures have been speculated on by owners of high-value parcels. Total acreage of riparian lands to be incorporated in the Conservation Area is estimated at 30,000. Acquiring one-half of this total (15,000 acres) at 1988 values would be about $22.5 million. If this amount is broken down over a 20-year period, the annual cost would be $1.12 million. | $22,500,000 |
| Set-aside and tax-incentive programs are expected to cost a percentage of appraised value annually (approximately $100-300/year/acre). If 15,000 acres were placed in a set-aside program, this would result in an annual cost of $3 million. | $3,000,000/yr |



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C. Implement a management plan for the Sacramento River Riparian Conservation Area.

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| Governing Board of Directors' annual expenses. | $150,000/yr |
| Agencies would be responsible for covering their own costs. Primary expenses would be for reimbursement of Board members' out-of-pocket costs and clerical and technical support. | |
| 1) Manage for the recovery of State and federal listed species. | 0 |
| 2) Reimbursement of taxes to local government . | |
| a) Payments in-lieu of taxes to local government (15,000 acres @ 1%). | $225,000/yr |
| 3) Public Access | |
| a) and b) Provide for public education and personnel to patrol public lands. | $100,000/yr |
| c) Develop a Sacramento River Recreation and Access Plan (covered under "A. Develop the Sacramento River Riparian Conservation Area Plan"). | |
| 4) Construct bank stabilization, as indicated by the Sacramento Riparian Conservation Area Plan | |
| a) and b) Require the use of alternatives to land-side placement of rock riprap revetment where feasible and encourage continued research on biotechnical, and other methodologies. Include adequate mitigation palisades for all projects. | $10,000,000 |
| Estimates for bank protection, depending on method and required mitigation, range from $200 to $400 per linear foot. This equates roughly to a cost between $1 and $2 million per linear mile, plus annual maintenance; $10,000,000 is a rough estimate, subject to revision after completion of the Riparian Conservation Plan. | |
| Annual maintenance cost | $200,000/yr |
| 5) Revegetation | |
| a) Monitor natural revegetation and initiate a program of restoring riparian habitat. | $150,000/yr |
| b) Adopt Reclamation Board's standards for maintenance of levees and revetted sites. | 0 |
| c) Encourage an integrated management approach to vegetation control (may incur an increased cost to some local levee maintenance districts). | 0 |
| 6) Riparian Conservation Program | |
| a) Implement and administer a Riparian Lands Restoration Grant Program. | $250,000/yr |
| b) Establish a Riparian Landowner Education and Technical Assistance Program. | $ 50,000/yr |
| Total Initial Costs | $33,000,000 |
| Total Annual Costs | $4,125,000 |



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## Estimated Benefits

Reestablishment of a viable riparian ecosystem along the upper Sacramento River will increase the acreages and variety of riparian habitats and reverse the decline in wildlife, fishery, and human use values.

A continuous riparian ecosystem would: (1) provide essential habitat for State and federal candidate, threatened, and endangered species; (2) increase wildlife populations, including waterfowl and numerous migratory bird species dependent on riparian habitat; (3) contribute to the productivity and ecological stability of the river system on which salmonids and other fish depend; and (4) preserve overall habitat values that are recognized as having critical importance on a State and national level.

Obtaining the above benefits could lead to other positive consequences. Increased and enhanced riparian habitat would probably halt the decline of listed species and could cause population increases leading to delisting of these species. Establishment of a Riparian Conservation Area managed in part for the recovery of listed species may eventually result in less restrictions on the use of agricultural chemicals for the protection of listed species by adjacent landowners. Increased fish and wildlife populations could also provide landowners with an income from hunting and fishing. Additionally, it will provide a quality recreational river experience which may provide enhanced revenues to local economies.

Reduced conflict between resource management agencies and landowners and guaranteed boundaries to agricultural operations protected from erosion and upstream and downstream mismanagement are secondary benefits. Riparian vegetation within the Conservation Area would also reduce floodflow damage to adjacent lands and retard bank erosion better than nonriparian river banks.

## Potential Conflicts and Resolution

Unless there is adequate compensation for the loss of property taxes for lands acquired, counties will suffer a reduction in revenue due to an increase in public lands. Payments in-lieu of taxes or their equivalent should be paid on all State and federal acquisitions. Proposed increases in federal subventions to local government are presently under review by Congress. Legislation will be required to provide payments in-lieu of taxes for lands acquired by the State. This must include a mechanism for keeping in-lieu payments current with prevailing tax rates on private land. Payments in-lieu of taxes paid on lands acquired by the State should come from the general fund and not the budget of resource management agencies. Additionally, revenues lost because of granted tax exemptions or incentives should be reimbursed to local government.

Problems associated with public access and trespass are major concerns with area landowners, conservation groups, and agencies. A focus of the Riparian Conservation Plan is to develop and manage specific public access and recreation areas and severely limit and control public trespass on private and public lands. However, present staffing does not permit adequate monitoring, maintenance, and law enforcement on some public land. User fees and/or legislated monies should be established to help cover enforcement and management costs.

For the middle river, the Riparian Conservation Area Management Plan solution is an alternative to the Chico Landing to Red Bluff Comprehensive Bank Stabilization Plan. Although the use of bank stabilization to protect farmland and the development of a continuous band of riparian vegetation will help slow bank erosion, the proposed action will not attain the downstream flood control benefits attributable to the Corps of Engineers' Chico Landing to Red Bluff Plan. The Corps' involvement in the new plan may require new congressional authorization due to a reduction in flood control benefits.



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This reduction may be balanced with an increase in benefits to fish, wildlife, and people. If new congressional authorization is not forthcoming, the alternative would be State authorization and funding.

Consistency and reliability of funds for establishment of a Riparian Conservation Area are extremely important. If landowners allow erosion to occur on their land, there must be guarantees that government agencies will follow through with adequate funding to assure fulfillment of prior agreements. Alternatively, sufficient penalties should be adopted to discourage arbitrary withdrawal from set-aside or tax-incentive programs by landowners.

Acquisition of parcels can be difficult for a variety of reasons. It is sometimes difficult to separate riparian areas from agricultural lands through purchase due to a mortgage holder's interest in the property or zoning restrictions. This means that some properties are not candidates for acquisition, or acquiring the riparian parcel may require purchasing the entire property. Many landowners fear the loss of riparian water rights if their waterside riparian land is separated from the remainder of their property. Reservation of water rights to adjoining lands can be retained if they are included in the deed. Finally, appraisals must take into account the complexity of farm economies.

Because the Riparian Conservation Area will be adjacent to populated areas in some instances, public health and safety considerations must be considered in management decisions.

## Implementation

Congress and the State Legislature should designate the boundaries agreed upon in the planning process as defining a Sacramento River Riparian Conservation Area and set guidelines for establishing its Board of Directors. Establishment of a riparian set-aside program, tax incentives, and credits will also require legislative actions and guidance. Direct purchase and conservation easements for the preservation and restoration of riparian lands can be implemented by local governments, State and federal agencies, and private conservation groups.

Landowners, agencies, and interested parties should continue to cooperatively develop the Conservation Area boundaries and refine policies and key issues. The Corps and the Department of Water Resources would provide needed expertise in river geomorphology, planning, and economics.

A set-aside program would be administered by an agency designated by the Legislature and Congress. Both a set-aside program and tax credit/incentive programs would need to be carried out in cooperation with the State's resource management agencies.

Educational and technical assistance programs would be developed through the University Extension Program, the Soil Conservation Service, the Farm Bureau, community colleges, the Departments of Fish and Game and Water Resources, and conservation organizations.

## Special Funding

Presently, the U. S. Fish and Wildlife Service and the California Wildlife Conservation Board are actively seeking to acquire conservation easements or fee ownership of high-priority riparian lands under the Sacramento River Wildlife Refuge ($3 million) and Proposition 70 ($4 million) funding, respectively. The Wildlife Conservation Board has additional variable funding from Environmental License Plate Funds for Threatened and Endangered Species, public access, and wildlife restoration funds.

The National Audubon Society, Nature Conservancy, and other private conservation groups also have programs for acquiring high-priority parcels. The Reclamation Board has $700,000 to acquire Murray, Burns and Kienlen sites on the Sacramento River this year.



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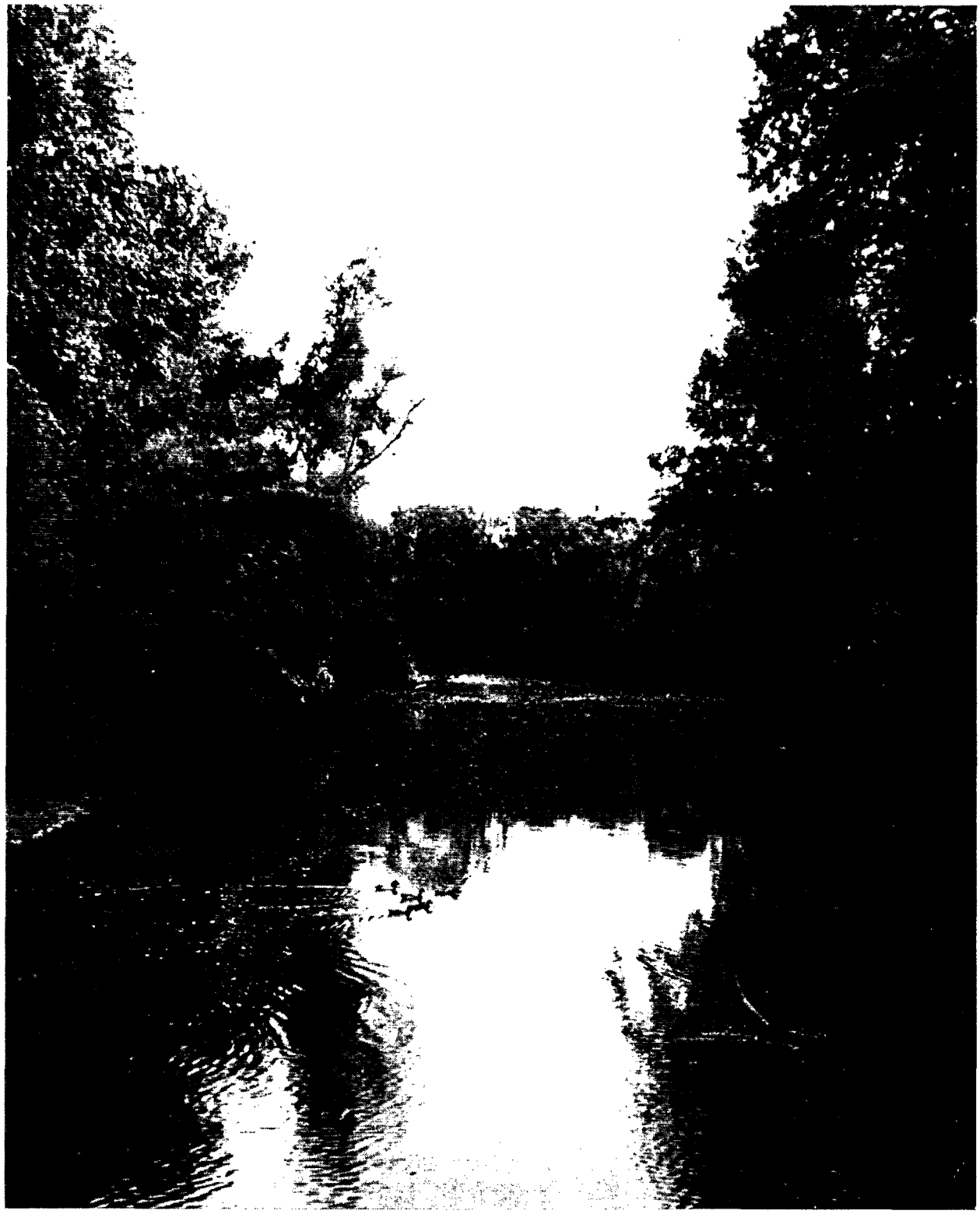

*Essentially all Sacramento River tributaries support a ribbon of riparian vegetation, which is vital habitat for many wildlife species.*



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# Riparian Habitat Preservation on Sacramento River Tributary Streams

## Purpose

The purpose of this action is to preserve remaining riparian habitat and restore high-quality riparian ecological systems on Sacramento Valley tributary streams.

## Background

Historically, bands of riparian vegetation paralleling tributary streams of the Sacramento River extended to about the 100-year flood line, or spread out into tule marsh "sinks." It is estimated that 800,000 to 1,000,000 acres of riparian land existed in the Sacramento River Valley prior to the arrival of early settlers. These riparian areas averaged 400,000 to 500,000 acres along the Sacramento River, with approximately the same amount existing along tributary streams in the Sacramento Valley. Riparian bands were typically two miles wide along tributary streams. Approximately 85 to 95 percent of the historical extent of riparian vegetation existing on Sacramento River tributary streams was lost to agricultural conversion, urbanization, channelization, bank and levee protection, impoundments, timber and wood-fuel harvesting, road building, and other land development activities. Those riparian areas that remain are, in large part, degraded by livestock grazing, reduced or diverted river flows, flood channel and levee maintenance activities, gravel mining, and agricultural practices. Some activities, such as cattle grazing and bank protection maintenance, not only degrade habitat quality, but directly suppress regeneration of the riparian plant community.

## Discussion

The riparian plant community has a significant influence on the stream environment. Therefore, stream depth, current velocity, substrate composition, cover, temperature, nutrient input, and bank stability, as well as other important factors, can change dramatically when the riparian plant community is altered. Riparian vegetation also provides a wide variety of high-quality habitats, including extensive areas of successional riparian plant communities, ecologically diverse edge, and a complex aquatic/vegetation interface. Riparian lands remaining in the Sacramento Valley provide critical wildlife habitat for several species of particular concern, including the bank swallow, chinook salmon, the endangered western yellow-billed cuckoo, the threatened valley elderberry longhorn beetle, and the endangered bald eagle.

What needs to be accomplished:

1. Preserve what riparian vegetation remains.
2. Restore remaining riparian vegetation to high quality habitat.
3. Restore lands that have been put into other uses.
4. Conserve remaining riparian vegetation through appropriate land stewardship on those lands remaining in private ownership.



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How these goals can be accomplished:

1. Legislation to encourage riparian conservation by landowners through economic incentives.
2. Direct purchase of riparian areas and potential riparian restoration areas.
3. Appropriate land use policies and management, including:
   a. Conservation easements
   b. Land use zoning
   c. Riparian zone management plan
   d. Alternative bank protection techniques
   e. Setback levees
   f. Modified levee operation and maintenance procedures
   g. Restore riparian areas within project levees
4. Volunteer labor and public education programs:
   a. Community–based environmental groups
   b. Private lands riparian restoration program
   c. Educational and technical assistance programs

## Recommended Solutions

The best circumstances may result from implementation of all the proposed solutions. Collectively, the recommended solutions will substantially reduce or eliminate the amount of riparian vegetation on Sacramento River tributaries lost to incompatible land uses.

1. Seek legislation to encourage riparian conservation and riparian habitat improvement by private landowners through a program of economic incentives that will reduce or eliminate property taxes on riparian lands that are left in an undisturbed condition.

   Several states, including Oregon, California, and Indiana, have implemented programs which either reduce or eliminate property taxes on lands that contain important riparian areas, agricultural soils, wildlife habitat, or wetlands. A policy for California riparian zones and wetlands could be implemented to preserve these areas throughout the State, including tributary riparian zones in the Sacramento Valley. The programs described below are examples of how a California riparian tax incentive plan might be utilized.

   a. The Oregon Riparian Tax Incentive Program

      Legislation similar to the Oregon Riparian Tax Incentive program, but modified and improved to be more effective and pertinent to California, would be the most appropriate means of preserving riparian habitat on Sacramento River tributary streams. Legislation could be written for a California riparian tax incentive program, using the existing programs as a model, with improved legislation similar to the Oregon program the ideal goal.



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The Oregon Riparian Tax Incentive program, created by passage of Oregon Senate Bill 397, was enacted to encourage the protection and rehabilitation of privately owned riparian zones. The program is administered by the Oregon Department of Fish and Wildlife and contains two different mechanisms to encourage the maintenance or rehabilitation of riparian areas on privately owned lands.

1) OSB 397 provides landowners a property tax exemption for riparian lands that are left undisturbed and protected and/or enhanced. Landowners who make an agreement with the Oregon DFW to preserve riparian areas on their parcel are eligible for a complete property tax exemption on those lands left protected.

2) OSB 397 grants landowners a 25-percent personal or corporate income tax credit for costs incurred in riparian habitat improvement projects.

Because of excessive regulations governing the amount of land eligible for inclusion in the program, and the relatively small tax credit granted for riparian habitat improvement projects, the Oregon Riparian Tax Incentive program has not been as successful as originally was hoped for. For example, landowners are restricted from enrolling riparian areas that extend outward more than 100 feet from the water's edge, all parcels enrolled in the program must be zoned either for agriculture or timber production, and no more than 100 miles of streams per year can be enrolled in any one county.

To make legislation similar to Oregon SB 397 more effective in California, the economic rewards offered to the landowner must be increased, and greater amounts of land should be made eligible for enrollment in the program. The Oregon program can be improved in the following ways for implementation in California:

1) The possibility of property tax relief for landowners who preserve riparian areas in excess of the current taxation rate for those riparian lands should be investigated. For example, landowners who agree to preserve 20 acres of riparian land on their parcel might receive a property tax exemption equivalent to 20 acres of orchard land.

2) Landowners should be granted a personal or corporate income tax credit for all costs incurred in riparian habitat improvement projects.

3) The full extent of riparian lands existing on a parcel should be eligible for enrollment. There should be no restriction on the total amount of riparian lands eligible for enrollment on a parcel, as currently practiced under the Oregon program.

4) All parcels containing riparian lands should be eligible for enrollment regardless of their zoning designation.

5) There should be no restriction on the number of stream miles enrolled per county per year.

b. The California Williamson Act

The Williamson Act, implemented by the State of California in 1965, provides an incentive for owners of agricultural land to keep that land in agricultural production. The Williamson Act also provides tax benefits for non-agricultural open space, wildlife habitat, and recreational land. An amendment to the Williamson Act, one that will provide the riparian landowner with the same economic incentives available to the agricultural landowner, would be a workable and relatively easy-to-achieve goal for preserving private land riparian environments.



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The Williamson Act works by allowing local governments to assess agricultural landowners, and in the proposed amendment, riparian landowners, based upon the income-producing value of their property, rather than the "highest and best use" value which had previously been the rule. Participating counties are then reimbursed by the State of California through the State general fund for the loss of property taxes that the county would have realized if the property had been assessed at its highest and best use value. There is strong support for the Williamson Act among local government, participating farmers and ranchers, and the general public.

c. The Indiana Classified Wildlife Habitat Act

The Indiana Classified Wildlife Habitat Act was implemented by the State of Indiana to preserve sensitive and critical wildlife habitat areas throughout the State. The Act works by allowing landowners of sensitive and critical habitat areas the opportunity to reduce the property taxes on those lands to $1.00 per acre. The Act is voluntary and the landowner can withdraw his property from the program at any time. Sensitive and critical habitat areas are classified by the Indiana Division of Fish and Wildlife and can include wetland areas if they qualify.

2. Complete a Sacramento Valley tributary riparian zone inventory as the first step in obtaining conservation easements or purchasing remnant riparian areas. This work could be completed by one of several agencies and organizations, including the University of California or State University system, the California Department of Fish and Game, and the California Department of Forestry and Fire Protection.

3. Protect and restore privately owned riparian lands through conservation easements or direct purchase.

a. Conservation Easements

A conservation easement is a non-possessory interest in real property conveyed by a landowner to another party, either by grant or payment of a fee. The conservation easement usually is a transfer of development rights by the landowner to a qualified government agency or charitable organization. The title to the property remains in the landowner's name, and the land may be sold on the open market, subject to the terms and restrictions contained in the easement.

The conservation easement could be utilized to protect and restore privately owned riparian lands through property grants to appropriate State or federal agencies. Conservation easements are generally written "in perpetuity," meaning that an easement is usually operative for a period of unlimited duration.

Affirmative easements grant the landowner certain rights in the property, such as hunting and fishing access. Affirmative easements can also allow specific commercial uses of the property, such as grazing or crop production, if the land is managed properly.

Easements should be tailor-made for each land use situation. They can be written as simply or as detailed as desired, but to be the most enforceable legally, they should be written very specifically, clearly stating exactly what resources are to be protected with the easement.

The recipient of the easement has the right to enforce compliance with the terms of the easement. When land controlled by an easement is sold or transferred, the new landowners are bound by the terms and restrictions of the easement.



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b. Purchase Riparian Areas

Remnant riparian areas considered to be in need of preservation could be preserved through direct purchase by public agencies or private groups. For example, the Wildlife Conservation Board operates by purchasing, at the fair market value, significant environments in need of preservation. Once an inventory of remnant riparian areas is completed, this and other organizations could purchase those areas that deserve this type of attention.

Results from a "willing seller" questionnaire completed by the Wildlife Conservation Board this year indicate that 62 percent of 109 landowners adjacent to the Sacramento River would be willing to convey a conservation easement or sell their land if the purchase price was at least fair. While these statistics represent only those landowners along the main stem Sacramento River, they can be used as an indication of the number of potential willing sellers located along Sacramento Valley tributary streams.

4. Establish a Riparian Lands Restoration program, similar to the Urban Streams Restoration program, encouraging landowners to apply for available grant money for riparian restoration and enhancement work on their riparian properties.

The objective of this program would be to assist riparian landowners, through monetary grants and technical assistance, with riparian restoration and enhancement work on their property. The Riparian Lands Restoration program would be administered in a manner similar to the existing Urban Streams Restoration program. Landowner-initiated projects receiving funding through the program might include bank stabilization projects incorporating bioengineering methodologies, drip-irrigating riparian areas now removed from streams, revegetation work, and floodplain management. Project proposals demonstrating a strong sense of land stewardship and management on the part of the landowner would be encouraged.

5. Local governments and State agencies should cooperate in developing riparian protection and restoration plans for all major tributaries by means of streamside-riparian zoning, transfer of development rights, and riparian habitat management plans.

The State of California's Office of Planning and Research could make it statewide policy under the conservation and open space elements of the general plan guidelines that cities and counties develop and implement riparian zone management plans.

a. Streamside-Riparian Zoning

Local governments could implement a program of "performance zoning" in riparian areas. Unlike more traditional forms of zoning, which separate incompatible land uses outright, performance zoning in riparian areas would allow most land uses, as long as the established performance standards for those land uses were met. These performance standards might include retaining all or the majority of riparian vegetation at a site, eliminating any potential for bank erosion, retaining vegetation-supporting wildlife species of special concern, and retaining existing water quality standards along streams near the site. Performance zoning does not prohibit development in riparian areas. Rather, it allows for creative and environmentally benign development and land uses to take place, as long as the riparian resource is not significantly disturbed. Performance zoning is consistent with general plan goals and objectives for protecting riparian vegetation in the six counties in the upper Sacramento Valley. Although many of the six counties in the upper Sacramento Valley list the conservation of riparian vegetation as part of their general plan goals and objectives, only Butte and Shasta Counties actively regulate land uses through zoning or permit conditions well enough to effectively conserve riparian vegetation.



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b. Transfer of Development Rights

Transfer of development rights (TDR) is a method of transferring potential development from a location where local government wishes to limit development to a location where local government is willing to see increased development. TDRs have been most widely used in California for regulating residential and commercial development activities.

Counties which have significant riparian areas along Sacramento River system tributaries should develop planning policies that include TDRs as a means of regulating development in riparian zones. A TDR could be utilized by local government to relieve development pressures from riparian zones by offering riparian zone landowners development rights in another part of the county. Under a TDR program, a landowner is allowed to sell "development credits" assigned to his or her land by local government. These credits may be purchased and used by a landowner in an area where the local government is prepared to allow development at increased densities over what would otherwise be permissible.

c. Riparian Habitat Management Plan

Similar to recent efforts by the Department of Fish and Game to protect and enhance critical winter deer ranges in the State, DFG could pursue similar efforts to protect and enhance sensitive riparian zones throughout the State. Riparian zones would have to be inventoried and evaluated before a management plan is established. The establishment of a management plan would increase significantly the advisory role DFG would have in county-level land use planning. It would also increase communication between county land planners and DFG concerning the management and protection of riparian zones. The riparian zone management plan would not be regulatory in nature. It would be utilized as a guide and serve as a policy statement reflecting the desired goals for managing riparian zones throughout the State.

6. Encourage conservation and proper management of privately owned riparian lands through education and technical assistance. Riparian conservation concepts and proper management techniques should be actively promoted by the University of California Cooperative Extension program, the Soil Conservation Service, relevant State and federal agencies, the Farm Bureau, and conservation organizations.

   The UC Cooperative Extension program should collaborate with the Soil Conservation Service, the Farm Bureau, and other appropriate agencies to develop an Educational and Technical Assistance program to conserve privately owned riparian areas. The Departments of Water Resources and Fish and Game could provide technical assistance in the program. These programs could assist local government in riparian zone management plans and policies. These programs would also be available to individual riparian landowners seeking assistance and advice on riparian land management methods and techniques. Information on the effects that herbicide over-spray and fire have on the riparian community would be especially beneficial to the riparian landowner, as well as adjacent landowners. The UC Cooperative Extension program should encourage the community college system to offer courses on riparian zone land management techniques and other appropriate means of land stewardship to conserve riparian vegetation.

7. Encourage the use and further study of alternatives to rock riprap as bank protection techniques in both project and nonproject tributaries.

   Bioengineering techniques for stream and riverbank protection should be promoted in all project and nonproject tributaries. Rock riprap reduces or eliminates riparian vegetation. The elimination of riparian vegetation at the water's edge reduces critical habitat and cover for fish and wildlife.



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Rock riprap also reduces gravel recruitment to streams critical for the regeneration of spawning gravels for salmon.

Vegetated gabions, palisades, woven fences of organic material, brush mattresses, willow and cottonwood plantings, and branch packings have all proven to be successful in stabilizing streambanks. These techniques are environmentally benign, compared to rock riprap, and are significantly less expensive to construct. Bioengineering techniques could be utilized by the Reclamation Board, local flood control districts, landowners, and community-based stream-restoration groups.

Stream improvement and restoration groups have received grants from the DWR Urban Streams program to work on local streams. They have utilized many bioengineering techniques, with the advice of DWR experts, to stabilize banks and improve fish habitat. Bioengineering techniques for stream and bank protection are often both environmentally and economically superior to rock riprap in many instances.

8. Where possible, reconstruct existing U. S. Army Corps of Engineers-designed flood control projects with setback levees to allow for both the adequate passage of floodwater and reestablishment of the riparian community.

   Corps of Engineers-designed flood control projects have removed significant amounts of riparian vegetation on Sacramento River tributary streams. The replacement of existing levees with setback levees will allow for the reestablishment of the riparian community within the floodplain of the stream. The amount of setback given each stream would vary, depending on specific environmental conditions, but the potential for reestablishing the riparian community would increase considerably over the potential that now exists.

   Setback levees would be designed to pass the same flow that the existing levee system passes. The difference in the two is that a setback levee would provide a wider channel, allowing the stream to carry its design flow capacity in the presence of naturally occurring or managed riparian plant communities. Riparian vegetation also provides a high degree of bank stabilization and protection.

9. Change operation and maintenance procedures for project tributaries to allow for the retention of riparian vegetation where this would not significantly interfere with channel capacity. Restore riparian areas contained within Corps of Engineers' tributary flood control projects.

   Operation and maintenance procedures for project levees include mowing, cutting, burning, and spraying riparian vegetation to suppress its growth and development, and excavation of the stream channel. This type of levee maintenance is expensive and requires constant attention, while also proving to be a significant impact to fisheries and wildlife. Levee systems void of riparian vegetation benefit fish little and provide little for fish in terms of cover from wildlife predators or shade. Operation and maintenance schedules for project levees should be modified to allow for the retention of riparian vegetation where it will benefit fish and wildlife and not interfere significantly with the channel's ability to pass high water.

   Several actions can be taken to restore and revegetate Corps of Engineers' flood control projects. A significant action would be to restrict livestock grazing within project areas. Efficient management of livestock grazing within project areas will increase the rate at which riparian vegetation reestablishes itself within the floodplain. Livestock prevent vegetation from reestablishing itself through crushing and trampling of the vegetation and soil, while also accelerating erosion on levees and streambanks. Barbed wire fencing would work best in excluding cattle from riparian areas, while still allowing access to wildlife.



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Proper management of livestock grazing between project levees will also increase the water quality within project streams and promote more widespread ecological diversity within the levee system.

## Estimated Costs

| | | |
|---|---|---|
| 1. | Seek legislation to encourage riparian conservation by private landowners through a program of economic incentives and land management policies. | 0 |
| 2. | Inventory extent of riparian and potential riparian restoration sites on Sacramento River tributaries in the Sacramento Valley. | $200,000 |
| 3a. | Protect and restore privately owned riparian lands through conservation easements. | Unknown, pending inventory of riparian sites |
| 3b. | Purchase and retain or restore significant remnant riparian areas. | |
| 4. | Implement and administer a Riparian Lands Restoration Grant Program. (Cost covered in a Comprehensive Management Plan for the Sacramento River Riparian System). | 0 |
| 5. | Establish local and State plans for the protection and restoration of all major tributaries. | $100,000 |
| 6. | Establish a Riparian Landowner Educational and Technical Assistance Program. (Cost covered in a Comprehensive Management Plan for the Sacramento River Riparian System) | 0 |
| 7. | Encourage the use and further study of alternatives to rock riprap | 0 |
| 8. | Where possible, reconstruct existing U. S. Army Corps of Engineers–designed flood control projects with setback levees alternative (generally undertaken as an alternative to repairing existing levees). | * |
| 9. | Change operation and maintenance procedures for project levees to allow for the retention of riparian vegetation where this would not significantly interfere with channel capacity | 0 |
| | Restore riparian areas contained within Corps of Engineers' tributary flood control projects | $200,000 |
| | Total Initial Costs | $500,000 |

*Indicates that cost incurred will be largely offset by reduced maintenance cost over the life of the project.

## Estimated Benefits

The overall objective of the recommended solutions is to preserve remaining riparian vegetation, restore degraded riparian areas into high quality habitat, and restore lands previously developed for other uses back to high-quality riparian habitat. Benefits to the salmon and steelhead fishery will result by implementing the recommended solutions. Fish habitat will be improved through decreased water temperatures as a result of increased shading. Wildlife habitat in the Sacramento Valley will be improved tremendously, including habitat for threatened and endangered species. Streambank stability



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will increase as the riparian community becomes established. Additional benefits include a significant reduction in the costs of bank protection and fishery restoration work.

## Potential Conflicts and Resolution

Any proposed changes in land use and land use policies in riparian areas are likely to be met with skepticism, and perhaps opposition, by affected landowners. Negotiated agreements with landowners must not imply a loss of land without just compensation.

Landowners affected by any proposed performance zoning ordinances will be compensated for losses in property values if those losses constitute a "taking." Zoning is a power of local and State government granted by a U. S. Supreme Court decision in the early 1900s. Zoning grants government the right to protect public resources and private landowners from incompatible land uses through land use regulations and policies.

The establishment of a California riparian tax incentive program will require new State legislation and possibly an amendment to the State Constitution.

Proper funding must be allocated to agencies charged with implementation and administration of the proposed programs. Counties will suffer a reduction in revenue due to an increase in public lands unless there is adequate compensation for the loss of property taxes. Proposed increases in State and federal subventions to local governments are presently under review by the Legislature and Congress.

Proponents of Oregon SB 397 successfully argued that this tax exemption was a shift in the property tax base and not a gift to the landowner. Taxes lost because of granted exemptions would be made up by slightly higher taxes on other lands within the taxing district. Because of Proposition 13 limitations, this would not be feasible in California. Reduced property tax revenue would have to be offset by the State.

In its current form, the Oregon Riparian Tax Incentive program has not been highly successful. The Oregon program could be improved primarily by increasing the economic incentives for enrolling and the conditions set for enrollment. If a tax incentive program is selected, legislation should be written utilizing the Oregon program as the primary model, as well as the Indiana program and the California Williamson Act as guides, improving on these programs to design a successful California riparian tax incentive program.

## Implementation

Implementation of the recommended solutions would be through a wide range of government agencies and organizations. Conducting a Sacramento Valley tributary riparian inventory and establishing a general plan for the acquisition of land to preserve Sacramento Valley riparian areas should be directed by a multiagency team coordinating with the Sacramento River Riparian Conservation Area Board.

1. DFG and The Resources Agency should work with the Legislature in developing programs and policies to protect and conserve riparian lands.

2. Conservation easements could be utilized by city, county, and State agencies, as well as federal agencies and private conservation groups.

3. Riparian protection and restoration plans could be drafted by city, county, and State agencies, as well as private organizations, such as the Nature Conservancy. One source of funding for this



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solution has become available with the passage of the California Parks and Wildlife Bond Act (Proposition 70 of 1988).

4. Riparian protection and restoration plans could be drafted by city, county, and State agencies. Riparian zone management plans would be developed jointly by the Departments of Fish and Game and Water Resources. Streamside–riparian zoning, and policies of transferring development rights away from riparian areas, would be implemented through city and county planning departments.

5. Educational and technical assistance programs would be developed through the University of California Cooperative Extension program, the Soil Conservation Service, the Farm Bureau, community colleges, and the Departments of Fish and Game and Water Resources.

6. Alternatives to rock riprap for bank protection work can be investigated and developed by DWR, the Corps of Engineers, the University of California, and private organizations experienced in bioengineering techniques.

7. A riparian restoration and enhancement program, similar to the Urban Streams Restoration program, would be developed and administered by the Board of the Sacramento River Riparian Conservation Area.

8. Reconstructing Corps of Engineers–designed flood control levees to incorporate riparian vegetation would be performed by any agencies or groups that could meet Reclamation Board requirements and specifications. Technical assistance could be provided by the Corps of Engineers and DWR.

9. Modifying operation and maintenance procedures for project levees would be implemented by DWR and would require acceptance by The Reclamation Board. Technical assistance could be provided by the Corps of Engineers and DFG.

10. Fencing off project levees and management of livestock grazing would be implemented by The Reclamation Board. Technical assistance would be provided by the Departments of Water Resources and Fish and Game. An agreement with affected ranchers would have to be reached to complete implementation.

## Special Funding

Proposition 70, the California Parks and Wildlife Bond Act, was passed by State voters June 7, 1988. This Act provides $776 million statewide to State and local agencies to acquire new park lands, expand existing park lands, acquire critical habitat areas, and protect farm lands. The Parks and Wildlife Bond Act has allocated $4 million to the Wildlife Conservation Board for the acquisition of riparian habitat along the upper Sacramento River from Shasta Dam to the mouth of the Feather River. In addition, Proposition 70 makes grant money available to counties, communities, landowners, and citizen groups for riparian habitat and restoration work, as well as similar projects which protect, restore, or enhance riparian areas in the upper Sacramento Valley.

Other funding sources include moneys remaining from the SB 400 fund and money generated from salmon stamp sales. Consulting and volunteer labor for riparian restoration projects would be available from environmental and conservation groups, including those groups working under grants from the Urban Streams Restoration program administered by DWR.



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# FISHERIES RESTORATION PLAN



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*Recent studies have demonstrated that the Red Bluff Diversion Dam is a major impediment to upstream migrating anadromous salmonids. A cooperative multiagency five-year Fish Passage Action Program to identify ways to correct this problem was completed in 1988.*



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# Red Bluff Diversion Dam

## Purpose

The purpose of this action is to reduce or eliminate the delay/blockage of upstream-migrant adult salmonids and mortality of downstream-migrant juvenile salmonids at the Red Bluff Diversion Dam (RBDD).

## Background

Construction of RBDD on the upper Sacramento River was completed in 1964. The purpose of the dam is to divert water into the Tehama-Colusa (T-C) and Corning Canals. Water conveyed through the T-C Canal is used for agriculture, wildlife refuges, and the T-C Fish Facilities. The Corning Canal is used only for agriculture. RBDD began operation when the dam gates were lowered in August 1966.

Declining populations of salmon and steelhead in the upper Sacramento River during the 1970s and early 1980s prompted investigations by concerned agencies and public groups. Conclusions reached in many of these studies attributed much of the fishery declines to RBDD. Substantial evidence surfaced which showed that RBDD impedes upstream migration of anadromous salmonids to their natural spawning habitat, and adversely affects downstream passage of juvenile salmonids en route to the ocean.

Based on annual aerial counts of fall-run salmon redds (nests) conducted by the Department of Fish and Game, the proportion of fall spawning chinook salmon in the upper Sacramento River utilizing the river above Red Bluff declined substantially since RBDD was put into operation. In addition, recent studies have demonstrated that RBDD is a major impediment to all four races of adult salmon attempting to migrate upstream past the dam.

Another significant fishery problem identified at RBDD is downstream migrant salmonid mortality. Recent studies have indicated that substantial mortality can occur for juvenile salmonids passing RBDD. Four possible causes of downstream-migrant salmonid mortality at RBDD were studied:

1. Losses attributable to diversion into the T-C and Corning Canals.
2. Direct injury from passing under the dam gates or through the fish louver bypass facility.
3. Predation resulting from ideal conditions created by RBDD for piscivorous fishes and birds in Lake Red Bluff or immediately below the dam.
4. Delay of juvenile salmonids in Lake Red Bluff, which could cause downstream migrants to be asynchronous with normal smoltification and with seasonal cycles of water temperatures and food production in the lower river or estuary.

In addition, a possible indirect loss of young salmonids from recruitment to the population could be caused by excessive delay of maturing adult salmonids below RBDD to the point where spawner fecundity declines (e.g., prespawning mortality, reduced egg viability, spawning in less than optimal habitat, etc.).

Based on results of previous studies conducted at RBDD and recognizing the need for action, the Bureau of Reclamation, the Fish and Wildlife Service, the Department of Fish and Game, the



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National Marine Fisheries Service, and the Department of Water Resources initiated a five-year Fish Passage Action Program in October 1983 to develop methods to improve upstream and downstream anadromous salmonid passage at RBDD. The action program was developed to identify and resolve specific problems and implement corrective measures.

## Discussion

The five-year Fish Passage Action Program was completed in September 1988. Findings on specific aspects of upstream and downstream fish passage problems at RBDD are as follows:

1. Passage of downstream-migrant chinook salmon at RBDD occurs every month of the year.
2. Yearling entrainment of downstream migrants through the T-C Canal headworks varied from 0.2 to 0.6 million salmon from 1982 to 1987.
3. Losses of downstream migrants due to physical injury in passage under the RBDD gates are negligible (i.e., at or near zero percent).
4. Physical injury losses of those downstream migrants passing through the T-C Canal headworks fish bypass system were in the range of 1.6 to 4.1 percent.
5. Delays in juvenile salmon out migration due to the effects of RBDD are negligible; however, delays of juvenile steelhead can be significant during low-flow periods (i.e., 4,000-10,000 cfs).
6. Predation is the primary cause of downstream-migrant salmon mortality at RBDD.
7. Delay and blockage of adult chinook salmon at RBDD are severe.
8. Dam spill configurations and spill manipulations within RBDD Standard Operating Procedures were ineffective in improving fish passage conditions.
9. Raising the RBDD gates during the nonirrigation season dramatically improved fish-passage conditions.
10. There are severe problems in operating the existing fish ladders at maximum design capacity.
11. The existing RBDD fish ladders operated at maximum design flow capacity do not provide adequate attraction for adult salmon.
12. After considerable experimentation and modification, the removable gate 6 (center dam) fish ladder was useful in passing fish by RBDD during the nonflood season.

## Recommended Solutions

The following recommendations identified in the U. S. Fish and Wildlife Service's final report on the Fish Passage Program should be implemented:

1. Install state-of-the-art fish screens and a new fish bypass system at the T-C Canal headworks to replace the existing fish louvers and bypass system (under construction).
2. Test and operate the gate 11 flip gate to facilitate downstream passage of juvenile steelhead.
3. Conduct more intensive evaluation of predation in Lake Red Bluff and at RBDD.
4. Develop, evaluate, and implement measures to control predation by squawfish at RBDD.



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5. Continue the practice of turning off the RBDD high-intensity lights at night to reduce predation.
6. Conduct an evaluation of bird predation at RBDD.
7. Provide major increases in flow through existing fishways at RBDD, if possible.
8. Enlarge the size and capacity of the existing left bank fish ladder.
9. Construct a new large-scale fish ladder on the left bank.
10. Examine the feasibility of a new high-flow river bypass on the left bank to improve fish passage.
11. Establish a permanent program to provide daily monitoring and maintenance of all fish passage facilities.
12. Continue use of the seasonal gate 6 fish ladder as an interim measure until new permanent fishways are provided.
13. Continue raising the RBDD gates during the nonirrigation season.
14. Conduct follow-up evaluations of fish passage facilities improvements.

## Estimated Costs

| | |
|---|---|
| 1. Construct new fish screens and a new fish bypass facility and enlarge headworks | $15 million * |
| 2. Test and operate gate 11 flip gate | 3-year study totaling $75,000 |
| 3. Evaluate Lake Red Bluff predation | 3-year study totaling $150,000 |
| 4. Develop, evaluate, and implement squawfish control | $100,000 annually |
| 5. Turn off high intensity lights at night | N/C * |
| 6. Evaluate bird predation | 3-year study totaling $75,000 |
| 7. Increase flow in existing fishways | N/C |
| 8. Enlarge size and capacity of existing fish ladder | $2 million |
| 9. Construct large-scale left bank fish ladder | $5 million |
| 10. Make feasibility study of high-flow river bypass | $100,000 |
| 11. Monitor and maintain fish facilities daily | $150,000 annually |
| 12. Install and use Gate 6 ladder until completion of permanent fishway | $50,000 annually |
| 13. Continue to raise RBDD gates during nonirrigation season | N/C * |
| 14. Follow up evaluations | 4-year study totaling $600,000 |
| Total Initial Costs | $23,000,000 |
| Total Annual Costs (items 4, 11 and 12) | $300,000 |

*Actions already implemented or under construction



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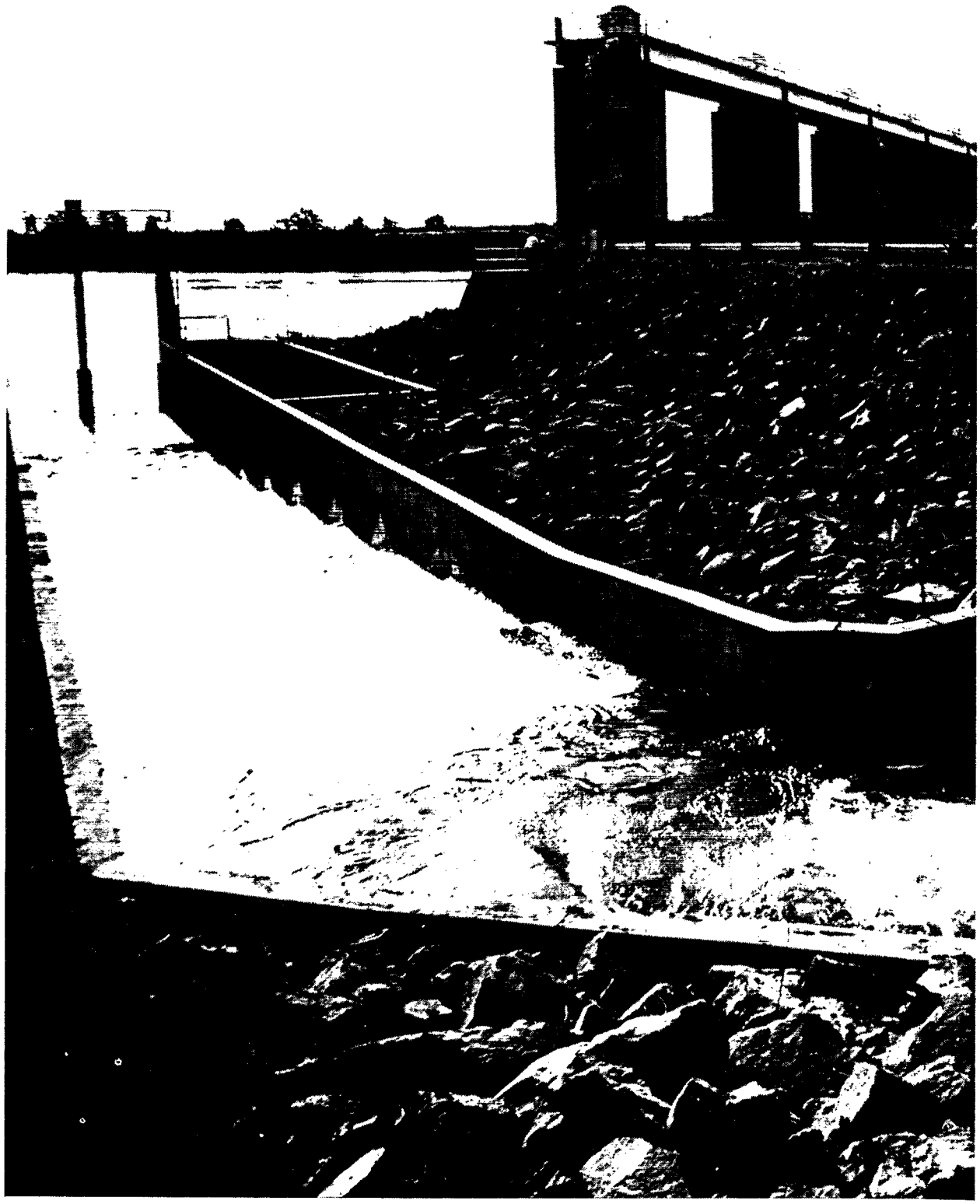

*This fish ladder on the left abutment of the Red Bluff Diversion Dam should be enlarged or replaced.*



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## Estimated Benefits

Hallock (1987) reported that between 1969 and 1982, RBDD reduced upper Sacramento River system salmon populations by an estimated 114,000 fish: 57,000 fall-run, 17,000 late-fall-run, and 40,000 winter-run salmon. These losses have reduced the sport and commercial fisheries by about 228,000 salmon a year. These estimates are supported by Reisenbichler (1986), who indicated that solving the RBDD problems would restore the fall run salmon population to 1955-65 levels (i.e., from about 103,000 in 1978-87 to 175,000 in 1955-65). In addition, RBDD has reduced annual steelhead populations in the upper Sacramento River system by about 6,000 fish. Correcting the problems at RBDD is expected to substantially reverse these losses.

## Potential Conflicts and Resolution

Continuing to raise the RBDD gates during the nonirrigation season creates problems with delivery of water to wildlife refuges and to farmers during periods when the gates are open. These problems can be solved by temporarily closing the gates or by supplying the needed water from other sources.

The Bureau of Reclamation entered into an agreement with the Tehama-Colusa Canal Authority on October 13, 1988, whereby all operation and maintenance of Tehama-Colusa and Corning Canals in-line control facilities, turnouts, etc., would be the responsibility of the Authority. This agreement is effective until September 30, 1995. Additional facilities, including RBDD, the Corning Canal Pumping Plant, and the T-C Fish Facilities, could be included under the terms of this agreement, if such action would be agreeable to both the Bureau and the Authority. In the event that RBDD and T-C Fish Facilities are turned over to the Authority, the agreement must contain provisions to ensure that the actions recommended in this action item are implemented. The Authority would also have continuing responsibility to mitigate for 3,000 fall-run chinook salmon impacted by inundation of spawning habitat in Lake Red Bluff above RBDD.

## Implementation

Correcting the major fishery problems defined at RBDD would require congressional authorization and major funding. The Bureau of Reclamation has already initiated construction of the new fish screens and bypass facilities. The National Marine Fisheries Service is studying the potential for a commercial squawfish fishery.



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*During drought years such as 1977 and 1988, heavy drawdown of Shasta Lake results in release of water with temperatures in excess of 57.5 degrees F, which is detrimental to the incubation of salmon eggs. A structure capable of releasing cold water from the reservoir bottom is needed at Shasta Dam.*



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# Sacramento River Temperature and Turbidity

## Purpose

To increase fish production in the main stem Sacramento River by maintaining a temperature range from 52 to 56 degrees F between Keswick Dam and the Red Bluff Diversion Dam (RBDD) and minimizing turbidity discharged from Shasta Dam.

## Background

### Temperature

The Department of Fish and Game has found that average daily water temperatures above 56 degrees F are detrimental to incubating salmon eggs in the Sacramento River. Approximately 10 percent mortality occurs at a sustained temperature of 57.5 degrees F; 100 percent mortality occurs at 62 degrees F and above. The Sacramento River exceeds 57.5 degrees F downstream from Keswick Dam during years when there is low water storage in Shasta Lake. During the drought years of 1976 and 1977, water temperature at Bend Bridge exceeded 57.5 degrees F almost 70 percent of the time. Though not quantified, losses because of high water temperature are believed to be significant for fall-run salmon and, particularly, winter-run salmon during years of low reservoir storage. Unless water temperature control actions are taken, it is projected that in future years temperatures may increase during the late-summer/early-fall months due to increasing water demands on the Bureau of Reclamation's Central Valley Project.

In addition to elevated water temperature in the summer/fall months, the river is colder than optimum for juvenile salmon rearing in the winter/spring months. The optimum rearing temperature for juvenile salmon is from 52 to 56 degrees F. River temperatures within this range would increase the growth rate and, most likely, the survival rate of juvenile salmon. Increased growth would result in earlier downstream migration of juveniles so that these fish would pass through the Delta during a more favorable time of the year.

### Turbidity

Prior to construction of Shasta Dam and Shasta Lake, upper Sacramento River turbidity increased and decreased with storm runoff. Analysis by the Bureau of Reclamation indicates that Shasta and Keswick Dams reduce the annual sediment discharge of the river. However, in some years, winter storms roil Shasta Lake to an extent that low-level turbidity exists in the discharge to the Sacramento River from winter into the succeeding fall. Such turbidity poses a threat to fisheries by reducing visibility for sight-feeding salmonids.

## Discussion

### Temperature

In the river reach between Keswick Dam and RBDD, temperatures are affected by ambient air temperature and other climatic conditions, tributary inflows, the volume of release at Keswick Dam, the ratio of Spring Creek Power Plant (SCPP) to Shasta releases, total storage at Shasta/Clair Engle Lakes, and the depth of releases from Shasta Lake. The most easily controlled of these factors are depth of release from Shasta and the ratio of SCPP/Shasta releases. Multilevel release (selective



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withdrawal) capability at Shasta Dam would allow for selection of "layers" of water with desired temperatures during most years. Although Shasta Dam has some selective withdrawal capability now, such withdrawal bypasses the turbines and results in a major loss of electrical power. Bureau of Reclamation modeling studies indicate that in water years with optimum-depth releases from Shasta and blending of SCPP releases, temperatures as far downstream as the RBDD can be lowered some 2 to 4 degrees F during July through October.

Providing selective withdrawal capability at Shasta would: (1) enable release of warmer (surface) water during winter/early spring months for enhanced juvenile salmon rearing, and (2) allow retention of colder water for release during the ensuing summer and fall.

The combination of selective withdrawal at Shasta and appropriate blending of imported Trinity water should provide an adequate temperature regime for salmonids in the Sacramento River between Keswick Dam and RBDD in most, if not all, years.

Turbidity

Installation of multilevel (selective) withdrawal capability at Shasta Dam would allow for operational flexibility in providing releases that would minimize downstream turbidity. Whether releases could be controlled to improve both water temperature and turbidity is problematical. Particularly in future years, attempting to control one of these parameters could be counter-productive in controlling the other. Should conflicts arise in future control programs, water temperature control should receive higher priority than turbidity control.

## Recommended Solutions and Estimated Costs

| | Cost | Schedule |
|---|---|---|
| 1. Design Shasta Dam modifications and award contract for construction of selective withdrawal structure | $800,000 | Dec. 1988 |
| 2. Construct Shasta Dam modification for selective withdrawal (Design and construct alternative multi-level withdrawal structure at Shasta Dam if the structure described above is ineffective or unreliable. Cost is unknown but could be as high as $40 million.) | $5,000,000 | Oct. 1990 |
| 3. Monitor selective withdrawal facilities to determine temperature and turbidity control benefits and determine potential design improvements | $500,000 | Oct. 1992 |
| 4. Study feasibility of modifying Spring Creek Tunnel Intake to lower temperature of Spring Creek Power Plant releases | $100,000 | |
| 5. Design and construct Spring Creek Tunnel Intake modifications if feasible for lowering temperature of SCPP releases | To be determined by item 4 | |
| 6. Coordinate operations of Shasta/SCPP releases to optimize Sacramento River temperatures | Costs covered in ongoing programs | Ongoing |
| Total Initial Costs | $6,400,000 | |



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## Estimated Benefits

Temperature

Improving temperature control will increase salmon production in the most important remaining salmon spawning area in the upper Sacramento River. Benefits can most easily be equated to the percentage of salmon eggs/juveniles saved by the control action. Without the action, up to 100 percent of winter-run and early fall-run chinook eggs/juveniles could be killed by excessive temperature in the river reach below Kewsick Dam in adverse water years. To put such loss in perspective, the 1987 adult winter and fall runs of salmon upstream from RBDD totaled about 68,000 spawners.

Turbidity

Turbidity reduction in the Sacramento River downstream from Keswick Dam would improve fish rearing habitat; e.g., increase juvenile growth rate during those years when turbidity would interfere with food foraging. Although unrelated to instream benefits, turbidity reduction would also reduce municipal water treatment costs.

## Potential Conflicts and Resolution

One potential conflict in implementing the recommendations concerns maintaining sufficient cold water in Shasta Lake during dry and critically dry years. With selective withdrawal and an effective operations program, the Bureau expects to minimize this potential conflict under future contract conditions.

The potential conflict between temperature and turbidity control is described above. Priority conflicts will be resolved by the coordinated operation described in solution 6.

## Implementation

Recommended actions will be carried out by the Bureau of Reclamation with cooperation from the Department of Fish and Game and the Central Valley Regional Water Quality Control Board.

## Special Funding

The Bureau of Reclamation has received budget approval for 1987–1988 studies relative to a Shasta Dam modification for selective withdrawal. The Bureau expects to implement the remaining recommended actions through its annual budgeting process.



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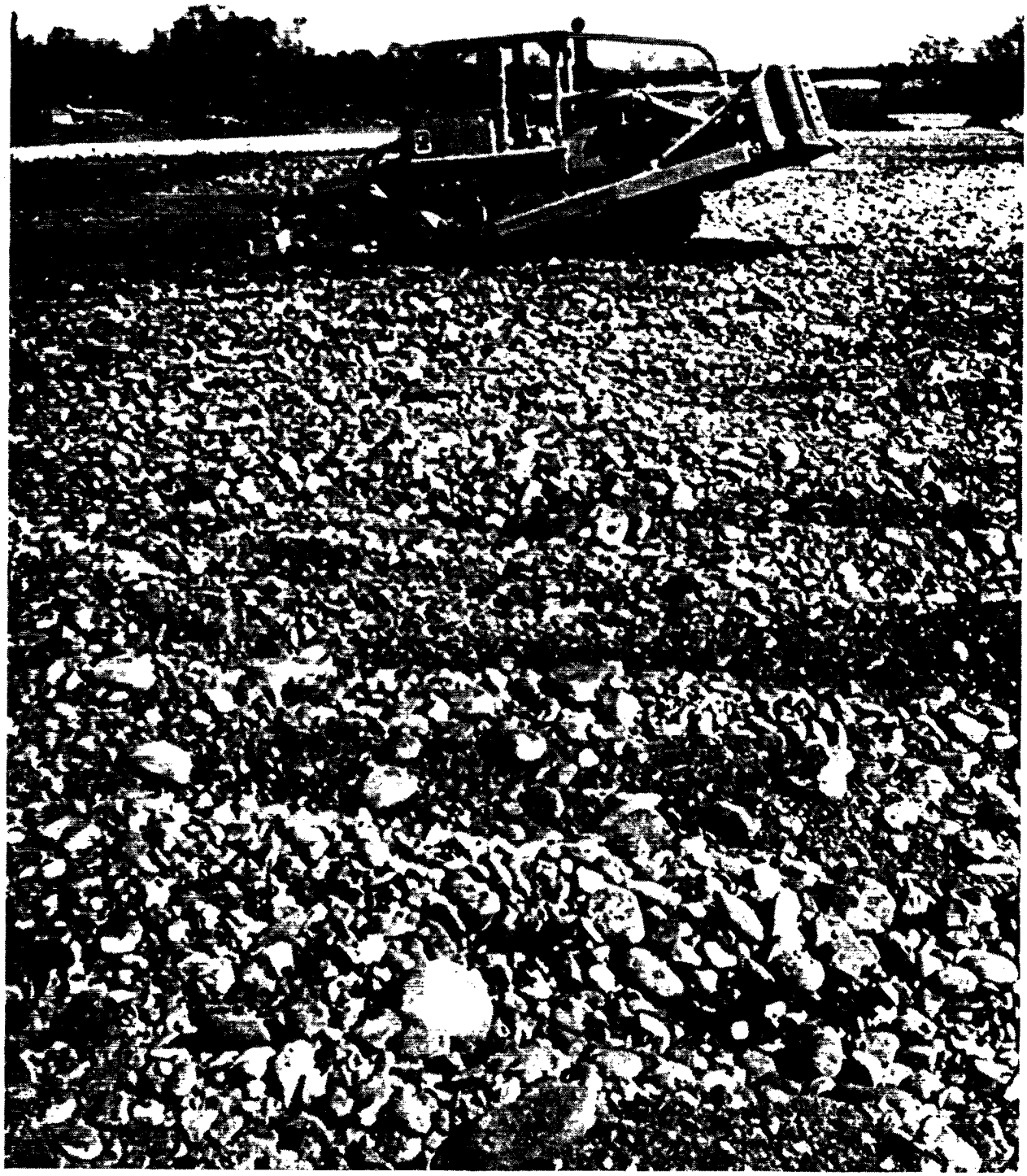

*Some restoration work on the upper Sacramento River has already begun, but a comprehensive coordinated program is needed to reverse the long-term trend of habitat degradation.*



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# Sacramento River Spawning Gravel Restoration

## Purpose

The purpose of this action is to support greater fish populations by increasing the quantity of suitable spawning and rearing habitat in the main stem Sacramento River below Keswick Dam to the level that existed before Shasta Dam was built.

## Background

The decline of chinook salmon in the upper Sacramento River is partially caused by the loss of spawning gravel in the area below Keswick Dam. This degraveling process occurs as floodflows wash gravel downstream without replacement from upstream areas or tributaries. Once a section of river loses most of its spawning gravel, it becomes armored by cobbles too large for salmon to move or degrades to bedrock. The degraveling process has three main causes: (1) dam construction, (2) gravel mining, and (3) bank protection work, including levee construction and riprap.

## Discussion

After construction of Shasta and Keswick Dams, the natural gravel recruitment and transport in the main river channel was stopped by the dams. As high flows are released from the dams, gravel is moved downstream at a much greater rate than it is replaced by small tributaries below Keswick Dam, leaving mainly large rock or bedrock in the river channel, which is unsuitable for spawning. This has also occurred on Clear Creek below Whiskeytown Dam. Today, 85 percent of the spawning gravel entering the river between Redding and Red Bluff comes from the tributaries, primarily Cottonwood Creek.

A second factor which reduces gravel contribution to the river is extensive commercial gravel mining on tributary streams and along the main river. Essentially all sizable tributary streams between Keswick and Cottonwood Creek are heavily mined for construction gravels. Historically, Clear Creek has been the most heavily mined tributary, and today its gravel contribution to the river is essentially zero. Cottonwood Creek has one major gravel-extraction operation located near the Interstate 5 bridge, and five other large-scale gravel operations are being considered. These operations could remove more than 30 million cubic yards of gravel from the creek channel and upper terrace areas over the next 30 years.

Several areas immediately adjacent to the main river have been heavily mined. These include the Kutras Park area in Redding, where most of the concrete aggregate for Shasta Dam was excavated, and the east and west bank areas below Clear Creek, where commercial aggregate operations have existed for several decades. These operations normally dike off a portion of the floodplain containing an extraction area, making it unavailable for gravel contribution to the river.

The third activity that reduces gravel recruitment to the river is levee construction and riprapping of gravel-rich natural streambanks to protect adjacent developed property. This activity is most common below the Red Bluff Diversion Dam. Bank protection activity occurs to a lesser but still significant degree above Red Bluff, especially in the more heavily developed Redding-to-Cottonwood area.



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## Recommended Solutions

Several actions should be taken to maintain and increase the amount of spawning gravels in the upper river. Taking no action will result in a continuing decrease.

1. Spawning gravels should be placed in the river at locations where the probability is high that they will form suitable spawning habitat as they are transported downstream. Locations such as above the Anderson–Cottonwood Irrigation District (ACID) Dam, the mouths of tributaries, point bars, eroding streambank areas, and possibly some bridges may be suitable for placement. These projects do not require significant design or construction work, but should be carefully planned. Annual replacement of approximately 50,000 yards of gravel will be required.

2. New side–channel spawning areas, including adequate hydraulic controls in locations that have remained relatively stable during floods, should be built and maintained. These kinds of projects must be thoroughly planned, designed, and inspected during construction. Several suitable locations have already been identified by previous studies. One site (Turtle Bay East) was constructed in 1986 and another (Turtle Bay West) was constructed in 1988.

3. Many armored areas could be restored to good- or fair-quality spawning habitat by ripping with a bulldozer. Some of these areas are out of water during low–flow periods, and others have depths of less than 2½ feet during low–flow periods and are accessible to a bulldozer. This approach requires annual maintenance.

4. Gravel–mining activities on important gravel–producing tributaries should be carefully controlled to help prevent a continuing decrease in gravels available to the river. The most immediate priority appears to be Cottonwood Creek, where several use permits exist for large–scale gravel extraction from the creek channel and side–terrace areas. These operations may greatly increase the extraction of gravel from Cottonwood Creek.

   A detailed analysis is needed to measure the cumulative impacts of past, present, and foreseeable future gravel mining and bank protection work on the spawning gravel supply to the Sacramento River. This study should also estimate how much gravel is required to support the populations of salmon that could reasonably be expected to result from restoration efforts recommended in this management plan. It should also investigate alternative sources of gravel that can meet future construction needs without working in active floodplains.

   While the cumulative impact study is under way, the counties and/or State should control gravel extraction from major tributary floodplains. Essentially no new gravel extraction projects in major creek floodplains should be approved unless it can be demonstrated through a thorough and objective study that salmon–spawning habitat will not suffer further declines.

5. Shasta County presently has a floodplain ordinance that prohibits gravel removal from the main stem Sacramento River, Clear, Cow, and Bear Creeks; and the Shasta County side of Battle and Cottonwood Creeks. This ordinance needs some additional mapping work, which could probably be funded by the management program. A similar ordinance protecting Cottonwood Creek and the Sacramento River was recently adopted by Tehama County.

6. A monitoring and evaluation program should be implemented to determine the cost–effectiveness of these proposals.

7. Below Red Bluff, the river should be allowed to meander through a selected reach, as described in the comprehensive plan for riparian vegetation; however, public structures will need to be protected.



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## Estimated Costs

| | | Cost |
|---|---|---|
| 1. Selective placement of spawning gravel in river (The required quantity will be determined by the previously described cumulative impacts study.) Assume 1 million cu yd at $10/cu yd | | $10,000,000 |
| 2. Planning, design, and construction of side channel spawning areas | | |
| $100,000 each x 10 sites | | $1,000,000 |
| 3. Ripping of armored areas | | $50,000 |
| 4. Cumulative impact study | | $250,000 |
| 5. Mapping required for ordinances | | $500,000 |
| 6. Monitoring and Evaluation Program | | $200,000 |
| | Total Initial Costs | $12,000,000 |
| Annual gravel replacement (assume 50,000 cu yd at $10/cu yd) | Total Annual Costs | $500,000 |

*This side channel spawning and rearing area was constructed by the Department of Fish and Game near Redding (Turtle Bay East) in 1986. A similar project (Turtle Bay West) was constructed upstream in 1988.*



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## Estimated Benefits

The main benefit of these actions would be to increase suitable spawning habitat below Keswick Dam.

Action 1 will provide spawning habitat for approximately 70,000 salmon under the assumption that 10 percent of the total quantity of gravel placed in the river will be used for spawning in any given year. Action 2 will provide spawning habitat for 3,000 salmon. Action 3 will provide spawning habitat for approximately 1,000 salmon. Actions 4 and 5 will provide the data base and justification to enact ordinances that will protect the presently remaining natural sources of river spawning gravels. Action 6 will identify the most cost-effective measures. Action 7 will permit erosion of gravel terraces that contribute to spawning gravels in the lower river.

## Potential Conflicts and Resolution

Working in the main stem Sacramento River is difficult because of stringent water quality control regulations, which are exceeded by almost any instream construction activity. This potential conflict can probably be resolved by coordinating closely with the Central Valley Regional Water Quality Control Board and working when critical fishery resources are least impacted.

There are three potential water quality conflicts related to restoring spawning areas by placing gravel in the river:

1. Maintaining lower flows conducive to placing rock weirs for hydraulic control and placing and distributing spawning-sized gravel in the river. Desirable flows are 5,000 cfs or less at most sites. In normal years, it is difficult for the Bureau of Reclamation to guarantee flows this low during the late summer due to downstream requirements. If flows can be reduced, the Bureau often can't continue them for more than five consecutive days due to problems with downstream agricultural diversions.The five-day maximum work period is too short to get the job done.

2. Flow constraints make it very difficult to work in the river during the August 1 to September 15 period prescribed in the waste discharge permits. In most years, the Bureau is unable to reduce flows during this period due to hydropower needs, downstream agricultural demands, and Delta water quality standards.

3. Turbidity standards are difficult to meet at certain sites, requiring full isolation of the work area from the main river flow. In many cases, simply driving a tractor, backhoe, or front-end loader across existing gravel areas produces significant short-term turbidity by disturbing colloidal silts, clays, and algae.

The five-day work period and short construction season further aggravates these problems when gravel is not available on-site. The contractor must obtain and prepare gravel off-site, then transport it to the work site where it is stockpiled until flow conditions are suitable for the work. If the Bureau is then unable to reduce flows, the contractor can't begin work. Reclamation Board regulations prohibit stockpiling gravel in the Designated Floodway, so the contractor eventually must haul the gravel away. This adds significant cost to the project.

The first two problems could be resolved by the Department of Fish and Game petitioning the Regional Water Quality Control Board to amend the waste discharge permit to allow work between September 16 and October 15. This would avoid potential problems with redds and juvenile winter-run salmon, which are more likely to occur during the August 1 through September 15 period. It would also increase the chances of getting the Bureau to reduce river flows to 5,000 cfs or less. Potential conflicts with removing the Anderson-Cottonwood ID Diversion Dam would also be minimized.



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The third problem can be solved in most cases by isolating the work area from the river with temporary rock weirs. This is time-consuming and costly and requires maintaining low flows in the river. The replacement gravel could also be washed more thoroughly to remove a greater percentage of sediment and silt. In general, the turbidity requirements contained in current waste discharge permits can be met by additional planning and expenditure of more time and money at each site.

Ripping is a relatively inexpensive method of restoring spawning areas, but it must be repeated periodically. The major negative factors associated with ripping are the short-term turbidity created when it is done in flowing water and the possibility that ripping may encourage increased downstream movement of gravels.

## Implementation

The Bureau of Reclamation has agreed to initiate implementation of solution 1 by placing 16,000 yards of spawning-sized gravel in the river in 1988 between Keswick Dam and the mouth of Cottonwood Creek. The Bureau will seek funding to replace up to 50,000 yards annually. The other proposals will be implemented by the Departments of Water Resources and Fish and Game, with assistance from federal and State water development agencies.



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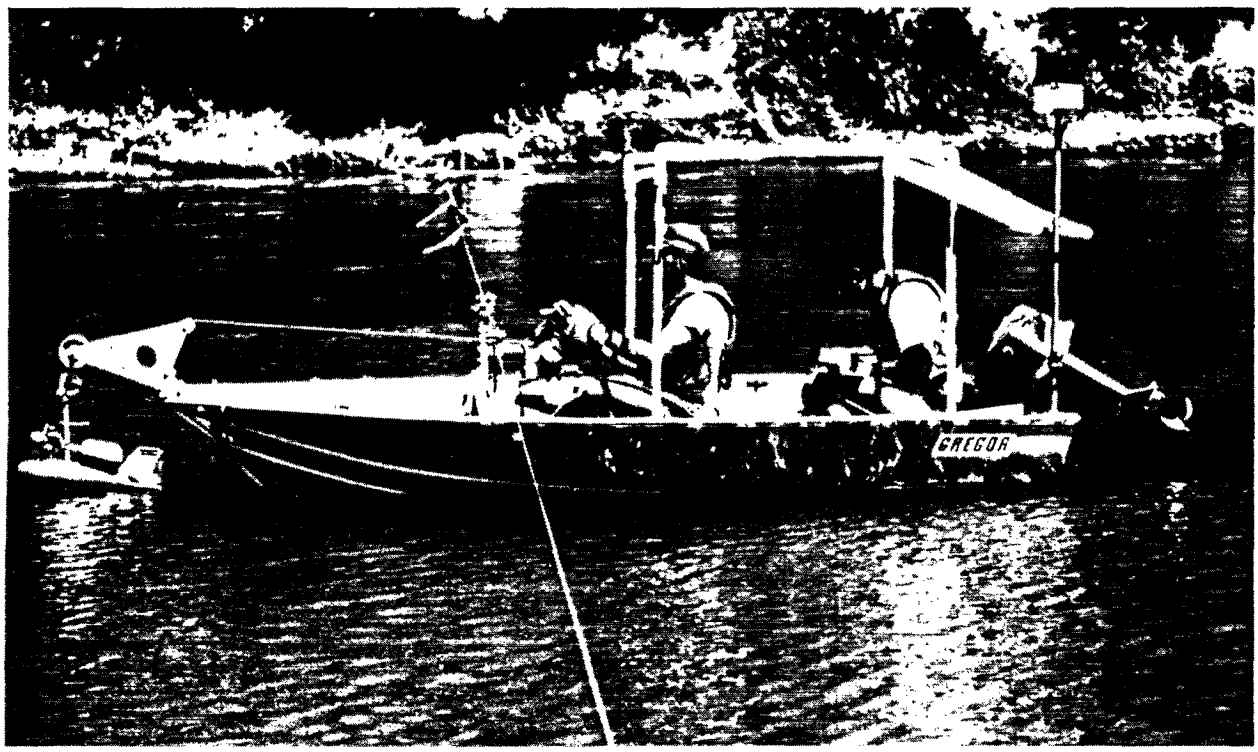
*The Departments of Fish and Game and Water Resources are currently conducting an instream flow study to determine the quantity of fish habitat occurring at various river flows.*



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# Sacramento River Flows

## Purpose

The purpose of this action is to improve the main stem Sacramento River flow regimen that significantly limits fish production in the habitat remaining below Shasta Dam.

## Background

Blockage of the Sacramento River upstream from Shasta Dam reduced anadromous fish habitat by about 50 percent. Providing optimum flows and temperatures below Keswick Dam can compensate for much of the habitat lost to the various species and races of anadromous fish. With steelhead trout and four races of salmon, some life stages of salmonids occur in the river every season of the year.

Adequate flow is necessary for anadromous fish to ensure successful upstream migration, spawning, egg incubation, juvenile rearing, and migration out to sea.

Flow needs for the different life stages of salmon and steelhead in the upper Sacramento River are not presently known. Therefore, the Departments of Fish and Game and Water Resources are currently conducting an instream flow study to determine the quality and quantity of habitat associated with various flows at specific locations along the river. This study is expected to be completed in late 1989.

The present flow regimen in the upper Sacramento River reflects the Bureau of Reclamation's current method of operating the Central Valley Project. Flow levels and changes in flows are currently based on authorized purposes for flood control, power production, navigation, water supply, and fish and wildlife.

In 1948, the Bureau and the Fish and Wildlife Service signed an agreement that promised necessary maintenance of adequate flows and temperature below Shasta Dam for fishery purposes. Although there is currently disagreement as to whether or not the agreement is legally binding, it nevertheless indicates the Bureau's commitment to protect fishery resources in the Sacramento River.

In 1960, the Bureau of Reclamation and DFG consummated a Memorandum of Agreement to protect and preserve fish and wildlife resources of the Sacramento River, as affected by the operation of Shasta and Keswick Dams. The agreement, which emphasizes fall-run salmon, stipulates minimum flow releases below Keswick Dam that vary from 2,300 to 3,900 cfs in normal years and 2,000 to 2,800 cfs in critically dry years. The agreement also expresses intent to minimize flow fluctuations during the period September 1 through December 31 to achieve the best possible conditions for salmon reproduction. There are exceptions provided for emergencies, such as increased releases required by flood conditions or a mechanical or operational failure beyond the control of the Bureau. In most years, actual flows in the river have been higher (generally between 3,200 and 5,000 cfs) than those stipulated in the agreement due to the Bureau's need for power generation, requirements for meeting Delta water quality standards, and cooperation with DFG in trying to maximize fish production.



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## Discussion

The 1960 agreement for river flows does not address managed floodflow releases, which typically destroy deep salmon redds and later strand shallow redds containing eggs and fry. These problems are most acute for fish spawning in September and October (spring-run and fall-run chinook), as well as late fall-run chinook which spawn in December and January. During low runoff years, flows during the two-month incubation period are frequently reduced to one-half or less of the flows during spawning, thus leaving many redds dewatered. In contrast, during years of high rainfall, mandated flood control releases often exceed 50,000 cfs during incubation periods. These flows move gravels, thereby destroying deep and shallow redds containing eggs and fry. To overcome these problems, proper balancing of flows and temperature requirements among different races and life stages of salmon and steelhead will be required.

The rate that river flows can be fluctuated is not specified in the 1960 agreement for river releases. There are numerous instances when rapid flow reductions occur during the spring and the fall to accommodate adjustment of the Anderson-Cottonwood Irrigation District (ACID) diversion structure. These rapid drawdowns result in significant stranding and suffocation of juvenile salmon, steelhead, and rainbow trout. Studies are needed to determine both the rate of flow reduction and the time of day that flow reductions should occur to minimize stranding of juvenile fish. Also, modifications of the ACID dam are needed so that these flow changes will not be required. (A proposal to modify the dam is included later in this plan.)

## Recommended Solutions

To maximize anadromous fish production from the habitat below Keswick Dam, all of the following solutions should be implemented in an integrated manner:

1. Conduct the following studies to form the basis for future actions:
   a. Complete the current instream flow studies to establish the amount of usable habitat for each life stage of salmon and steelhead for the entire range of flows occurring below Keswick Dam. This should include a determination of flows needed to maintain suitable flowing water in side-channel areas that provide valuable habitat, especially for rearing.
   b. It is recognized that operation of the Central Valley Project requires some flow fluctuations in the Sacramento River. A study should be conducted to determine the best rate of flow change as well as the time of day for making flow changes that would minimize stranding of juvenile fish.
2. Using the results of the above studies, identify river flows that maximize overall habitat requirements for all life stages of salmon and steelhead. These habitat requirements would then be balanced with spring flow releases needed for out-migration. This process also should consider the fact that, during years of low reservoir storage in Shasta, releases of warm water cause temperature-induced mortality. During these periods, it may be necessary to reduce flows below Keswick so that cold water from the Trinity Diversion provides the majority of the river flow.
3. Construct structural modifications at the ACID Dam to eliminate the need for short-term flow fluctuations to adjust the boards in the diversion dam. (Action to accomplish this recommendation is contained in the ACID Diversion Dam proposal.)



C—051762

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## Estimated Costs

1. Instream flow study – already funded by DFG and DWR:

| | |
|---|---|
| DFG participation | $400,000 |
| DFG contract to DWR | 450,000 |
| DWR funds | 150,000 |
| Subtotal | $1,000,000 |

2. Study of changes in flow needed to reduce stranding: $100,000

3. Potential costs due to decreased water supplies and power production: Unknown

Total Initial Costs $1,100,000

## Estimated Benefits

Improving the flow regimen in the Sacramento River below Keswick Dam would increase salmon spawning success and increase survival of juvenile salmon and steelhead.

## Potential Conflicts and Resolution

Implementing a fixed flow schedule to maximize anadromous fish production from the remaining habitat below Keswick Dam may affect the Bureau's present method of operating the Central Valley Project. If studies demonstrate a need to increase flows, the Bureau's ability to fulfill its existing water supply contracts may be impacted. Future plans for marketing additional water and present levels of power production may be similarly affected. Existing seepage problems affecting landowners along the river could be exacerbated by flow regimes designed to benefit fish.

Most of these potential conflicts probably can be resolved by compromises that will improve flow conditions for fish without undue adverse effects on other project accomplishments (water supply, energy generation, navigation, flood control).

## Implementation

1. Using results of the studies described above as the basis for desired river flows, a new Memorandum of Agreement should be consummated between the Bureau of Reclamation, Department of Fish and Game, the Fish and Wildlife Service, and the National Marine Fisheries Service that stipulates the following:
   a. To the extent possible, require controlled (nonflood) releases on a monthly schedule at Keswick Dam and Red Bluff Dam that maximize availability of anadromous fish-spawning habitat and minimize dewatering of incubating eggs and fry.
   b. When flow changes are necessary, require prescribed rates of change for controlled releases at Keswick and Red Bluff Dams to avoid stranding of juvenile fish.
2. Continued close cooperation between DWR and the Bureau of Reclamation through the Coordinated Operating Agreement will be necessary to help maintain an adequate flow schedule in the upper Sacramento River. Potential impacts of any given flow schedule will have to be carefully evaluated each water year to avoid temperature problems in the following water year that cannot be accommodated by the proposed temperature curtain at Shasta Dam.
3. It may be necessary for the State Water Resources Control Board to modify the Bureau's water rights permits for the Central Valley Project to include terms and conditions to implement the provisions contained in the Memorandum of Agreement described above.



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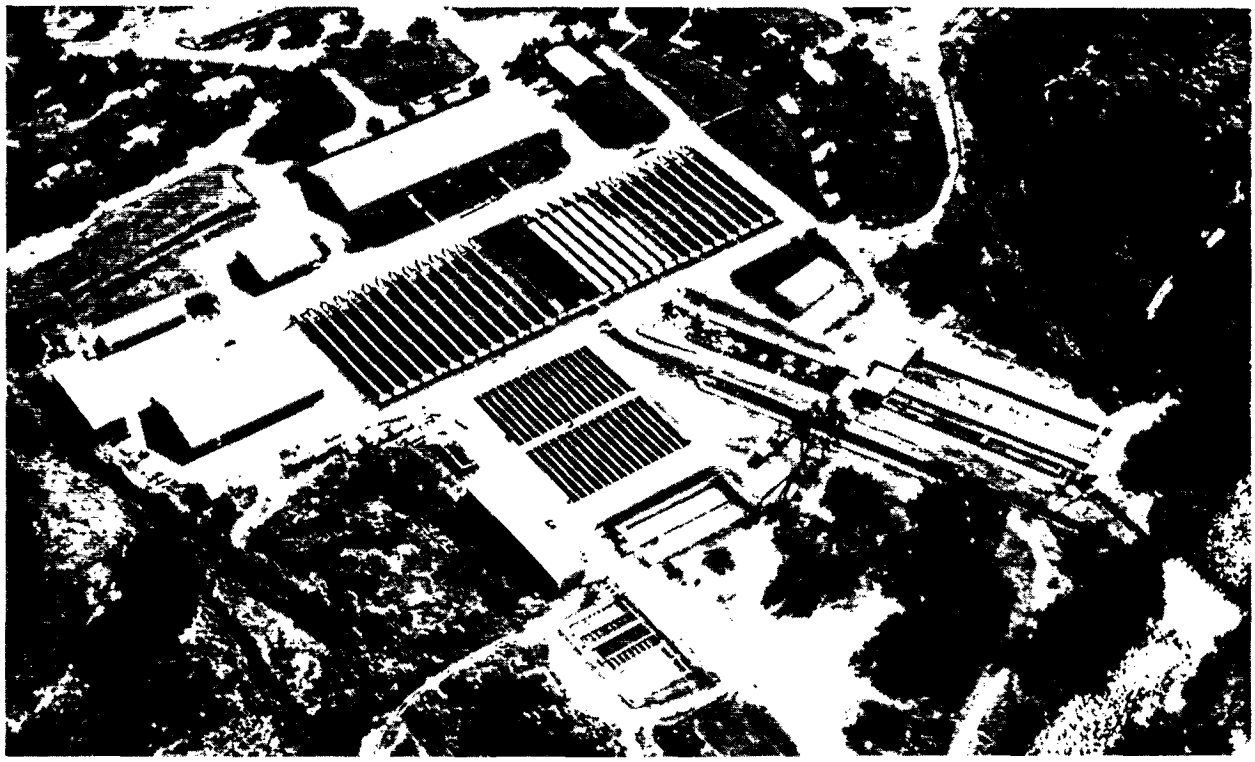

*Coleman Fish Hatchery is more than 40 years old, and is in need of extensive modernization. Even with a $24 million rehabilitation program, the hatchery will not fully compensate for habitat reductions caused by construction of Shasta, Keswick, and Whiskeytown Dams, and the Red Bluff Diversion Dam.*

C—051764

C-051764

# Coleman National Fish Hatchery

## Purpose

The purpose of this action is to upgrade Coleman National Fish Hatchery (NFH) to meet long-term fish production goals.

## Background

Coleman NFH was constructed in 1942 as part of the mitigation measures to help preserve significant runs of chinook salmon threatened by the loss of natural spawning areas resulting from construction of Shasta Dam on the Sacramento River. Construction of the facility was authorized as an integral part of the Central Valley Project. Total cost for the hatchery and Keswick Fish Trap was $2,013,750.

Four plans were proposed by the U. S. Fish and Wildlife Service to salvage the runs of Sacramento River salmon blocked by Shasta Dam. A board of consultants (appointed by the Bureau of Reclamation) recommended one of these plans, called the "Sacramento River, Battle Creek, Deer Creek Plan," which the Bureau accepted. Objectives of the plan were to: (1) ensure proper distribution of salmon in the river for natural spawning, (2) reduce spring chinook losses in the main river due to high water temperatures while Shasta Lake filled, (3) release young salmon from hatcheries in accord with the natural migration period, and (4) continue studies of artificial propagation.

It was anticipated that the fall chinook run could be held in the main stem Sacramento River by racks to encourage natural spawning. Excess fish would be trapped and taken to the hatchery facilities on Battle Creek. Spring chinook would be trapped and transferred to suitable tributaries, such as Deer Creek, for natural spawning, and to Battle Creek for artificial propagation at the Coleman Hatchery. The selected plan included the following annual objectives:

1. Transfer of 10,000 spring chinook salmon to Deer Creek for natural propagation.
2. Transfer of 2,000 spring chinook salmon to Battle Creek for artificial propagation.
3. Transfer of 18,000 summer and early fall chinook to Battle Creek for artificial propagation.
4. Distribution of 30,000 fall chinook in the Sacramento River by installing three racks to control salmon migration.

To carry out this plan, the Bureau of Reclamation agreed to provide the following:

1. A fish ladder, trap, and lift at Keswick Dam and at Balls Ferry rack.
2. Seven 1,000-gallon capacity fish tank trucks.
3. A hatchery on Battle Creek with the capacity for 58,000,000 eggs or advanced fry and 29,000,000 fingerlings and appurtenant ponds, cold storage facilities, and buildings.
4. Five racks in Battle Creek to form four holding and ripening pools for adult spring salmon transferred from the Sacramento River.
5. Three racks across the Sacramento River.



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6. A fishway around the lower falls on Deer Creek to make accessible an additional five miles of spawning gravel.

Two hatcheries on Battle Creek participated in these operations: the old Battle Creek Hatchery near the mouth of Battle Creek, which was closed after the 1944 season, and the new Coleman Station located approximately six miles upstream from the Sacramento River, which began operation in 1943.

All the agreed-upon plans were not carried out for various reasons, and the salvage goals were only partially realized. Only two racks were installed in the Sacramento River, and these failed to function properly. The total salmon population allowed to spawn in the river between Balls Ferry and Keswick Dam was much greater than planned. Mortality of spring chinook transferred to Deer Creek was high, and the ultimate success of this operation appeared quite dubious. Mortality of adult spring chinook salmon transferred to Battle Creek was also high, primarily because of warm water temperatures. Propagation of spring chinook salmon at Coleman was subsequently suspended.

By 1946, none of the racks on the Sacramento River were operating, and trapping of spring chinook at Keswick had ceased. Hatchery operations at the Coleman station were considered successful, except for the problem of holding adult spring chinook until ready for spawning. It was concluded that the spring run of salmon was more likely to be perpetuated if left undisturbed in the Sacramento River because ecological conditions (temperature and flow) below Shasta Dam were satisfactory. The only remaining federally operated elements of the Shasta Salmon Maintenance Plan are the Coleman Hatchery and the Keswick Fish Trap.

In 1949, a Memorandum of Agreement was signed between the Bureau and the Fish and Wildlife Service pertaining to the custody and future operation of the Coleman Hatchery and other fishery maintenance facilities of the upper Sacramento River, including the Keswick Fish Trap. Since July 1, 1949, the Service has assumed all annual operation, maintenance, and replacement costs at Coleman Hatchery. The Keswick Fish Trap is operated by the Service and is maintained by the Bureau in conjunction with their facilities at Keswick Dam, in accordance with a 1951 Memorandum of Agreement.

Over the years, the Coleman NFH has suffered from a variety of problems--old age, inadequate funding, serious fish diseases, water temperature problems, and difficulty advancing with fish propagation technology. However, Coleman NFH remains as the key feature mitigating for the Central Valley Project in maintaining fall run chinook salmon and steelhead trout populations in the upper Sacramento River while, at the same time, contributing large numbers of salmon to the Northern California ocean harvest.

## Discussion

Current development and production concerns that have an adverse effect upon the achievement of program objectives for Coleman NFH include the following:

1. Facilities Deterioration. Many facilities at Coleman are antiquated and require considerable maintenance to continue their usefulness. These include feed storage facilities, water supply systems, emergency power-generating equipment, and heating and cooling plants. Extended delays in rehabilitation or replacement of facilities may result in injury to hatchery personnel, loss of production, and/or acceleration in the rate of deterioration.

2. Disease. Fry and fingerling mortality due to infectious hematopietic necrosis (IHN), columnaris, and external parasites cause a significant loss in hatchery production.



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3. Water Quality. The existing Battle Creek water supply carries a high sediment–sand load during critical production periods. The untreated water also provides the source of infection for both bacterial and parasitic infections. Wells Nos. 2, 3, 4, and 5 are high in nitrogen. Well No. 5 also contains lethal levels of ammonia.

4. Water Quantity. The existing Battle Creek intakes Nos. 2 and 3 do not provide sufficient water supply during the low–flow periods. Modification of No. 3 intake for more efficient debris removal is needed. Wells Nos. 2, 3, 4, and 5 are no longer capable of producing adequate water. Replacement wells are necessary to maintain production.

5. Water Temperature. Winter water temperatures are too low (42–44 degrees F) for effective control of the IHN virus. Summer temperatures (+60 degrees F) are excessive for holding winter and spring chinook adult salmon.

6. Pollution Abatement Facilities. Current facilities are inadequate for efficient management of the work force and adequate pollution control.

7. Energy Management. Project power is provided by the Bureau of Reclamation. The agreement for this requires a 0.95 power factor and has a ceiling of 2,200 kW. Meeting these requirements is essential to project operation.

8. Additional Production Facilities. Space in existing prerelease ponds is insufficient for rearing young salmon until they reach the desired size for release. Additional production facilities and adult holding facilities are necessary if Coleman NFH is to meet chinook salmon and steelhead trout production goals needed for maintenance of upper Sacramento River stocks.

9. Keswick Fish Trap. Coleman NFH is presently dependent on utilization of the Bureau of Reclamation's Keswick Dam Fish Trap to obtain most of the late–fall run chinook salmon hatchery broodstock. With implementation of future plans to propagate winter and spring run chinook at Coleman NFH, dependence on the Keswick Fish Trap will increase. Due to the present design of the Keswick Fish Trap, it is very difficult to operate the trap when the flow past Keswick Dam is in excess of 14,000 cfs. Flows in excess of 14,000 cfs commonly occur during the time period when late-fall-run and winter-run salmon are in the vicinity of Keswick Dam.

Recently, production objectives for Coleman NFH were modified to increase the chinook salmon contribution to commercial and sport fisheries and steelhead trout contribution to sport fisheries. In 1987, the Fish and Wildlife Service updated its Station Development Plan for the hatchery to put into perspective the priorities the Service had agreed were necessary to more fully meet mitigation on the upper Sacramento River, to incorporate the latest fish propagation technology, to correct water quality problems associated with fish diseases, and to correct design and operational deficiencies. As a consequence, a major reprioritization of hatchery reconstruction features was incorporated into the updated plan, along with a basic philosophical approach to include the total expanded cost for engineering design, contingencies, and assessments, not just the expected contract costs.

Proposed projects included in the Coleman NFH development plan would:

1. Control disease.

2. Control water temperature in an energy–efficient manner.

3. Increase Coleman Hatchery capacity to accommodate winter and spring chinook.

4. Optimize production pond loading and smolt release at hatcheries.



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5. Increase egg to smolt survival through improved health and physiological fitness.

6. Plan, design, and construct new propagation capacity as needed.

7. Provide water temperatures that do not exceed 55 degrees F for holding winter and spring adult chinook salmon.

8. Maintain capability to distribute fish so as to maximize adult contributions while ensuring sufficient broodstock returns to the hatchery. Present evidence suggests this will require distribution of a substantial share of production below Red Bluff Diversion Dam.

9. Provide facilities and systems that will reduce the probability of catastrophic fish losses to acceptable low levels.

## Recommended Solutions

It is recommended that the Coleman NFH Development Plan be implemented. The recent reprioritized Coleman NFH development program needed to satisfy Fish and Wildlife Service objectives and resolve major site concerns has nine separate construction phases. The initial implementation phases would correct current major problems which threaten or impair the ability of the hatchery to minimally satisfy fish mitigation objectives. The intermediate phases address long-term efficiency to production conditions, while the final phases concentrate on increased fish production. The construction phases are identified to result in a logical sequence of station development. The plan should be implemented within a five-year period.

Coleman NFH will be heavily dependent on utilization of the Bureau of Reclamation's Keswick Dam Fish Trap to obtain most of the late-fall-, winter-, and possibly spring-run chinook salmon hatchery broodstock. It is currently very difficult to operate the fish trap when the flow past Keswick Dam is in excess of 14,000 cfs, which can commonly occur when late fall and winter run salmon are in the vicinity of the dam. Because the fish trap is owned and maintained by the Bureau of Reclamation, the Fish and Wildlife Service has no provision in the Service's Coleman NFH Development Plan to redesign the fish trap to operate at high river flows. Resolution of this problem would be to provide the Bureau with funding to improve the operation of the fish trap to operate effectively at high river flows (i.e., 14,000–20,000 cfs).



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## Estimated Costs

| | |
|---|---|
| **Phase One** | |
| 1. Water Treatment Facilities. Additional ozone generation capacity will provide 15,000 gpm single-pass, disease-free water to the 8' x 80' raceways and hatchery building. | $4,540,000 |
| **Phase Two** | |
| 2. Facility Rehabilitation. A backlog of deferred rehabilitation is addressed in a comprehensive, multi-facility project. | $1,950,000 |
| **Phase Three** | |
| 3. Feed Storage Building. The existing feed storage building will be replaced with a new 4,600-square-foot facility capable of storing frozen and dry food. | $600,000 |
| **Phase Four** | |
| 4. Barrier Dam. The Battle Creek Barrier Dam will be completely reconstructed, including improvements to the fish ladders. | $740,000 |
| **Phase Five** | |
| 5. Pollution Abatement Facilities. The pollution abatement system will be expanded to ensure compliance with the discharge permit. | $720,000 |
| **Phase Six** | |
| 6. Water Treatment Facilities. An additional 25,000 gpm of treated water will be supplied to the 15' x 150' raceways. | $5,490,000 |
| **Phase Seven** | |
| 7. Pre-Release Ponds. Twenty additional 15' x 150' raceways and necessary water supply improvements will be constructed | $4,950,000 |
| **Phase Eight** | |
| 8. Water Treatment Facilities. Facilities to treat an additional 20,000 gpm of water will be constructed to supply the new pre-released ponds | $2,910,000 |
| **Phase Nine** | |
| 9. Visitor Facilities. Improvements planned to upgrade the public use experience include parking modifications, signs, and interpretive exhibits. | $200,000 |
| Development Program Total | $22,100,000 |
| 10. Winter-Run Salmon Holding Ponds (under construction) | $2,100,000 |
| 11. Keswick Dam Fish Trap (refer to "Potential Conflicts and Resolution"): Redesign the fish trap to operate at high river flows (i.e., 14,000-20,000 cfs). | $250,000 |
| Total Initial Costs | $24,450,000 |
| Total Annual Costs | $900,000 |



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## Estimated Benefits

Implementation of the Coleman NFH Development Plan is expected to achieve the following production objectives:

**Coleman National Fish Hatchery**
**Production Objectives**

| Fish Stock | Production Capabilities Current | Production Capabilities Future |
|---|---|---|
| Fall Chinook | 12,000,000 smolts (May release)<br>1,000,000 pre-smolts (April release) | 12,000,000 smolts (May release)<br>1,000,000 pre-smolts (April release)<br>2,000,000 fingerlings (March release)<br>2,000,000 fingerlings (February release) |
| Late-Fall Chinook | 960,000 smolts (November release)<br>40,000 smolts (October release) | 1,000,000 smolts (December release) |
| Winter Chinook | No production capability | 1,500,000 smolts (March release) |
| Spring Chinook | No production capability | 1,500,000 yearlings (November release)<br>500,000 smolts (May release) |
| Steelhead Trout | 727,000 yearlings (January release)<br>273,000 yearlings (December release) | 786,000 yearlings (January release)<br>214,000 yearlings (February release) |



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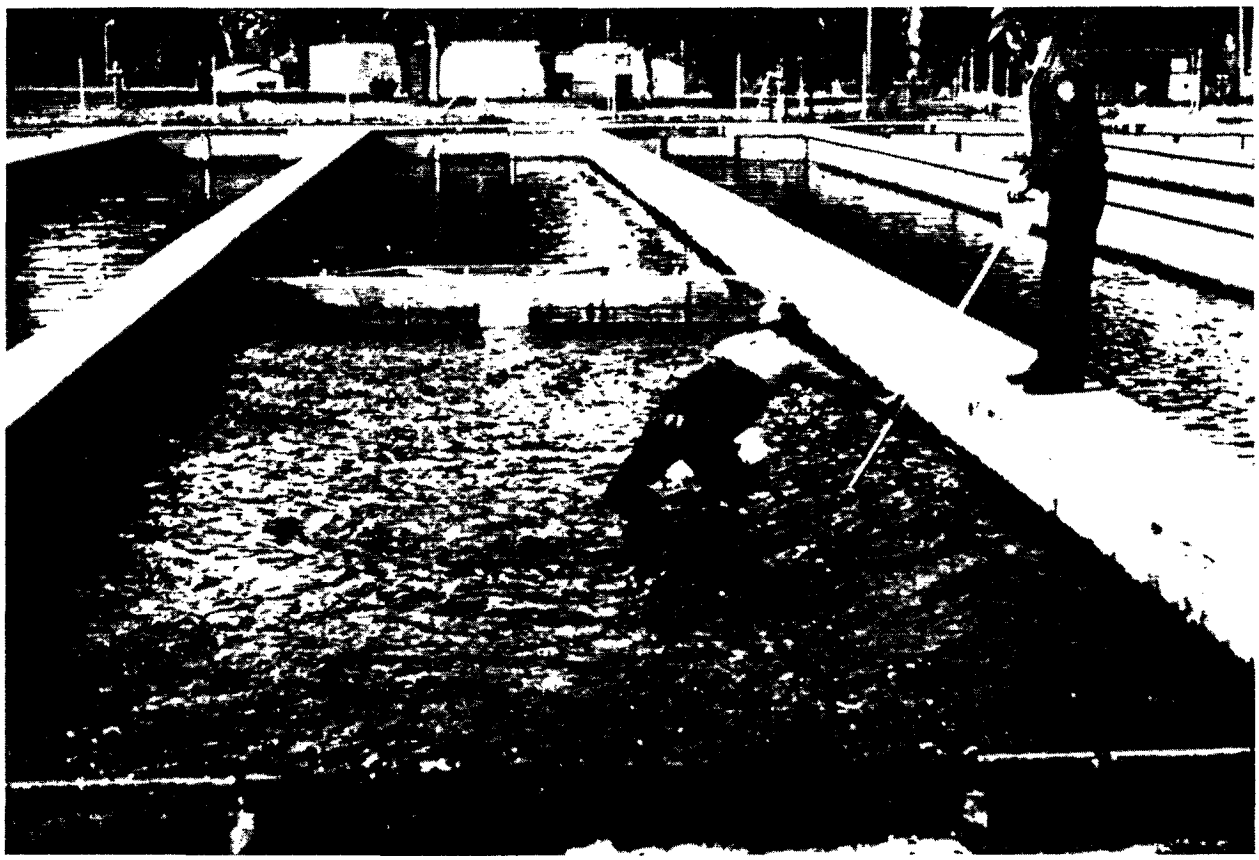

*Additional ponds will be constructed to meet salmon and steelhead production goals.*

## Potential Conflicts and Resolution

Because Coleman NFH is dependent on the operation of the Keswick Dam Fish Trap, a high degree of coordination will be required between the Bureau of Reclamation and the Fish and Wildlife Service in upgrading these facilities.

## Implementation

It is unlikely that the U. S. Fish and Wildlife Service can obtain funding for the Coleman NFH Development Plan through its normal budgetary process; therefore, implementation can best be achieved through specified funding to the Service for the Station Development Plan and to the Bureau for improvement of the Keswick Dam Fish Trap (e.g., line-item budgeting or special legislation).



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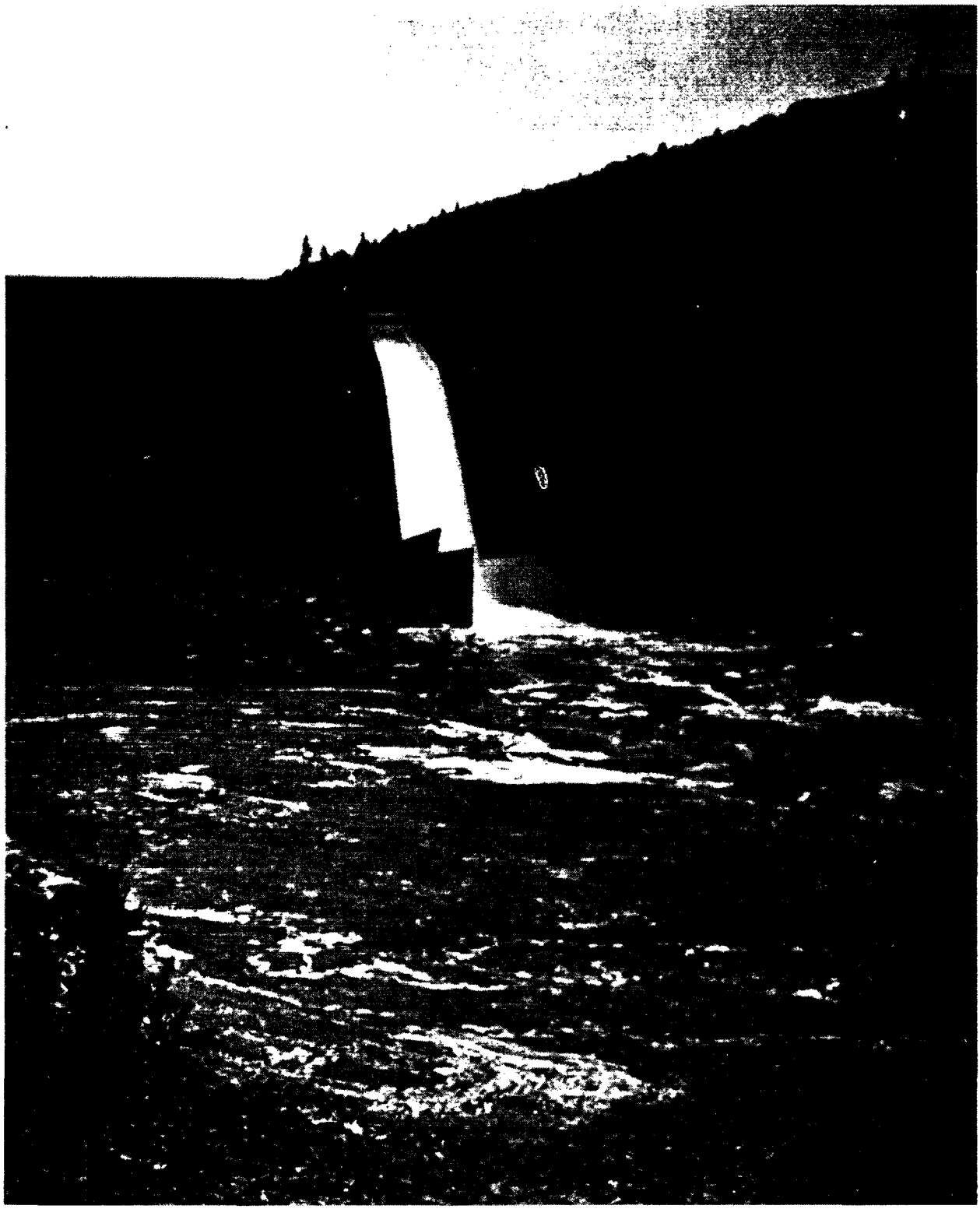

*The principal source of Sacramento River heavy metal contamination is the runoff from the Iron Mountain Mine complex, which is inadequately controlled by Spring Creek Reservoir, shown spilling here.*



C—051772

C-051772

# Heavy Metals

## Purpose

To protect fisheries from chronic and acute toxicity caused by heavy metals in acid mine drainage.

## Background

Inactive and abandoned mines discharge acid mine drainage containing metals (mainly copper and zinc) that are toxic to resident and anadromous fish in the Sacramento River for some 20 miles downstream from Keswick Dam. The principal source of metal contamination is from the Iron Mountain Mine complex, which discharges to the river via Spring Creek and Keswick Reservoir. Since the Bureau of Reclamation completed construction of the Spring Creek Pollution Control and Debris Dam in 1963, mine drainage has been partially controlled by storing and discharging the drainage consistent with available dilution flows from Shasta Dam and Spring Creek Power Plant. Because of limitations of storage in Spring Creek Reservoir and limitations on dilution water availability, copper and zinc levels in downstream waters periodically exceed the tolerance of salmon, steelhead, and resident trout.

For example, documented fish kills occurred in the river downstream from Keswick Dam in 1964, 1966, 1967, 1969, and 1978 when the Debris Dam spilled. In addition, copper and zinc in the river routinely exceed levels determined to be detrimental to salmonids on a long-term basis. Although the overall impact of metals on the Sacramento River fisheries downstream from Keswick Dam is not known precisely, the Department of Fish and Game believes the impact to be significant. The Department of Fish and Game has found a correlation between high metal levels in the river and subsequent reduced numbers of adult salmon returning to spawn three or four years later. It takes three to four years for young-of-the-year salmon to be recruited into the adult fishery.

## Discussion

During the early 1980s, studies by the Environmental Protection Agency (EPA) and State agencies resulted in recommended control measures for the Iron Mountain Mine complex that are to be implemented under "Superfund," a federal Clean Water Act program for controlling hazardous materials. The Iron Mountain Mine complex contributes about 82 percent of the metals that enter Keswick Reservoir. The staged program, which started in 1983, will reduce metals through source control actions and water resource management actions. EPA has contracted with the Bureau of Reclamation to design the water resource management actions, while EPA and private contractors will primarily implement the source control actions. Although the Superfund program is behind schedule, the majority of control actions are planned to be in place by the late 1980s or early 1990s.

The objective of the source control actions (Recommended Solutions 1 and 2, below) is to reduce the amount of ground water that reaches the mine shafts and attendant ore bodies. Less water in contact with the metals in the mine will result in reduced flows and dissolved metals from the mine shafts. Water management actions (3 through 6) will divert unpolluted stream flows upstream from the metal sources, thus reducing the volume of toxic water that will continue to be stored in Spring Creek Reservoir. These diversions (and source control actions) may negate the need for enlarging Spring Creek Dam, but this will not be confirmed until the other control actions are in place.



C—051773

C-051773

## Recommended Solutions and Estimated Costs

| Actions approved or being studied include: | Cost | Schedule |
|---|---|---|
| 1. Cap caved and cracked ground above the ore bodies | $2,500,000 | 1988 |
| 2. Fill underground mine working with cellular concrete and conduct associated hydraulic studies (demonstration studies followed by implementation if feasible) | $1,650,000*<br>$40,000,000** | 1988*<br>1991** |
| 3. Divert upper Spring Creek | $3,900,000 | |
| Initiate design work | | 1988 |
| Complete construction | | 1990 |
| 4. Divert South Fork Spring Creek | $1,900,000 | |
| Initiate designs | | 1988 |
| Complete construction | | 1990 |
| 5. Divert upper Slickrock Creek | $850,000 | |
| Design started | | 1988 |
| Complete construction | | 1989 |
| 6. Enlarge Spring Creek Dam and Reservoir (if needed to meet objectives) | $17,200,000 | After 1999 |
| Total Initial Costs | $68,000,000 | |
| Total Annual Costs | Unknown | |

**Implementation
*Demonstration studies

## Estimated Benefits

Source control and water management actions are expected to significantly reduce copper and zinc in the Sacramento River below Keswick Dam. Such reduction would result in metal concentrations that consistently meet water quality objectives and that have been determined to be safe for fisheries. Although benefits are hard to quantify precisely, the control actions are being designed to protect fisheries from chronic and acute toxicity during all years. Without the control actions: (1) all salmonids (particularly the more vulnerable juveniles) will continue to be subjected to chronic toxicity, which is evinced by physiologic problems and slow growth, and (2) salmonid reproduction between Keswick Dam and Cottonwood Creek will be greatly reduced by acute toxicity in unfavorable water years.

## Potential Conflicts and Resolution

One apparent conflict in implementing this program concerns the current mine owner (Iron Mountain Mine, Inc.). IMM, Inc., has consistently opposed the EPA cleanup program and has threatened legal action to prevent its implementation. EPA believes that it is acting within its mandated responsibility under Superfund and that any legal challenge to prevent implementation of this program would be unsuccessful.



C—051774

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The second potential conflict concerns the future releases from Shasta Dam to dilute heavy metal concentrations. EPA and the Bureau of Reclamation are working out an arrangement that will address the question of water releases for dilution purposes. Having a bearing on this is the Bureau's current water contracting study, which is evaluating the amount of uncommitted yield that is available for firm long-term contracts. As part of this study, the Bureau will evaluate how the allocation alternatives could affect the Bureau's flexibility to release "extra" dilution water during critical metal periods. The hoped-for solution to this potential conflict is that implementation of the Superfund program will eliminate the need for releases of dilution water that exceed normal Bureau operations.

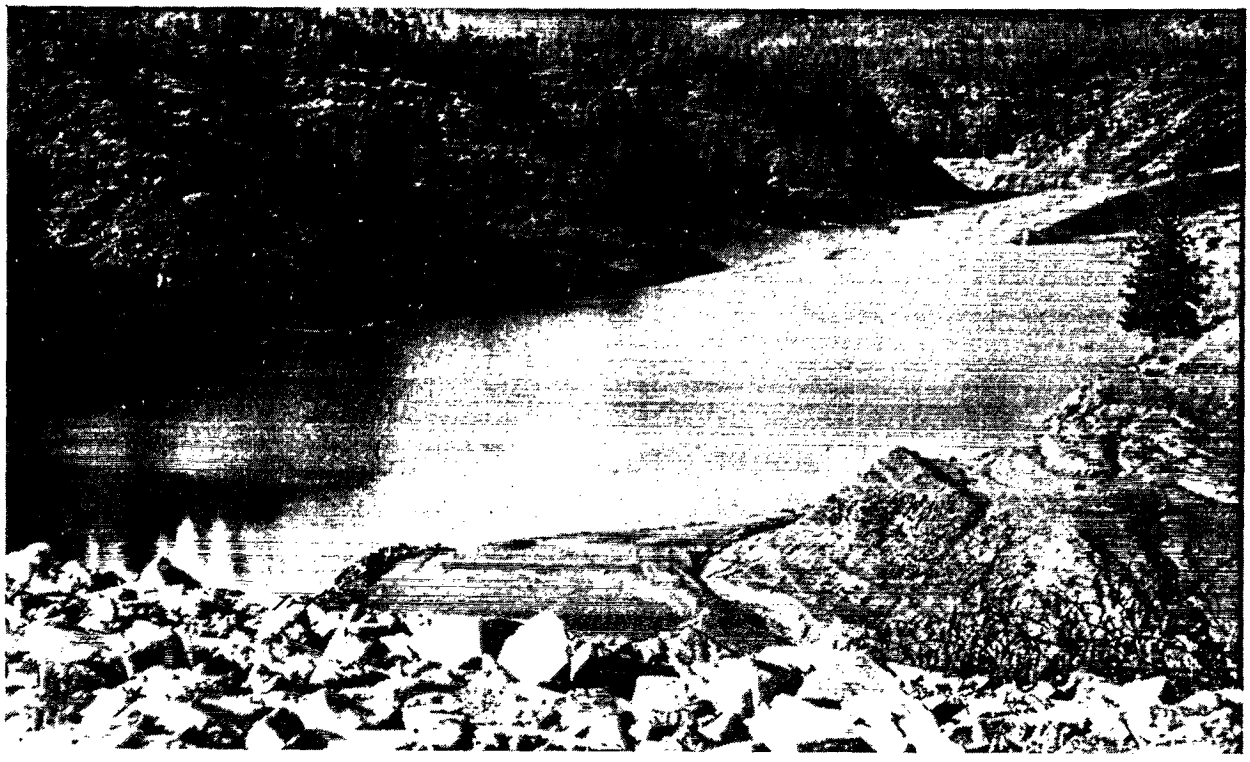
Some concern has been expressed that the concrete required to fill the mine shafts would place an inordinate demand on stream gravel, thus adversely affecting fish reproduction. However, the type of concrete envisioned requires mostly fines. The source of the fines will be tailing piles located in the Iron Mountain complex.

## Implementation

Control actions will be carried out by EPA, the Bureau of Reclamation, and private contractors, with assistance from State agencies. The schedule for specific actions is shown in the above tabulation.

## Special Funding

EPA has earmarked existing Superfund money for implementation of all actions described above. Although EPA has approved funding for the demonstration aspects of these actions, funding approval for the actual improvement will be postponed until completion of the demonstration studies.



*If needed, the final proposed action to control heavy metals would be to enlarge the existing Spring Creek Dam and Reservoir.*



C—051775

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*Clough Dam is the largest of three diversion dams on Mill Creek, but it diverts the least amount of water.*



C—051776

C-051776

# Mill Creek

## Purpose

The purpose of this action is to restore the salmon and steelhead fishery in Mill Creek, Tehama County.

## Background

Several problems impact salmon and steelhead populations of Mill Creek. They include inadequate flows and high temperatures in the valley reach at critical times, siltation and armoring of spawning gravels, and deteriorating fish ladders and fish screens.

In Mill Creek, flows too low for fish passage typically occur in late spring and fall of dry or critically dry years. These periods of low flow are directly related to diversion of most of the natural flow at three diversion dams located in the lower 10 miles of the stream. Water right holders on Mill Creek may legally divert the entire summer flow. The most serious fishery impact of these diversions is the reduction of "transportation" flows for upstream-migrating adult spring-run salmon and downstream-migrating salmon and steelhead smolts during the late spring and early summer, especially during dry years. Reduced streamflows also cause increased water temperatures or even a complete temperature block leading to expensive fish rescue operations and large fish losses. The overall result is increased mortality of juvenile salmon and steelhead and reduced future populations of adult fish. Low flows and high temperatures during the spring months also impede or block migration of adult spring-run chinook salmon to summer holding areas.

Siltation is primarily a problem in upstream spawning and nursery areas between State Highway 36 and the Big Bend area below Hole-in-the-Ground Campground. Much of the silt comes from unstable areas near the Sulfur Works area of Lassen Volcanic National Park; some is from poor timber harvest and road building practices outside the park. Siltation of spawning gravels and rearing areas results in reduced spawning success, stream productivity, and fry survival.

Some spawning areas in lower Mill Creek are armored with rocks and boulders too large for salmon to move. Often these areas become locked together by sediment.

There are three irrigation diversion dams on Mill Creek. All three diversions are screened. The upper and lower dams are operated by the Los Molinos Mutual Water Company; the middle dam is a private diversion that irrigates the Clough and Owens properties. Fish ladders at all three dams work reasonably well, although the ladder at Clough Dam, which has the largest elevation change, frequently has entrance problems. The upstream ladder was rebuilt by the Department of Fish and Game in 1987. Although each fish ladder works fairly well, their cumulative effect is to slow migration of adult salmon and steelhead. In addition, these dams, particularly Clough Dam, reduce spawning habitat by inundation and backwater effect.

## Discussion

Mill Creek supports runs of spring- and fall-run chinook salmon and steelhead. During the past four decades, these runs have varied from a few hundred to a few thousand fish, with averages near 1,400 spring-run salmon, 2,600 fall-run salmon and 1,000 steelhead. In 1986 and 1987, the total spring-run in Mill Creek declined to fewer than 200 adult salmon. These fish are important to the Sacramento



C—051777

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River fishery far beyond their numbers because they are among the last wild stocks in the system, and there are growing fears that they may be threatened with extinction.

Upstream from the canyon mouth, above the three irrigation diversions, suitable holding and spawning habitat for several thousand steelhead and adult spring-run salmon exists. Excellent rearing habitat for juvenile salmonids also is available. The future of these few remaining wild salmon and steelhead is largely dependent on sufficient "transportation" flows to get the adults from the Sacramento River upstream past the diversion structures, and to get the downstream migrants back to the Sacramento River.

Some riffles in lower Mill Creek are presently composed of rocks and boulders too large for chinook salmon to utilize for spawning, but they could be altered to provide good spawning habitat and increase food production for juvenile salmonids.

## Potential Solutions

Inadequate Flows and Temperatures:

1. Three potential solutions could alleviate the problem of inadequate transportation flows during critical migration periods:

    a. Negotiate an agreement with water right holders to pump at State expense ground water for irrigation in exchange for leaving an equal amount of natural flow in the stream at critical times for fish migration. The amount of flow needed is estimated to be about 50 cfs. Negotiating an agreement with water right holders appears to be both economically and politically feasible, and could be accomplished relatively quickly.

    b. Construct an offstream reservoir to provide water for release at critical times. Mill Creek Reservoir, a possible 10,000-acre-foot offstream storage project located on the valley floor to the north of Mill Creek, is the only potential reservoir site of adequate size to provide necessary flows. Preliminary estimates indicate a construction cost of $30 million.

    c. Purchase water rights from willing sellers. It is not likely that water rights owners would be willing to sell the full amount of water needed.

2. Long-term measures to improve temperatures include establishing land use agreements to protect existing riparian vegetation along lower Mill Creek and developing programs to produce additional riparian habitat.

Siltation and Armored Spawning Gravel:

3. Rip silted and compacted gravel areas on important spawning riffles and food-producing areas.

4. Engineer and construct improved spawning areas with graded gravel where feasible.

Passage Over Diversion Dams:

5. Change the diversion of the Clough water right to the upper (District) dam and the existing Los Molinos Mutual Irrigation Ditch on the north side of Mill Creek. Then run the water south through a short pipeline across Mill Creek to the Clough Ditch. Finally, remove the Clough Dam, fish ladder, and screen. This would remove the most difficult obstacle to adult fish migration and eliminate maintenance costs for the dam, ladder, and fish screen. This solution could be accomplished only with approval of the water right owners and landowners.



C—051778

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6. If no agreement on the removal of the Clough Dam can be reached, the present fish ladder could be improved by modifying the entrance conditions and/or by constructing a new ladder on the north side of the dam.

*Even normal winter flows can make Clough Dam and its fish ladder a formidable barrier to salmon and steelhead migrating up Mill Creek.*

## Recommended Solutions

Solution 1a, construction of wells, solves several problems and should be implemented. The State would construct new wells and pay pumping and other operation, maintenance, and replacement (OM&R) costs. In return, water right holders would leave an equivalent amount of surface water in the creek for fish migration. The safe yield of the ground water system will be determined in order to avoid overdrafting. This solution takes no land out of production and does not threaten existing water rights. Water would be pumped only when needed, usually for one or two months during dry years, to preserve natural instream flows. This solution could be implemented fairly quickly, an important consideration in view of the precarious status of the spring–run salmon in the drainage.

Solutions 1b (offstream reservoir) and 1c (buy water rights) are not recommended; an expedient solution is needed.

Solution 2 (riparian restoration) should be implemented through agreements with private landowners and Tehama County.



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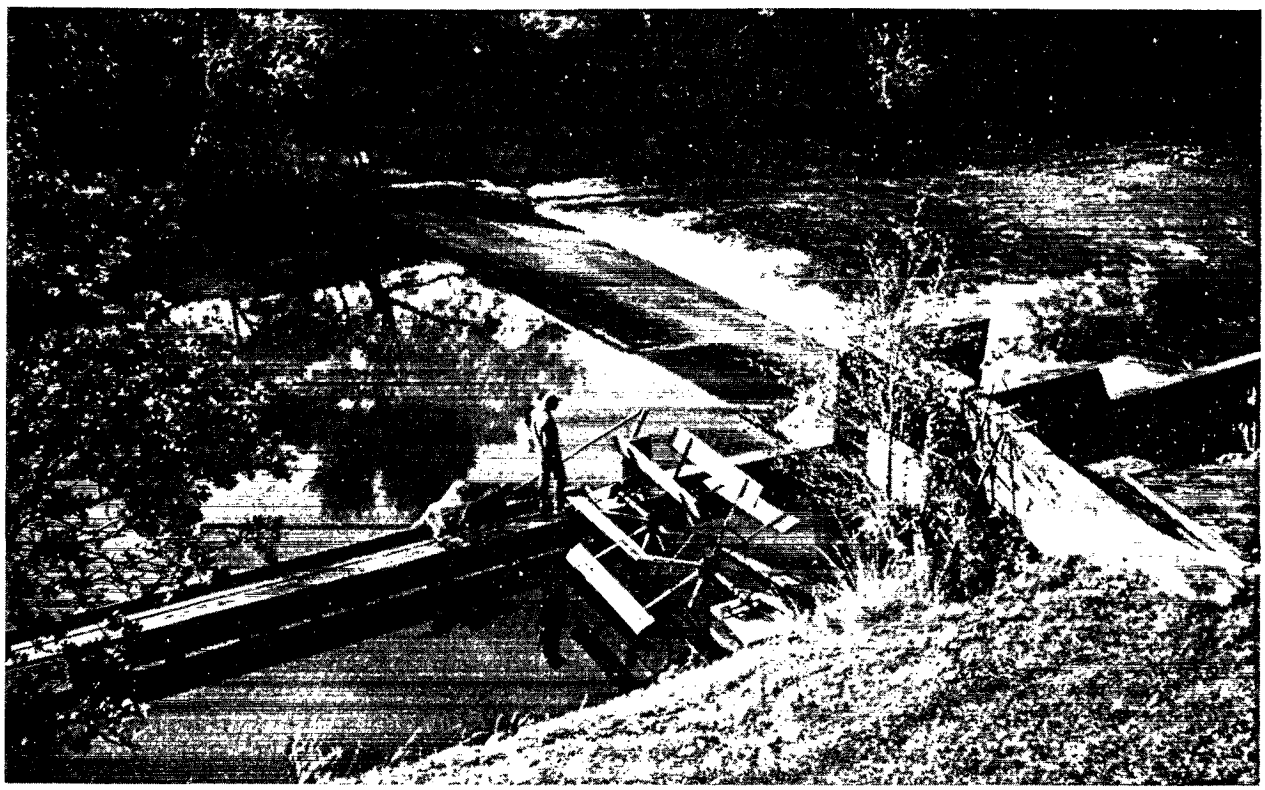
Solutions 3, 4, and 6 are construction and habitat restoration measures that should be funded and implemented. Solution 5 (removal of Clough Dam) should be funded and implemented if agreement can be reached with the owners.

In addition to the above solutions, it is recommended that fishing in the Sacramento River adjacent to the mouth of Mill Creek be closed to salmon fishing. (Mill Creek is already closed to salmon fishing.)

## Estimated Costs

| | | Cost |
|---|---|---|
| 1. Construct wells with sufficient capacity to pump 50 cfs | | $1,000,000 |
| 2. The cost of protecting and restoring riparian habitat along lower Mill Creek is described in the riparian restoration program developed for the Sacramento River tributaries | | |
| 3. Rip and clean riffles on lower Mill Creek | | $100,000 |
| 4. Construct spawning areas where needed | | $300,000 |
| 5. Revise the diversion system and remove Clough Dam (Repair and/or reconstruct Clough Dam fish ladder – $30,000) | | $150,000 |
| | Total Initial Costs | $1,550,000 |
| O,M&R costs to pump an average of 30 days annually | Total Annual Costs | $50,000 |



*The Upper (or Company) Diversion Dam on Mill Creek has a satisfactory fish ladder and screen. At high water, fish can swim directly over the dam.*



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## Estimated Benefits

The overall objective of these proposed actions is to restore adult salmon and steelhead populations in Mill Creek to the levels of the 1950s (about 2,000 spring-run and 6,000 fall-run salmon and 2,000 steelhead). Additional benefits would include: reduced costs for fish rescue by DFG and good public relations for agencies and the Los Molinos Mutual Water Company for helping restore a threatened and unique fishery.

## Potential Conflicts and Resolution

Water right owners are extremely protective of their rights. Discussions with the Los Molinos Mutual Water Company about replacing the surface water supply with ground water for short periods have met with cooperation and support. Thus, a negotiated agreement seems to be the best resolution of the primary problems and would likely encourage cooperation on other recommended solutions.

If pumping creates excessive drawdown of ground water, landowners would have to be compensated.

## Implementation

A negotiated agreement should be obtained with the Los Molinos Mutual Water Company to construct wells and provide an alternate water supply during critical migration periods. Most of the other recommended solutions could be carried out by an appropriate agency.

The Fish and Game Commission and the Department of Fish and Game would be responsible for establishing and enforcing a salmon fishing closure on the Sacramento River adjacent to the mouth of Mill Creek.

*Deep pools, undercut banks, and cold springs combine to provide excellent habitat for spring-run salmon in upper Mill Creek canyon.*



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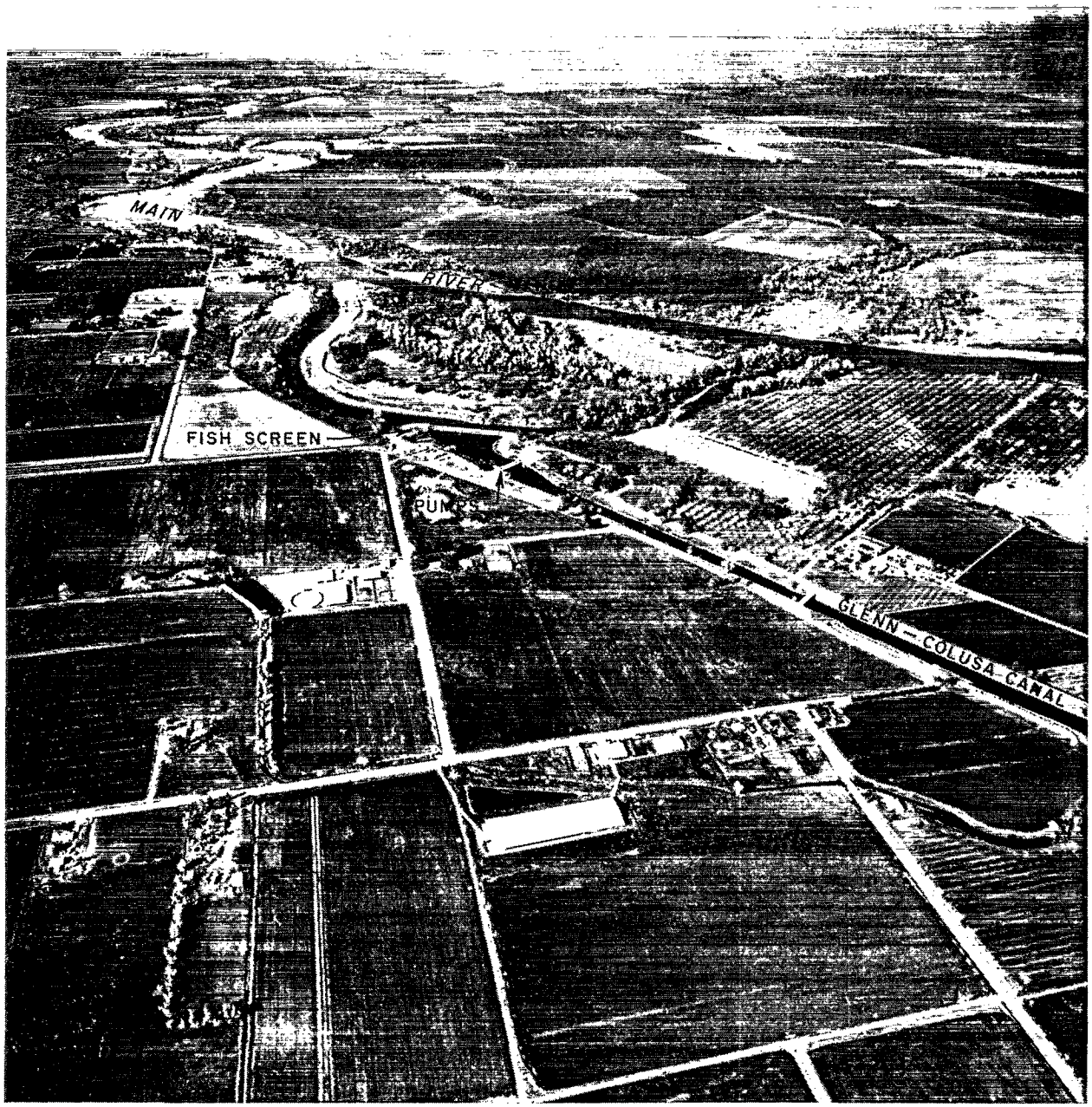


*Since 1972 when the existing fish screen was installed at the entrance of the Glenn-Colusa Irrigation District Diversion, the river channel has degraded about 4 feet. This has resulted in lower water depth on the screens and has increased water velocities to a level that kills juvenile fish by impinging them on the screens.*



C—051782

C-051782

# Glenn–Colusa Irrigation District Diversion

## Purpose

The purpose of this action is to substantially reduce downstream migrant salmonid mortality by improving fish screening efficiency at the Glenn–Colusa Irrigation District's Hamilton City Pump Diversion.

## Background

The Glenn–Colusa Irrigation District (GCID) was organized in 1920 to take over the Central Irrigation District's diversion project, which had been in operation since 1905.

GCID's point of diversion is located on the Sacramento River 3.5 miles upstream from the town of Hamilton City. The pumping plant, with a capacity of 3,000 cfs, is on a side channel of the Sacramento River 1.2 miles downstream from the inlet and 0.8 mile from the point where the bypass channel rejoins the Sacramento River's main flow. The existing fish screens were installed in 1972 at a cost of $2.6 million. Since then significant hydraulic changes have occurred in the river which reduced the elevation of the entrance to the diversion by about 3 feet. This has resulted in lower water depths on the screens, thereby decreasing the effective area of the screen surfaces and increasing the velocity through the screens, which kills juvenile fish by impingement on the screens.

An additional problem resulting from flattening of the river profile is that bypass flows needed to allow juvenile fish to return to the river are so insufficient that reverse flows can occur when drawdown in the intake channel exceeds the natural fall of the main channel of the river. Consequently, it is believed that most fish entering the diversion during these periods are lost to predation.

Original screen design criteria did not call for screening out smaller (under 1¾ inches) salmonid fry. It is now recognized that these screens were never completely effective. The Department of Fish and Game estimates an average annual loss of 7 million downstream salmonid migrants at this diversion.

## Discussion

There are two basic ways to substantially increase the effectiveness of screening fish from the GCID pumping facility. One is to modify the hydraulics of the Sacramento River to reduce water velocity through the screens and provide adequate fish bypass flows. The existing screens would then be modified as necessary to screen out smaller juveniles. The second way is to totally replace the fish screening facilities with screens designed using current design criteria (0.33 fps approach velocity and approximately ⅛-inch mesh).

In September 1987, GCID and DFG signed an agreement to share the cost of a study aimed at finding a solution. That joint study work began in the spring of 1987 and includes $360,000 in engineering and fishery studies that will be completed in 1989. Recommended solutions discussed below may have to be modified as a result of these studies.



C—051783

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## Recommended Solutions

1. Restore the elevation of the river at the head of the GCID diversion channel sufficiently to reduce water velocities through the screen to acceptable levels and to assure that adequate bypass flows are maintained to return screened fish to the river. (It is possible that this might be accomplished by replacing gravel bars at strategic locations in the main river and restoring the river to its previous surface elevation at river mile 206.0). Any river restoration would have to demonstrably improve conditions over those existing in 1972 when the screens were first put into operation. To be beneficial, the resulting screen velocities would have to approach the currently recommended 0.33 fps and bypass flows substantially increased over the originally agreed-upon 90 cfs. Modify the screen openings as necessary to screen out smaller juveniles.

2. In the event that existing screens cannot be modified to work properly in conjunction with the above solution, a new screening system using state-of-the-art knowledge will be required.

3. To the extent possible, alternative water supplies should be used to reduce the amount of water diverted through the GCID Canal, especially during critical downstream migration periods. Stony Creek is already a GCID diversion point. Trading water from Stony Gorge, Black Butte, and/or East Park Reservoirs for Sacramento River water, or wheeling water through the Tehama–Colusa Canal should be considered to reduce the amount of GCID pumping. For the last 3 years, the Bureau of Reclamation has increased releases from Shasta Reservoir during critical outmigration periods to help juvenile fish reach the ocean. During this period, GCID voluntarily increased deliveries from the aforementioned sources and reduced water diversions through the fish screens. However, the ramifications of these changes on affected reservoirs must be examined to preclude transferring fishery problems to these units during gamefish spawning periods.

4. Reduce or eliminate fish predation. The degree of predation is unknown but is probably substantial under present conditions. Studies should be conducted to evaluate ways to reduce predators from the pool at the GCID pump entrance by netting, shocking, and/or by greatly increasing bypass flows.

## Estimated Costs

| | Cost |
|---|---|
| 1. River water level restoration: | |
| Sheet pile subsurface gabions retaining (spawning size) gravel bars. | $5,000,000 |
| 2. If necessary, construct new screens using state-of-the-art technology to eliminate loss of juvenile salmonid. | $20,000,000 |
| 3. Interim use of alternative water supplies during critical fish migration periods, 3–10 days (may result in other fish problems). | $80,000/yr |
| 4. Predatory fish studies and monitoring program. Costs of implementation will be dependent on the method used. | $100,000 |
| Total Initial Costs | $25,100,000 |
| Total Annual Costs | $80,000 |



C—051784

C-051784

## Estimated Benefits

Fish losses at this facility are estimated to be up to 20 percent of the annual juvenile salmon production of the Sacramento River system, including a major portion of the Coleman National Fish Hatchery production. If this project is completed, juvenile salmon losses could be reduced by about 7 million annually, with a resulting increased annual salmon population of about 70,000 adults.

## Potential Conflicts and Resolution

Restoring the river water elevation at GCID diversion to pre-1169 levels would cause a backwater effect that would extend approximately 1.5 miles upstream to River Mile 207.5. Riparian landowners should not be negatively affected because structural and agricultural systems were predominantly designed and built using pre-1969 low water elevations. The low-water controls would be designed in accordance with State and federal floodplain criteria, which mandate that such encroachments will have a negligible effect on 100-year flood high-water elevations. Therefore, no conflicts should arise from this aspect of the project.

Approximately one-fourth mile of river channel presently used by salmonids for spawning would be inundated. Recent DFG reconnaissance identified several redds in this area. The gravel riffles that would be established by implementing alternative (a) would develop far more spawning habitat than would be lost.

## Implementation

This project will be a cooperative effort with DFG and GCID as lead agencies. Coordination must be developed between the Fish and Wildlife Service, the Corps of Engineers, the National Marine Fisheries Service, the Department of Water Resources, the EPA, and The Reclamation Board to maximize the efficiency of the study, design, and implementation of the project. The Corps would have ultimate jurisdiction over construction in a federal navigable river. The Reclamation Board and DWR will review all specifications and permits on a State level.



C—051785

C-051785

*Department of Fish and Game employees rescued downstream migrant salmon and steelhead trapped between the headgate and the fish screen in the north Stanford-Vina Ditch on Deer Creek.*



C—051786

C-051786

# Deer Creek

## Purpose

The purpose of this action is to restore the salmon and steelhead fishery in Deer Creek, Tehama County.

## Background

Several problems impact the salmon and steelhead populations of Deer Creek.These include inadequate flows and high water temperatures in the valley reach at critical times, flood management activities, and armoring of spawning gravels.

In Deer Creek, inadequate flows typically occur in late spring and fall of dry or critically dry years. This directly relates to diversion of most of the natural flow at two diversion dams located in the lower 12 miles of the stream. Water right holders on Deer Creek customarily divert the entire summer flow. The most serious fishery impact of these diversions is the reduction of "transportation" flows for upstream-migrating adult spring-run salmon and downstream-migrating salmon and steelhead smolts during the late spring and early summer, especially during dry years. Reduced streamflows also cause increased water temperatures or even a complete temperature block. This leads to expensive fish rescue operations and large fish losses. Low flows and high water temperatures during the spring months also impede migration of adult spring-run chinook salmon to summer holding areas. The overall result is increased mortality of juvenile salmon and steelhead and reduced future populations of adult fish.

The Department of Water Resources is responsible for maintaining flood channel capacity in the valley portion of Deer Creek, which is a leveed Corps of Engineers flood control project. Salmon spawning areas in the lower five miles of Deer Creek are damaged by flood control activities, when important spawning gravels are removed from the stream to increase channel capacity and when spawning riffles are compacted by heavy equipment, or simply covered by soil, sand, or silt. In some cases, the stream channel has been leveled during this process so that no low-flow channel remained. This makes upstream migration by adult salmon difficult or impossible.

Some spawning areas in lower Deer Creek are armored with rocks and boulders too large for salmon to move. Often these become locked together by sediment.

There are three irrigation diversion dams on Deer Creek. The upper dam is operated by the Deer Creek Irrigation District. The lower dams are operated by the Stanford-Vina Ranch Irrigation Company. The middle dam, called the Kimball Diversion, was screened by the Department of Fish and Game in 1980. Stanford-Vina Dam, the farthest downstream and largest of the three, has two fish ladders, one near each bank. During low water conditions, adult salmon have difficulty getting past this dam due to inadequate flows through the ladders.

This situation was improved in 1986 by DWR as part of the flood channel maintenance work on Deer Creek. A boulder weir was placed across the channel immediately downstream of the dam to restrict flow and raise the water surface about two feet. This has caused a more favorable water surface elevation with respect to the entrance to each ladder. DFG also rebuilt the south ladder in 1987 to make it more efficient at lower flows. The water right permit for this diversion does not require adequate downstream flows to provide fish passage over the dam.



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All major diversions from Deer Creek are effectively screened, especially since DFG rebuilt the north bank diversion at the Stanford–Vina Dam in 1987.

## Discussion

Deer Creek supports runs of steelhead and spring– and fall–run chinook salmon. During the past four decades, these runs have varied from a few hundred to a few thousand fish, with averages near 2,800 spring–run salmon, 1,300 fall–run salmon and 1,000 steelhead. The total spring–run in Deer Creek declined to about 540 adult salmon in 1986 and 200 in 1987. These fish are important to the Sacramento River fishery far beyond their numbers because they are among the last wild stocks in the system. There are growing fears they may be threatened with extinction.

Fall–run salmon spawn in the valley reaches of the creek upstream as far as the third diversion dam. Upstream from the canyon mouth, above the irrigation diversions, there is suitable holding and spawning habitat for several thousand adult spring–run salmon. Excellent rearing habitat for juvenile salmonids is also available. The future of these few remaining wild salmon is largely dependent on sufficient "transportation" flows to get the adults from the Sacramento River upstream past the diversion structures and to get the downstream migrants back to the Sacramento River.

Some riffles in lower Deer Creek are presently composed of rocks and boulders too large for chinook salmon to utilize for spawning, but they could be altered to provide good spawning habitat and increase food production for juvenile salmonids.

## Potential Solutions

Inadequate Flows and High Temperatures:

1. Three potential solutions that would resolve the problem of inadequate transportation flow are as follows:

    a. Negotiate an agreement with water right holders to pump ground water at State expense into the irrigation systems at critical times in exchange for leaving an equal amount of natural flow in the stream for fish migration. The amount of flow needed is estimated to be 50 cfs. The possibility of negotiating an agreement with water right holders to trade ground water for surface water appears to be both economically and politically feasible.

    b. Construct reservoirs to provide water for release at critical times. Two potential reservoirs, Deer Creek Meadows and Crown, were thoroughly investigated by DWR in the 1960s. Deer Creek Meadows Dam would be located at the head of Deer Creek Canyon to create a 153,000-acre–foot reservoir. Crown Reservoir would be an 11,000-acre–foot storage project located on Brush Creek. Estimated cost to construct Deer Creek Meadows Dam is $60 million; construction of Crown Dam is estimated at $20 million.

    c. Purchase water rights from willing sellers. (It is not likely that enough water rights could be purchased.)

2. Long–term measures to reduce temperatures include establishing land–use agreements to protect existing riparian vegetation along lower Deer Creek and developing programs to restore riparian vegetation.

Flood Management/Habitat Management Activities:

3. Plan and coordinate flood management activities carefully with appropriate agencies (DWR, DFG, the Corps, the Reclamation Board, and County Flood Control) and integrate fish habitat



C—051788

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improvement whenever possible. Recent DWR flood management activities on lower Deer Creek have successfully increased channel capacity and repaired levee damage, while maintaining a low-flow channel to improve fish passage. Also, large boulders and stumps were placed to create scour holes and provide resting habitat. Compacted gravel areas on spawning riffles were ripped to improve spawning habitat. In some cases, it may be necessary to engineer and construct spawning areas with graded gravel or construct controls to decrease velocities so that suitably sized gravel can accumulate.

Armored Spawning Gravel:

4. Rip compacted gravel areas on certain riffles to improve spawning conditions and food production.

5. Engineer and construct spawning areas with graded gravel, where feasible.

## Recommended Solutions

Solution 1a, construction of wells, would solve several problems and should be implemented. The State would construct new wells as needed and pay pumping and other O,M&R costs. In return, water right holders would leave an equivalent amount of surface water in the creek for fish migration. Additional flow measurement devices and limited term watermaster service may be required to monitor the migration flows past the lower dams. This solution would take no land out of production, would threaten no existing water rights, and would require pumping only when needed, usually during one or two months during dry years. It could be implemented fairly quickly, an important consideration in view of the precarious status of spring-run salmon in this drainage.

Solution 2 should be implemented through agreements with private landowners.

Solutions 3, 4, and 5 are feasible construction and habitat restoration measures that should be funded and implemented.

In addition, a fishing closure in the Sacramento River adjacent to the mouth of Deer Creek should be considered to increase the escapement of spring-run salmon up Deer Creek. (Deer Creek already is closed to salmon fishing.)

## Estimated Costs

| | | Cost |
|---|---|---|
| 1. Construction of wells with sufficient capacity to pump 50 cfs. | | $1,000,000 |
| 2. Protecting and restoring riparian habitat along lower Deer Creek is described in the riparian habitat restoration proposal for the Sacramento River tributaries. | | --- |
| 3. Fisheries habitat restoration/enhancement can typically be completed during flood maintenance operations at little additional cost. Each proposal should be considered on its own merit. | | --- |
| 4. Rip and clean riffles on lower Deer Creek. | | $100,000 |
| 5. Construct spawning areas. | | $300,000 |
| | Total Initial Costs | $1,400,000 |
| O,M&R to pump an average of 30 days annually | Total Annual Costs | $50,000 |



C—051789

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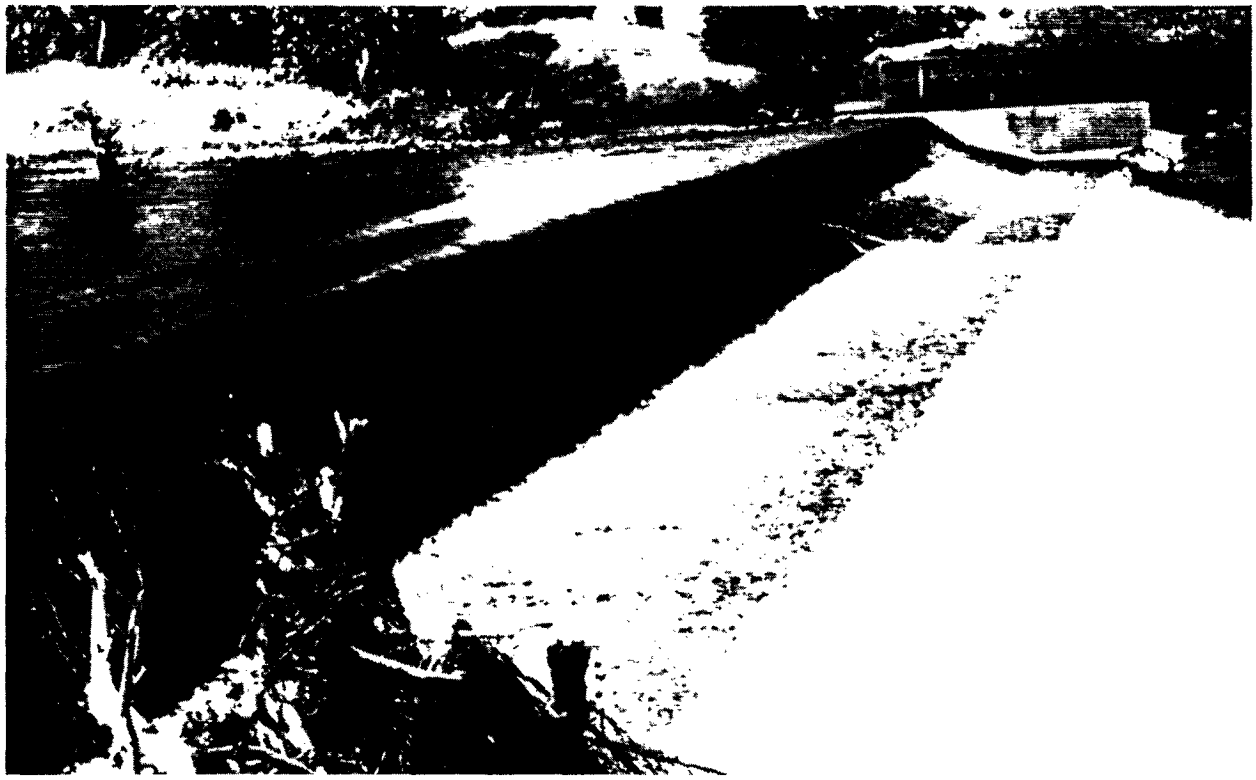

*Stanford-Vina Dam on Deer Creek*

## Estimated Benefits

The overall objective of these actions is to restore salmon and steelhead populations in Deer Creek to the levels of the 1950s (about 2,000 spring-run and 3,000 fall-run salmon and 1,000 steelhead). Additional benefits would include reduced costs for fish rescue by the Department of Fish and Game and improved public relations for agencies and water districts for helping restore a threatened and unique fishery.

## Potential Conflicts and Resolution

Water right owners are extremely protective of their rights. Attempts to obtain water needed for the fishery by purchase or condemnation would be met with extreme opposition. If pumping creates excessive drawdown of ground water, landowners would have to be compensated.

## Implementation

Negotiated agreements should be sought with the Deer Creek Irrigation District and the Stanford-Vina Ranch Irrigation Company to implement the proposal to construct wells and provide an alternative water supply during critical migration periods. Improved communication between the State agencies and the water districts is essential to accomplish this goal. Most of the other recommended solutions could be carried out by an appropriate agency. The Fish and Game Commission and DFG would be responsible for establishing and enforcing any salmon fishing closure on the Sacramento River adjacent to the mouth of Deer Creek.



C—051790

C-051790

# Unscreened Diversions

## Purpose

To significantly reduce the mortality of salmonids at unscreened water diversions on the Sacramento River from Keswick Dam to the mouth of the Feather River.

## Background

Between Redding and the Feather River, there are over 300 diversions on the Sacramento River. Only the Anderson–Cottonwood Irrigation District's diversion at Redding, Tehama–Colusa Canal at Red Bluff Diversion Dam, and Glenn–Colusa Irrigation District's facility at Hamilton City are screened. (These screens are discussed separately in this report as individual actions). Approximately 1.2 million acre–feet of water is diverted annually through these unscreened diversions, with an estimated annual loss of 10 million juvenile salmonids. Most of the impacts occur between Ord Ferry and Knights Landing (Hallock, 1987).

## Discussion

Although some information exists on water diversion locations and pumping capacities, detailed data such as diversion construction and intake design/location of each are lacking or not readily available. Studies are needed to identify diversions that significantly affect the fishery and to determine the cost of work required to effectively screen each diversion.

Sections 5980–5993, 6020–6028, and 6100 of the California Fish and Game Code provide the Department of Fish and Game authority to require fish screens needed to protect fish and to require adequate bypass flows to make fish screens effective. DFG recently proposed new, stringent design criteria regarding allowable screen approach velocities, mesh geometry, and flow requirements.

These criteria are not consistently applied by experts in DFG, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and the American Fisheries Society. Variation in these criteria is often due to policy directives, or "best judgment" solutions. The bioengineering aspects of screen design have never been adequately studied to yield the objective data needed to establish consistent screen design criteria.

## Recommended Solutions

1. Define the minimum size of diversion that significantly affects the fishery and inventory all larger diversions of water from the Sacramento River between Redding and the mouth of the Feather River. This inventory should describe each diversion in detail.

2. The Corps of Engineers should inventory each diversion currently under its permit. If a screen is a condition of the Corps' permit, require full installation and maintenance compliance to meet screening requirements of fishery management agencies. Interagency cooperation is essential to accomplish this task.

3. Require screening and screen maintenance on all diversions on the Sacramento River that significantly impact the fishery and develop a process for funding this work.



C—051791

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4. Obtain funding to design and install screens at private diversions currently not under permit from the Corps of Engineers.

5. Adequate funds should be appropriated to conduct comprehensive fish screen design studies. These studies should be performed by a qualified independent research organization, such as a major laboratory specializing in fish swimming energetics, metabolism, stress, and predation response. A technical advisory group should be formed to review this work. This group should include engineers, biologists, and management specialists knowledgeable in fish behavior.

   Hydraulic parameters addressed by the study should include flow uniformity under varied stage and volume, erosion, deposition, and screen fouling. Mechanical parameters should include dependable operation and cleaning systems, with system bypass or removal options in case of screen failure. Future screen designs should be physically modeled to assure their performance meets the specified requirements prior to construction and/or reconstruction of major new facilities.

   Alternative fish protection methods also should be considered. Innovative techniques should be studied in an effort to minimize fish losses and maximize screening efficiency in a cost-effective manner.

## Estimated Costs

Studies

| | | Cost |
|---|---|---|
| 1. | Locate and document each diversion | $35,000 |
| 2. | Determine ownership of each diversion | $15,000 |
| 3. | Inspect each diversion for screens and screening compliance | $100,000 |
| 4. | Notify all landowners of their screening problems | Not applicable |
| 5. | Prioritize the diversions in need of remedial action | $10,000 |
| 6. | Make a comprehensive fish screen study | $1,000,000 |
| | Total Study Costs | $1,160,000 |

Facilities

| | | |
|---|---|---|
| 1. | Design and construction | $6,000,000* |
| 2. | Operation and maintenance | $300,000/yr |
| | Total Initial Costs | $7,160,000 |
| | Total Annual Costs | $300,000 |

*This estimate was based on a maximum diversion rate of 4,000 cfs, with a screening cost of $1,500/cfs of diversion capacity.



C—051792

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## Estimated Benefits

The effects of over 300 unscreened diversions on the fishery are not accurately known. However, based on estimates prepared for Glenn–Colusa Irrigation District, the annual diversion of approximately 1.2 million acre–feet of water suggests that the losses may exceed 10 million juvenile salmonids each year. This represents an annual loss of up to 100,000 adult salmon and steelhead.

## Potential Conflicts and Resolution

The cost to screen private diversions will be objectionable to individual owners. This project would provide funding for screen installation and maintenance at water diversions that are not presently required to have screens.

## Implementation

Generally the restoration activity above can be accomplished as a cooperative effort by the Bureau of Reclamation, the Department of Fish and Game, the Department of Water Resources, the Fish and Wildlife Service, the National Marine Fisheries Service, and the owners of the diversions. Funding would be provided by legislative action, except for costs to water users required by law to provide screens.



C—051793

C-051793

*Anadromous fish in Clear Creek are blocked by McCormick-Saeltzer Dam 6 miles above the mouth of the creek.*



C—051794

C-051794

# Clear Creek

## Purpose

The purpose of this action is to significantly improve the Clear Creek fishery.

## Background

Whiskeytown Dam was constructed as a part of the Trinity River Division of the federal CVP. Since the project began operation in 1963, more than 85 percent of the natural flow of Clear Creek has been diverted to Spring Creek Power Plant, leaving only 10 to 15 percent in Clear Creek. Clear Creek has experienced fishery habitat degradation problems, including diversion of water supply, heavy sedimentation due to decomposed granite sand, riparian vegetation encroachment, reduction of available spawning gravels, and past mining damage. The few remaining areas of suitable streamside gravels which could supply the creek with spawning gravel in the future are threatened by proposed gravel-mining operations. The creek now supports an average run of about 2,000 salmon and a few steelhead, but this level could be greatly increased by improved flows and rehabilitation work.

Clear Creek presently produces approximately 2 percent of the upper Sacramento River salmon run, but with rehabilitation work and increased flows, has the potential to produce around 6 percent. Steelhead production could be increased to many times the present numbers if additional summer instream flows are released.

## Discussion

The majority of the Clear Creek salmon-improvement potential lies in the lower eight miles where some spawning gravels still exist and where streamflow is controlled by Whiskeytown Dam, located at mile 16.5. The potential for steelhead is in the upper 8 miles where summer water temperatures remain cold. Much of the fishery habitat improvement could be accomplished immediately, simply by releasing increased flows below the dam. Increased flow releases to cool water temperatures and improve habitat, along with construction of adequate fish passage facilities at McCormick-Saeltzer Dam would create several additional miles of suitable habitat for steelhead and salmon. Full restoration would also require instream-habitat restoration work such as sediment control, riffle ripping, and pool and riffle construction. For further discussion, see *Clear Creek Fishery Study* (March 1986), published by the Department of Water Resources, and *Evaluation of Benefits and Costs of Improving Anadromous Fishery of Clear Creek* (September 1986), published by the Bureau of Reclamation.

## Recommended Solutions

1. Increase flow releases below Whiskeytown Dam from 42,000 acre-feet to about 90,000 acre-feet annually, on a schedule similar to that shown in Table 14 of DWR's *Clear Creek Fishery Study*. This represents about 30 percent of the average annual runoff of Clear Creek at Whiskeytown Dam.

2. Reconstruct the fish ladder at McCormick-Saeltzer Dam to allow effective fish passage. A screen would then be required on the diversion.

3. Reconstruct spawning riffles below McCormick-Saeltzer Dam which have been damaged by floodflows.



C—051795

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4. Mechanically rip silt- and sand-damaged riffle areas in the lower six miles to improve natural spawning and food-producing areas for juvenile salmonids.

5. Purchase land or obtain long-term easements along portions of the Clear Creek floodplain to allow restoration and permanent protection of fish and their habitat. Future gravel mining should be restricted to areas far enough away from the creek to insure that floodflows will continue to have enough available nearby gravels for recruitment into the creek channel to replace those that wash downstream.

6. Construct instream structures made of boulders, rock, or wood (logs) to create new fish cover and resting habitat.

7. Periodically dredge McCormick-Saeltzer Dam to reduce transport of harmful decomposed granite sand to downstream spawning areas.

8. Study the potential for a steelhead hatchery on Clear Creek below Whiskeytown Dam.

## Estimated Costs

| | | Cost |
|---|---|---|
| 1. | Reduced annual revenues from decreased hydroelectric energy generation | $600,000/yr |
| 2. | Fish ladder and screen | $50,000 |
| 3. | Spawning gravel restoration | $200,000 |
| 4. | Gravel ripping, clearing | $100,000 |
| 5. | Land acquisition, easements | $1,000,000 |
| 6. | Instream structures | $100,000 |
| 7. | Dredging above McCormick-Saeltzer Dam | $550,000 |
| 8. | Study potential for steelhead hatchery | Unknown |
| | Total Initial Costs | $2,000,000 |
| | Annual O&M Costs | $200,000 |
| | Reduced energy revenue | $600,000 |
| | Total Annual Costs | $800,000 |

## Estimated Benefits

If all the above actions are taken, an increase in annual salmon-spawning runs in the order of 13,000 fish is possible, and habitat capable of supporting a similar number of adult steelhead would be created.



C—051796

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## Potential Conflicts and Resolution

1. Providing increased flows in Clear Creek could reduce the firm water supply of the CVP. This loss could be eliminated by reducing the Keswick release by the amount of increased release into Clear Creek.

2. Increased flows in Clear Creek would slightly reduce energy production of the CVP. This loss would be partially offset by increased energy produced at the City of Redding's power plant below Whiskeytown Dam. Losses could be further reduced by dry-year reductions in Clear Creek releases.

3. The total capital cost of the Clear Creek restoration work would be about $2 million. Annual costs would be about $200,000 for O&M, plus annual energy losses of $600,000. These costs would be more than offset by the value of increased production of salmon and steelhead and may be considered mitigation for losses resulting from construction and operation of the Trinity River Division of the Central Valley Project.

## Implementation

Generally, the restoration activities described above could be done as a cooperative effort by the Bureau of Reclamation, DWR, and DFG. Flow re-regulation would be a Bureau responsibility. DFG already has budgeted to reconstruct the fish ladder at McCormick-Saeltzer Dam. Either the Bureau or DWR could supervise the repair and reconstruction of spawning riffles and sediment removal, depending on the specific funding source.

## Special Funding

Federal authorizing legislation (1955) for the Trinity River (and Whiskeytown) Division of the CVP required the "preservation and propagation" of anadromous fish runs in the Trinity River and Clear Creek. Flows sufficient to protect these resources have been granted in the Trinity. No such increase has been granted in Clear Creek. The only costs of increased flows would be in the form of energy revenue forgone. No loss of water supply would result if operated in conjunction with Shasta-Keswick releases.



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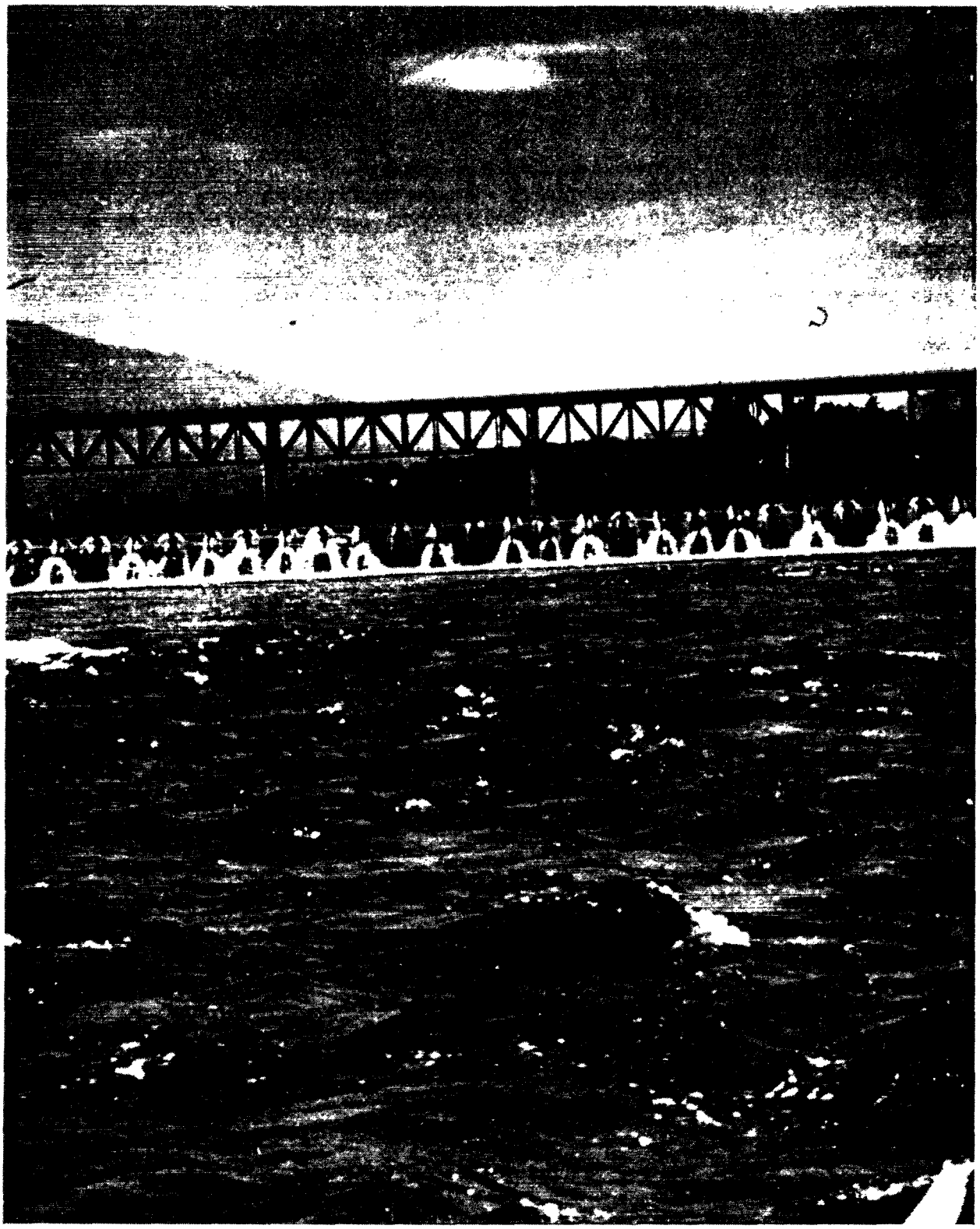

*The Anderson-Cottonwood Irrigation District Diversion Dam, constructed in 1917, creates fish passage problems and periodic flow reductions which can dewater salmon redds (nests) and strand fish in side channels.*



C—051798

C-051798

# Anderson-Cottonwood Irrigation District Diversion Dam

## Purpose

To improve fish passage past the Anderson-Cottonwood Irrigation District (ACID) Diversion Dam and to eliminate river flow fluctuations required to install, remove, and periodically adjust the dam flashboards for maintenance of adequate flows in the ACID canal.

## Background

The ACID Diversion Dam (river mile 298.5) was constructed in 1917 to divert a maximum of 400 cubic feet per second (cfs) from the Sacramento River at Redding into the ACID main canal. The dam is a 450-foot-long flashboard-type structure which raises the backwater level 10 feet. Normally, the flashboards are installed annually in early April and removed in early November. The dam has a fish ladder on the north abutment, but it is very inefficient at passing upstream migrating fish.

This was the first dam constructed on the Sacramento River, and ACID has one of the earliest water rights.

## Discussion

The ACID Diversion Dam creates three significant problems for anadromous fish in the river. First, the fish ladder is too narrow and its flow too low (60 cfs) to fully attract and pass upstream-migrating fish from April through October when the dam is in place. This is of particular significance to the badly depressed winter run. Second, river flows must be temporarily reduced from 10,000 to 15,000 cfs to around 6,000 cfs when the flashboards are installed, removed, or adjusted. Adjustments to the dam flashboards are normally required two or three times each year whenever the releases from Keswick Dam are changed by several thousand cfs. This lowering of releases can disrupt salmon spawning activity, dewater salmon redds, and strand fish in side-channel areas. And third, lowered flows required for flashboard adjustments help increase water temperatures to levels detrimental to young fish and developing eggs.

## Recommended Solutions

1. Both interim and long-term solutions to the ACID Diversion Dam problems have been proposed. Assuming that long-term solutions will include construction of a new fish ladder and a new gate system to automatically adjust head levels at the dam, the following interim solutions are planned by DFG:

    a. The fish ladder on the north side of the dam will be repaired, including new pool floors, weirs, and entrance slot. These repairs will be made only to maintain fish passage until the new gate and ladder system is constructed. No major structural changes will be made.

    b. A steel modified-denil fish ladder about 4 feet wide and 42 feet long will be placed in the slot at the south end of the ACID dam. This ladder will be removed when the new gate structure and permanent fish ladder are installed.

    c. A mechanical system is being developed by DFG to pull the ACID flashboards at higher than normal flows.



C-051799

C-051799

2. Fish passage at the ACID Dam can be greatly improved by reconstructing the fish ladder to widen its entrance area and increase attraction flow to about 1,500 cfs (10 percent of total flow). Also, a reconstructed fishway should include fish-trapping capability. This would allow fish to be taken more efficiently than at Keswick Dam and at a location closer to Coleman Hatchery.

3. The adverse effects of reducing river releases to allow safe adjustment of flashboards at the ACID Dam could be eliminated by construction of a limited-length gate structure located adjacent to the fish ladder. The new gate structure would pass a large portion of the river flow and help attract fish to the fishway entrance.

## Estimated Costs

| | | Cost |
|---|---|---|
| 1. Interim solutions (ladder improvements and board puller) | | $25,000 |
| 2. Construct new fishway and fish trap | | $200,000 |
| 3. Construct new gate structure | | Up to $800,000 |
| | Total Initial Costs | $1,025,000 |
| | Total Annual Costs | Unknown |

## Estimated Benefits

1. Repair of the north bank fish ladder and installation of a denil ladder on the south bank would help maintain fish passage on an interim basis. A portable mechanical flashboard-pulling device would allow adjusting the dam height to maintain constant flow into the ACID canal without the necessity of temporarily reducing river flow, which strands fish and dewaters nests.

2. A new fish ladder will increase the attraction and passage of upward migrating fish during the period when the dam is in operation. Efficient trapping of adult fish will also be possible at a location closer to Coleman Hatchery than Keswick Dam.

3. Construction of the new gate structure would replace approximately 50 feet of the flashboard dam. It will automatically maintain a constant lake elevation as river flows vary, without the necessity for temporarily reducing the river flow for flashboard adjustments. This will eliminate stranding of fish and dewatering of fish nests.

## Potential Conflicts and Resolution

The City of Redding has proposed construction of a low-head hydropower generation dam at the existing ACID Dam location. Studies on this low-head hydro project are ongoing and no decision on its construction has been made. This project has received considerable opposition from fishery agencies because of potential significant adverse impacts on salmon. If this project includes a permanent dam, it would eliminate all of the alternatives discussed in this item because fish would be blocked from using the 3.5 miles of river above the dam.



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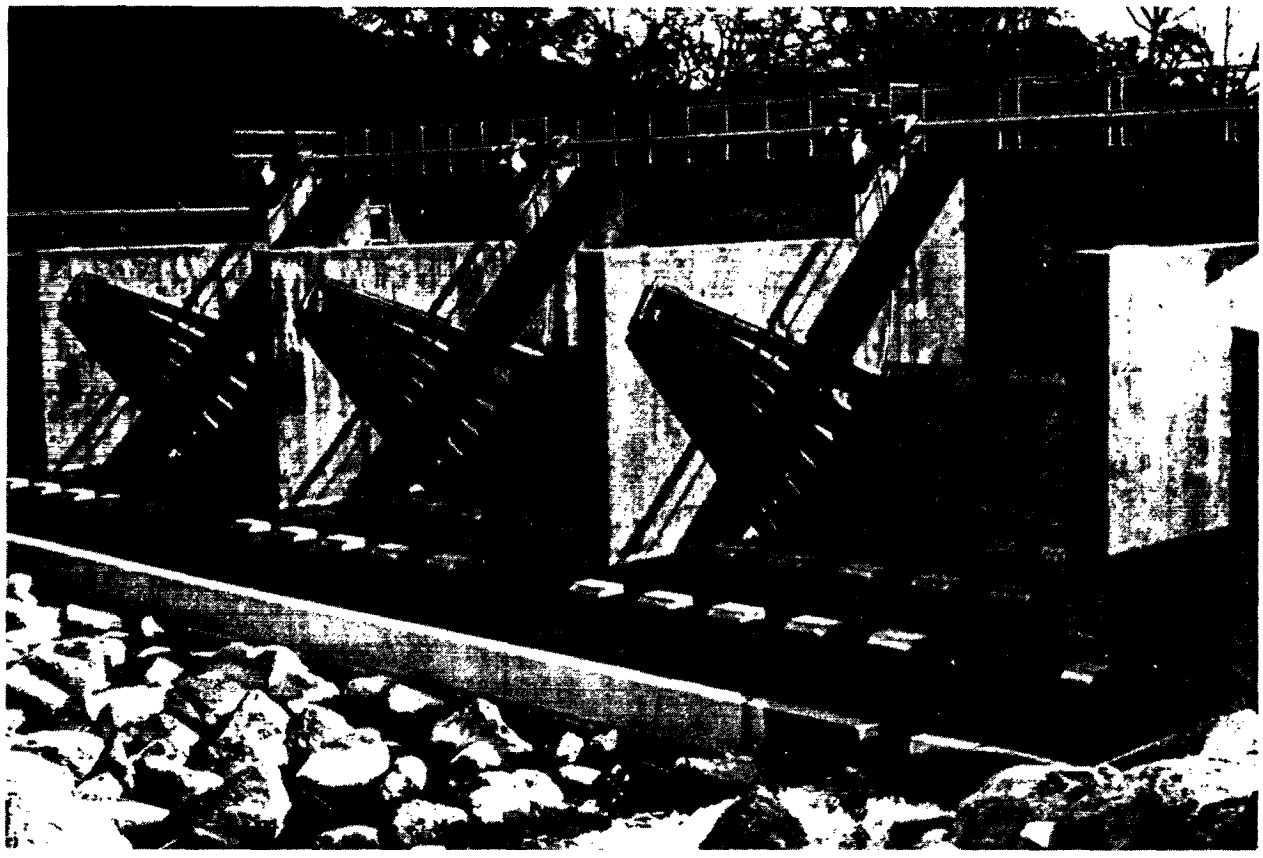
## Implementation

Each of the recommended solutions would require additional design work to identify specific features and final costs. Final decisions on these solutions are contingent on the disposition of the City of Redding's proposed hydro project.

## Special Funding

Proposition 19 funds are recommended as a potential source for implementation of the interim solutions. Construction and operation of a new fish ladder, fish trap, and gate structure will require some combination of local, State, and federal funding.

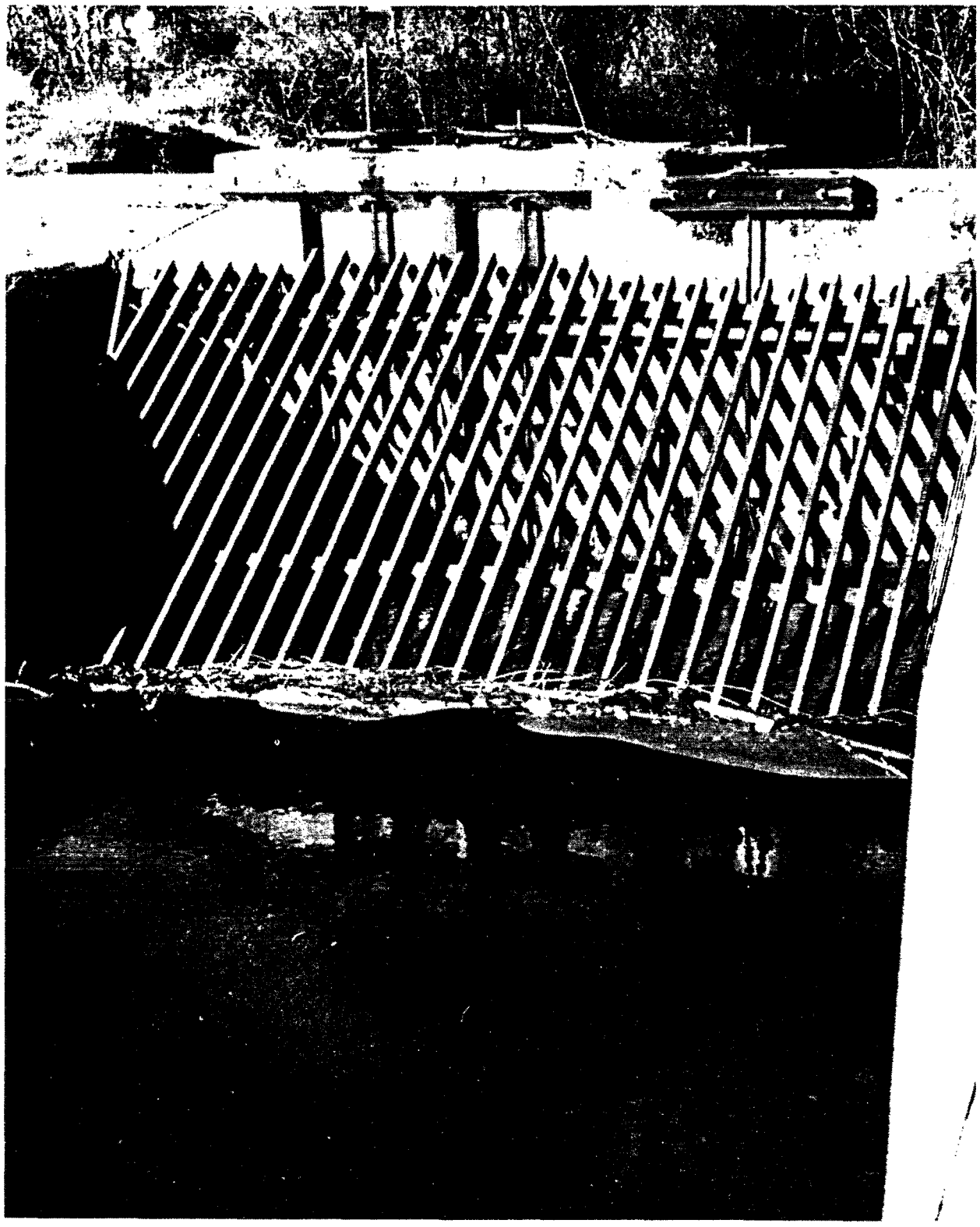


*A gate structure similar to this one on Kelsey Creek in Lake County could be constructed on the Sacramento River to make adjustment of flashboards at the ACID dam easier.*



C—051801

C-051801



*The decline of Butte Creek's once numerous salmon and steelhead fisheries is attributed to inadequate flows, poor water quality, inadequate fish ladders, and unscreened diversions at several dams, like this one in lower Butte Creek canyon.*



C—051802

C-051802

# Butte Creek

## Purpose

The purpose of this action is to restore the Butte Creek salmonid fishery.

## Background

As late as the 1960s, Butte Creek (see following maps) supported a spring run of chinook salmon of over 4,000 adults (a maximum of 20,000 in 1960), a lesser number of fall run and a small number of steelhead trout. Currently, the spring-run numbers fewer than 200 adults, over a 95 percent decline in the past 30 years. DFG population estimates, and PG&E fish surveys indicate, that few adult spring-run salmon reach upper Butte Creek, where excellent flow, temperature, and habitat conditions are available. The fall-run population varies between a few to as many as 1,000 (1985) and the number of steelhead trout is unknown.

The decline of Butte Creek's chinook and steelhead fisheries is attributed to problems associated with inadequate flows, numerous unscreened diversions, inadequate fish passage over diversion dams, unblocked drains that attract and strand fish, and poor water quality. There are 10 diversion dams on lower Butte Creek that supply water for irrigation, gun clubs, and domestic use (listed by location on the following table). At least nine are known to impair passage of migrating fish. All of the diversions from these dams are unscreened. Between 1983 and 1985, DFG attempted to restore the spring run by planting surplus fry from the Feather River Hatchery. In 1988, more than 1,000 adult spring-run salmon returned to Butte Creek to spawn. Most probably resulted from the hatchery release. Spring-run adults migrate upstream in Butte Creek during March-June. They hold over primarily in pools from the confluence of Little Butte Creek to the Centerville Head Dam and then spawn in early October. Spring-run smolts emigrate the following March to May. Below the Western Canal Dam, spring-run adults normally have sufficient water to migrate upstream. During dry years, there are several areas that must be carefully monitored to assure adequate passage. Fish ladders at all of the diversion dams require continuous monitoring to operate successfully.

Above the Western Canal Dam, spring-run adults often encounter low, warm flows. DFG has begun seining adult salmon below the Gorrill and Durham Mutual Dams and transporting them upstream into Butte Creek Canyon. Without improved flow conditions, it is anticipated that rescue operations for adult spring runs will continue.

Fall-run adults enter lower Butte Creek during late September and early October. Their passage upstream is often blocked by dewatered sections caused by diversions for the flooding of duck clubs. Most fall-run salmon spawn in the area from Durham to the Parrott-Phelan Dam, although some are known to spawn above. Spawning generally takes place during October through December. Fall-run smolts emigrate during April and May and are heavily impacted by diversions and poor water quality. Below the Western Canal, adult fall-run fish often encounter impassable barriers, dewatered areas, siltation, a lack of suitable gravels, and inadequate cover and shade. Above the Western Canal, several barriers exist which impede the adult migration until high flows occur.



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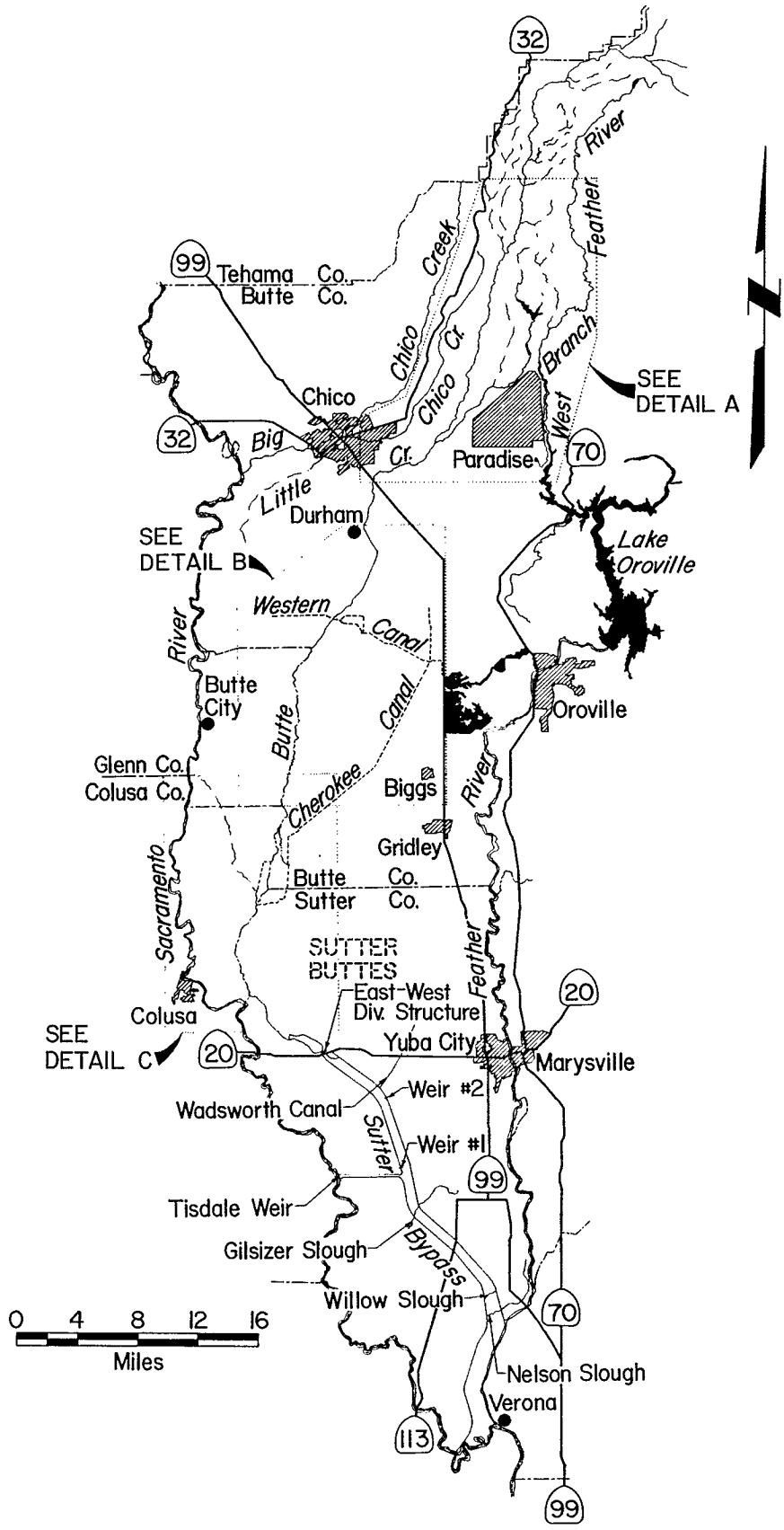


Butte Creek Diversion System



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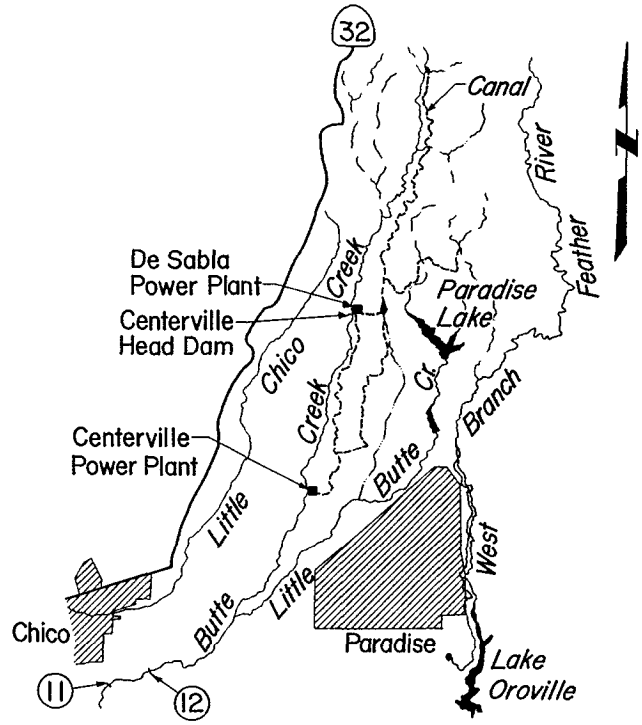
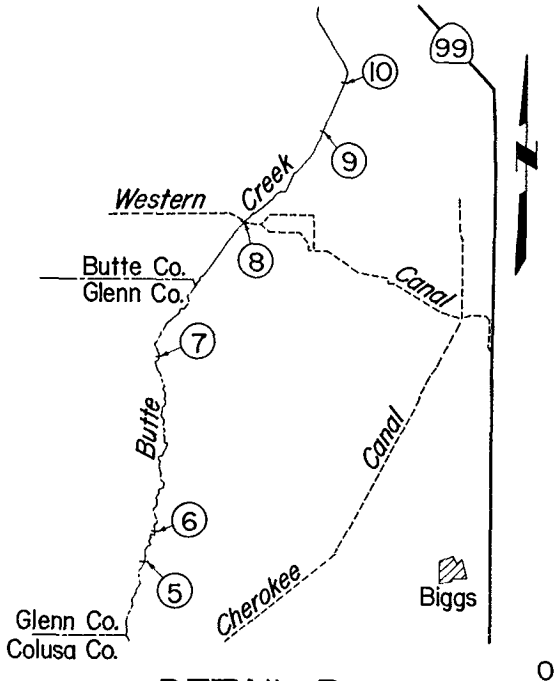
C-051804

LEGEND

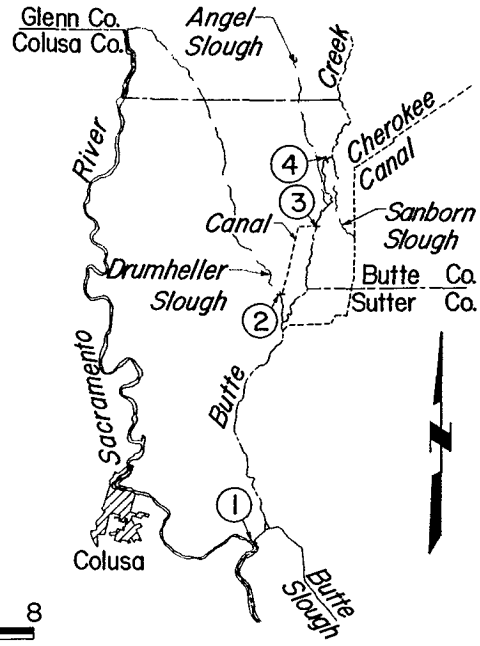
1. Butte Slough Outfall
2. Five Points
3. White Mallard Dam
4. Sanborn Slough Dam/Bifurcation
5. Howard Slough Dam
6. McGowan Dam
7. Point Four Dam
8. Western Canal Dam
9. Gorrill Dam
10. Adams Esquon Dam
11. Durham Mutual Dam
12. Parrott-Phelan Dam




DETAIL A




DETAIL B




DETAIL C

0 2 4 6 8
Miles

**Detail of Butte Creek Diversion System**



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### Summary of Butte Creek Diversions

| Diversion | Location | Unscreened | Needs New Ladder or Ladder Improvements | Flows Need Regulation | Not Gaged/ Monitored | Stranded Fish | Blocked Fish Passage |
|---|---|---|---|---|---|---|---|
| 1. Butte Slough Outfall Gates | Butte Slough junction with Sacramento River | | | | | | X |
| 2. Five Points | Where Drumheller Slough meets a levee at right corner of the California Duck Club | X | | X | X | X | |
| 3. White Mallard Dam | Where irrigation canal near White Mallard Hunting Club bifurcates from Butte Creek | X | X | X | X | | X |
| 4. Sanborn Slough Dam | Where Sanford Slough bifurcates from Butte Creek | X | | X | X | | |
| 5. Howard Slough Dam | Approx. 3 miles downstream of Hwy 162 bridge | X | | X | X | | |
| 6. McGowan Dam | Approx. 1 mile upstream of Highway 162 | X | | | | X | |
| 7. Point Four Ranch Dam | Approx. 2 miles downstream of Aguas Frias Rd. | X | X | X | X | | X |
| 8. Western Canal Dam | Approx. 1 mile upstream of Nelson West Road | X | | | | X | |
| 9. Gorill Ranch Dam | Approx. 1/4 mile downstream of Midway Road | X | | X | | | |
| 10. Adams Esquon Ranch Dam | Approx. 1-1/2 miles upstream of Midway Road | X | X | X | | | X |
| 11. Durham Mutual Dam | 3/4 upstream from Highway 99 | X | X | | X | X | X |
| 12. Parrot-Phelan Ranch Dam | Off Honey Road 2 miles upstream of the Skyway | X | | | | X | |

## Discussion

Correcting passage problems in the 30-mile reach between the Butte Slough outfall and the Parrot Phelan Dam will substantially improve the Butte Creek salmonid fishery. Most of the improvements can be accomplished by providing adequate transportation flows, improving older fish ladders, or constructing new ladders, and by screening all major diversions. Improvements could also be accomplished by providing selected barriers and screens (or traps) as physical conditions warrant.

In addition to the 30-mile reach described above, passage problems within the Sutter Bypass system need correction. Known passage problems exist at the east-west structure, at Gilsizer Slough, and at the pool and jump ladder located at weir No. 2. Passage conditions at Nelson Slough, Wadsworth Canal, and Tisdale Bypass also need improvement.

Instream flow requirements for both adult and juvenile fish passage are inadequate at this time. Long-term maintenance of adequate instream flows during critical spring and fall migration periods will require strict management of available flows, or development of alternative water sources during critical irrigation periods. This may entail identifying water rights and restricting diversions to only authorized amounts, and development of additional water supplies through purchase or exchange.

Restoring salmonid populations in Butte Creek should be initiated by (1) assuring adequate transportation flows for both upstream-migrating adults and downstream-migrating juveniles;



C—051806

C-051806

(2) correcting fish-passage problems at existing dams; and (3) screening/trapping at all major diversions based on presently unresolved physical constraints. This first action might be accomplished immediately on an interim basis by diverting water from DWR's Thermalito Afterbay during critical migration periods in trade for reducing releases to the Feather River. A permanent solution may require a determination of water rights and purchase of supplemental water. Structural improvements at some of the dams, correction of passage problems at Butte Slough and in the Sutter Bypass, and habitat-restoration efforts should begin after the first three actions are initiated.

## Recommended Solutions

Some solutions depend on pre-project investigations. These investigations should occur immediately and are thus separated as individual recommended solutions.

Investigative Solutions:

1. Gage and monitor creek flow and diversions as necessary to maintain required instream flows, especially during the critical migration period, April and June. Conduct a basin-wide water rights and water use investigation on Butte Creek. The assured availability of water for instream flow needs may require the adjudication of Butte Creek below Western Canal and purchase of supplemental water.

2. Investigate the adequacy of fish passage into the Butte Creek system at the Butte Slough outfall gates and up the Sutter Bypass (Nelson Slough, Wadsworth Canal, and Tisdale Bypass). Investigate for other unknown diversions and barriers. Correct passage problems at these locations.

3. Investigate water temperature and agricultural drain water quality problems in lower Butte Creek.

4. Determine instream flow needs on Butte Creek by conducting an instream flow study.

5. Investigate alternative ways of supplying water to landowners: (1) routing a portion of State Water Project deliveries from Thermalito Afterbay through Butte Creek via the Western Canal to supplement transportation flows; (2) the possibility of trading off with PG&E, M&T Ranch, and Parrot Ranch of West Branch of the Feather River water diverted into Butte Creek through the DeSabla Power Plant; (3) supplementing creek flows with ground water; and (4) using the Western Canal to supply water to landowners who have dams and removing existing dams where possible. (The solutions should be done in conjunction with solution 1, above.)

Corrective Solutions:

6. Critically evaluate the 11 unscreened diversions from Butte Creek. Install screens (or traps) or take no action, as appropriate for each location.

7. Improve existing ladders or construct new ladders at four dam locations as needed. Point Four Ranch and Adams Esquon Dams should be considered priority locations for alleviating passage problems.

8. Undertake appropriate instream habitat restoration work in lower Butte Creek, such as sediment control, riffle construction, and revegetation of streambanks.

9. Construct new fish ladders at the east-west structure and at Gilsizer Slough (Sutter Bypass locations). Improve the existing ladder at weir No. 2 (Sutter Bypass location).



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## Estimated Cost

| | | Cost |
|---|---|---|
| 1. | Water Rights and Use Investigation | $200,000 |
| 2. | Fish Passage Investigation and corrective actions – Butte Slough, Sutter Bypass | $100,000 |
| 3. | Water Quality Study | $100,000 |
| 4. | Instream Flow Study | $150,000 |
| 5. | Water transportation/power/pumping | Unknown |
| 6. | Construct screens or fish traps, as appropriate | $500,000 |
| 7. | Construct new or modify existing fish ladders | $300,000 |
| 8. | Instream Habitat Improvements | |
| | Gravel restoration | $100,000 |
| | Revegetation of streambanks | $50,000 |
| 9. | Construct new and modify existing fish ladders (Sutter Bypass) | $100,000 |
| | Total Initial Costs | $1,600,000 |
| | O&M Cost for ladders, screens | $80,000 |
| | Spawning area restoration | $20,000 |
| | Total Annual Costs | $100,000 |

## Estimated Benefits

Completing the nine actions should return the spring-run population to near its previous average of about 4,000 fish annually and the fall run to 2,000 fish annually. Steelhead runs would be increased by an unknown amount.

## Potential Conflicts and Resolution

1. Diverters may oppose implementing the suggested improvements or accepting liability or O&M costs. A reasonable plan will have to be negotiated between the irrigation districts, private diverters, and responsible agencies.

2. Installing and maintaining fish screens will require consistent long-term funding and substantial State agency involvement. Adequate funding and staffing must be available to DFG to cover screen construction and future operation and maintenance costs.

3. Butte Creek is an extremely complex water delivery system. Maintaining adequate instream fishery flows will require coordinated and skilled operation by cooperating water users. Extension of State Watermaster Service into the lower reach of Butte Creek should be considered to fulfill these management goals. Availability of State Watermaster Service to all of Butte Creek would require a statutory adjudication of Butte Creek below Western Canal.



C—051808

C-051808

4. The Central Valley Regional Water Quality Control Board has requirements for holding drain water on rice fields to control the levels of herbicides in the Sacramento River. Conflicts exist between recommended instream flows for fish and the need to regulate return flows to Butte Creek. The timing of opening the Butte Slough outfall for fish passage may result in a similar conflict. Open communication and cooperation between the concerned agencies and local waters users (and among the agencies involved) is essential to identify these conflicts and minimize their impacts to restoring the Butte Creek salmonid fishery. A thorough understanding of the entire stream/irrigation system would evolve from a basin-wide investigation and would assist in resolving these conflicts.

5. Sports clubs that receive water from Butte Creek (approximately 30,000 acres) provide some of the most valuable wildlife habitat remaining in the Sacramento Valley. Rice culture along Butte Creek is at the core of the area's agricultural economy. There is an inherent conflict between the timing of the need for water among duck clubs, agriculture, and the anadromous fisheries in Butte Creek. The seasonal flooding of duck clubs conflicts with the need for instream flows for spawning fall-run salmon. Irrigation of rice fields overlaps with the need for transportation flows for both spring-run adults and juvenile salmon in April and May. The process of sorting out water rights, water use, and instream flow needs will be a long-term effort requiring the involvement of irrigation districts, private landowners, and agency personnel. In reestablishing the salmon runs on Butte Creek, efforts will have to be made by all concerned to balance the legitimate needs of wildlife, agriculture, and fishery resources.

## Implementation

Ladder construction and diversion trapping/screening should be carried out as soon as possible, under the direction of DFG. To a large extent, actions taken will be based on site-specific needs mutually acceptable to DFG and water users.

A cooperative effort between DWR, DFG, the State Water Resources Control Board, and local irrigation districts will be required to assure proper water supply management of instream flows for fish transportation. DWR is investigating the possibility of supplementing Butte Creek flows with Thermalito Afterbay water, which will require the cooperation of the Western Canal Irrigation District.

DFG has already taken several steps to resolve fishery problems at White Mallard Dam and Drumheller Slough. DFG would continue to take the lead in investigating and solving fisheries-related problems on Butte Creek, with the assistance of DWR and SWRCB. Habitat-restoration items such as gravel restoration and revegetation would be handled cooperatively between DFG and DWR. DWR, DFG, and RWQCB would cooperate in establishing a water quality investigation/monitoring program.

## Special Funding

DWR will perform a basin-wide water supply/use survey of the Butte Creek irrigation system. Similar funding may be available from other agencies and local irrigation districts.



C—051809

C-051809

*This culvert dam at Five Mile Recreation Area could provide flow management in Lindo Channel, although fish passage should be improved just below the dam.*



C—051810

C-051810

# Big Chico Creek

## Purpose

The purpose of this action is to restore the Big Chico Creek salmonid fishery.

## Background

The lower portions of Big Chico Creek, Lindo Channel, the Sycamore Diversion, and Mud Creek have been modified by a U.S. Corps of Engineers' flood control project constructed in 1963. The project starts at the Five Mile Recreation Area (where Lindo Channel separates from Big Chico Creek) and ends at the Sacramento River below the confluence of Big Chico Creek, Mud Creek and Lindo Channel (see following map).

Anadromous fish entering Big Chico Creek and Lindo Channel include spring- and fall-run chinook salmon and steelhead trout. Spring-run fish were historically the main salmonid supported by Big Chico Creek. In 1958, the spring run was estimated at 1,000 adults, although the average annual run was probably less than one-half this amount during the 1950s and 1960s. Steelhead are thought to have averaged around 150 returning adults during this same period. Recent estimates indicate only a remnant spring-run chinook population, a depressed steelhead population, and a highly variable spawning population of fall-run salmon.

Spring-run adults are interrupted in their upstream migration by flow reversals at the M&T Ranch pumps, intermittent flows in Lindo Channel, poor fish passage at the One Mile Recreation Area, and inadequate fish passage at Five Mile Culvert Dam and Iron Canyon in upper Bidwell Park. Fall-run salmon have access to marginal spawning and rearing habitat in Big Chico Creek and Lindo Channel below the Five Mile Recreation Area. In Lindo Channel, excellent spawning gravels are available, yet inconsistent flow conditions preclude successful spawning in most years. Downstream migrating smolts of both runs suffer substantial losses at diversions.

The Department of Fish and Game completed a major portion of a plan to restore the Chico Creek anadromous fishery. The stream from Higgins Hole, the upstream limit of salmon migration, down to Bear Hole below Iron Canyon, was chemically treated to remove competing nongame species in the fall of 1986. This reach was restocked with steelhead trout and spring-run salmon fingerlings in 1987. Studies show the survival of planted fish in upstream areas to be excellent. These fish are expected to return in 1989.

The City of Chico has an active interest in solving fishery problems at One Mile and Five Mile pools. The city and DFG constructed a sill to concentrate flows for migrating salmon and is testing the removal of the dam during high flows to flush out accumulated gravels in One Mile pool. The city has also agreed to remove gravel at Five Mile pool to control the flow into Lindo Channel. DFG plans to evaluate the effectiveness of netting downstream migrants at the M&T pumps and transporting them to the Sacramento River this spring.

## Discussion

Restoring spring-run chinook and steelhead trout fisheries will require correcting migration problems from the Sacramento River through upper Bidwell Park. Correcting migration problems in lower Big Chico Creek and improving low-flow management of the Big Chico Creek system below the Five Mile Recreation Area will improve the fall run. A major obstacle to restoring the fisheries in the Big Chico Creek system is pumping from the lower creek during the critical juvenile out-migration period, April through June.



C—051811

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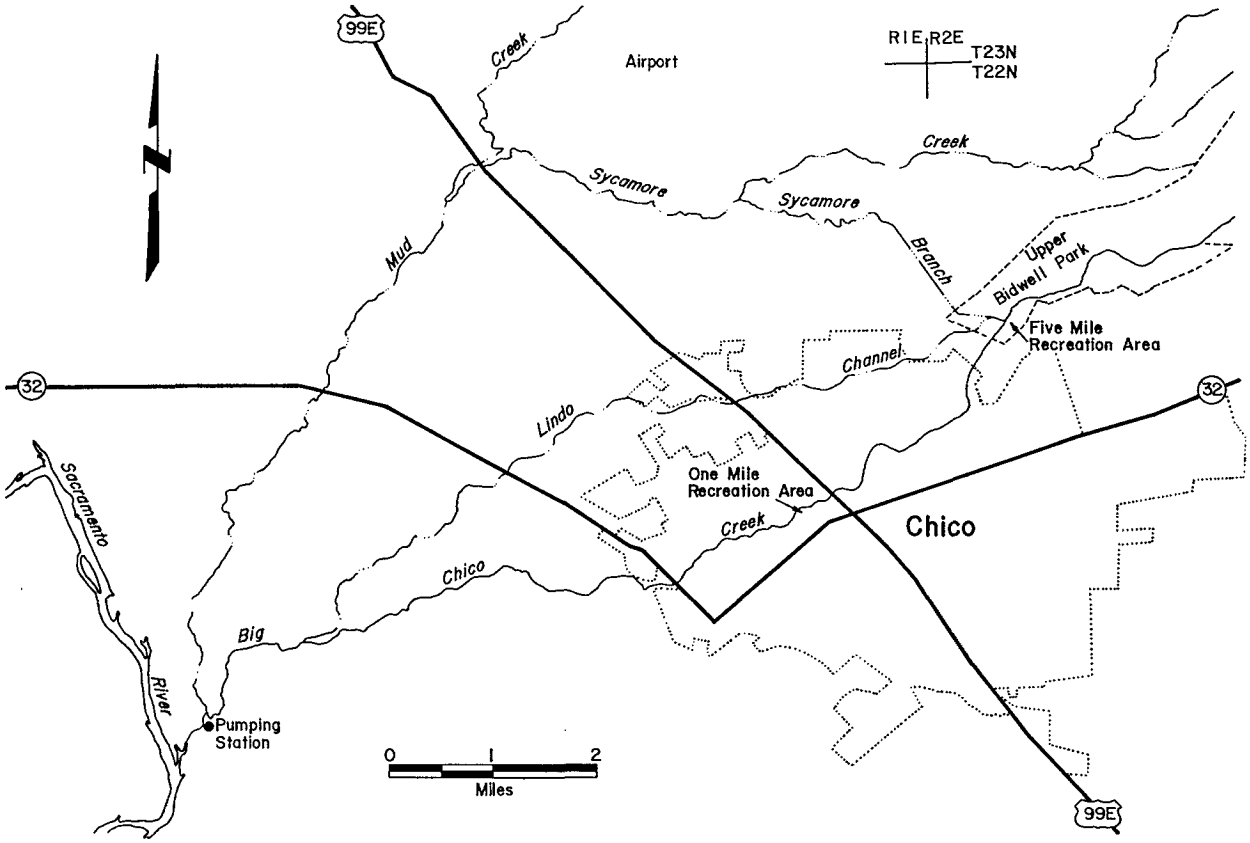


Lower Big Chico Creek Stream System

The following fishery and habitat related problems have been identified in the Big Chico Creek stream system:

1. The M&T pumps located on Big Chico Creek near its confluence with the Sacramento River are not presently screened. These pumps actually cause streamflow reversals during the critical downstream out-migration period in approximately one out of four years. A 100 percent loss of downstream migrants occurs during these periods of flow reversal. Further, adult spring-run chinook migrating up the Sacramento River have difficulty locating the mouth of Big Chico Creek when flows are reversed.

2 Passage for adult spring-run chinook and steelhead at the Five Mile Culvert Dam is poor under low-flow conditions.

3. Gravel buildup behind the Five Mile flow control structures causes inconsistent distribution of flows into Big Chico Creek and Lindo Channel. Periodic stranding of adult and juvenile salmonids in Lindo Channel occurs. Spawning adults and outmigrating juveniles become stranded in Lindo Channel because the flow split from Big Chico Creek is not managed for fishery needs.

4. The flashboard dam at the One Mile Recreation Area causes gravel and silt buildup in the swimming area (Sycamore pool) above the dam. Removal of the material by the City of Chico causes siltation of fall-run chinook spawning areas downstream of the dam. Removing the



C—051812

C-051812

flashboards to flush the pool causes water to spill over the concrete apron rather than flow through the fish ladder. This impedes migrating adult spring-run chinooks.

5. During low-flow conditions, spring-run salmon and steelhead cannot pass the fishway (partially destroyed by a flood) at Iron Canyon. Instead, they must hold downstream, where migration is delayed and poaching becomes a problem.

6. Flood maintenance and gravel-mining activities have eliminated streamside vegetation in areas of Lindo Channel. This reduces habitat quality and increases stream temperatures.

7. Gravel mining and flood maintenance activities reduce gravel recruitment in Big Chico Creek and Lindo Channel, causing depletion of spawning gravels and armoring of the channel below Five Mile.

8. Reducing floodflows through lower Big Chico Creek prevents the natural reworking of existing gravels. This results in compaction and siltation of the stream bottom.

9. Water quality in Big Chico Creek and Lindo Channel is degraded by cadmium, mercury, and other metals in mine drainage from the upper watershed and by runoff from the Chico urban area. The urban area runoff typically consists of residual petroleum compounds, pesticides, solid pollutants, and other waste products which enter the creeks via storm drains.

## Recommended Solutions

Item 1 below includes the need for a pre-project feasibility study. Item 2, development of a comprehensive fisheries management plan, will require the completion of hydrologic and fisheries studies. The rest of the recommended solutions are specific actions.

1. Install a culvert to provide gravity flow water from a screened intake on the Sacramento River to a closed sump at the present M&T pump location. The advantages of such a system include:

   a Pumps stay where they are safe from floods and possibly unstable river conditions.

   b. Fish passage to and from Big Chico Creek would be guaranteed at all times.

   c. A large bypass flow would exist at the screen.

   d. An emergency gate could provide temporary connection of the sump to Chico Creek in case of screen clogging.

   e. A gate at the river end of the conduit could be closed as needed to prevent siltation during floods.

   A feasibility study that analyzes the location of the intake, size of the culvert, relative elevation of pump intakes and river, possible siltation problems, costs for materials and installation, and possible increased cost of pumping will be conducted before proceeding with implementation of this recommended solution.

   Other possible solutions for obtaining an alternative water source include: (1) relocate the M&T pumps to the Sacramento River, (2) supplement during critical times with ground water pumping, and (3) provide a conduit for the safe passage of low-flow Chico Creek water and smolts to the river. Each of these alternatives has significant engineering, cost, and environmental considerations that make them less suitable than the recommended solution.



C—051813

C-051813

An interim solution proposed by Fish and Game is to install a fish screen and trap on Big Chico Creek upstream from the existing pumps. Trapped out-migrants will be trucked directly to the Sacramento River. This procedure should reduce the loss of juvenile salmonids during low-flow years, but it will not alleviate flow reversals which hinder migrating adults.

2. Develop a fisheries management plan for lower Big Chico Creek and Lindo Channel, emphasizing proper flow management for fish during peak migration periods. The plan should indicate the most beneficial flow allocation between Big Chico Creek and Lindo Channel for a variety of needs. Analysis of the low-flow hydrology and studies of flow needs for fish in the lower creek system will be needed to develop this plan.

   Determine flood channel capacities within the Big Chico Creek, Lindo Channel, and Mud Creek flood control system, and devise a management plan that meets both flood control and fishery flow/habitat needs.

3. Build and operate control structures at Five Mile necessary to implement flow recommendations developed in item 2, above. The Department of Water Resources has completed preliminary engineering studies on the installation and operation of flow-control gates at both culvert dams. Control gates will allow for the regulation of both low flows and floodflows in both Big Chico Creek and Lindo Channel.

4. Redesign the One Mile Dam to allow for efficient silt removal and fish passage. (The City of Chico is investigating a modified dam design.)

5. Investigate and repair, or replace, fish ladders at the Five Mile Culvert Dam and Iron Canyon.

6. Replant disturbed streambanks with appropriate native plant species.

7. Remove and screen the annual gravel buildup at the Five Mile location; return suitable spawning gravels to the creek system immediately below this area.

8. Initiate a program to clean and restore stream gravel.

9. Incorporate a requirement into the Chico urban area drainage plan to integrate environmentally appropriate techniques for removing solid sediments, foreign materials, and pollutants to maintain good water quality in urban reaches of these creeks. Provide adequate monitoring and enforcement of water quality standards.

## Estimated Costs

| | Cost |
|---|---|
| 1. Feasibility study of M&T pump intake relocation, including preliminary engineering and design | $40,000 |
| Relocate and screen M&T pump intakes to the Sacramento River | $1,000,000 |
| 2. Develop fisheries management plan | |
| Study low-flow hydrology | $70,000 |
| Study of flow needs for fish | $50,000 |
| 3. Modification of control structures at Five Mile location to regulate flow split between Big Chico Creek and Lindo Channel | $100,000 |



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| | | |
|---|---|---|
| 4. | Implement dam modification/new silt removal procedures at One Mile location | $50,000 |
| 5. | Evaluate and modify, or replace, fish ladders at Lindo Channel Culvert Dam and Iron Canyon | $60,000 |
| 6. | Revegetate Lindo Channel | $30,000 |
| | Total Initial Costs | $1,400,000 |
| 7. | Screen and return spawning gravels to creek system | $20,000 |
| 8. | Restore spawning gravels | $10,000 |
| 9. | Increased cost for water quality monitoring and enforcement | $10,000 |
| | Total Annual Costs | $40,000 |

## Estimated Benefits

Removing obstacles to fish passage should restore spring-run chinook to an average of 1,000–2,000 and steelhead to 500 returning adults annually.

Enhancement of downstream habitat, including flow management between Big Chico Creek and Lindo Channel, gravel replenishment, and further fisheries management, will greatly increase the spawning success and survival of fall-run salmon, adding, on the average, 500 returning adults to the system.

## Potential Conflicts and Resolution

1. A reasonable solution to fish losses at the M&T pumps is dependent on negotiations between M&T Ranch and various agencies. The solution selected must be acceptable to M&T, as well as the Reclamation Board, DFG, and the Corps of Engineers.

2. Implementing recommended actions and management items will have an impact on DFG's fishery management goals, local planning, and State-mandated flood control responsibilities. Recommendations should be integrated into DFG's Fishery Management Plan for Big Chico Creek and coordinated with Butte County, the City of Chico, and DWR's Division of Flood Management.

3. Because these streams flow through recreational and urban areas, public health and safety considerations must be considered in any proposed alteration of flow regimes.

## Implementation

DFG and DWR should seek a cooperative solution with the M&T Ranch to alleviate the problem of flow reversals due to irrigation pumping from lower Big Chico Creek. The feasibility of using treated effluent from the City of Chico should be considered to supplement the M&T Ranch supply. M&T could cease or reduce pumping during brief periods.

The City of Chico is responsible for correcting problems at the One Mile location. The solution must be acceptable to the Central Valley Regional Water Quality Control Board and will require the direct involvement of DFG.



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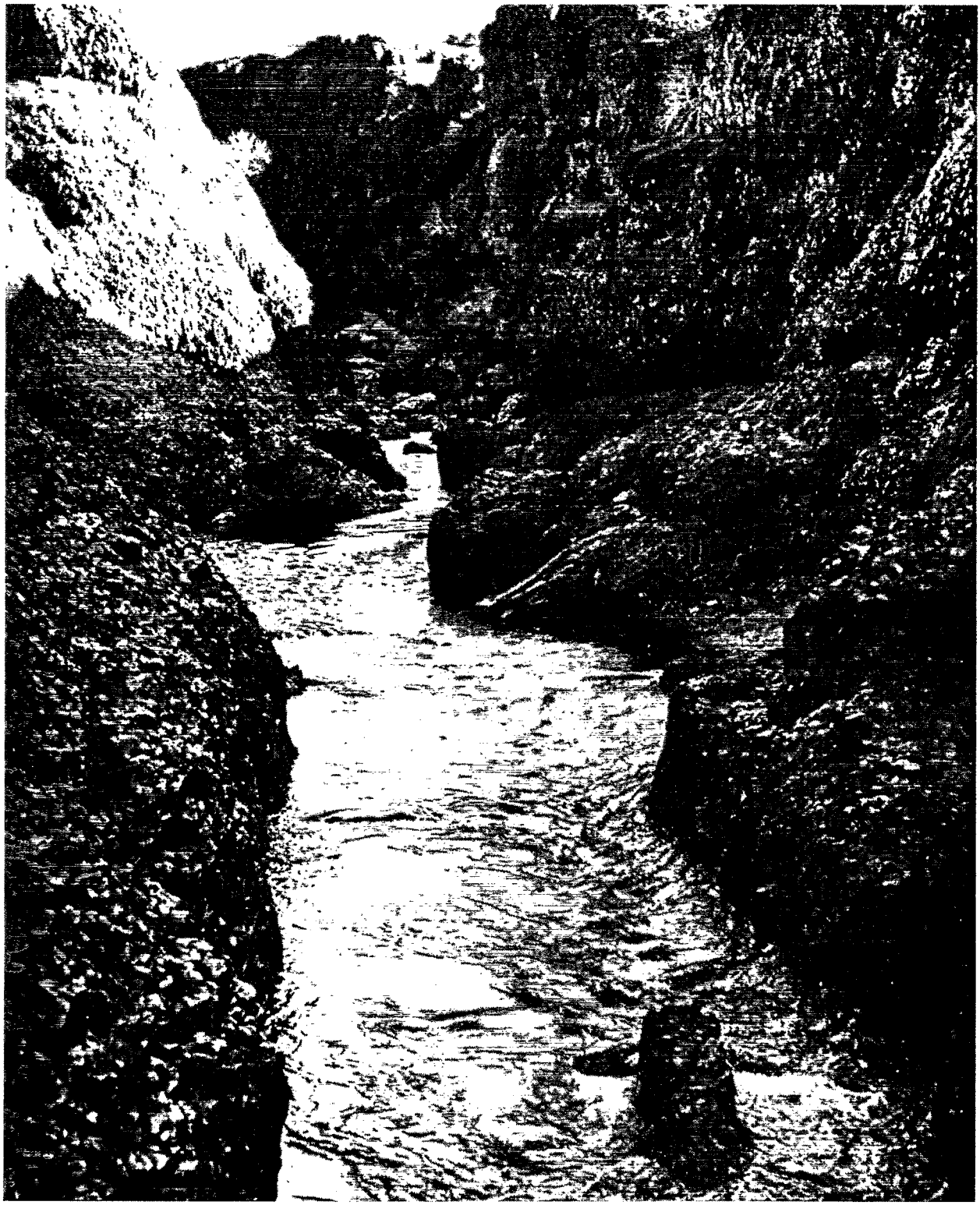


*Good habitat for salmon and steelhead remains in this reach of Big Chico Creek near Bear Hole in Upper Bidwell Park.*



C—051816

C-051816

Studies are needed to perform engineering, design, construction, and operation of the control structures (gates) on the Five Mile Culvert Dam. Change in the management of flows between Big Chico Creek and Lindo Channel will require agreement among DWR, DFG, the City of Chico, and Butte County. DWR has begun a hydrologic analysis of the Big Chico Creek system in relation to fishery needs. DFG will conduct instream flow studies on Big Chico Creek and Lindo Channel.

DFG developed a fisheries management plan for Big Chico Creek and will continue to provide leadership in restoring the anadromous fisheries. DFG will upgrade this plan after completion of recommended hydrologic and flow needs studies. A local stream restoration group, Streaminders, has already taken steps to restore fish and wildlife habitat along Lindo Channel and would be available as a low-cost volunteer resource.

## Special Funding

DWR initiated a hydrologic study of the lower stream system. Additional funding for flood channel evaluation is anticipated. DWR Urban Streams Restoration Grant monies are supporting local restoration efforts and are likely to continue.

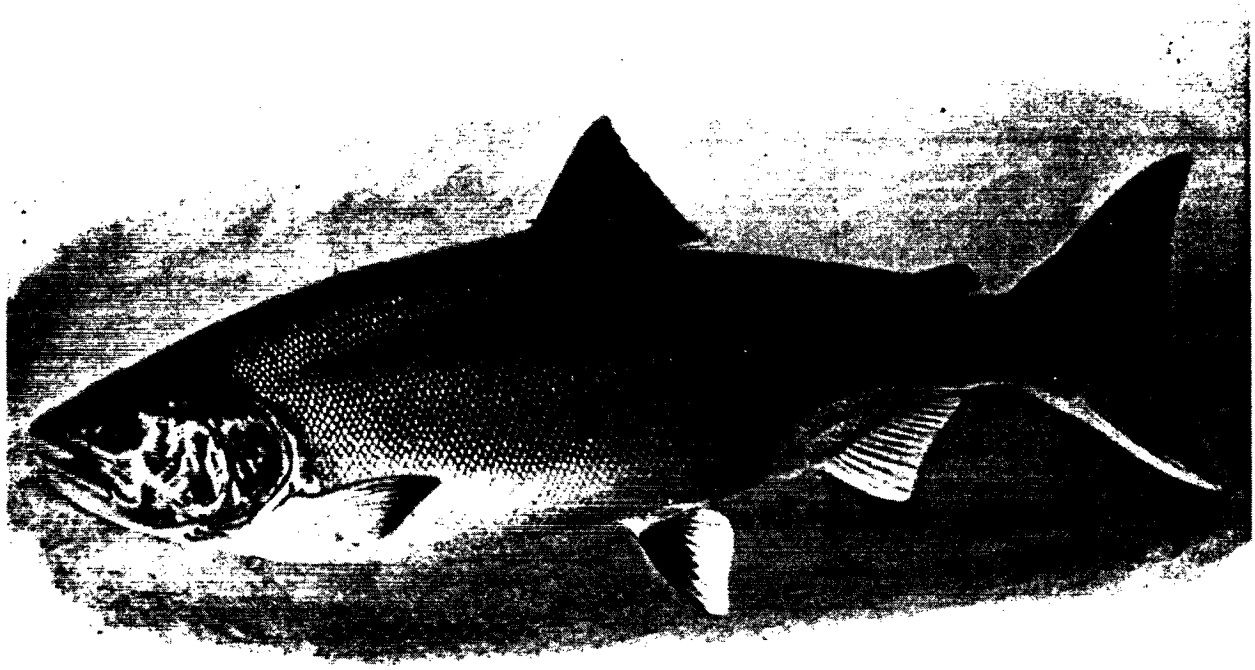
A water rights and water use investigation would be the logical first step towards adjudication.



C—051817

C-051817

*In three or four years, the tiny salmon fry above could return to the upper Sacramento River as the 20-pound adult below.*





C—051818

C-051818

# Sacramento River Fish 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).

## Background

Construction of Shasta and Keswick Dams in the early 1940s caused the loss of about 50 percent of the natural spawning and rearing habitat in the Sacramento River system. Coleman National Fish Hatchery and several other mitigation features of the "Shasta Salvage Plan" were identified to mitigate these losses, but by 1946 Coleman Hatchery and the Keswick trap were the only remaining elements of the original salvage plan. These facilities were intended to support about one-third of the spring- and fall-run chinook salmon displaced by Shasta Dam. However, it soon became obvious that the spring-run could not be handled successfully at Coleman, and it became essentially a fall-run salmon facility which rarely was used to capacity. The average number of eggs collected has been about 40 percent of the original goal. Current production goals are 12 million fall chinook smolts, 2 million late-fall chinook smolts, and 1 million steelhead yearlings.

Construction of Whiskeytown Dam on Clear Creek in 1963 blocked most of the Clear Creek drainage and reduced flows by 85 percent in the lower portions of the creek. The fishery release schedule from Whiskeytown Dam has proven to be inadequate and, combined with extensive gravel mining and sedimentation in the lower creek, has led to reduced salmon and steelhead populations in Clear Creek.

Completion of Red Bluff Diversion Dam and the Tehama-Colusa Canal in 1966 caused additional fish losses in the Sacramento River by inundating spawning and rearing habitat above the dam. In an attempt to mitigate these losses, and to provide substantial fisheries enhancement, the Tehama-Colusa Fish Facilities were constructed and operated for fall-run salmon spawning and rearing. After nearly 20 years, operation of the fish facilities ceased in October 1988 due to many unresolvable problems.

## Discussion

The fishery losses caused by all of these projects collectively cannot be fully compensated by Coleman Hatchery and increased natural production below the dams through habitat restoration. Thus the remaining fishery losses should be compensated by additional hatchery production in the upper river.

## Potential Solutions

Four potential solutions were considered:

1. Enlarge Coleman National Fish Hatchery. This was rejected because of insufficient suitable water, continuing disease problems, and temperature problems. Coleman Hatchery needs major rehabilitation just to meet its current production goals; it does not seem prudent to consider expansion. (See Action Item under "Coleman National Fish Hatchery").



C—051819

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*Chinook salmon eggs develop into yolk sac fry in about a month.*

C—051820

C-051820

2. Develop the privately owned, abandoned Buckhorn Trout Hatchery near Anderson. This was rejected because of inadequate water supply, difficulty in collecting returning adults, and general disrepair of the facility.

3. Construct a hatchery on Clear Creek below Whiskeytown Dam. Although a hatchery on Clear Creek has potential to produce steelhead and some races of salmon, it was not recommended at this time for the following reasons: (a) there is inadequate land available for a large hatchery immediately below Whiskeytown Dam, (b) the McCormick–Saeltzer Dam and fish ladder several miles downstream has a lengthy history of fish passage problems, (c) a pipeline several miles long to serve water to a hatchery located below McCormick–Saeltzer Dam would be expensive. However, a small steelhead hatchery should be considered in conjunction with the Clear Creek restoration program when it is implemented.

4. Construct a new hatchery on the Sacramento River below Keswick Dam. This option appears to have significant advantages over the other alternatives. These include: (a) an adequate cold water supply can be obtained from either Keswick Dam, or the Clear Creek–Spring Creek Diversion, or both: (b) adequate land is available: and (c) the hatchery could support winter–run salmon without handling or transportation to another site. Therefore, this is the recommended solution.

## Recommended Solution

Construct a 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.

## Estimated Costs

| | |
|---|---|
| Capital cost of hatchery | $ 25 million |
| Annual O&M cost for hatchery | $1.5 million |

## Estimated Benefits

Assuming about 0.5 percent of the salmon and steelhead smolts released would return to the fishery, the Sacramento River Hatchery could contribute about 110,000 adult salmon and 16,500 steelhead to the fisheries.

## Potential Conflicts and Resolution

Increased hatchery production may conflict with the Advisory Council goal to emphasize natural production. Hatcheries are known to depress natural stocks by encouraging increased angling pressure on the wild fish, and by reducing genetic diversity and the ability of fish to survive in the wild. This problem can be reduced by balancing hatchery production with maximum feasible restoration of natural habitat.

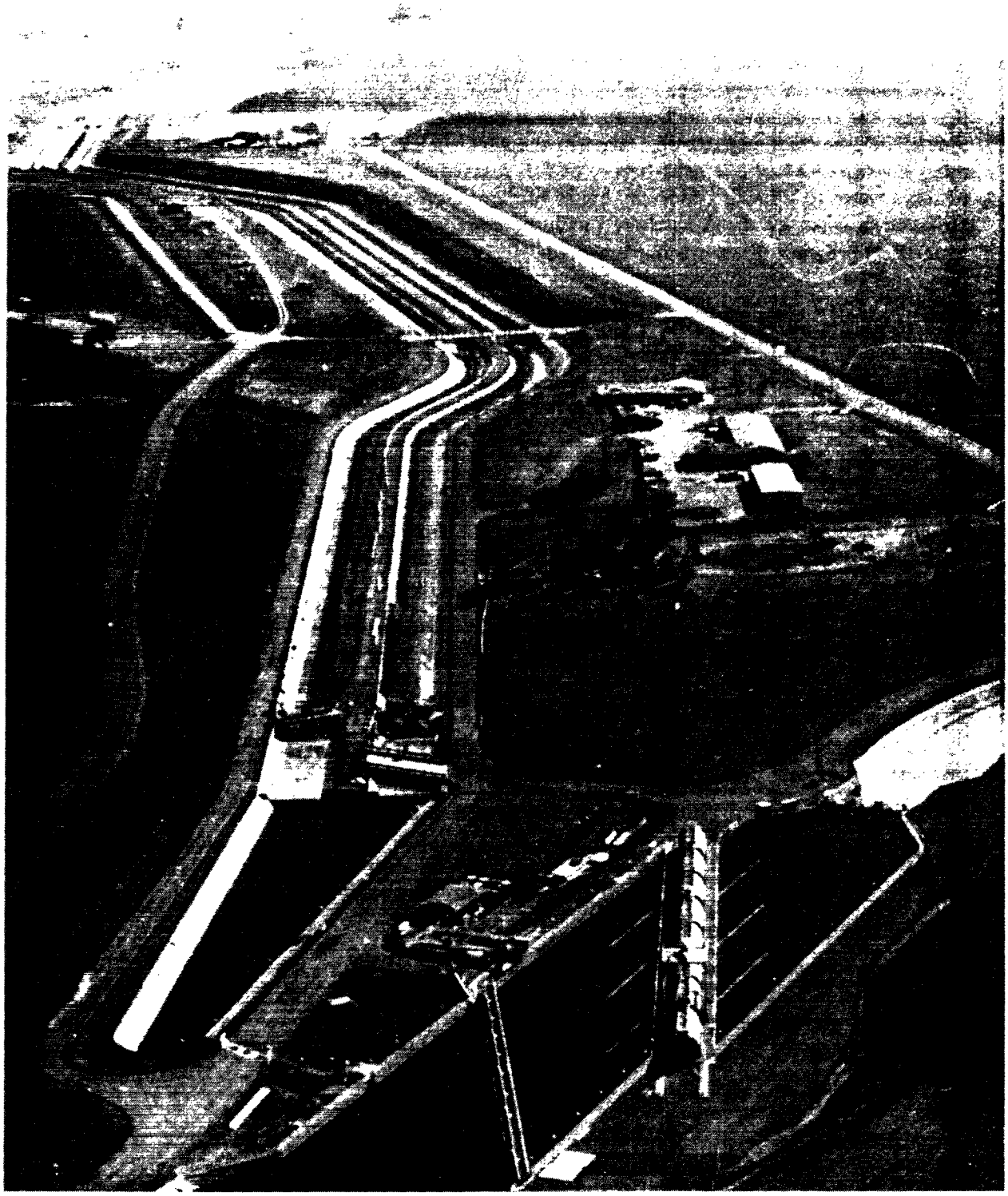
## Implementation

Since the purpose of the Sacramento River Hatchery would be to restore part of the unmitigated damage from construction of several features of the CVP, this action would be implemented by the federal government through the Bureau of Reclamation and/or the Fish and Wildlife Service. This action should not be implemented until all items emphasizing natural production are completed and restoration goals are met.



C—051821

C-051821



*The single-purpose channels of the Tehama-Colusa fish facilities extend south from the Tehama-Colusa Canal near Red Bluff.*



C—051822

C-051822

# Tehama-Colusa Fish Facilities

## Purpose

The purpose of this action is to resolve fishery mitigation and enhancement issues associated with closing the Tehama-Colusa Fish Facilities (TCFF).

## Background

The Tehama-Colusa Canal and Red Bluff Diversion Dam (RBDD) were authorized in 1950 as features of the Sacramento River Division, Central Valley Project, for California. The primary purpose of the project is to provide water for irrigation in Tehama, Glenn, Colusa, and Yolo Counties. The U.S. Bureau of Reclamation, working with the U.S. Fish and Wildlife Service and the California Department of Fish and Game, incorporated artificial spawning channels for salmon into project planning. The channels are integrated with the irrigation canal system and were built (spawning facilities were completed in July 1971) to mitigate the loss of 3,000 adult fall-run chinook salmon that had used natural spawning areas inundated by RBDD. Also, as part of the Bureau's project justification, the facility was designed to provide spawning habitat for 37,000 adult fall chinook salmon. Additional artificial spawning habitat for Stony and Thomes Creeks was planned and designed to accommodate 15,000 and 5,000 adult salmon, respectively, but was never built. Current thinking is that this was fortunate, due to high water temperatures and various other problems. Thus, the project was expected to enhance (i.e. increase) the number of adult salmon returning to the upper Sacramento River by 54,000.

The fish facility, operated by the U.S. Fish and Wildlife Service, consists of a large 3.25-mile-long, dual-purpose spawning channel and two smaller 1-mile-long spawning channels. Water is provided to the spawning channels through the headwork at RBDD. Since the fall of 1986, the spawning channels have been inoperable because the gates at RBDD have been raised during the nonirrigation season to facilitate winter chinook passage at the dam. In 1985, the lower 1,000 feet of each single-purpose channel was converted into juvenile salmon rearing facilities to raise a portion of Coleman National Fish Hatchery production (approximately 1 million fish) over the summer months, with the goal of achieving an increased survival rate by releasing larger-sized fish.

## Discussion

During the 1980s, the Fisheries Assistance Office of the U.S. Fish and Wildlife Service conducted evaluations of factors limiting fish production at TCFF. Those studies revealed numerous problems associated with achieving maximum fish production in the spawning channels. While the spawning channels could meet the intended mitigation goals, there are recognized problems meeting the enhancement goals. The problems include: water temperatures too high for successful spawning and egg incubation, lack of a firm water supply to operate the channels for fish production (primarily due to constraints on releasing water back to the river), adverse hydraulic conditions that create poor conditions for spawning, ineffective screens to exclude predatory fish and to retain fish produced in the spawning channel, aquatic weed growth which complicates the screening problems, inability of returning adults to home back to the channels, and conflicts with minimum flow requirements in the Sacramento River. Also, when the facility was experimentally used for summer rearing, uncontrollable fish diseases resulted.



C—051823

C-051823

The cost to correct the major deficiencies (high water temperatures, inadequate year-round flows, adverse hydraulic conditions, and frequent disease problems) could exceed $100 million, so fixing the TCFF is viewed as impractical. Despite the recommendations and good faith effort put forth by the Department of Fish and Game and the Fish and Wildlife Service during the early design stage, the idea must now be recognized for what it is, an idea which seemed to have great attractiveness and potential, but one that unfortunately didn't work. Fish production activities have been temporarily suspended at the TCFF until 1993 in response to an agreement between the Bureau and the Fish and Wildlife Service.

## Recommended Solutions

It is recommended that alternative means of meeting the mitigation and enhancement requirements of RBDD and TCFF be developed and implemented. A combination of the following actions may be necessary to achieve the mitigation goal of 3,000 adult salmon and the enhancement goal of 54,000 adult salmon:

1. Restore main stem Sacramento River spawning habitat to support 24,000 adult chinook salmon (refer to Action Item under "Upper Main Stem Sacramento River Spawning Gravel Restoration").

2. Increase hatchery production by constructing a new hatchery below Keswick Dam to maintain 33,000 adult fall chinook salmon (refer to Action Item under "Sacramento River Fish Hatchery").

## Estimated Costs

1. Spawning gravel restoration (spawning habitat for 24,000 adult chinook salmon). This would be funded as part of the Action Item under "Upper Main Stem Sacramento River Spawning Gravel Restoration."

2. Sacramento River Hatchery near Keswick (capacity of 22 million chinook salmon smolts). Costs for this action are shown in the Action Item under "Sacramento River Fish Hatchery."

## Estimated Benefits

Implementing these actions will produce 57,000 adult chinook spawners in the upper Sacramento River and contribute about 110,000 adult salmon to the commercial and sport fisheries. These fish are also included in the benefits for the other actions, described above.

## Potential Conflicts and Resolution

The Bureau of Reclamation's position is that the enhancement goals of the TCFF (54,000 salmon) are simply a potential benefit foregone if the facility cannot be operated successfully, with no legal obligation for replacement. The mitigation responsibility (3,000 salmon) cannot be met during those years when the RBDD gates are opened to facilitate passage for winter-run salmon. However, if fish passage problems at RBDD can be resolved, then the gates can remain closed year-round and mitigation probably can be met with relatively minor modifications of the TCFF.

Increased hatchery production may conflict with the goal of emphasizing natural production. Hatcheries are known to depress natural stocks by encouraging increased angling pressure on the wild fish, and by reducing genetic diversity and the ability of fish to survive in the wild. This problem can be reduced by balancing mitigation resulting from increased hatchery production with maximum restoration of natural habitat.



C—051824

C-051824

## Implementation

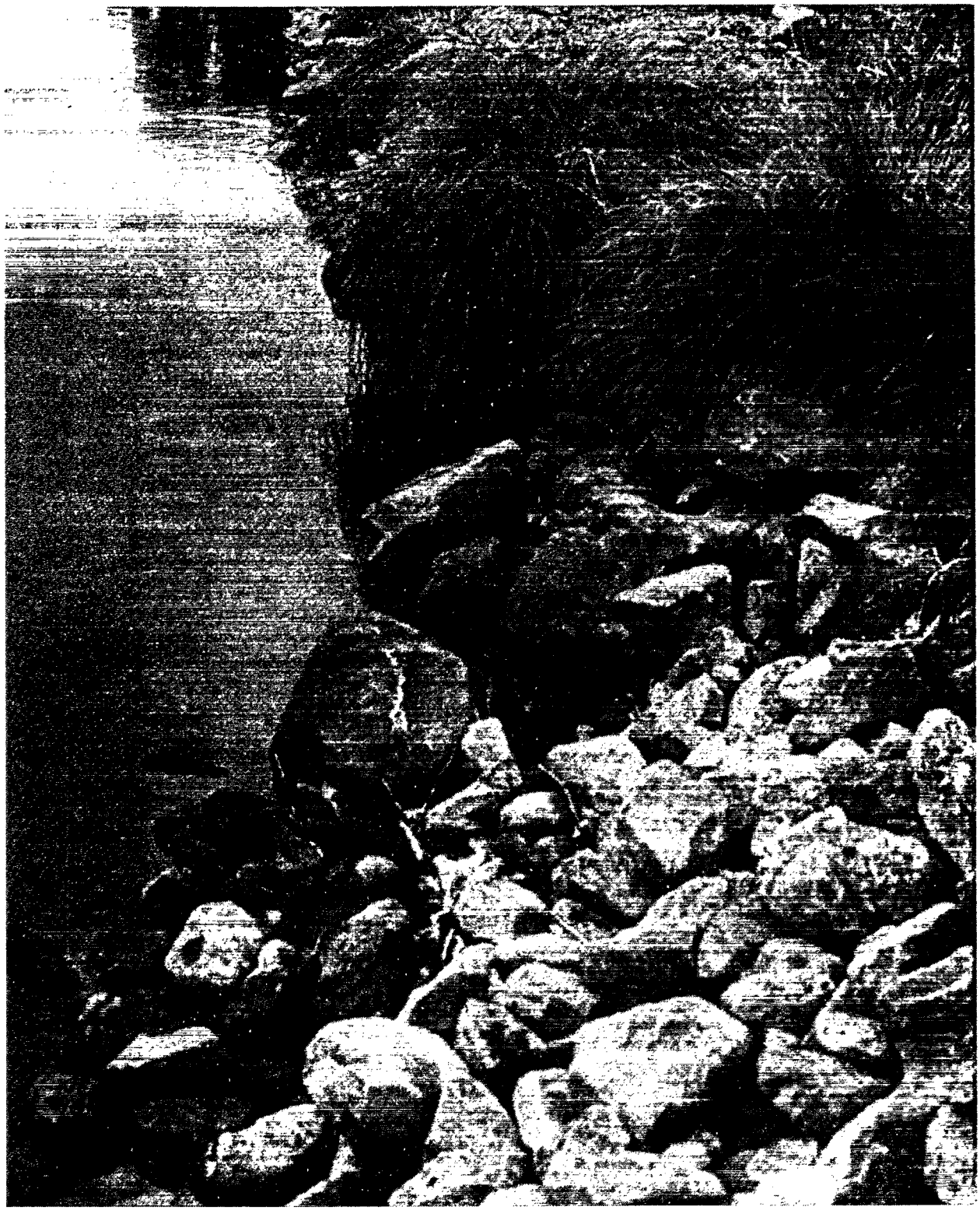
The Bureau of Reclamation and/or the Fish and Wildlife Service should jointly implement the proposed actions through additional congressional authorization and appropriation.

*A Department of Fish and Game aide checks a Sacramento River chinook salmon for readiness to spawn in the Tehama-Colusa Fish Facility.*



C—051825

C-051825



*New rock work (at bottom of photo) joins old at this Sacramento River bank stabilization site.*



C—051826

C-051826

# Bank Stabilization

## Purpose

The purpose of this action is to restore and maintain habitat for juvenile salmon at areas impacted by bank stabilization.

## Background

Studies conducted by the Department of Fish and Game and the Fish and Wildlife Service have shown that near-shore habitat adjacent to conventional bank protection areas (riprap) supports 80–90 percent less use by juvenile salmon than do nearby natural bank areas. These studies indicate that significant numbers of juvenile salmon are found in the outside bends where bank stabilization work is usually conducted, although these areas may not be the primary rearing habitat for juvenile salmon. Conventional bank protection typically changes the near-shore habitat from eroding earth to rock riprap, which adversely affects the salmon habitat in these areas. The relative importance of outside banks for salmon habitat may vary within different reaches of the river, depending on the availability of more suitable habitat, such as snags, island bars, point bars, and on the life stages of salmon present. In some reaches, the river may function primarily as a migration route, with only limited rearing.

Extensive bank stabilization work from Chico Landing (river mile 194) downstream is needed to protect the Sacramento River Flood Control Project (SRFCP). Some of this work is needed in the important spawning and rearing areas upstream from Ord Ferry (river mile 184). There is no active bank stabilization project in the Chico Landing to Red Bluff reach of the river (river miles 194–244), since the project has been halted as required by a jeopardy opinion issued by the Fish and Wildlife Service to avoid damaging habitat of the threatened valley elderberry longhorn beetle. A number of ongoing studies have been funded by the Corps of Engineers to evaluate impacts and develop potential mitigation measures. These measures usually consist of some physical modification to standard rock revetment intended to create desirable rearing conditions for juvenile salmon. However, these measures must be compatible with the structural integrity of the bank stabilization work, which limits the type of measures that can be incorporated.

At the request of the Corps, the National Fishery Research Center of the Fish and Wildlife Service in Seattle, Washington, has initiated a study to comprehensively evaluate the total rearing habitat in the river and to estimate the impact of proposed bank protection on this habitat. Previous studies have been limited to assessing the reduction in habitat at eroding banks on outside bends, and have not addressed impacts on the total river environment, or the overall impacts on juvenile salmon. During the first year, the Research Center will conduct a review of existing information, determine whether a study can be designed to assess these objectives, and offer recommendations for further study, if feasible.

## Discussion

Valuable rearing habitat for juvenile salmon exists in the Sacramento River below Red Bluff (river mile 243). Proposed bank protection work has the potential for removing a portion of the available rearing habitat in this area. Potential mitigation methods have been developed and others are under study. Existing fish habitat is an integral part of the river system and should be maintained.



C—051827

C-051827

## Potential Solutions

Three approaches to resolving these issues are presented below.

1. Determine the overall impacts of bank stabilization on the total juvenile salmon habitat in the river and the specific impacts on the numbers of smolts produced.

   a. The study being conducted by the National Fishery Research Center may identify the research needed to provide the desired answers.

2. Continue to develop and evaluate means of physically creating rearing habitat in conjunction with standard bank stabilization work. Many of these measures are appropriate only at specific locations on large rivers like the Sacramento. One problem with most of these measures is the lack of ways to evaluate their efficiency in replacing salmon rearing habitat. Additional information is needed to determine the most cost-effective measures.

   a. Gravel-Covered Riprap: This measure consists of covering riprap with river-run gravel of the proper size to fill interstitial spaces in the quarry rock. The objective is to reduce turbulent flow along the surface of the rock and to provide conditions similar to natural gravel bars.

   b. Fish Slopes: With this technique, a 5:1 slope covered with river-run gravel is constructed in a standard 2:1 or 3:1 bank protection site at a specific elevation to ensure use by juvenile salmon during out-migration and rearing periods. The objective is to create conditions similar to natural gravel bars. However, its utility is limited to a narrow range of flows.

   c. 6:1 Bank Slope: This measure would consist of constructing the entire bank protection work at a 6:1 slope and covering with small gravel to fill interstitial spaces. The objective is to create conditions similar to natural gravel bars that would provide rearing habitat at a wide range of flows.

   d. Woody Structure: This alternative would replace woody structure normally found in and along natural banks. It would entail the placement of tree tops, logs, and similar natural or manmade materials in and along the near-shore zone of riprap. These materials would be embedded in the rock work or cabled/chained to suitable structures along the shoreline. The objective would be to replace in-water cover used by juvenile salmon.

   e. Artificial Structures: This technique would consist of placing artificial structures in the rock riprap. They would be designed to simulate natural cover. These structures could be eel-like grass made of plastic anchored in the rocks. An alternative approach would be structures shaped like tree limbs and anchored in the rock to simulate trees or shrubs overhanging the water.

   f. Groins and Jetties: This technique involves the construction of a variety of measures intended to create flow and habitat conditions suitable for juvenile salmon along standard riprap banks. A simple example of this approach would be the construction of a series of groins spaced 50 feet apart, built perpendicular to the bank, and protruding into the river. The intent of this technique is to create low-velocity habitat adjacent to backwater areas. A form of this technique called "fish groins" is planned for the 1988 bank protection work. These groins consist of piles of rock laid on top ofstandard rock revetment, placed to create desired flow distribution patterns over the normal summer low range.

   g. Placement of Boulders: This alternative involves the placement of large boulders in the near-shore zone adjacent to bank protection works. This measure was implemented at river mile 241.0 R. As with other measures, the intent is to create low-flow habitat adjacent to backwater areas.

   h. Other Nonhabitat Techniques: Replacement of salmon affected by bank stabilization could be provided by a hatchery or by capturing and trucking affected fish to the Delta, thus increasing overall salmon production to offset the losses.



C—051828

C-051828

3. Develop alternative approaches to traditional bank stabilization.

   a. Palisades: This bank stabilization technique is an example of an alternative to standard rock revetment. A pilot project was recently installed at Woodson Bridge State Recreation Area (river mile 218.6 L) as an experiment and is currently being evaluated. A second palisades site is planned for construction in the Butte Basin area and will also contribute to the evaluation. This technique consists of a series of metal pilings placed perpendicular to the flow at regular intervals, with nylon mesh stretched between them. Because this technique causes woody debris and silt to accumulate and eventually provides a place for vegetation to root, increased shade, shelter, and food production are provided, thus increasing rearing habitat.

   b. Limited Meander Zone Concept: This approach would define a meander zone for the river within certain prescribed limits. It would be greater than that envisioned under a comprehensive channel stabilization plan, but less than the historic meander zone of the river. Bank protection would not be constructed until the limits of this zone were reached. This would allow riparian vegetation to develop naturally along the river banks, thus providing shade and insects to rearing fish. Vegetation toppled into the river by erosion would provide additional shelter.

   c. Iowa Vanes: These are small, double-curved, flow-training devices that are designed to modify river currents and reduce sediment movement away from outside banks. Their double-curved shape and rounded nose minimize down-wash and local bed scour. Installation along the outer banks of a river produces patterns of current and sediment transport that reduce erosive attack and undermining of the bank. In short, Iowa vanes reduce the velocity and erosive power of the flowing stream along the outer bank.

*Special mitigation measures should be taken to ensure that future bank protection work does not destroy a portion of the available rearing habitat of the Sacramento River.*



C—051829

C-051829

## Recommended Solutions

1. Continue development and evaluation of methods to modify riprap to replace rearing habitat values.
2. Complete evaluation of the palisades technique.
3. Continue funding research efforts addressing rearing habitat/riprap relationships. This will provide the best available information to resolve the controversy surrounding the impact of bank protection on salmon-rearing habitat.
4. Implement a limited meander zone concept (see "A Comprehensive Management Plan for the Sacramento River Riparian System").
5. Design and construct measures that will provide rearing habitat in future bank protection work.
6. Develop ways to determine the efficiency and cost effectiveness of these measures.

## Estimated Costs

| | | |
|---|---|---|
| 1. | Develop and evaluate mitigation measures. | $ 20,000/yr |
| 2. | Evaluate palisades. | $120,000 |
| 3. | Fund research effort (two additional years). | $ 60,000 |

4. Develop and implement a limited meander zone between Chico Landing and Red Bluff. Its cost is defined in the Action Item under "A Comprehensive Management Plan for the Sacramento River Riparian System."
5. Incorporate mitigation measures into riprap, $30/linear foot more than the normal construction cost of approximately $225/linear foot.

## Estimated Benefits

The overall objective of the recommended solutions is to improve rearing habitat, while continuing to evaluate alternatives to standard bank protection. Benefits to the salmon and steelhead fishery would be improved instream habitat. Depending on the alternatives chosen, riparian wildlife habitat, including habitat for endangered species, could also be improved significantly. However, at present, there are no means to quantify these benefits, and they can be described only subjectively.

## Potential Conflicts and Resolution

Incorporating mitigation methods into riprap work could affect the structural stability of completed bank stabilization sites. Problems with structural integrity can be resolved by site-specific engineering review prior to construction.

Resolution of potential conflicts related to a limited meander zone is discussed in the Action Item under "A Comprehensive Management Plan for the Sacramento River Riparian System."

## Implementation

Implementation of the recommended solutions would be accomplished through existing programs currently addressing bank erosion and stabilization and natural resource protection along the Sacramento River. Lead agencies would be the Corps of Engineers, the State Resources Agency, and the Fish and Wildlife Service.



C—051830

C-051830

# Battle Creek

## Purpose

The purpose of this action is to restore naturally reproducing anadromous fish populations in Battle Creek upstream from Coleman National Fish Hatchery.

## Background

Historically, Battle Creek must be considered one of the most important chinook salmon–spawning streams. Stone (1897) referred to Battle Creek as "the most extraordinary and prolific place for collecting quinnat salmon eggs yet known." Rutter (1907) considered Battle Creek the most important salmon stream of the Sacramento–San Joaquin basin, and Clark (1929) called it one of the more "celebrated salmon stream(s) in the state."

Human activities, including hydroelectric power development and the operation of a sequence of fish hatcheries, have seriously reduced the annual runs of naturally reproducing salmon and steelhead in Battle Creek.

Hydroelectric development began on Battle Creek with the construction of Volta Powerhouse by Keswick Electric Power Company in 1901. This was followed by South and Inskip Powerhouses in 1910 and Coleman Powerhouse in 1911. This system of powerhouses was acquired by Pacific Gas and Electric Company (PG&E) in 1919. The project initially was licensed by the Federal Power Commission in 1932 and relicensed in 1976 for a period of 50 years. Volta II Powerhouse was constructed in 1980.

The Battle Creek Project (FERC No. 1121) consists of five powerhouses (Volta, Volta II, South, Inskip, and Coleman), two storage reservoirs (North Battle Creek and McCumber), three forebays (Grace, Nora, and Coleman), three diversions on North Fork Battle Creek, (North Battle Creek Feeder, Wildcat, and Eagle Canyon), three diversions on South Fork Battle Creek (South, Inskip, and Coleman), numerous tributary diversions, and a network of some 20 canals, ditches, flumes, and pipelines (see following map).

The first fish hatchery was established on Battle Creek by the California Fish Commission in 1895, with the U. S. Fish Commission assuming responsibility in 1896. Initially, eggs were hatched at the State's Mt. Shasta Hatchery or the U. S. Fish Commission's Baird Hatchery on the McCloud River. In 1913, the Battle Creek Hatchery began on–site hatching of eggs and, because of declining runs in Battle Creek, began planting a portion of the hatch back into Battle Creek. The Battle Creek Hatchery was abandoned in 1944, following the construction of the present Coleman National Fish Hatchery upstream on Battle Creek. The Coleman Hatchery's primary function is to provide partial mitigation for impacts of the Central Valley Project's Shasta Dam on chinook salmon and steelhead trout populations in the upper Sacramento River.

There are no run counts available on Battle Creek prior to the development cited above. However, some estimates can be made based on early information. Thomas R. Payne and Associates (1988) calculated a minimal fall–run size of over 37,500 fish in 1905 from an egg take of over 56.5 million, using an estimate of 6,000 eggs per female and three males to every female. This type of calculation underestimates actual run size, since it doesn't include fish spawning naturally in the stream.

There was also a "large" but unquantified spring run in Battle Creek (U. S. Commission of Fish and Fisheries, 1904).



C—051831

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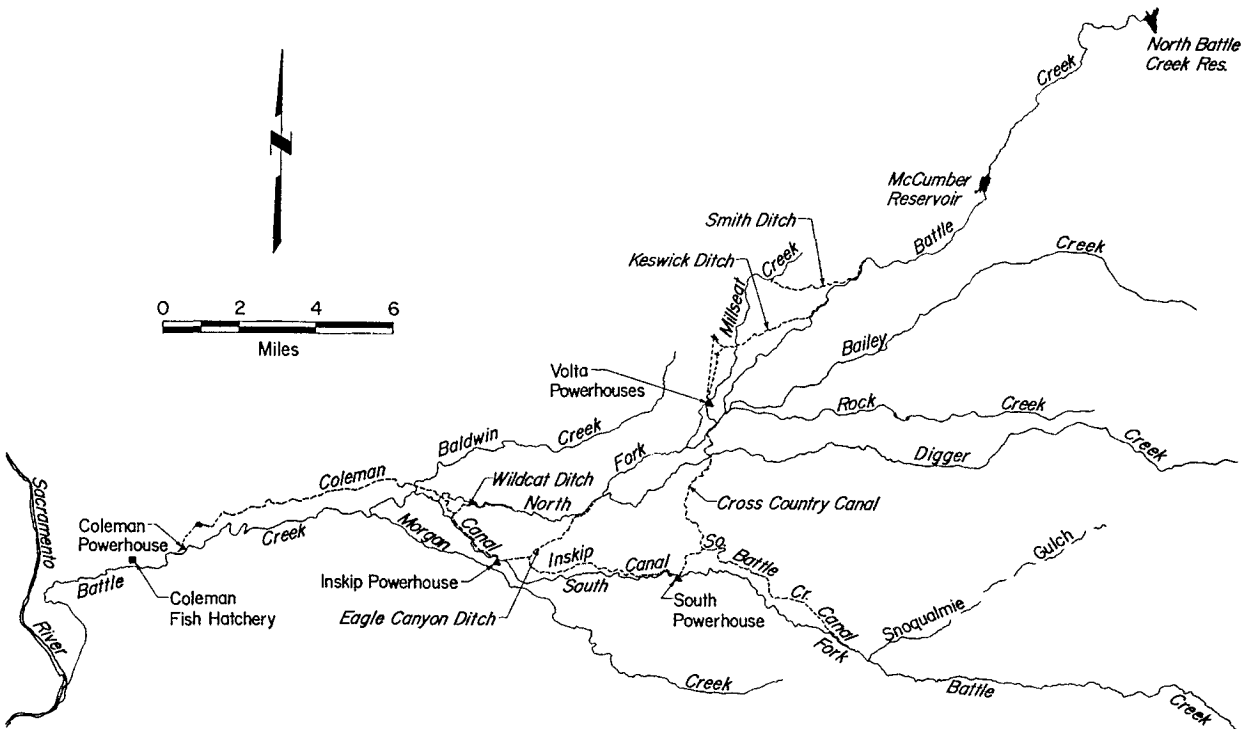


Battle Creek Drainage and Major Canal System

In the 1970s, Battle Creek fall-run salmon runs averaged just over 7,000 fish, with averages of 3,700 returning to the hatchery and 3,300 spawning naturally in Battle Creek downstream from the hatchery. The U. S. Fish and Wildlife Service did not allow spawning upstream of the hatchery during this period. Due to recent changes in basin-wide fishery management and improvements in hatchery management and operations, fall chinook runs in Battle Creek averaged 25,000 in the 1980s, with a peak return of 41,000 in 1985. During that year, approximately 13,000 fish spawned in Battle Creek downstream from Coleman Hatchery, over 16,000 were spawned at the hatchery, and nearly 12,000 were released above the hatchery to spawn naturally in the habitat available in Battle Creek. Limited observations indicate only a small portion (less than 10 percent) of the fish released above the hatchery spawned successfully, based on counts of live and dead fish during two surveys.

There is good potential for increasing anadromous fish production in the upper Sacramento River drainage by fully utilizing the spawning and rearing habitat available in Battle Creek. During the period 1984-87, excess fall spawners returned to Coleman Hatchery and were allowed to spawn in the stream above the hatchery weir. PG&E cooperated by providing some additional water for spawning and rearing flows in excess of that required by the license. For the near term, the company has also agreed to coordinate, to the greatest extent possible, its canal maintenance and repair operations to provide extra flow needed to benefit fall-run salmon migration and spawning.

The restoration potential for other runs of chinook salmon may be limited by stream temperatures. This potential will be evaluated by studies now under way.



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## Discussion

The two human factors cited above, hydroelectric power development and hatchery operation, have together reduced the natural spawning of salmon and steelhead trout in Battle Creek. Salmon once spawned in Battle Creek as far upstream as Bailey Creek on the North Fork and above South Diversion Dam on the South Fork (as indicated by the presence of fish ladders on all project dams downstream from these points). However, recent surveys as part of the Department of Fish and Game's instream flow study indicate there may be a natural barrier to anadromous fish migration about 300 yards below Eagle Canyon Diversion Dam. Additional study at higher flows will be done this winter to confirm this.

For the past several decades at least, natural spawning generally has been limited to the area downstream from Coleman National Fish Hatchery. Because of the hatchery's mitigation requirements, combined with the depressed Battle Creek returns, virtually all of the fall-run and late-fall-run chinook salmon and steelhead trout that reach the hatchery are spawned artificially. Some spring-run fish pass the Coleman Hatchery weir when its ladder is operating or during floodflows, but the extent of this population and its spawning success is unknown.

As noted above, recent changes in hatchery operations and changes in basin-wide fishery management to emphasize restoring salmon and steelhead runs in the upper Sacramento River resulted in improved salmon returns to Battle Creek. Steelhead runs remain at critically low levels. The increase in natural reproduction in the stream, however, is limited by available habitat in Battle Creek upstream from Coleman Powerhouse (located approximately 1.5 miles above the hatchery). This habitat limitation is a result of operating the Battle Creek Project.

Several specific operations affect spawning:

1. Power diversions reduce the amount of water available to provide spawning, holding, and rearing habitat in the affected reaches of Battle Creek. Required minimum bypass flows are only 3 cubic feet per second at North Fork diversions and 5 cfs at South Fork diversions. The average annual discharge of Battle Creek for 25 years, ending in 1986, was 533 cfs (records of the U. S. Geological Survey), with a range of 52 to 24,300 cfs. This characterizes the amount of flow historically in the stream and available for spawning and rearing purposes.

2. Power diversions reduce flows which indirectly increase temperature to levels adverse to salmonid survival. This is particularly true in South Fork Battle Creek.

3. Project diversions are unscreened, which removes naturally spawned fish produced above these diversions.

4. Available spawning habitat may be further limited by the practice at some project diversions of removing gravel that is deposited behind diversion dams and accumulates at the head of diversion ditches.

In 1988, the Department of Fish and Game contracted with Thomas R. Payne and Associates, a biological consulting firm, to conduct a $150,000 study of the Battle Creek fisheries and determine how the operations of the hatchery and the hydro project relate to any restoration efforts which may be proposed. The study report, with recommendations for PG&E and Coleman Hatchery operational charges to accommodate fishery restoration, is expected to be completed in July 1990.



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## Recommended Solutions

Interim

1. Continue to release fall-run salmon to Battle Creek upstream from Coleman Hatchery on an as-available basis, depending on total returns of fish to the hatchery (i.e., fish in excess of the number needed to fulfill mitigation requirements).

2. Continue to seek flow augmentations from PG&E as necessary to accommodate upstream fish releases.

3. Complete the Battle Creek Fisheries Study contracted to consultant Thomas R. Payne and Associates.

4. Evaluate the spawning success and production of fall-run salmon spawning upstream from Coleman Hatchery that occurs under present practices.

Long-Term

5. In consultation with the U. S. Fish and Wildlife Service and National Marine Fisheries Service, develop an anadromous fish management plan for Battle Creek which addresses upstream natural spawning restoration, as well as the operation of Coleman National Fish Hatchery. A portion of the salmon and steelhead runs at the hatchery should be released upstream, and the relative contribution of hatchery and upstream natural production should be assessed.

6. Initiate negotiations with PG&E to implement restoration measures identified through the Battle Creek Fisheries Study. Such measures are expected to include:

   a. Increase and stabilization of bypass flow releases from project diversions.

   b. Installation of fish screens at project diversions on Battle Creek.

   c. Modification, if necessary, of the practice of removing gravel which accumulates behind project dams with a schedule for releasing trapped gravels through sluice gates in the dams during high flows.

7. In the event that PG&E is not receptive to the needed changes in project operations, petition the Federal Energy Regulatory Commission (FERC) to correct the environmental problems created by the project.

8. Evaluate any restoration efforts that may be implemented and determine success. Identify any changes in facilities or practices that may be necessary.

## Estimated Costs

| | | |
|---|---|---|
| 1. | Solutions 1 through 5 | Already implemented or no definable cost |
| 2. | Solution 6a (reduced power generation) | To be determined |
| 3. | Solution 6b (six fish screens) | $2,000,000 |
| 4. | Solutions 6c, 7, and 8 | No definable cost |
| | Total Initial Costs | $2,000,000 |
| | Total Annual Costs | Unknown |



C—051834

C-051834

## Estimated Benefits

An accurate estimate of benefits will not be available until the instream flow study and fisheries management plan are completed. Earlier surveys by Department of Fish and Game biologists indicated that spawning habitat upstream from Coleman Hatchery may be in the order of 15–30 percent of that available downstream from the hatchery.

## Potential Conflicts and Resolution

1. PG&E may be unwilling to substantially increase bypass flows. If such increases are necessary to utilize the potential habitat, the fishery agencies will need to petition FERC for the necessary changes.

2. Large numbers of natural spawners migrating upstream from Coleman Hatchery may exacerbate disease problems at the hatchery. Coleman plans to develop full water sterilization, but no time schedule has been developed nor funding committed.

3. Implementation of this plan may conflict with the mitigation requirements of Coleman National Fish Hatchery. Agreement on any proposal will require negotiation between the management agencies.

## Implementation

1. Using the results of the studies described above, initiate the FERC relicensing process to seek appropriate modification of the Battle Creek Project.

2. Implement provisions of the Battle Creek fishery management plan relating to operation of Coleman National Fish Hatchery in conjunction with natural spawning above the hatchery.

## Special Funding

Some corrective measures, such as increased streamflows and installing and operating fish screens, would be the responsibility of PG&E. The fisheries study is being conducted by the Department of Fish and Game with funds allocated through the Stream Restoration Program (AB 723). Detailed evaluations of existing supplemental spawning and future restoration efforts will require additional funds.



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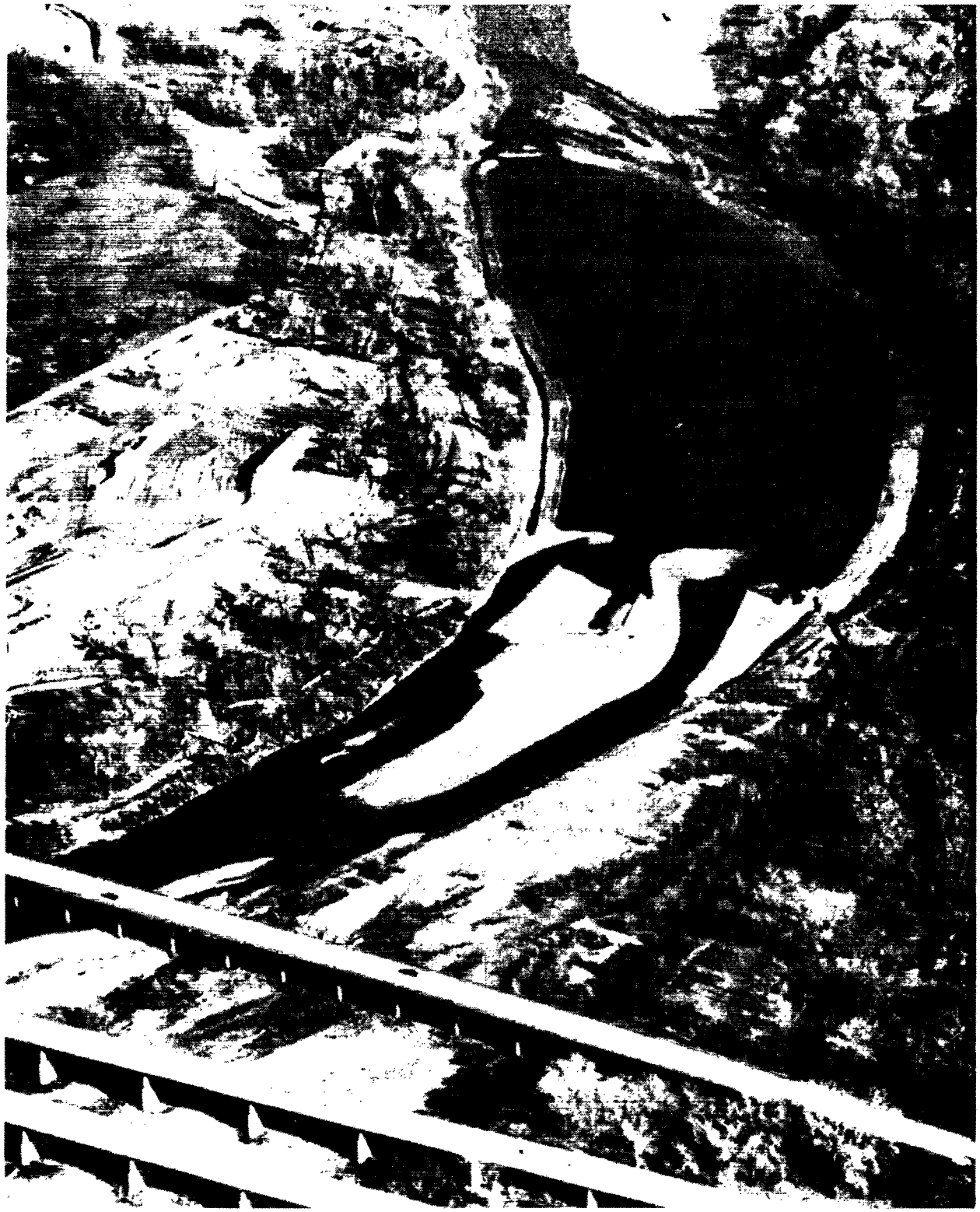

*Cottonwood Creek presently supports a sizable fall run of chinook salmon, but its fishery habitat is threatened by numerous gravel mining proposals. An existing gravel operation extracts about 110,000 cubic yards of creekbed material each year.*



C—051836

C-051836

# Cottonwood Creek

## Purpose

The purpose of this action is to improve the salmon and steelhead production in Cottonwood Creek, Shasta and Tehama Counties.

## Background

Several problems have contributed to reduced salmon and steelhead populations of Cottonwood Creek. These include flows that can be too high or too low, high water temperatures, siltation, gravel mining, a lack of good spawning areas, and armoring of gravel beds.

Flows in Cottonwood Creek respond quickly to rainfall. If rain comes too late in the fall, upstream migrating salmon and steelhead are delayed. If rains come early and flows are not sustained, fish are attracted to spawning areas that are later dewatered, thus destroying the eggs. When low flows occur in the late spring, downstream migrations of young salmon and steelhead are blocked or impeded by excessively high water temperatures that kill young fish. Low flows also increase exposure of young fish to predators. Low flows and high temperatures during the spring months may also impede or prevent upstream migration of adult spring-run salmon to summer holding areas.

Flows that are too high typically occur during the winter or early spring months. Very high flows destroy habitat by erosion or sedimentation. They also destroy redds and kill developing eggs, alevins, and young fry.

Siltation has a variety of adverse impacts on fish habitat, ranging from reducing basic stream productivity to specific impacts on spawning success and fry survival. Silt comes from many sources, some natural, but many a result of poor land-use practices. These sources include timber harvest and road-building activities on private and National Forest lands in the upper drainage, overgrazing, fires, and extensive land clearing in the foothill and valley areas.

Salmon spawning areas in the lower reaches of Cottonwood Creek have been degraded in various ways. Some areas are entirely covered with sand and silt, others are compacted with sediments or by armoring during flood flows. Armoring results when usable-size gravel is washed away during floods, leaving rocks and boulders too large for salmon to move. Sedimentation locks the gravel together so salmon cannot dig redds, and reduces inter-gravel oxygen so that eggs deposited in the gravel do not survive.

Gravel mining has occurred for many years on Cottonwood Creek. It damages spawning areas in the creek and reduces the recruitment of spawning gravels to the Sacramento River. One major instream gravel extraction project is presently operating in Cottonwood Creek below the Interstate Highway 5 bridge, and five use permit applications have been submitted to Tehama County for projects upstream from the I-5 bridge.

## Discussion

Cottonwood Creek supports significant runs of fall- and late fall-run chinook salmon and a small run of steelhead and spring-chinook salmon. Resident rainbow trout and brown trout occur in the upper tributaries. Fall-run chinook salmon, the most numerous of the three runs, migrate into Cottonwood



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Creek from October through December. These fish usually spawn in the lower reaches of Cottonwood Creek, but are known to ascend the South, Middle, and North Forks for considerable distances when flow conditions are favorable. The Department of Fish and Game estimates the average annual fall-run chinook salmon at 3,600 fish, although there is great annual variability in this number due to variations in flow and other factors.

Late fall-run salmon enter and spawn in Cottonwood Creek from January through March. They generally migrate further upstream than fall-run salmon and spawn in the main stem and lower reaches of the North Fork, Middle Fork, and South Fork. Observations are limited, but about 300 late-fall chinook salmon are thought to spawn in Cottonwood Creek annually.

Spring-run chinook salmon enter Cottonwood Creek during the spring months and migrate to the headwaters of the South and Middle Forks during April, May, and June. They spend the summer in deep pools which provide cool water temperatures and protective cover. Spawning occurs in the early fall. The two primary holding areas are the South Fork above Maple Gulch, and Beegum Creek, a tributary to the Middle Fork. No recent estimates of spring-run populations are available; however, past runs averaged about 500 salmon. Today there is likely to be only a remnant population.

Steelhead trout enter Cottonwood Creek during late fall or early winter and spawn during the winter or spring months. The upper reaches of the Middle Fork, Beegum Creek, and the South Fork provide spawning and nursery areas for these fish. Young steelhead spend from one to three years in fresh water before migrating to the ocean. The current population of steelhead spawners is probably only a few hundred fish.

## Potential Solutions

Improved Spawning Areas:

1. Rip and clean, or reconstruct important salmon spawning areas.
2. Improve land management practices on private and National Forest lands in the Cottonwood Creek basin.

Control Gravel Mining:

3. Coordinate and monitor gravel mining activities carefully with appropriate resource and regulating agencies to incorporate fish habitat improvement with these activities as a condition of mining (e.g., use spawning-size gravel from Cottonwood Creek to replenish Sacramento River gravels).
4. Reduce or eliminate gravel mining that affects important spawning and rearing areas of tributaries by county zoning ordinance and/or State legislation. Shasta County has a gravel mining ordinance that helps protect critical salmon spawning areas. Similar protection has been enacted by Tehama County to protect critical spawning habitat.

Cooler Temperatures:

5. Long-term measures to further improve water temperatures include establishing land use management to protect riparian vegetation along the streams and developing programs to restore lost riparian vegetation.

## Recommended Solutions

1. Rip and clean, or reconstruct important salmon spawning riffles on the South Fork Cottonwood Creek below Dippingvat Dam site, and on lower Cottonwood Creek below the South Fork.



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2. Implement improved land management practices on private and National Forest lands, and adopt stronger grading and road building ordinances to control erosion.
3. Restrict or eliminate gravel mining in important spawning areas by county zoning and/or State legislation.
4. Incorporate fish habitat improvement into all future gravel extraction permits.
5. Protect and restore riparian vegetation along stream channels and develop programs to maintain streamside vegetation.

## Estimated Costs

| | | Cost |
|---|---|---|
| 1. Rip and clean existing and potential riffles on Cottonwood Creek | | $100,000 |
| 2. Construct spawning areas on lower Cottonwood Creek | | $300,000 |
| 3. The costs for regulatory changes, increased coordination, and efforts to improve land use practices and protect riparian habitat and gravel resources | | Unknown |
| | Total Initial Costs | $400,000 |
| | Total Annual Costs | Unknown |

## Estimated Benefits

The overall objective of these proposed actions is to restore fall and spring-run chinook salmon and steelhead populations in Cottonwood Creek to the levels observed in the early 1960s (about 4,400 salmon and 1,000 steelhead).

## Potential Conflicts and Resolution

The Department of Water Resources is currently studying the Dippingvat-Schoenfield Reservoir project with possible construction sometime after the year 2000. If constructed, the Dippingvat-Schoenfield project could provide substantial fishery, water supply, and flood control benefits. However, it is not proposed as a recommended solution to Cottonwood fishery problems because considerable planning, coordination, and reformulation would be required to include fishery enhancement as a primary project purpose. Major dams and reservoirs on South Fork Cottonwood and Red Bank Creeks could cause significant fishery and environmental benefits or detriments, depending on how the projects are operated. Any detrimental impacts must be evaluated thoroughly and properly mitigated.

Restricting or eliminating gravel mining on Cottonwood Creek would have significant local economic impacts. These could be reduced by mining gravel terraces not directly feeding Cottonwood Creek, by mining only nonspawning-size gravels and by mining gravels from streams that do not support anadromous fish.

## Implementation

Most of the riffle cleaning and restoration proposals could be carried out by DFG and/or DWR under interagency agreements. The Fish and Wildlife Service and Tehama and Shasta Counties should strengthen land use regulations that protect fishery habitat and riparian vegetation.



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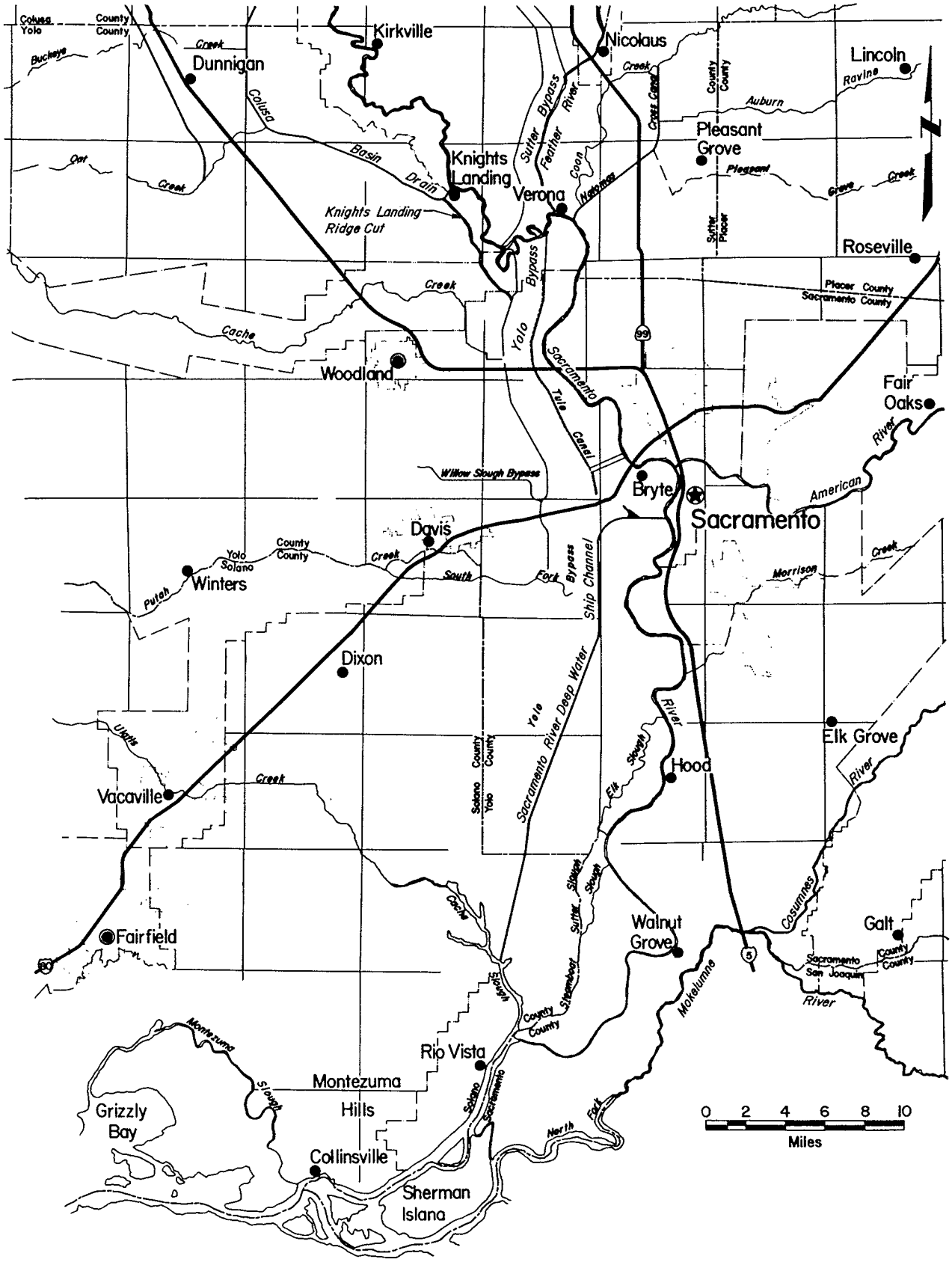


Lower Sacramento River - Colusa Drain



C—051840

C-051840

# Lower Sacramento River Temperature – Colusa Drain

## Purpose

The purpose of this action is to increase survival of emigrating salmon smolts through the lower Sacramento River and Delta by decreasing water temperatures in late April through June.

## Background

Water temperatures in the lower Sacramento River below Knights Landing during May and June can exceed 70 degrees F, temperatures detrimental to salmon smolts. The majority of salmon smolts generally emigrate from the upper Sacramento River in May and early June. High water temperature has been implicated in the decline of the upper Sacramento River chinook salmon runs. The Colusa Drain is a major contributor of warm water to the Sacramento during this period. Flows in the Colusa Drain occasionally exceed 2,000 second-feet with water temperatures over 80 degrees F.

## Discussion

The U.S. Corps of Engineers studied solutions to the flooding problems of the lower Colusa Drain. Their reconnaissance report, dated June 1968, included a project to take Colusa Drain flows south into the Yolo Bypass channels by deepening and widening the Knights Landing Ridge Cut, an existing channel that now takes some Colusa Drain water south for irrigation in the bypass (see map). Improvements to the Ridge Cut and Yolo Bypass channels were estimated to cost $810,000 in 1968, which would be about $3 million, updated to 1988 cost levels.

Construction of this added channel capacity would allow routing of the warm Colusa Drain flows into the Yolo Bypass, which returns to the Sacramento River just upstream from Rio Vista. Emigrating smolts would thus have cooler water in about 40 miles of the Sacramento River, but would still have to deal with this warm water for about 10 miles before reaching Suisun Bay. Agricultural diversions from the bypass should reduce the volume reaching the river and thus reduce warming in this last 10 miles.

Another potential solution to the warm water problem is to increase the flows of colder water. Two possibilities exist: (1) large increases into the Feather River from Oroville, or (2) smaller flow increases from Nimbus Dam to the American River. These possibilities, especially the latter, would be substantially more feasible if the Colusa Drain flows were rerouted. A feasibility study is needed to determine the viability of these solutions.

## Recommended Solutions

1. Investigate the feasibility of rerouting Colusa Drain flows from late April through June into the Yolo Bypass by constructing a larger Knights Landing Ridge Cut and improving the Bypass channels.

2. Investigate the feasibility of lowering Sacramento River water temperatures to 65 degrees F or less by increasing flows in late April through June in the American and/or Feather Rivers.



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## Estimated Costs

| | | Cost |
|---|---|---|
| 1. Feasibility study | | $300,000 |
| 2. Construction of an enlarged ridge cut and bypass channels | | $3,000,000 |
| 3. Restructuring flow releases in the rivers | | Unknown |
| | Total Initial Costs | $3,300,000 |
| | Total Annual Costs | Unknown |

## Estimated Benefits

A solution to this temperature problem would reduce temperature-related mortality of spring- and fall-run salmon smolts in the Sacramento River below Knights Landing. Removal of Colusa Drain flows alone will probably not eliminate the temperature problems, but may allow reoperation of existing projects to achieve temperature goals.

## Potential Conflicts and Resolution

The restructuring of flow releases to achieve temperature goals will involve power, water conservation, and Delta water diversion considerations. Water rights to the Colusa Drain water may be contested. An intensive study will be needed to resolve these conflicts.

## Implementation

The Corps of Engineers could be the planning and construction agency with nonfederal funding by a combination of local flood control agencies and State fisheries conservation funding. The U.S. Bureau of Reclamation and/or State Department of Water Resources should conduct a more comprehensive investigation which would look at the benefits of rerouting Colusa Drain flows as part of an overall study of potential ways to reduce lower Sacramento River water temperatures.



C—051842

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# APPENDIXES

A. Upper Sacramento River Advisory Council and Action Team

B. Text of Senate Bill 1086

C. Selected References

D. Summary of Sacramento River Riparian Atlas



C—051843

C-051843

## APPENDIX A

## UPPER SACRAMENTO RIVER ADVISORY COUNCIL AND ACTION TEAM

| Organization | Council Member | Action Team Member |
|---|---|---|
| Butte County | Jane Dolan, Supvsr. (916) 891-2830 | Bill Turpin (916) 538-7601 |
| Colusa County | William Waite, Supvsr. (916) 458-2101 or 438-2700 | Len Heist (916) 458-4527 |
| Glenn County | George (Fred) Pride, Supvsr. (916) 934-3364 | Fred Pride (916) 968-5117 (home) |
| Shasta County | Bob Bosworth, Supvsr.(916) 225-5557 (Chair) | Larry Preston (916) 225-5571 |
| Sutter County | Roger Chandler, Supvsr. (916) 741-7100 | James Howard (916) 673-5561 |
| Tehama County | Burt Bundy, Supvsr. (916) 527-4655 | George Robson (Chair) (916) 527-2200 |
| Corps of Engineers | Col. Jack A. LeCuyer (916) 551-2005 | Fred Kindel (916) 551-1857<br>Mike Welsh - Alt. (916) 551-1861 |
| U.S. Fish & Wildlife Service | Gary Edwards, Regional Director (503) 231-6118<br>Dave Riley (Alternate) (503) 231-6150 | Dave Vogel (916) 527-3043 |
| U.S. Forest Service | Paul Barker, Reg. Forester (415) 556-4310<br>Randy Long (Alternate) | Dean Carrier (916) 623-2121 |
| Bureau of Land Management | Richard Johnson, Deputy State Dir. (916) 978-4720 | Mark Morse (916) 246-5325 |
| National Marine Fisheries Serv. | Charles Fullerton (213) 514-6196 | Jim Bybee (707) 578-7513 |
| Bureau of Reclamation | David Houston (916) 978-5135 | Ken Lentz (916) 978-4923 |
| Dept. of Fish and Game | Peter Bontadelli, Director (916) 445-3535<br>ATSS 485-3535 | Gary Stacey, Region I (Vice Chair)<br>(916) 225-2371 ATSS 442-2371 |
| Department of Forestry | Robert Malain ATSS 442-2459 | Robert Malain (916) 225-2459 |
| Department of Food & Ag. | John Repanich (916) 824-2752 | John Repanich |
| Department of Water Resources | David Kennedy, Dir.(916) 445-6582 ATSS 485-6582<br>Bob Potter (Alternate) 445-3081 ATSS 485-3081 | Ralph Hinton (916) 527-6530<br>ATSS 446-2263 |
| The Reclamation Board<br>(Dept. of Water Res.) | Ray Barsch, General Mgr.(916) 445-9454<br>ATSS 485-9454 | Jake Angel (916) 445-9457<br>ATSS 485-9457 |
| State Lands Commission | Dwight Sanders (916) 322-7827<br>ATSS 492-7827 | Diana Jacobs (916) 445-5034<br>ATSS 485-5034 |
| State Water Resources<br>Control Board | Danny Walsh, Member (916) 445-0922<br>ATSS 485-0922 | Wendy Johnston, Regional Bd. Member<br>(916) 241-8008 (work)<br>(916) 241-4422 (home)<br>Robert Lewis,Alt.(916) 225-2045<br>ATSS 442-2052 |
| Wildlife Conservation Board | W. John Schmidt, Exec. Officer (916) 445-8448<br>(Vice Chair) ATSS 485-8448 | Jim Sarro, Chief Land Agent<br>(916) 324-7913 ATSS 454-7913 |
| Sacramento River Water<br>Contractors Assoc. | Michael A. Catino (916) 446-0197 | Bob Clark (916) 934-8881<br>Ben Pennock (Alternate) |
| (Commercial Fishing) | Mel Dodgin, Pacific Coast Fed.of Fishermen's Assoc's<br>(916) 635-6458 | Mel Dodgin |
| (Sport Fishing) | Claude Warden (415) 934-0201 | Claude Warden |
| (General Wildlife<br>and Conservation) | Daniel Taylor, Reg. Rep.<br>National Audubon Society | Daniel Taylor (916) 481-5332 |
| (County Government) | Janet Nicholas, Supervisor Sonoma County<br>(707) 935-0194 or 527-2241 | Janet Nicholas |
| Project Manager | Edwin Barnes (916) 527-6530 ATSS 446-2321 | |



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# APPENDIX B

## TEXT OF SENATE BILL 1086

### Senate Bill No. 1086

CHAPTER 885

An act to add Article 4.5 (commencing with Section 1385) to Chapter 4 of Division 2 of, and to add and repeal Chapter 4.5 (commencing with Section 1400) of Division 2 of, the Fish and Game Code, relating to the Upper Sacramento River Fisheries and Riparian Habitat, and making an appropriation therefor.

[Approved by Governor September 18, 1986. Filed with Secretary of State September 18, 1986.]

LEGISLATIVE COUNSEL'S DIGEST

SB 1086, Nielsen. Upper Sacramento River: fisheries and riparian habitat.

(1) Under the Wildlife Conservation Law of 1947, the Wildlife Conservation Board may authorize the Department of Fish and Game to acquire real property for the benefit of wildlife.

This bill would require the board by January 1, 1988, to inventory the lands along the upper Sacramento River, as described, to identify and determine the priority of those lands that are valuable to fish and wildlife. The bill would prescribe related matters.

(2) Existing law does not provide for an Upper Sacramento River Fisheries and Riparian Habitat Advisory Council.

This bill would create that council composed of specified members, and would require the advisory council to develop, for submission to the Legislature, the Upper Sacramento River Fisheries and Riparian Habitat Management Plan to provide for the protection, restoration, and enhancement of fish and riparian habitat and associated wildlife for the area between the Feather River and Keswick Dam. The bill would provide for an action team with specified members to develop proposed plan elements. The bill would specify related requirements for preparation of the management plan. The bill would require the advisory council to submit the management plan to the Legislature by January 1, 1989. These provisions of the bill would be repealed on January 1, 1989.

(3) The bill would appropriate $250,000 from the California Environmental License Plate Fund, with $150,000 to the Wildlife Conservation Board for the inventory and $100,000 to the Secretary of the Resources Agency for the preparation of the management plan.

Appropriation: yes.

*The people of the State of California do enact as follows:*

SECTION 1. Article 4.5 (commencing with Section 1385) is added to Chapter 4 of Division 2 of the Fish and Game Code, to read:



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Article 4.5. Lands Inventory

1385. For the purposes of this article, "upper Sacramento River" means the Sacramento River upstream from the confluence with the Feather River and downstream from Keswick Dam.

1386. The board shall, not later than January 1, 1988, inventory, or cause to be inventoried, the lands along the upper Sacramento River to identify and determine the priority of those lands that are valuable to fish and wildlife. The inventory shall be conducted so as to provide information needed to make evaluations pursuant to this chapter.

1387. The inventory made under this article shall take special efforts to identify lands that provide any of the following:

(a) A source of salmon spawning gravels, or lands that are otherwise important to anadromous and resident fisheries.

(b) Habitat for rare, threatened, and endangered species.

(c) Riparian habitat or an opportunity for reestablishment of riparian habitat.

1388. The board shall also make a preliminary identification of potential willing sellers in the inventory made under this article.

SEC. 2. Chapter 4.5 (commencing with Section 1400) is added to Division 2 of the Fish and Game Code, to read:

CHAPTER 4.5. UPPER SACRAMENTO RIVER FISHERIES AND RIPARIAN HABITAT MANAGEMENT PLAN

1400. The Legislature hereby finds and declares as follows:

(a) The Sacramento River system has tremendous social, environmental, and economic value to the people of California for many consumptive and nonconsumptive beneficial purposes. The Sacramento River system provides water for agricultural, municipal, and industrial uses, and for hydroelectric power, recreation, and navigation.

(b) The Sacramento River system is the state's largest producer of salmon, striped bass, sturgeon, and shad. It is also a major source of steelhead and other game fish and the source of water for much of the migratory bird population of the Pacific Flyway. It is essential that these values be protected.

(c) Various human and natural causes have contributed to substantial reductions in various anadromous fish populations in the Sacramento River system.

(d) Lack of a comprehensive management plan for the Sacramento River Basin has resulted in independent actions that pit some beneficial uses of water against others, thereby causing strong competition among competing water users.

(e) A comprehensive Upper Sacramento River Fisheries and Riparian Habitat Management Plan is needed to develop

information to provide for the protection, enhancement, and restoration of fish and riparian habitat and associated wildlife, as part of the orderly development of the water resources of the Sacramento River Basin for all beneficial purposes.

1401. As used in the chapter:

(a) "Advisory council" means the Upper Sacramento River Fisheries and Riparian Habitat Advisory Council created pursuant to Section 1402.

(b) "Action team" means the Upper Sacramento River Fisheries and Riparian Habitat Action Team created pursuant to Section 1403.

(c) "Management plan" means the Upper Sacramento River Fisheries and Riparian Habitat Management Plan prepared pursuant to this chapter.

1402. The Upper Sacramento River Fisheries and Riparian Habitat Advisory Council is hereby created consisting of the following members:

(a) The Director of Fish and Game, the Director of Water Resources, a designee of the State Lands Commission, a designee of the Chairperson of the State Water Resources Control Board, a designee of the Wildlife Conservation Board, and a designee of the Chairperson of the State Reclamation Board.

(b) The Director of the Mid-Pacific Region of the United States Bureau of Reclamation; the Sacramento District Engineer for the United States Army Corps of Engineers; the Regional Director, Region 1, for the United States Fish and Wildlife Service; the Regional Forester, Region 5, for the United States Forest Service; the State Director, California State Office, United States Bureau of Land Management; and the Regional Director, Region 3, for the National Marine Fisheries Service; provided that the foregoing federal officials agree to serve on the advisory council.

(c) One member of the board of supervisors, selected by the board of supervisors, from each of the following counties: Butte, Colusa, Glenn, Shasta, Sutter, and Tehama, provided that the county designates a board member to serve on the advisory council.

(d) Three persons, appointed by the Director of Fish and Game, who shall represent, respectively, commercial fishermen, recreational fishermen, and general wildlife and conservation interests. The Director of Fish and Game shall also appoint a representative of county government from a county not represented pursuant to subdivision (c) which contains a commercial fishing industry dependent on the upper Sacramento River. This person shall represent the commercial fishing industry interests of the San Francisco Bay area and north coast.

(e) One person, appointed by the Director of Forestry, who shall represent commercial timber operators.

(f) One person, appointed by the Director of Food and Agriculture, who shall represent agricultural interests and is a riparian landowner.



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(g) A representative of the Sacramento River Water Contractors Association, provided that the representative agrees to serve on the advisory council.

1403. The Upper Sacramento River Fisheries and Riparian Habitat Action Team shall consist of one person designated by each member of the advisory council, except that the Chairperson of the California Regional Water Quality Control Board for the Central Valley Region shall designate one member and the Chairperson of the State Water Resources Control Board shall not designate a member and except that the members of the advisory council appointed pursuant to subdivisions (d), (e), and (f) of Section 1402 shall themselves serve on the action team.

1404. The advisory council and the action team shall each select a chairperson from its members by majority vote.

1405. Members of the advisory council and the action team shall serve without compensation.

1406. The advisory council shall develop the Upper Sacramento River Fisheries and Riparian Habitat Management Plan, including a proposed implementation program, for submission to the Legislature. The management plan shall provide for the protection, restoration, and enhancement of fish and riparian habitat and associated wildlife. The management plan shall establish a series of priority actions with specified time frames, estimated costs and benefits, and proposed funding sources.

The action team and the advisory council shall consider and may incorporate into the management plan, where feasible, the findings and recommendations of studies conducted by the Department of Water Resources pursuant to Section 238 of the Water Code.

1407. The area of study of the management plan shall be the Sacramento River and tributary streams, and associated riparian habitat, upstream from the confluence with the Feather River and downstream from Keswick Dam.

1408. The action team shall serve as a working group to develop proposed plan elements. The action team shall submit its recommendations to the advisory council for its review and approval. The advisory council shall be responsible for the management plan submitted to the Legislature.

1409. The Secretary of the Resources Agency shall appoint a project manager to supervise plan preparation and to coordinate activities of the advisory council and the action team.

1410. The advisory council shall hold at least two public hearings in separate counties within the area of study prior to final approval of the management plan. The action team shall hold at least one workshop, open to the public, in each of the counties represented on the advisory council pursuant to subdivision (c) of Section 1402.

1411. The advisory council shall submit the management plan, including a proposed implementation program, to the Legislature not later than January 1, 1989.

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1412. This chapter shall not delay or preclude any current, pending, planned, or proposed fisheries and wildlife protection enhancement, restoration, or acquisition activities or bank protection, flood control, irrigation, or other management activities along the upper Sacramento River.

1413. This chapter shall remain in effect only until January 1, 1989, and as of that date is repealed, unless a later enacted statute, which is enacted before January 1, 1989, repeals or extends that date.

SEC. 3. The sum of two hundred fifty thousand dollars ($250,000) is hereby appropriated from the California Environmental License Plate Fund for expenditure in accordance with the following schedule:

(a) One hundred fifty thousand dollars ($150,000) to the Wildlife Conservation Board for the purposes of Article 4.5 (commencing with Section 1385) of Chapter 4 of Division 2 of the Fish and Game Code.

(b) One hundred thousand dollars ($100,000) to the Secretary of the Resources Agency for preparation of the Upper Sacramento River Fisheries and Riparian Habitat Management Plan pursuant to Chapter 4.5 (commencing with Section 1400) of Division 2 of the Fish and Game Code.

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## APPENDIX C

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## APPENDIX D

## SUMMARY OF SACRAMENTO RIVER RIPARIAN ATLAS

Senate Bill 1086 required the Wildlife Conservation Board (WCB) to inventory the lands along the Sacramento River between the town of Verona and Keswick Dam near Redding and to identify and determine the priority of lands valuable to fish and wildlife. *The Sacramento River Riparian Atlas* summarizes this survey of important wildlife, fish, and plant habitat and provides this information on a series of aerial photographs. It was prepared for WCB by the Nongame Heritage Program of the California Department of Fish and Game.

The primary purpose of the *Atlas* is to provide current information to the Upper Sacramento River Fisheries and Riparian Habitat Advisory Council, the group that SB 1086 charged with responsibility for preparing a "management plan [that] shall provide for the protection, restoration, and enhancement of fish and riparian habitat and associated wildlife."

Copies of the *Atlas* can be found in public libraries in the counties along the river, and individual copies may be obtained, while supplies last, from the Wildlife Conservation Board, 1416 Ninth Street, Sacramento, CA 95814.



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