DEFT Evaluation: Upstream Ecosystem Restoration Benefits for Chinook Salmon

Diversion Effect on Fisheries Team
Salmon Subgroup

Revised Draft for Subgroup Review

~~September 1, 1998~~
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Introduction

The DEFT Salmon Subgroup was assigned the task to evaluate the upstream actions proposed in the CALFED Stage I Implementation and during the long-term Ecosystem Restoration Program. The Salmon Subgroup was to assess the degree to which upstream actions would likely contribute to the recovery or restoration of endangered species including salmon stocks proposed for listing.

Clearly, assessing the probability that a chinook stock will be recovered is not possible by solely evaluating upstream actions and the health of populations without also considering water management and habitat conditions in the Delta and the affect of ocean commercial and ocean and inland recreational harvest on chinook stocks. In this evaluation the team considered the cumulative benefits of ongoing management and restoration actions, actions proposed during the Stage I Implementation and long-term CALFED implementation programs, and other restoration actions such as those being implemented under the auspices of the Anadromous Fish Restoration Program of the Central Valley Project Improvement Act. The team felt comfortable in assessing the degree to which upstream restoration actions would or would not contribute to the recovery or restoration of chinook salmon.

Role of Adaptive Management

It is difficult to predict outcomes in ecosystem restoration programs, and the CALFED Ecosystem Restoration Program is based on the premise that we do not know everything we need to know at this time to implement a successful restoration program. This premise identifies the need for a true adaptive management approach. The DEFT Salmon Team reiterates the need for and role of adaptive management in the restoration of ecological processes and aquatic habitats, and the reduction of stressors in the short- and long-term restoration program. The analysis of upstream actions assumes that we will adjust the restoration program and restoration actions accordingly as we learn more about the system. According to Walters (1986) designing an adaptive management strategy involves four basic issues:

1. bounding the management problem in terms of objectives, practical constraints on action, and the breadth of factors to be considered in designing and implementing management policy and programs;

2. representing our existing understanding of the system(s) to be managed in terms of explicit models of dynamic behavior that spell out both assumptions and predictions clearly enough that errors or inconsistencies can be detected and used as a basis for learning about the system;

3. representing uncertainty and how it propagates through time and space in relation to a range of potential management actions that reflect alternative hypotheses about the system and its dynamics; and

4. designing and implementing balanced management policies and programs that provide for continuing resource production while simultaneously probing for better understanding and untested opportunity.

Put another way, AM involves: 1) having clear goals and objectives for management that take account of constraints and opportunities inherent in the system to be managed; 2) using models to explore the consequences of a range of management policy and program options in relation to contrasting hypotheses about system behavior and uncertainty; and 3) selecting and implementing policies and programs that sustain or improve the production of desired ecosystem services while, at the same time, generating new kinds of information about ecosystem function.

The critical variable in AM is uncertainty, uncertainty in the dynamics of complex systems and uncertainty in the consequences of various potential management interventions. In a program like CALFED, the uncertainty is compounded by the need to effect change at large time and space scales. The only way to learn about such systems and their dynamics is through large scale manipulations of the system. CALFED is such a large scale manipulation of the environment and it is impractical, indeed impossible, to gather the information necessary to predict the consequences of CALFED without undertaking CALFED. The program to solve the problem, therefore, becomes the means by which we can learn about the problem. The trick in AM is to design the management program to ensure that beneficial actions are taken in a timely manner but also to structure projects so that alternative concepts are probed and learning is an active consequence of management. As Lee (1993) argued, information has value both as a stimulus for action and as a product of action. The information value of action is the component of value routinely ignored in traditional approaches to management (Healey and Hennessey 1994).

Definition of Recovery

The Conservation Strategy team has made a preliminary assignment of a management goal for each of the species addressed by the Conservation Strategy. The Conservation Strategy team has recommended to CALFED that it adopt these goals and incorporate them into the CALFED Program. Below is the definition of the Conservation Strategy goal "Recover." This definition does not necessarily equate to the definitions of these terms that may be found in any statute or any regulation nor are they intended to supplant any statutory or regulatory requirement, but are intended to be a part of the CALFED Program goals.

Recovery ("R"): For those species designated "R," the Conservation Strategy team recommends that the CALFED Program establish a goal to recover the species within the CALFED ERP Ecological Zones. A goal of Recovery was generally assigned to those species whose range is entirely or nearly entirely within the area affected by the CALFED Program and for which CALFED could reasonably be expected to undertake all or most of the actions necessary to recover the species (i.e., all runs of chinook salmon). The term recover generally means the decline of a species is arrested or reversed, threats to the species are neutralized, and thus, the species' long-term survival in nature is assured. In the case of most species listed under the Federal ESA, a goal of recovery is equivalent, *at a minimum*, to the requirements of delisting.

For certain species, such as anadromous fish, with threats outside the geographic scope or purview of the CALFED Program, CALFED may not be capable of completely recovering the species, but will implement all necessary recovery actions within the ERP Ecological Zones. For other species, CALFED may choose a goal that aims to achieve more than would be required for delisting (e.g., restoration of a species and/or its habitat to a level beyond delisting requirements). The effort required to achieve recovery may be highly variable between species. ***In sum, a goal of recovery implies that CALFED will undertake all actions within the ERP Ecological Zones and program scope necessary to recover the species.***

Selection of Chinook Stocks

In the analysis, we evaluated the potential benefits of restoration actions for the following stocks:

- Sacramento River winter-run chinook salmon
- spring-run chinook salmon
- late-fall-run chinook salmon
- fall-run chinook salmon
  - Sacramento stocks
  - San Joaquin stocks
  - Mokelumne stock

(Note: The team agreed to assess Mokelumne River independently due to its direct connection to the Delta and potential affects of conveyance alternatives on Mokelumne-origin chinook salmon).

Fall-run Chinook Salmon

For fall-run chinook salmon, we selected nine streams that accounted for nearly 96% of the returns during 1967-1991 (Table 1). These streams were analyzed for chinook salmon trend data and cohort replacement rates were calculated. These analyses contributed to the assessment of cumulative benefits of restoration actions. For example, the Team observed that rivers with relatively high or stable returns might only accrue incremental benefits (small to modest increases in chinook spawner returns) from restoration, while some streams with lower escapements or more variable returns might derive greater benefits. Some team members suggested using more up-to-date escapement/return data for this selection process. However, given time constraints, the team agreed that the following table was adequate for this evaluation.

Winter-run Chinook Salmon

Actions proposed in the mainstem Sacramento River and in Battle Creek contributed to the evaluation for winter-run chinook salmon. The mainstem constitutes much of the critical habitat for this endangered species. Battle Creek is considered in the longer-term restoration program due to its potential for providing for an additional spawning population of winter-run which would reduce the probability of extinction and contribute to or decrease the time required for recovery.

TABLE 1.	Distribution of Fall-run Chinook Salmon by Watershed Based On Average Returns for 1967-1991.					
Rank	River or Stream	Average spawners	Cumulative total	Percent of total	Cumulative percent	Selected for Analysis
1	Sacramento River	76,701	76,701	38.4%	38.4%	Yes
2	Feather River	41,003	117,704	20.5%	58.9%	Yes
3	American River	32,307	150,011	16.2%	75.1%	Yes
4	Yuba River	12,868	162,879	6.4%	81.6%	Yes
5	Tuolumne River	8,923	171,802	4.5%	86.0%	Yes
6	Battle Creek	8,369	180,171	4.2%	90.2%	Yes
7	Stanislaus River	4,807	184,978	2.4%	92.6%	Yes
8	Merced River	4,035	189,013	2.0%	94.7%	Yes
9	Mokelumne River	2,553	191,566	1.3%	95.9%	Yes
10	**Cottonwood Creek**	**1,647**	**193,213**	**0.8%**	**96.8%**	**No**
11	**Clear Creek**	**1,584**	**194,797**	**0.8%**	**97.6%**	**No**
12	**Cow Creek**	**1,373**	**196,170**	**0.7%**	**98.2%**	**No**
13	**Mill Creek**	**1,104**	**197,274**	**0.6%**	**98.8%**	**No**
14	**Cosumnes River**	**764**	**198,038**	**0.4%**	**99.2%**	**No**
15	**Butte Creek**	**418**	**198,456**	**0.2%**	**99.4%**	**No**
16	**Deer Creek**	**406**	**198,862**	**0.2%**	**99.6%**	**No**
17	**Miscellaneous**	**304**	**199,166**	**0.2%**	**99.7%**	**No**
18	**Big Chico Creek**	**242**	**199,408**	**0.1%**	**99.9%**	**No**
19	**Antelope Creek**	**192**	**199,600**	**0.1%**	**100.0%**	**No**
20	**Paynes Creek**	**90**	**199,690**	**0.05%**	**100.00%**	**No**

Late-fall-run Chinook Salmon

Late-fall-run chinook are evaluated based on actions proposed for the mainstem Sacramento River.

Spring-run Chinook Salmon

Spring-run chinook salmon are evaluated based on actions proposed in Mill Creek, Deer Creek, Big Chico Creek, and Butte Creek. In addition, restoration actions in the mainstem Sacramento River contribute to the recovery of this stock.

Chinook Population Data

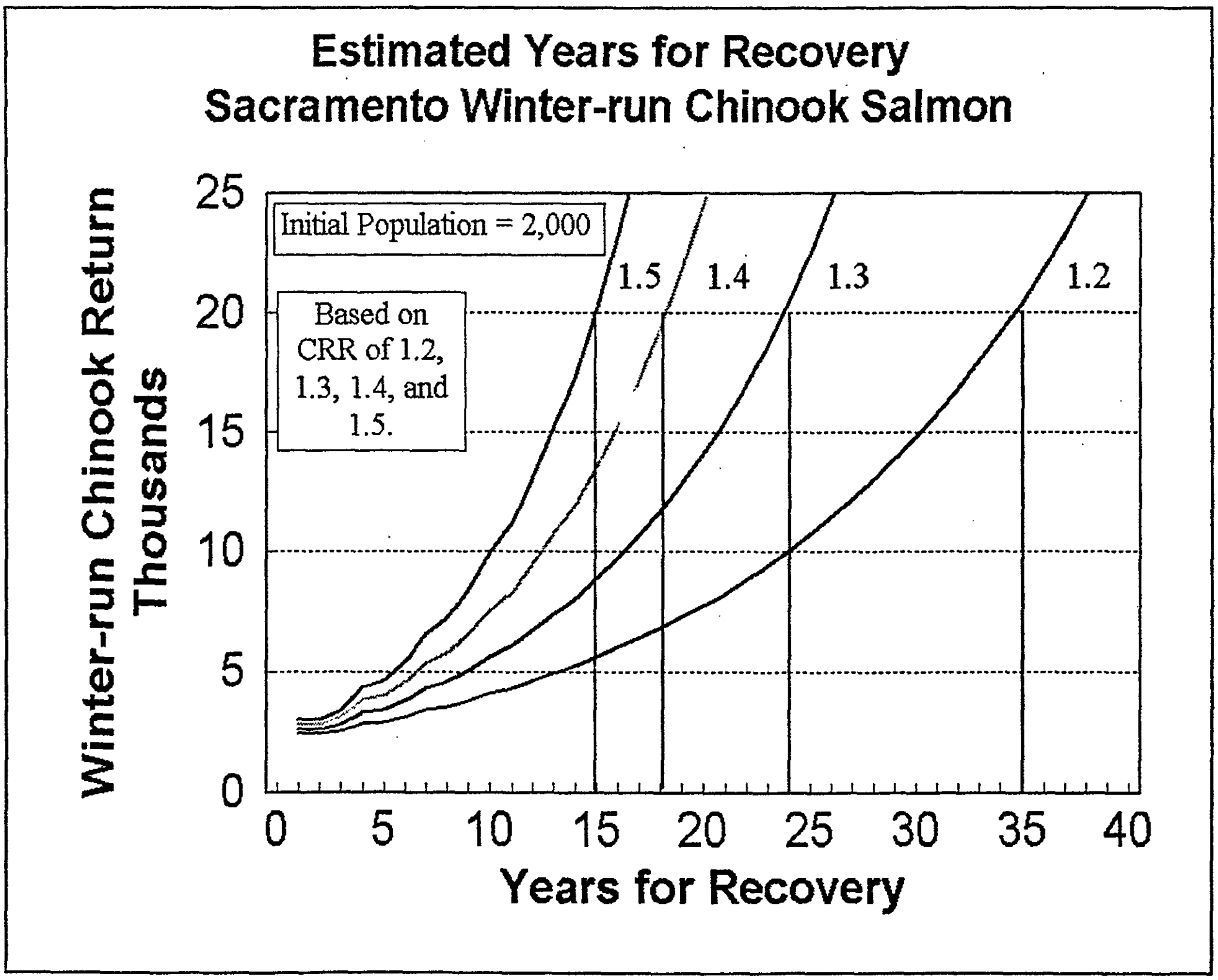
Fall-run chinook salmon return data are provided by the California Department of Fish and Game in the "GrandTab. Wk3" worksheet (Personal communication: Robert Kano, CDFG, Inland Fisheries Division), spring-run chinook salmon returns are from the Department of Fish and

Game Report to the Fish and Game Commission: a status review of the spring-run chinook salmon in the Sacramento River drainage (Candidate Species Status Report 98-01, June 1998), winter-run chinook returns are from the National Marine Fisheries Service (Proposed Recovery Plan for the Sacramento River Winter-run Chinook Salmon, 1997), and late-fall-run chinook returns are from Central Valley Anadromous Sport Fish Annual Run-size, Harvest, and Population Estimates, 1967 through 1991 (Terry Mills and Frank Fisher, 1993, Department of Fish and Game).

Estimates of Time for Recovery of Endangered Species

Recovery of endangered chinook salmon runs will require extended periods, depending on the initial population size at the beginning of the recovery period, the abundance level required for recovery, and the cumulative success (cohort replacement rate) of implementing individual actions within watersheds, the mainstem rivers, and the Delta.

For example (refer to attached figure), the simple estimated time for the recovery of winter-run chinook salmon ranges from 15 to 35 years. This estimate is based on cohort replacement rates



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of 1.2, 1.3, 1.4, and 1.5. This simple evaluation assumes no variation in annual replacement rates and assumes that cohort replacement rates are equal every year during the recovery period. In the example for winter-run chinook salmon, the initial population size is 2,000 fish, which is slightly less than the 1998 population estimate of 2,600 fish. Based on steady increases in each returning cohort, recovery of 20,000 fish (or 10,000) females would require 15 to 35 years. Although this analysis approach has severe limitations, it does provide a rough assessment of the required effort and the potential length of time for recovery. The model assumes that the cohort replacement rates reflect the number of restoration actions successfully implemented (i.e., a replacement rate of 1.2 reflects a moderately successful restoration program over a long period, which a replacement rate of 1.5 reflects a very aggressive and successful restoration program over a shorter period).

Recovery Goals

Additional information regarding recovery goals and restoration objectives for chinook salmon (excluding fall-run chinook) are provided as well as citations for sources of information.

Species include:

- Sacramento River winter-run chinook salmon
- late-fall-run chinook salmon
- spring-run chinook salmon
- San Joaquin fall-run chinook salmon

Recovery and delisting goals apply to formally listed threatened or endangered species, and restoration goals apply to species which are not formally listed. One of the key observations is the timeline for achieving recovery or restoration. There are two time frames of interest: (1) time for species to achieve higher population abundance, and (2) length of time that abundance levels must be maintained to achieve recovery or restoration. The time for species to achieve higher population abundance levels is unknown but could reasonably require 5 to 15 years, depending on the species life history. For example, delta smelt use an annual cycle (one year) in their reproductive strategy while green sturgeon life history requires more than 10 years for an individual fish to attain sexual maturity and to contribute to the reproductive pool of the population. In many instances, recovery goals or restoration objectives include provisions for recovering populations that require maintaining specified minimum population levels for 10 to 50 years. **Conceivably, the total time require to attain higher population levels and then to meet the time requirement for maintaining abundance levels for delisting, recovery or restoration could range from 15 to 35 years.**

The specific recovery goals and restoration objectives follow.

■ Sacramento River Winter-run Chinook Salmon

Winter-run chinook salmon are listed as endangered under both the ESA and CESA.

Recovery Criteria

The mean annual spawning abundance over any 13 consecutive years shall be 10,000 females. The geometric mean of the Cohort Replacement Rate over those same 13 years shall be greater than 1.0. Estimates of these criteria shall be based on natural production alone and shall not include hatchery-produced fish. The variability in Cohort Replacement Rate is assumed to be the same as or less that the current variability.

There must be a system in place for estimating spawning run abundance with a standard error less than 25% of the estimate, on which to base the calculation of the population criteria. If this level of precision cannot be achieved, then the sampling period over which the geometric mean of the Cohort Replacement Rate is estimated must be increased by one additional year for each 10% of additional error above 25%.

Source: *NMFS Proposed Recovery Plan for the Sacramento River Winter-run Chinook Salmon. National Marine Fisheries Service, Southwest Region, Long Beach, California. August 1997.*

■ Spring-run Chinook Salmon

Spring-run chinook salmon are proposed as a threatened species under the ESA and are a recently listed threatened species under CESA.

Restoration Criteria

Sacramento spring chinook will be regarded as restored when (1) self-sustaining populations in excess of 500 spawners each are present in both Deer and Mill creeks; (2) the number of wild spawners in Sacramento River tributaries reaches a mean number of 8,000 fish and does not drop below 5,000 fish, for 15 years, three of which are dry or critical dry years and (3) when the smolt survival rates between Sacramento and Chipps Island approach pre-project levels when the number of adults in the tributary streams is fewer than 5,000. Restoration will be measured by three interacting criteria: (1) presence of self-sustaining spawning populations in Deer, Mill, Antelope, Butte, Big Chico, Begum, South Fork Cottonwood, and Clear creeks and (3) smolt survival rates through the Delta. The number of spawners can be estimated by carcass and red counts and counting from weirs at dams on Deer and Mill creeks, but smolt survival cannot yet be satisfactorily estimated. These restoration goals can be achieved only if there is simultaneously improvement in conditions in spawning and rearing streams, in the Delta for passage of juveniles and adults, and improved management of the fishery to allow for increased survivorship of adults during periods of low population size.

Source: *Recovery Plan for the Sacramento/San Joaquin Delta Native Fishes. U.S. Fish and Wildlife Service, Portland, Oregon. November 1996.*

■ Late-fall-run Chinook Salmon

Late-fall-run chinook salmon are included in the Central Valley fall-run Evolutionarily Significant Unit (ESU) and are proposed for listing as a threatened species under the ESA.

Restoration Criteria

Sacramento late-fall chinook salmon will be regarded as recovered when (1) the number of wild spawners in the Sacramento River reaches a mean number of 22,000 fish and does not drop below 15,000 fish, for 15 years, three of which are dry or critical dry and (2) when the juvenile survival rates approach pre-project levels following years when the adult populations are fewer than 15,000 fish in the Sacramento River. The number of spawners can be estimated by carcass and redd counts or enumerated through dam counts, while smolt survival cannot yet be satisfactorily estimated. The Team recognizes that these restoration goals can be achieved only if there is simultaneously improvement in conditions in spawning and rearing streams, in the Delta for passage of juveniles, and improved management of the fishery to allow for increased survivorship of adults.

Source: *Recovery Plan for the Sacramento/San Joaquin Delta Native Fishes. U.S. Fish and Wildlife Service, Portland, Oregon. November 1996.*

Status Review of Chinook Salmon from Washington, Idaho, Oregon, and California. National Marine Fisheries Service. February 1998. NOAA Technical Memorandum NMFS-NWFSC-35.

■ San Joaquin Fall-run Chinook Salmon

San Joaquin fall-run chinook salmon are included in the Central Valley fall-run Evolutionarily Significant Unit (ESU) and are proposed for listing as a threatened species under the ESA.

Restoration Criteria

San Joaquin fall-run chinook salmon will be regarded as restored when (1) the number of naturally spawning fish in the Stanislaus, Tuolumne, and Merced rivers reaches a median number of 20,000 fish and the three-year running average does not drop below 3,000 fish, for 15 years, three of which are dry or critically dry and (2) when the smolt survival rates approach pre-project levels when adult numbers decline to fewer than 3,000 naturally spawning fish. The number of spawners can be estimated by carcass and redd counts. A model has been developed for estimating smolt survival through the Delta. The smolt survival index is a calculated variable base upon on-going tagging studies, that is presumed to have a strong positive relationship to actual smolt survival rates. The model relies on the relationship between (1) salmon smolt survival and flows in the San Joaquin River, (2) rates of diversion into Old River, and (3) export rates at the CVP and SWP pumps. The model to set smolt survival criteria was considered but rejected due to a lack of sufficient precision to set specific criteria. A revised model incorporating more data is now available and should be considered. These restoration goals can be achieved only if there is simultaneously (1) improvement in conditions in the spawning and rearing streams, (2) improvements in conditions in the lower San Joaquin River and in the Delta, and (3) improved management of the fishery to allow for increased survivorship of adults during periods of low population size. Salmon taken by hatcheries for artificial propagation will not be counted toward meeting criteria.

Source: *Recovery Plan for the Sacramento/San Joaquin Delta Native Fishes. U.S. Fish and Wildlife Service, Portland, Oregon. November 1996.*

Status Review of Chinook Salmon from Washington, Idaho, Oregon, and California. National Marine Fisheries Service. February 1998. NOAA Technical Memorandum NMFS-NWFSC-35.

TABLE 2. Summary of estimated recovery and restoration timelines for chinook salmon stocks present in the Sacramento-San Joaquin Watershed.

Species	Range of Time to Reach Higher Abundance Levels [1]	Length of Time Higher Abundance Levels Must be Maintained [2]	Total Range of Time for Delisting, Recovery or Restoration
Sacramento River winter-run chinook salmon	10-15 years	13-15 years	23-30 years
spring-run chinook salmon	5-10 years	15 years	20-35 years
late-fall-run chinook salmon	5-10 years	15 years	20-35 years
San Joaquin fall-run chinook salmon	5-10 years	15 years	20-35 years

1. Estimate of initial population recovery is highly speculative and is contingent on implementation of numerous restoration actions, harvest management for many species, and rainfall and flow patterns that support restoration efforts.
2. Time that higher population levels must be maintained to achieve recovery or restoration is taken directly from recovery and restoration goals.

Sources of Restoration Actions

The primary source of proposed restoration actions is the Ecosystem Restoration Program Plan, Volume II: Ecological Zone Visions (CALFED Programmatic EIS/EIR, Technical Appendix, March 1998). The primary source of proposed Stage I implementation actions is an exhibit prepared by CALFED staff for discussion by the Strategic Plan Core Team (Draft: July 30, 1998). Where appropriate, Salmon Subgroup members updated or corrected proposed actions based on personal knowledge of other ongoing actions such as the Category III early implementation actions, AFRP, and others.

Scoring

The Salmon Subgroup used a modification of the summary matrix and scoring system presented in the Diversion Effects Fish Issues and Impacts report (June 25, 1998) in this assignment. Scores could range from +1 to +7.

Benefits were estimated separately for many runs in various parts of the Central Valley system and then summarized by races of salmon for major portions of the system (Table 2). Scores were assigned using the following criteria:

- +1 or +2 Upstream improvements in stream habitat quality and function likely **will not** increase chinook salmon production within the stream sufficiently for CALFED through its system-wide program, to achieve its salmon recovery goal.

- +3 through +5 Upstream improvements in stream habitat quality and function **may** increase chinook salmon production within the stream sufficiently for CALFED , through its system-wide program, to achieve its salmon recovery goal.

- +6 and +7 Upstream improvements in stream habitat quality and function **likely will** increase chinook salmon production within the stream sufficiently for CALFED , through its system-wide program, to achieve its salmon recovery goal.

Two types of general uncertainty were associated with the evaluation: 1) uncertainty associated with the existing condition and causes of impacts on chinook salmon stocks, and 2) uncertainty associated with the predicted benefits and impacts of the cumulative restoration actions. Both types were integrated in the uncertainty scores in the table below. For existing conditions, the salmon subgroup felt the causes of impacts on salmon species are well-known and the uncertainty scores do not apply. The salmon team also recognized that considerable information exists as to causes, but decided to reflect only uncertainty in predicted benefits and impacts in assigning uncertainty scores. The adaptive management program will be an important aspect of recovery and the scores reflect the Subgroups opinion regarding the potential of resolving uncertainty issues.

The integrated levels of uncertainty associated with the scores were assigned:

1 = High uncertainty
2 = Moderate uncertainty
3 = Low uncertainty.

Cumulative Scoring Matrices for Chinook Salmon Upstream Restoration Actions

The following cumulative score matrix is a summary of the scoring for each of the nine stream reviewed for fall-run chinook salmon.

Fall-run Chinook Salmon: Cumulative Scores by River or Stream System				
Stream System	**Stage I Program**		**Long-Term Program**	
	Stage I Actions	***Stage I Certainty***	***Long-term Actions***	***Long-term Certainty***
Sacramento Basin				
Sacramento River	+4	3	+7	2
Battle Creek	+3	3	+7	3
Feather River	+3	3	+6	2
Yuba River	+3	3	+6	2
American River	+2	2	+5	2
Sacramento Cumulative	***+3*** *(mean 3.0)*	***3*** *(mean 2.8)*	***+6*** *(mean 6.2)*	***2*** *(mean 2.2)*
Mokelumne River	**+4**	**2**	**+6**	**3**
San Joaquin System				
Stanislaus River	+2	3	+4	2
Tuolumne River	+4	3	+4	2
Merced River	+2	3	+4	2
San Joaquin Cumulative	***+3*** *(mean 3.0)*	***3*** *(mean 3.0)*	***+4*** *(mean 4.0)*	***2*** *(mean 2.0)*
Total	**+3** **(mean 3.0)**	**3** **(mean 3.1)**	**+5** **(mean 5.4)**	**2** **(mean 2.0)**

Late-fall-run Chinook Salmon: Cumulative Scores by River or Stream System				
Stream System	**Stage I Program**		**Long-Term Program**	
	Stage I Actions	***Stage I Certainty***	***Long-term Actions***	***Long-term Certainty***
Sacramento Basin				
Sacramento River	+5	1	+6	2

Winter-run Chinook Salmon: Cumulative Scores by River or Stream System				
Stream System	**Stage I Program**		**Long-Term Program**	
	Stage I Actions	***Stage I Certainty***	***Long-term Actions***	***Long-term Certainty***
Sacramento Basin				
Sacramento River	+5	1	+6	2

Spring-run Chinook Salmon: Cumulative Scores by River or Stream System				
Stream System	**Stage I Program**		**Long-Term Program**	
	Stage I Actions	***Stage I Certainty***	***Long-term Actions***	***Long-term Certainty***
Sacramento Tributaries				
Mill Creek	+2	1	+5	1
Deer Creek	+1	2	NA	NA
Butte Creek	+5	1	+6	2
Big Chico Creek	+3	2	+5	2
Tributaries Cumulative	***+3*** *(mean 2.5)*	***1*** *(mean 1.5)*	***+5*** *(mean 5.3)*	***2*** *(mean 1.7)*

APPENDICES

The following appendices provide chinook salmon population trend and dynamics data for the purposes of assessing status and trends. Following the trend and dynamics are listings of (1) proposed CALFED Stage I Implementation Actions, and (2) Proposed CALFED Long-term Implementation Actions. The Stage I actions are derived from the Developing a Draft Preferred Program Alternative (Draft Final, August 5, 1998). The long-term actions are from the Ecosystem Restoration Program (ERP) Plan, Volume II, Ecological Zone Visions (March 1998).

The format for the long-term actions follows:

- **First bullet -- ERP target statement**
    - **Second (or indented) bullet -- ERP programmatic action.**

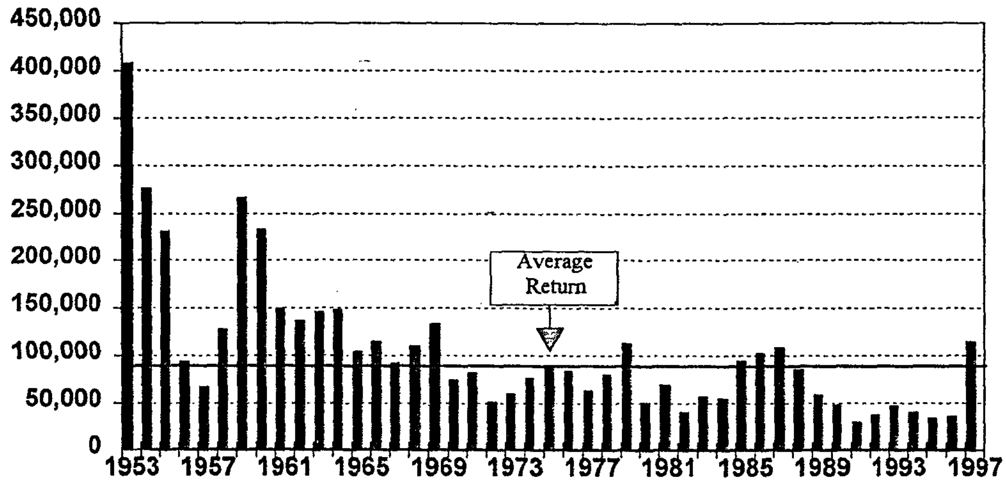
The explanation for the diamond notation for the ERP target statements follows:

Class	Description
◆	Target for which additional research, demonstration, and evaluation is needed to determine feasibility or ecosystem response.
◆◆	Target which will be implemented in stages with the appropriate monitoring to judge benefit and success.
◆◆◆	Target that has sufficient certainty of success to justify full implementation in accordance with adaptive management, program priority setting, and phased implementation.

Assessment of Restoration Actions in the Sacramento River

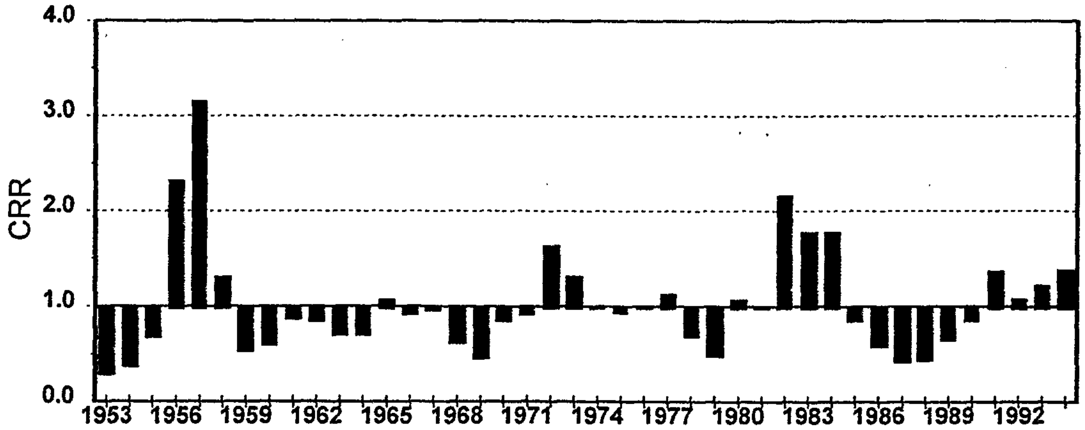
The estimates of Sacramento River naturally spawning fall-run chinook salmon during 1953 through 1997 have ranged from 33,600 in 1995 to 408,000 in 1953. The average annual return during this period was 90,400 fish including jacks and adults.

Sacramento River Naturally Spawning Fall-run Chinook

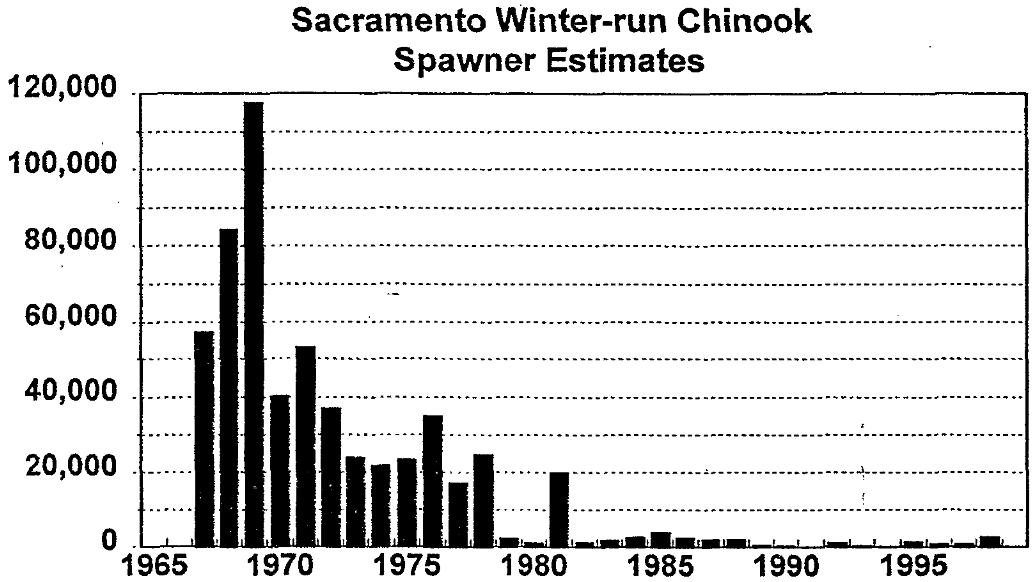


Cohort replacement rates (CRR) during this period have ranged from a low of 0.3 for the 1953 cohort to a high of 3.2 for the 1957 cohort. The average CRR during this period has been 1.0 but has been and alarming 0.9 during 1985 to 1994.

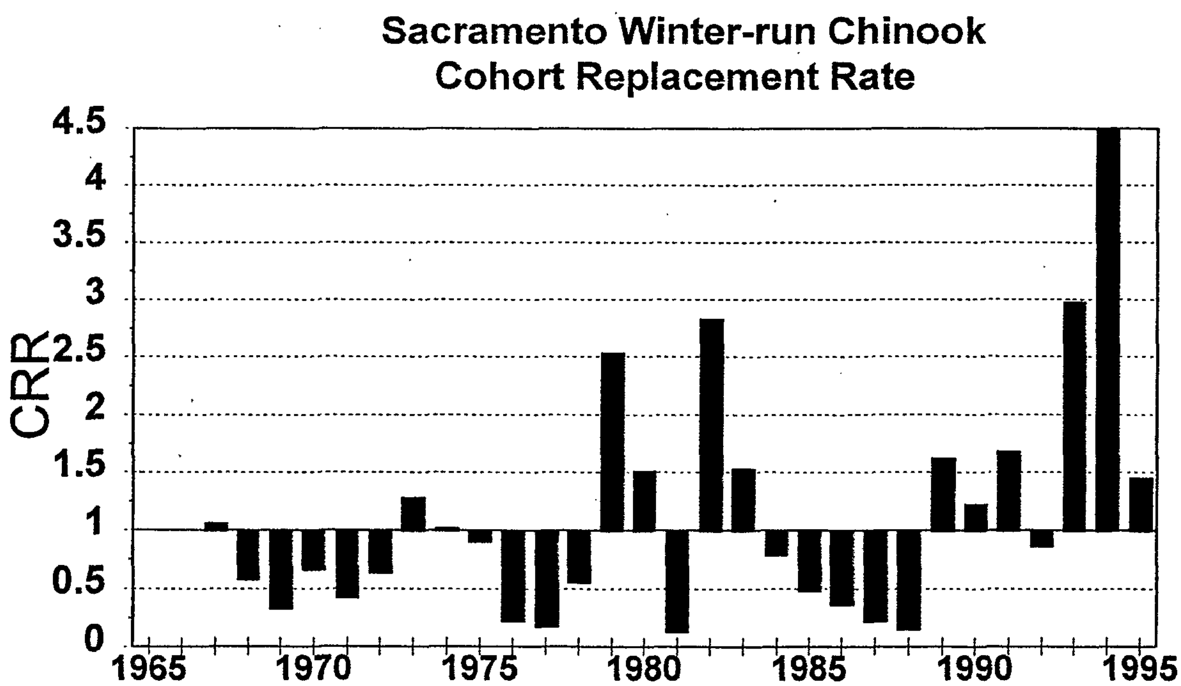
Sacramento River Fall-run Chinook Cohort Replacement Rate



The estimates of winter-run chinook returns to the upper Sacramento River have ranged for 189 in 1994 to 117,800 in 1969. The average annual return since 1989 has been about 580.



Cohort replacement rate (CRR) during 1967 through 1989 was 0.7, but has increased to 2.2 for 1989 through 1995.



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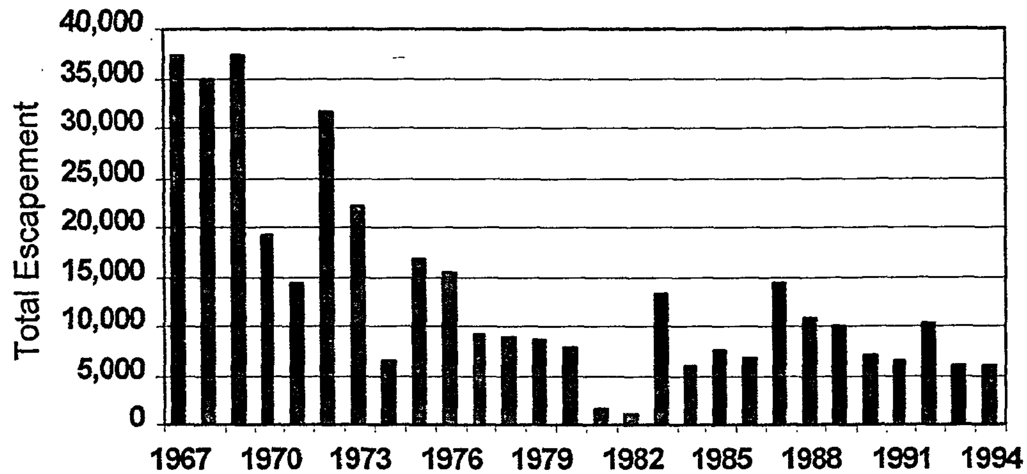
Late-fall-run Chinook Salmon

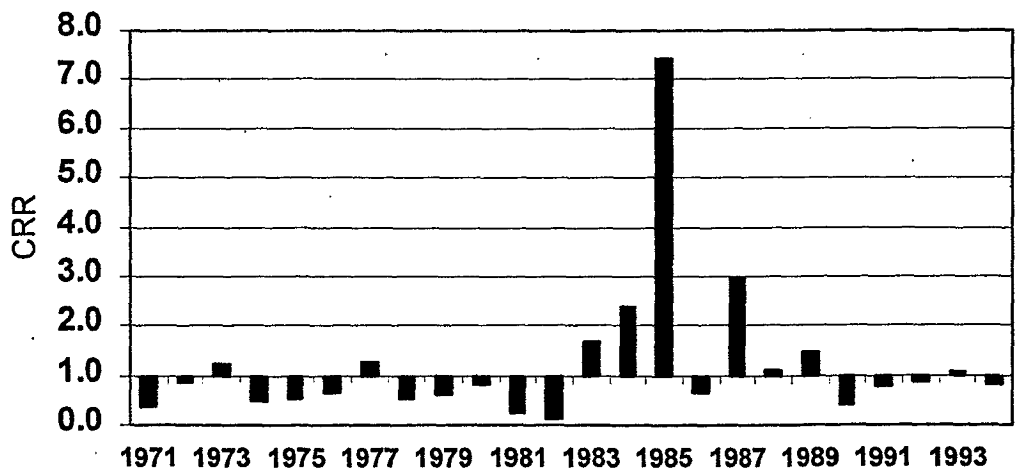
The estimated escapement of naturally spawning late-fall chinook from 1971 to 1994 averaged 12,000, and ranged from about 20,000 in the early 1970's to about 5,000 in 1982. The trend has been declining since the early 1970's.

Late-fall-run Chinook Total Escapement, 1967-1994



The cohort replacement rate from 1985 to 1994 ranged from 2.5 in 1985 to 0.5 in 1991, but has been less than 1 from 1990 to 1994.

Late-fall-run Chinook Salmon
Cohort Replacement Rate, 1971-1994



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Proposed CALFED Stage I Implementation Actions

Actions proposed by CALFED for implementation during the first 7 years which will benefit fall-run chinook salmon, winter-run chinook salmon, late-fall-run chinook salmon and other chinook runs using the mainstem Sacramento River for adult and juvenile migration and juvenile rearing include:

- Establishing an endowment for the long-term operation of the water quality treatment plant for Iron Mountain Mine.
- Evaluating the feasibility of revegetating levees along the Sacramento River from Verona to Sacramento (Collinsville)
- Screening all diversions of 100 cfs or less (assumes that the CVPIA Anadromous Fish Screen Program will be screening diversions greater than 100 cfs)
- Screening of the Glenn-Colusa Irrigation District's diversion on the mainstem Sacramento River
- Install a barrier on the Colusa Basin Drain to eliminate the straying of adult chinook from the mainstem Sacramento River

Proposed CALFED Long-term Implementation Actions

The following actions will be further developed and implemented during the long-term (30 year) implementation program for improving the ecological health of the Sacramento River.

- More closely emulate the seasonal streamflow patterns in dry and normal year- types by allowing a late-winter or early-spring flow event of approximately 8,000 to 10,000 cfs in dry years and 15,000 to 20,000 cfs in below normal water-years to occur below Keswick Dam (◆◆).
    - Provide a flow event by supplementing normal operating flows from Shasta and Keswick Dams in March during years when no flow event has occurred during winter or is expected to occur. Flow events would be provided only when sufficient inflow to Lake Shasta is available to sustain the prescribed releases. This action can be refined by evaluating its indirect costs and the overall effectiveness of achieving objectives.
- Maintain base flows of 6,000 to 8,000 cfs during the fall (◆).
    - Provide flow releases from Shasta Lake and Keswick Dam when necessary to provide the target base flows. Releases would be made only when inflows equal or exceed prescribed releases.

- Increase gravel recruitment in the upper Sacramento River between Keswick Dam and the RBDD by 10,000 to 20,000 cubic yards annually to provide adequate spawning habitat for targeted levels of salmon and steelhead and to sustain stream meander processes below Red Bluff. (This is the estimated amount of spawning-sized gravel captured annually by Shasta Dam.) (◆◆).
  - Develop a cooperative program to stockpile gravel at strategic locations along the Sacramento River below Keswick Dam where river flow will move gravel into the river channel to mimic natural gravel recruitment into the upper river. Determine the adequacy of this action and adjust amount and locations as necessary.
  - Develop a cooperative program to reactivate gravel recruitment to the river by exposing existing sources of river gravel on islands, bars, and banks that have become armored to riverflows. This action should be implemented on a conservative basis, because the availability of such inchannel gravel, costs of activating the gravel, indirect impacts, and potential effectiveness have not been determined.
- Preserve and improve the existing stream meander belt in the Sacramento River between Red Bluff and Chico Landing by purchase in fee or through easements of 8,000 to 12,000 acres of riparian lands in the meander zone (◆◆◆).
  - Develop a cooperative program to evaluate the feasibility of removing riprap from banks to the extent possible, consistent with flood management requirements, and reduce effects of other structures, such as bridges, to provide a sustainable meander corridor.
  - Purchase easements to offset losses to property owners for land lost to meander process.
- Preserve and improve the existing stream meander belt in the Sacramento River between Chico Landing and Colusa by purchase in fee or through easements of 8,000 to 12,000 acres of riparian lands in the meander zone (◆◆◆).
  - Develop a cooperative program to evaluate the feasibility of removing riprap from banks to the extent possible, consistent with flood control management, and reduce effects of other structures, such as bridges, to provide a sustainable meander corridor.
  - Purchase easements to offset losses to property owners for land lost to meander process.
- Increase and maintain floodplains in conjunction with stream meander corridor restoration (◆◆).
  - Develop and implement a cooperative program, consistent with flood control requirements, to evaluate the feasibility of altering river channel configurations in leveed reaches of the Sacramento River to increase the areal extent of floodplains inundated during high flow periods.

- Maintain mean daily water temperatures at levels suitable for maintaining all life-history stages of chinook salmon and steelhead in the Sacramento River between Keswick Dam and RBDD in above normal and wet years, and between Keswick Dam and RBDD in other year types (◆◆◆).

  - Cooperatively develop and implement a balanced river regulation program that provides sufficient carryover storage at Shasta Dam to ensure that suitably low water temperatures are reached to protect chinook salmon spawning, incubating eggs, and young fish, particularly in consecutive dry and critically dry years.

- Provide conditions for riparian vegetation growth along channelized portions of the Sacramento River (◆).

  - Develop a cooperative program to plant vegetation on unvegetated, riprapped banks consistent with flood control requirements. Implementation will occur in phases, results will be monitored and restoration approach will be adjusted as necessary under adaptive management.

  - Setback levees may be constructed on leveed reaches of the river to provide a wider floodplain and greater development of SRA habitat. Because of the potential indirect impacts on land use and uncertainty of cost and technical feasibility of setback levees, such development will be experimental and conservative, and will depend on adaptive management.

  - Cooperatively develop and implement a study to determine appropriate conditions for the germination and establishment of riparian woody plants along the river.

- Increase the ecological value of low-to moderate-quality SRA habitat by changing land use and land management practices (◆◆).

  - Purchase property or easements and allow habitat to improve naturally. Properties to be considered should be developed through a prioritizing process that considers habitat quality and importance, technical feasibility and cost of purchase and improvement, and consent of landowners.

  - Provide incentives and technical support for private landowners to protect and improve existing SRA habitat

- Maintain existing streamside riparian vegetation (◆◆◆).

  - Through purchase, conservation easement, and voluntary participation of landowners, protect SRA habitat from development. Where high-priority properties are already in government ownership or available for purchase or easement, preservation efforts should be undertaken as experiments to develop technical details, cost-effectiveness, and overall approach and consensus for the program. Full implementation of this program would depend on results of experiments and would be subject to adaptive management.

- Reduce entrainment of juvenile salmon, steelhead, sturgeon, and splittail into water diversions to levels that will not impair stock rebuilding or species restoration (◆◆◆).

    - Develop a cooperative program to screen all diversions greater than 250 cfs and one- to two-thirds of all smaller unscreened diversions. This programmatic level of action should be sufficient to provide the data necessary to modify this target through adaptive management.

    - Develop a cooperative program to upgrade screening at diversions with ineffective screening. Where existing screening has proven less than effective and entrainment problems continue, immediate action should be taken to upgrade screens.

    - Develop a cooperative program to reduce diversions when and where juvenile salmon are present in large or significant numbers. Even with screens, some diversions may pose a threat to young salmon and steelhead, and it may be necessary to modify operations of the diversion. Such determinations will be made after necessary monitoring and evaluation, and on a case-by-case basis. Decisions will be made with agency and stakeholder involvement and with consideration given to appropriate alternatives.

    - Promote and support relocating water diversions and developing alternate methods of supplying water from the Sacramento River that protect fish but also minimize conflict with maintaining dynamic fluvial processes.

- Minimize survival problems for adult and juvenile anadromous fish at RBDD by permanently raising the gates during the non-irrigation season and improving passage facilities during the irrigation season (◆◆◆).

    - Upgrade fish passage facilities at the RBDD.

- Reduce blockage to fish migrations at the ACID dam (◆◆).

    - Upgrade fish passage facilities at the ACID dam.

- Construct setback levees along leveed reaches of the river as part of the stream meander corridor (◆◆).

    - Develop a cooperative program, consistent with flood control requirements, to evaluate potential sites for establishing setback levees along leveed reaches of the Sacramento River.

- Reduce the adverse effects of predatory fish by identifying and eliminating human made instream structures or operational conditions that allow unnatural predation rates (◆◆).

- Selectively evaluate areas and make physical changes to structures in the Sacramento River, such as bridge abutments, diversion dams, rip-rap banks, and water intakes, that currently may attract predators and provide them with additional advantages in preying on juvenile salmon and steelhead. Pilot studies and evaluations are needed to determine the types of changes required and the potential degree of implementation.

- Reduce losses of fish and wildlife resulting from pesticide, hydrocarbon, heavy metal, and other pollutants in the Sacramento River (◆◆).

  - Develop a cooperative program to remedy heavy metal pollution from IMM to meet basin plan standards, and implement reliable and proven remedies that ensure continued treatment and control of heavy metal waste before water is discharged to the Sacramento River.

  - Develop a cooperative program to eliminate scouring of toxic, metal-laden sediments in the Spring Creek and Keswick Reservoirs.

  - Control contaminant input to the Sacramento River system by constructing and operating storm water treatment facilities and implementing industrial best management practices (BMPs) for storm water and erosion control.

  - Develop a cooperative program to assess and monitor contaminant input from agricultural drainages in the Sacramento River watershed.

- Reduce illegal harvest of fish species to a minimum to maintain or increase populations by increasing enforcement efforts by 50 to 100% (◆◆◆).

  - Increase enforcement efforts.

  - Develop a cooperative program to educate the public on the threats to populations from illegal harvest. Various actions include ad campaigns, signs along streams, and various types of outreach programs to schools, watershed conservancies, and groups.

  - Provide additional funding for the poaching hotline and rewards for arrest and convictions of poachers.

- Manage the legal harvest of chinook salmon, steelhead, and sturgeon by shifting harvest from natural stocks to hatchery-reared stocks, where possible, or reducing harvest of wild stocks until the naturally produced populations recover (◆◆◆).

  - Develop a cooperative program to mark all hatchery salmon and steelhead, allowing selective harvest of hatchery fish, while limiting harvest of wild fish. This action should be implemented on a short-term and experimental basis to ensure that it meets its objective and is cost-effective.

- Encourage regulatory agencies to change fishing regulations (i.e., by restricting seasons, limits, and gear and reducing harvest of wild fish) to further reduce legal harvest and any ancillary effects of fishing gear or techniques. Restrictions should be severe in the short term. Long-term restrictions would depend on response of populations and effectiveness of restrictions and the degree of effectiveness of the action.

- Minimize the likelihood that hatchery-reared salmon and steelhead in the upper Sacramento River will stray into non-natal streams to protect naturally produced salmon and steelhead (◆◆◆).

  - Develop a cooperative program to evaluate the costs and benefits of limiting stocking of hatchery-reared salmon and steelhead in the upper Sacramento River. Stocking may be reduced in years when natural production is high in selected populations.

- Limit hatchery stocking to populations that cannot be sustained through natural production (◆◆◆).

  - Augment winter-run, spring-run, and late-fall-run chinook salmon and steelhead with hatchery-produced smolts during the short-term rebuilding phase of restoration efforts and only when alternative measures are deemed insufficient to provide recovery of the populations. Stocking of hatchery-reared fish will be undertaken as experiments and adjusted or terminated as necessary, depending on results.

- Employ methods to limit straying and loss of genetic integrity of wild and hatchery supported stocks (◆◆◆).

  - Rear salmon and steelhead in hatcheries on natal streams to limit straying. If hatchery augmentation of Sacramento River populations of salmon and steelhead is necessary, then hatcheries should be built on the Sacramento River for that purpose.

  - Limit stocking of salmon and steelhead fry and smolts to natal watersheds to minimize straying that may compromise the genetic integrity of naturally producing populations.

- Minimize further threats of hatchery fish contaminating wild stocks of salmon and steelhead (◆◆◆).

  - Where hatchery production is underway and continues, methods should be adopted and improved for the selection of an appropriate cross section of the adult population for spawning at the hatchery.

  - Select spawning adults of appropriate genetic makeup to minimize genetic contamination of existing hatchery and naturally producing stocks of salmon and steelhead. Given the present difficulty of determining genetic makeup of spawning adults selected for hatcheries, this action will necessarily be experimental. Hatchery-reared adults may be preferentially selected or not selected if they are adequately marked or tagged, or have other identifiable feature.

Cumulative Benefit Evaluation

Sacramento River fall-run chinook salmon will continue to be the most abundant naturally spawning population in the Sacramento Valley. In view of the relatively high returns throughout the earlier period of record and the recent decline in returns, it is probably necessary to attempt to significantly increase returns. The proposed short-term and long-term actions will contribute to maintaining a healthy and robust naturally spawning population.

The fall-run chinook abundance trend in the Sacramento River, when coupled with the proposed restoration actions, suggests that an increase in abundance is likely and that there is a high likelihood that restoration and recovery goals for this important river will significantly contribute to the overall basin-wide goal for fall-run chinook salmon.

Sacramento winter-run and late-fall-run chinook will benefit from short-term and long-term actions in and along the Sacramento River. Stage 1 actions will improve condition for winter-run but will fall short of providing conditions that will contribute to recovery. The long-term actions will be sufficient to improve stream habitat and function and will likely increase production sufficiently that the system-wide program will contribute to overall species recovery.

Scoring

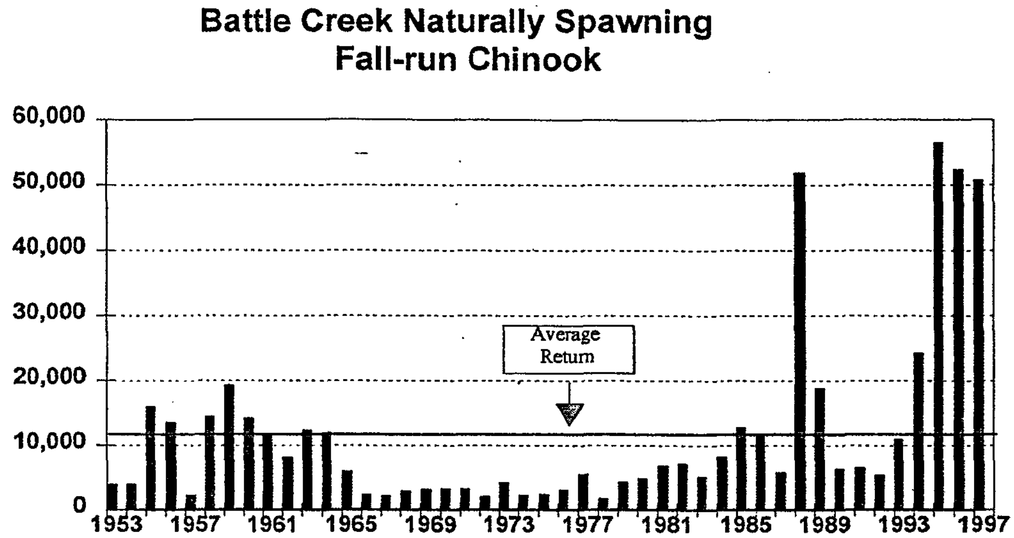
The cumulative benefits of proposed actions in the Sacramento River will likely provide a significant increase in naturally spawning fall-run, winter-run, and late-fall-run chinook abundance and are scored as follows:

Sacramento River Chinook Salmon: Cumulative Score		
Fall-run	**Score**	**Uncertainty**
Stage I Actions	+3	3
Long-term Actions	+6	2
Winter-run		
Stage I Actions	+5	3
Long-term actions	+6	2
Late-fall-run		
Stage I Actions	+5	1
Long-term actions	+6	2

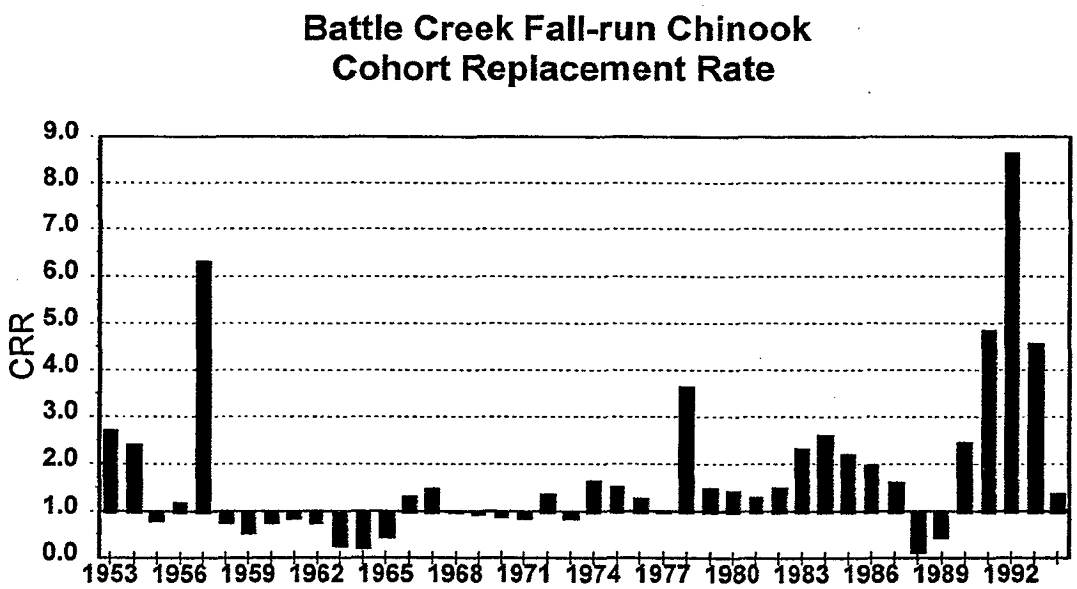
There is a high certainty that Stage I Actions will likely increase the abundance (or reduce the loss) of fall-run chinook salmon in the main stem Sacramento River. The long-term actions are more extensive and have a high likelihood of achieving the goals of recovery. The Stage I actions have a higher level of certainty based on present knowledge of the system, while the longer-term program actions have a lower level of certainty due to the need to further evaluate and fine-tune restoration actions.

Assessment of Restoration Actions in the Battle Creek

Battle Creek was the 6th most important producer of chinook salmon in the Central Valley during 1967-1991. The estimates of Battle Creek naturally spawning fall-run chinook salmon during 1953 through 1997 have ranged from 1,770 in 1978 to 56,500 in 1995. The average annual return during this period was 11,700 fish including jacks and adults.



Cohort replacement rates (CRR) during this period have ranged from a low of 0.12 for the 1988 cohort to a high of 8.64 for the 1992 cohort. The average CRR during this period has been 1.8 and has been 2.8 during 1985 to 1994.



Proposed CALFED Stage I Implementation Actions

Actions proposed by CALFED for implementation within the Battle Creek drainage during the first 7 years include:

- Removing barriers to fish passage
- Improving streamflows
- Installing fish ladders to improve fish passage
- Implementing hatchery management practices designed to better protect the integrity of wild stocks.

Proposed CALFED Long-term Implementation Actions

The following programmatic actions will be further evaluated and refined for implementation during the full 30-year CALFED implementation program.

- Augment flow in Battle Creek by 25 to 50 cfs (◆◆).
  - Augment flow in Battle Creek by 25 to 50 cfs
- Maintain existing levels of erosion and gravel recruitment in streams of the North Sacramento Valley Ecological unit and, where necessary, supplement gravel recruitment through adaptive management and monitoring (◆◆).
  - Cooperatively develop appropriate land use plans that allow the natural recruitment of sediments to streams in the North Sacramento Valley Ecological Zone.
- Develop a cooperative program to establish riparian habitat zones along streams in the North Sacramento Valley Ecological Zone through conservation easements, fee acquisition, or voluntary landowner measures (◆◆◆).
  - Encourage the development of long-term measures in the comprehensive watershed management plan to further improve water temperatures. Develop a cooperative approach with counties and local agencies to implement land use management that protects riparian vegetation along the streams and develop programs to restore lost riparian vegetation.
  - Cooperatively negotiate long-term agreements with local landowners to maintain and restore riparian communities along the lower reaches of Cow, Bear, and Battle Creeks.

- Reduce or eliminate conflicts between the diversion of water and chinook salmon and steelhead populations at all diversion sites on Battle Creek (◆◆◆).
  - Develop a cooperative approach to improve conditions for anadromous fish in Battle Creek by installing fish screens at four diversions on the North Fork, three diversions on the South Fork, and one diversion on the mainstem, or acquire water rights to eliminate the need for diversion and screening.
  - Improve the survival of adult salmon and steelhead in Battle Creek by installing a rack at the head of Gover Diversion Canal to prevent straying.
- Work with landowners, diverters, and other state or federal agencies managing Battle Creek to improve fish passage (◆◆◆).
  - Develop a cooperative program to upgrade or replace existing fish ladders or evaluate the removal of diversion dams and other impediments to passage.
- Reduce or eliminate conflicts in Battle Creek that require excluding anadromous fish from the upper section to protect the Coleman National Fish Hatchery water supply (◆◆◆).
  - Develop an alternative or disease-free water supply for Coleman National Fish Hatchery to allow naturally spawning salmon and steelhead access to the full 41-mile reach of Battle Creek above the Coleman National Fish Hatchery weir.
- Protect, restore, and maintain ecological functions and processes in the Clear, Cow, Bear, and Battle Creek watersheds by eliminating conflicts between land use practices and watershed health (◆◆).
  - Work with landowners, land management agencies, and hydropower operators to facilitate watershed protection and restoration and increase the survival of chinook salmon and steelhead in Battle, Clear, Bear, and Cow Creeks by implementing land use plans that establish, restore, and maintain riparian habitats and create buffer zones between the creek and developments or other land use activities, such as livestock grazing.

Cumulative Benefit Evaluation

Battle Creek fall-run chinook salmon will continue to be one of the more abundant naturally spawning population in the Sacramento Valley. The average returns throughout the period of record have been modest but have greatly increased within the last decade. This increase is most probably a result of improved hatchery practices at Coleman National Fish Hatchery. Because of the very high recent returns of fall-run chinook salmon to Battle Creek, it is probably not desirable to increase returns, although efforts to sustain the recent levels is a valid goal. A significant increase in abundance is unlikely but any increase will provide a high likelihood of achieving recovery goals for fall-run chinook. The proposed short-term and long-term actions will contribute to maintaining a healthy and robust naturally spawning population.

The fall-run chinook abundance trend in Battle Creek, when coupled with the proposed restoration actions, suggests that a great increase in abundance is not likely but that recent return levels could be maintained.

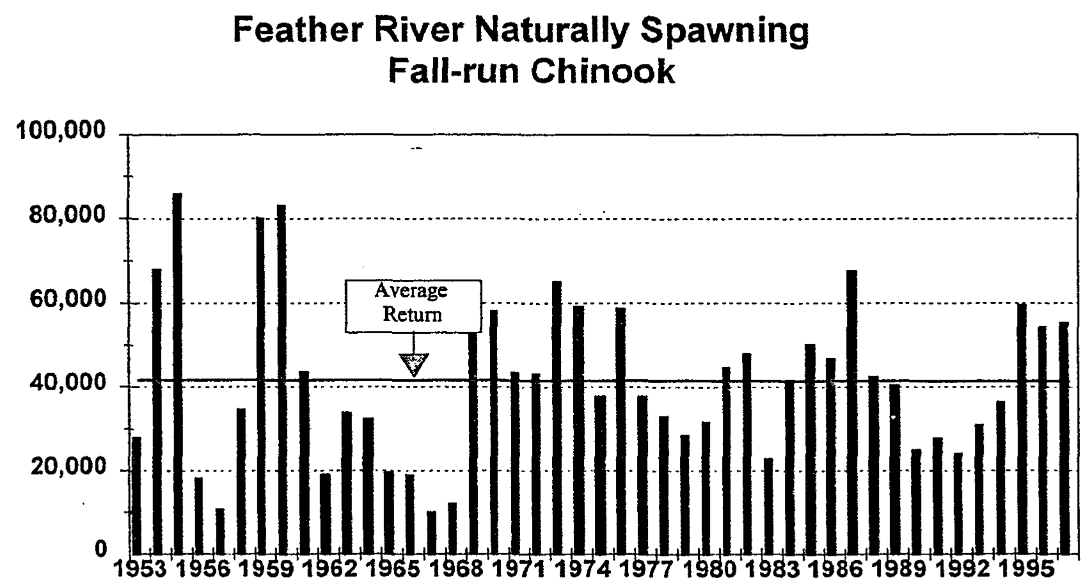
Scoring

The cumulative benefits of proposed actions in the Battle Creek will likely maintain naturally spawning fall-run chinook abundance and is scored as follows:

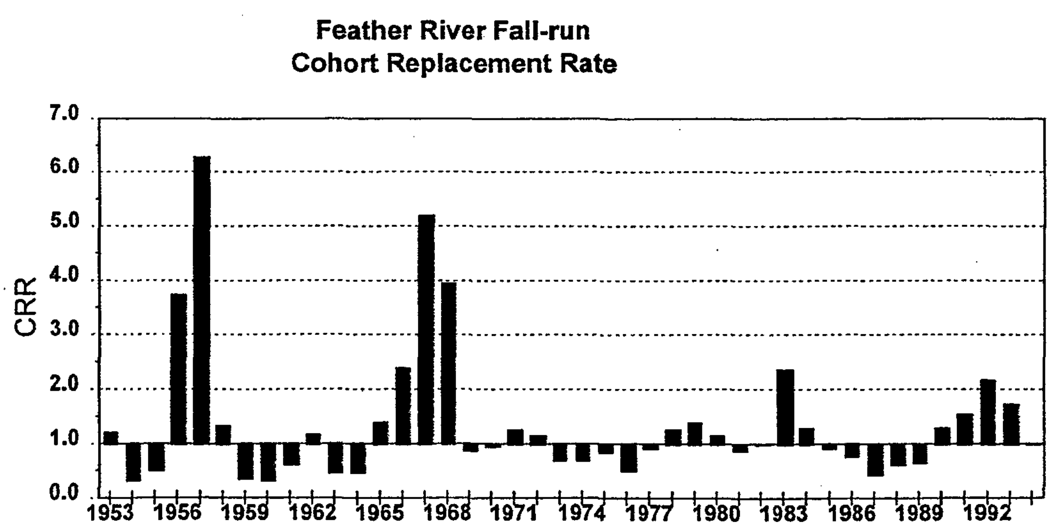
Battle Creek Cumulative Score		
Fall-run chinook	**Score**	**Uncertainty**
Stage I Actions	+3	3
Long-term Actions	+7	3

Assessment of Restoration Actions in the Feather River

The Feather River is the 2nd most important producer of fall-run chinook salmon in the Central Valley. The estimates of Feather River naturally spawning fall-run chinook salmon during 1953 through 1997 have ranged from 10,100 in 1967 to 86,000 in 1955. The average return during this period was 41,600 fish including jacks and adults.



Cohort replacement rates (CRR) during this period have ranged from a low of 0.36 in 1960 to a high of 6.27 in 1957. The average CRR during this period has been 1.4 but has been 1.1 during 1985 to 1994. Both the number of naturally spawning chinook salmon and the calculated CRR's are influenced by the production and return of fish to Feather River Hatchery. Operation of the hatchery may be partly responsible for maintaining relatively abundant spawning populations and maintaining an average CRR above 1.0.



Proposed CALFED Stage I Implementation Actions

Actions proposed by CALFED for implementation during the first 7 years include:

- Evaluating the feasibility of revegetating levees along the Sacramento River from Verona to Sacramento (Collinsville)
- Screening all diversions of 100 cfs or less (assumes that the CVPIA Anadromous Fish Screen Program will be screening diversions greater than 100 cfs)
- Screening of the Sunset Pumps on the Feather River.

Proposed CALFED Long-term Implementation Actions

The following programmatic actions will be further evaluated and refined for implementation during the full 30-year CALFED implementation program.

- More closely emulate the seasonal streamflow pattern in the Feather River by providing March flow events of 4,000 to 6,000 cfs in dry years, 6,000 to 8,000 cfs in below-normal years, and 8,000 to 10,000 cfs in above-normal years. Provide or maintain flows that mobilize and transport sediments, allow upstream and downstream fish passage, create point bars, and contribute to stream-channel meander and riparian vegetation succession. In addition, provide minimum flows recommended by DFG (1993). Flows will be provided only if they are less than or equal to Oroville Reservoir inflow (◆◆).
    - Develop a cooperative program to evaluate the benefits of supplemental Feather River flows to ecological processes and riparian and riverine aquatic habitats.
- Maintain existing erosion and gravel recruitment levels in tributaries that sustain an adequate level of gravel recruitment, or restore desirable levels by directly manipulating and augmenting gravel supplies where the natural fluvial process has been interrupted by dams or other features that retain or remove the gravel supply (◆◆).
    - Evaluate spawning gravel quality in areas used by chinook salmon in the Feather River. If indicated, renovate or supplement gravel supplies to enhance substrate quality by importing 4,000 to 8,000 tons of additional gravel below the hatchery as conditions require.
- Preserve and expand the stream-meander belts in the Feather, Yuba, and Bear Rivers by adding a cumulative total of 1,000 acres of riparian lands to the meander zones (◆◆◆).
    - Acquire riparian and meander-zone lands by purchasing them directly or acquiring easements from willing sellers, or provide incentives for voluntary efforts to preserve and manage riparian areas on private land.

- Build local support for maintaining active meander zones by establishing a mechanism whereby property owners would be reimbursed for lands lost to natural meander processes.

- Develop a cooperative program to improve opportunities for natural meander by removing riprap and relocating other structures that impair stream meander.

■ Restore and improve opportunities for rivers to seasonally flood their floodplain (◆).

- Conduct a feasibility study to construct setback levees in the Feather, Yuba, and Bear lower river floodplains.

- Restore, as needed, stream channel and overflow basin configurations within the floodplain.

- Minimize effects of permanent structures, such as bridges and diversion dams, on floodplain processes

- Develop a floodplain management plan for the Feather River.

■ Improve water quality conditions in the Feather, Yuba, and Bear Rivers to benefit anadromous fish (◆◆).

- Develop and use a temperature model as a tool for managing the Feather River.

- Develop a cooperative program to identify and remove physical and water quality barriers in the Feather River that impede access for white and green sturgeon to spawning habitat, or facilitate passage around these barriers.

- Develop a cooperative program to maintain mean daily water temperatures below 65°F for at least 1 month from April 1 to June 30 for American shad spawning in the Feather River. This is consistent with actions to protect chinook salmon and, steelhead and, when hydrologic conditions are adequate, to minimize adverse effects on water-supply operations.

■ Provide conditions for riparian vegetation growth along river sections in the Feather River/Sutter Basin Ecological Zone (◆◆).

- Purchase streambank conservation easements from willing sellers or establish voluntary incentive programs to improve salmonid habitat and instream cover along the Feather River.

■ Improve the survival of juvenile anadromous fish in the Feather River by installing, upgrading, or replacing fish screens (◆◆◆).

- Develop a cooperative program to evaluate and screen diversions in the Feather River to protect all anadromous fish life stages.

Cumulative Benefit Evaluation

Feather River fall-run chinook salmon will continue to be one of the more abundant naturally spawning population in the Sacramento Valley. This reflects the high spawner abundance from 1953 through the present and the operation of Feather River Hatchery. In view of the relatively high returns throughout the period of record, it is probably unnecessary to attempt to greatly increase returns, although an increase in abundance is likely. The proposed short-term and long-term actions will contribute to maintaining a healthy and robust naturally spawning population.

There will be a need to further balance the production level of hatchery fish with naturally produced fish. Presently, the majority of fall-run hatchery production is trucked to the western Delta for release. We should anticipate that as instream conditions improve in the Feather River and in the mainstem Sacramento River between Verona and Sacramento, the need to truck smolts to release sites downstream to increase their survival and return will greatly diminish.

The fall-run chinook abundance trend in the Feather River, when coupled with the proposed restoration actions, suggests that an increase in abundance is likely and that there is a high likelihood that restoration and recovery goals for this system will contribute to the overall basin-wide goal for fall-run chinook salmon.

Scoring

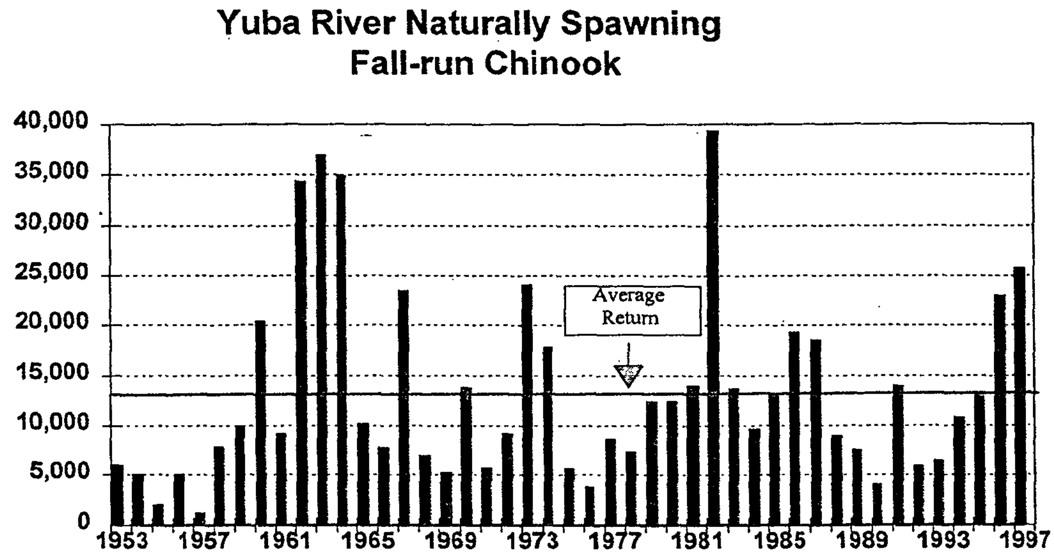
The cumulative benefits of proposed actions in the Feather River will likely provide an increase in naturally spawning fall-run chinook abundance and is scored as follows:

Feather River Cumulative Score		
Fall-run Chinook	**Score**	**Certainty**
Stage I Actions	+3	3
Long-term Actions	+6	2

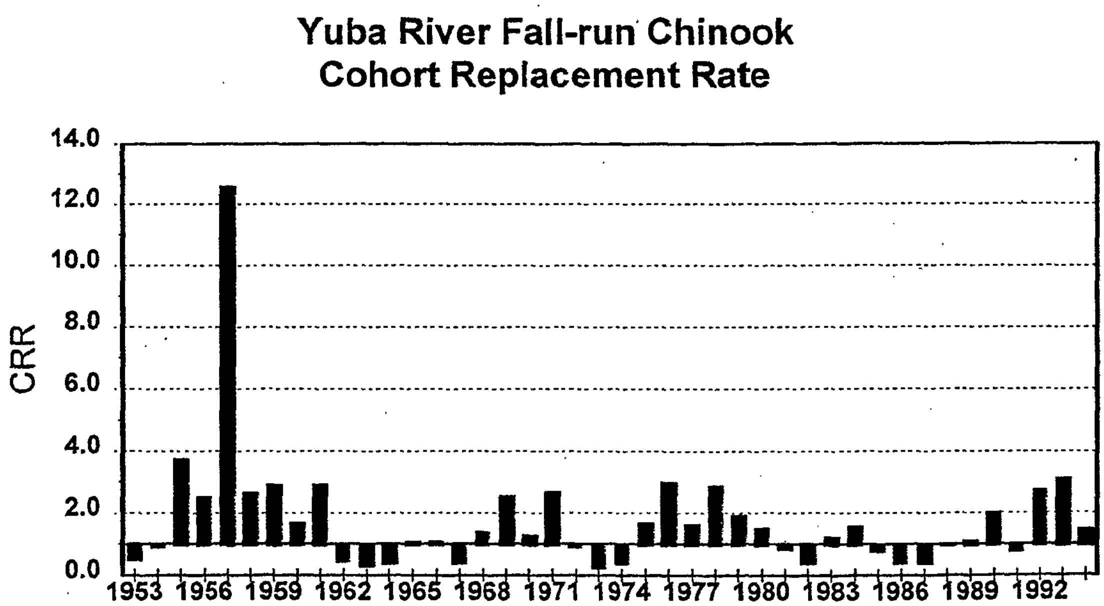
There is a high certainty that Stage I Actions will likely contribute to the recovery of fall-run chinook salmon in the Feather River. The long-term actions are more extensive and have a high likelihood of achieving the goals of recovery. The Stage I action has a high level of certainty based on present knowledge of the system, and the longer-term program actions have a lower level of certainty due to the need to further evaluate and fine-tune restoration actions. Still, the fall-run of the Feather River is largely supported by Feather River Hatchery production. The role of hatchery fish in maintaining the naturally spawning population requires further evaluation.

Assessment of Restoration Actions in the Yuba River

The Yuba River is the 4th most important producer of fall-run chinook salmon in the Central Valley. The estimates of Yuba River naturally spawning fall-run chinook salmon during 1953 through 1997 have ranged from 1,205 in 1957 to 37,000 in 1963. The average annual return during this period was 13,231 fish including jacks and adults.



Cohort replacement rates (CRR) during this period have ranged from a low of 0.25 for the 1973 cohort to a high of 12.56 for the 1957 cohort. The average CRR during this period has been 1.8 but has been 1.4 during 1985 to 1994.



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Proposed CALFED Stage I Implementation Actions

Actions proposed by CALFED for implementation during the first 7 years include:

- Evaluating the feasibility of revegetating levees along the Sacramento River from Verona to Sacramento (Collinsville)
- Screening all diversions of 100 cfs or less (assumes that the CVPIA Anadromous Fish Screen Program will be screening diversions greater than 100 cfs)
- Screening of the Sunset Pumps on the Feather River.

Proposed CALFED Long-term Implementation Actions

The following programmatic actions will be further evaluated and refined for implementation during the full 30-year CALFED implementation program.

- Supplement flows in the Yuba River with March flow events of 2,000 to 3,000 cfs in dry years and 3,000 to 4,000 cfs in normal years to improve conditions for all chinook salmon, steelhead, and American shad life stages. In addition, provide minimum flows recommended at Marysville by DFG (1993). See table below. Flows will be provided only if inflow to Englebright and New Bullards Bar Reservoirs is sufficient to meet the flow requirements (◆◆).
  - Supplement flows in the Yuba River below Englebright Dam with water acquired from new water sources, water transfers, and willing sellers, consistent with applicable guidelines or negotiated agreements to provide flows recommended by DFG (1993) to improve conditions for all of chinook salmon and steelhead life stages.
- Maintain existing erosion and gravel recruitment levels in tributaries that sustain an adequate level of gravel recruitment, or restore desirable levels by directly manipulating and augmenting gravel supplies where the natural fluvial process has been interrupted by dams or other features that retain or remove the gravel supply (◆◆).
  - Evaluate spawning gravel quality in areas used by chinook salmon in the Yuba River. If indicated, renovate or supplement gravel supplies to enhance substrate quality
- Preserve and expand the stream-meander belts in the Feather, Yuba, and Bear Rivers by adding a cumulative total of 1,000 acres of riparian lands to the meander zones (◆◆◆).
  - Acquire riparian and meander-zone lands by purchasing them directly or acquiring easements from willing sellers, or provide incentives for voluntary efforts to preserve and manage riparian areas on private land.

- Build local support for maintaining active meander zones by establishing a mechanism whereby property owners would be reimbursed for lands lost to natural meander processes.

- Develop a cooperative program to improve opportunities for natural meander by removing riprap and relocating other structures that impair stream meander.

- Restore and improve opportunities for rivers to seasonally flood their floodplain (◆).

  - Conduct a feasibility study to construct setback levees in the Feather, Yuba, and Bear lower river floodplains.

  - Restore, as needed, stream channel and overflow basin configurations within the floodplain.

  - Minimize effects of permanent structures, such as bridges and diversion dams, on floodplain processes

  - Develop a floodplain management plan for the Yuba River.

- Improve water quality conditions in the Feather, Yuba, and Bear Rivers to benefit anadromous fish (◆◆).

  - Develop a cooperative approach to operating reservoirs in the Yuba River watershed to provide adequate water temperatures for anadromous fish.

  - Evaluate whether improving water temperature control with shutter configuration and present coldwater pool management at New Bullards Bar Dam on the Yuba River are effective. Modify the water release outlets at Englebright Dam if these improvements are effective.

  - Develop a cooperative program to maintain mean daily water temperatures below 65°F for at least 1 month from April 1 to June 30 for American shad spawning in the Yuba River. This is consistent with actions to protect chinook salmon and steelhead and, when hydrologic conditions are adequate, to minimize adverse effects on water-supply operations.

- Provide conditions for riparian vegetation growth along river sections in the Feather River/Sutter Basin Ecological Zone (◆◆).

  - Purchase streambank conservation easements from willing sellers or establish voluntary incentive programs to improve salmonid habitat and instream cover along the Yuba River.

- Evaluate the benefits of restoring stream-channel and riparian habitats on the Yuba River, including creating side channels to serve as spawning and rearing habitats for salmonids.

- Improve the survival of juvenile anadromous fish in the Yuba River by installing, upgrading, or replacing fish screens (◆◆◆).

    - Develop a cooperative program to improve screening device efficiency in the Yuba River at the Hallwood-Cordua water diversion, and construct screens at the Brown's Valley water diversion and other unscreened diversions.

    - Evaluate the need to improve the efficiency of the fish-screening device and bypass at the Brophy-South Yuba Diversion on the Yuba River.

- Increase adult and juvenile anadromous fish passage in the Yuba River by providing access to 100% of the available habitat below Englebright Dam (◆◆◆).

    - Develop a cooperative program to improve anadromous fish passage in the Yuba River by removing dams or constructing fish ladders, providing passage flows, keeping channels open, eliminating predator habitat at instream structures, and constructing improved fish bypasses at diversions.

    - Facilitate passage of spawning adult salmonids in the Yuba River by maintaining appropriate flows through the fish ladders or modifying the fish ladders at diversion dams.

    - Conduct a cooperative study to determine the feasibility of removing Englebright Dam on the Yuba River to allow chinook salmon and steelhead access to historical spawning and rearing habitats.

Cumulative Benefit Evaluation

Yuba River fall-run chinook salmon will continue to be one of the moderately abundant naturally spawning population in the Sacramento Valley. In view of the relatively modest returns throughout the period of record, it is probably necessary to attempt to increase returns, although a significant increase in abundance is unlikely. The proposed short-term and long-term actions will contribute to maintaining a healthy and robust naturally spawning population.

The fall-run chinook abundance trend in the Yuba River, when coupled with the proposed restoration actions, suggests that an increase in abundance is likely and that there is a high likelihood that restoration and recovery goals for this system will contribute to the overall basin-wide goal for fall-run chinook salmon.

Scoring

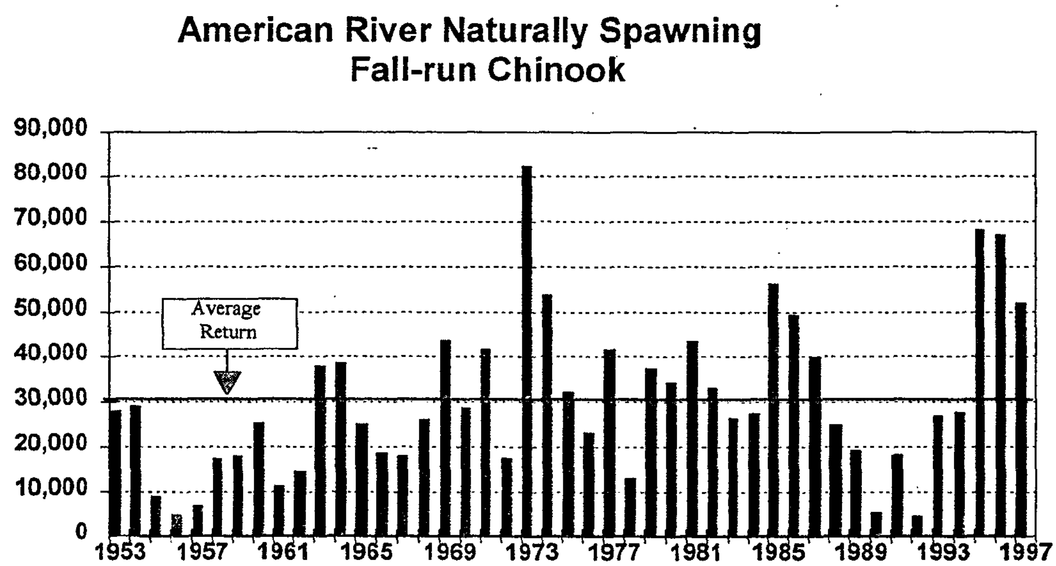
The cumulative benefits of proposed actions in the Yuba River will likely provide an increase in naturally spawning fall-run chinook abundance and is scored as follows:

Yuba River Cumulative Score		
Fall-run Chinook	**Score**	**Certainty**
Stage I Actions	+3	3
Long-term Actions	+6	2

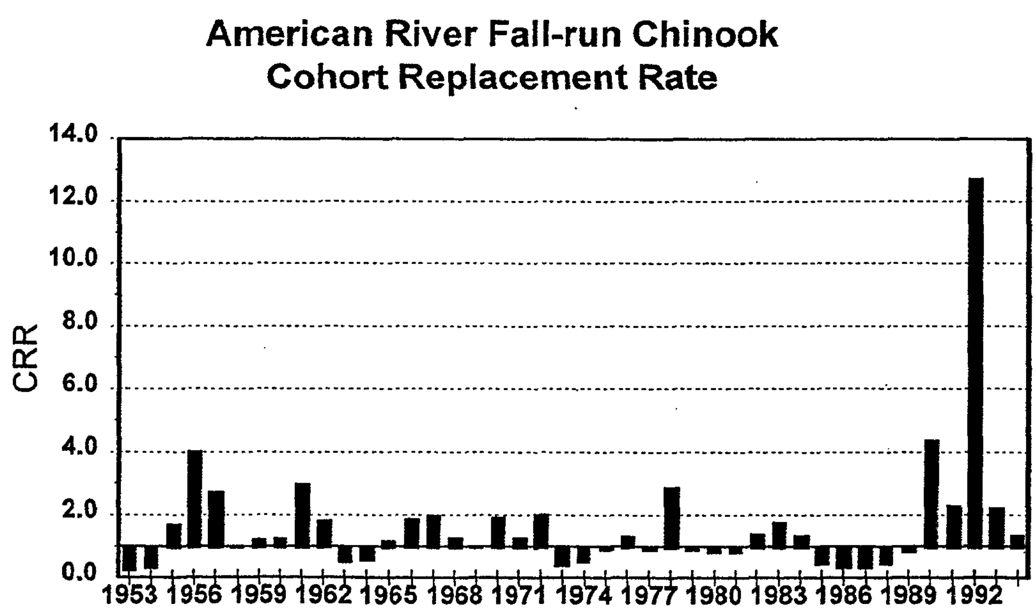
There is a high certainty that Stage I Actions will likely contribute to the recovery of fall-run chinook salmon in the Yuba River. The long-term actions are more extensive and have a high likelihood of achieving the goals of recovery. The Stage I action has a high level of certainty based on present knowledge of the system, and the longer-term program actions have a lower level of certainty due to the need to further evaluate and fine-tune restoration actions.

Assessment of Restoration Actions in the American River

The American River is the 3rd most important producer of fall-run chinook salmon in the Central Valley. The estimates of American River naturally spawning fall-run chinook salmon during 1953 through 1997 have ranged from 4,472 in 1992 to 82,200 in 1973. The average annual return during this period was 30, 300 fish including jacks and adults.



Cohort replacement rates (CRR) during this period have ranged from a low of 0.25 for the 1953 cohort to a high of 12.71 for the 1992 cohort. The average CRR during this period has been 1.7 but has been 2.5 during 1985 to 1994.



Proposed CALFED Stage I Implementation Actions

Actions proposed by CALFED for implementation during the first 7 years include:

- Improve hatchery management and release strategies to maintain the genetic integrity of wild fish.

Proposed CALFED Long-term Implementation Actions

The following programmatic actions will be further evaluated and refined for implementation during the full 30-year CALFED implementation program.

- Develop and implement an ecologically based streamflow regulation plan for the American Basin creeks and lower American River. The lower American River should meet the recommended minimum flows and flow targets for the lower American River. Lower American River flow events should be coordinated with similar flows that occur naturally in the Sacramento Valley and with storage releases from Shasta and Oroville Reservoirs (◆◆◆).

  - Provide target flows by modifying CVP operations and acquiring water as needed from willing sellers, with consideration given to reservoir available carryover storage and flows needed to meet needs determined by the water temperature objective

  - Develop and implement a comprehensive watershed management plan for the American Basin and lower American River to protect the channel (e.g., maintain flood control capacity and reduce bank erosion) and preserve and restore the riparian corridor. Upper watershed health should be improved by reducing the potential for wildfire and implementing other watershed improvement practices to protect streamflows, stream channel morphologies, spawning gravel condition, and riparian habitats, and minimize sediment input to the stream.

  - Acquire water from willing sellers to augment river flow during dry years to provide fishery benefits.

- Minimize flow fluctuations below Nimbus Dam that can dewater salmonid redds and reduce survival of juvenile anadromous fishes from stranding and/or isolation from the main channel (◆◆◆).

  - Complete on-going collaborative efforts to develop flow ramping criteria and operationally implement these criteria to reduce adverse affect of flow fluctuations on lower American River fishery resources.

- Provide flows of suitable quality water that more closely emulate natural annual and seasonal streamflow patterns in American Basin watersheds (◆◆).

- Enter into agreements with water districts and wetland managers to provide return flows of high quality water from irrigated agriculture and seasonal wetlands to the American Basin

- Enter into agreements with landowners and water districts to limit diversions of natural flows from creeks to improve stream flows

- Limit diversion of natural stream flows from American Basin creeks into irrigation canals and ditches by providing other sources of water or through purchase of water rights from willing sellers.

■ Maintain, improve, or supplement gravel recruitment and natural sediment transport in the lower American River and American Basin watersheds to maintain natural ecological processes linked to stream channel maintenance, erosion and deposition, maintenance of fish spawning areas, and the regeneration of riparian vegetation (◆◆).

  - Monitor spawning gravel conditions in the lower American River and American Basin watersheds, and identify specific sites where mechanical cleaning or gravel introductions would be beneficial to enhance or increase gravel spawning habitat.

  - Implement a pilot study to assess the benefits of mechanical cleaning to improve gravel permeability.

  - Develop a collaborative program to investigate erosion, bedload movement, sediment transport, and depositional processes and their relationship to the formation of point bars and riparian regeneration in the lower American River and American Basin watersheds.

■ Maintain the existing stream meander configuration along the American River between Nimbus Dam and the Sacramento River (◆).

  - Maintain a stream meander configuration along the lower American River by working with involved parties to develop a floodplain management program consistent with flood control needs. These parties include the Corps, the California Reclamation Board, the Sacramento Area Flood Control Agency, the Lower American River Task Force, and the American River Water Forum.

  - Where possible, maintain mainstem and side channel habitats typical of a natural river that provide salmon and steelhead spawning and rearing habitat.

■ Maintain and enhance floodplain overflow areas in the lower American River and floodplain of the American Basin (◆◆).

  - Protect existing overflow areas from future reclamation

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- Maintain lower American River water temperatures in the spawning and rearing reach between Arden Bar and Nimbus Dam at or below 60°F beginning as early in October as possible, based on annual coldwater pool availability (◆◆).
  - Optimally manage Folsom Reservoir's coldwater pool via real-time operation of the water-release shutters to provide the maximum equitable thermal benefits to lower American River steelhead and chinook salmon throughout the year, within the constraints of reservoir coldwater pool availability.
  - Reconfigure Folsom Dam shutters to improve management of Folsom Reservoir's coldwater pool and maintain better control over the temperature of water released downstream.
  - Install a temperature control device at the urban water intakes at Folsom Dam. Doing so would facilitate diverting water at elevations above 317 ft (msl), which would preserve the reservoir's cold water pool for releases to the lower American River.
  - Investigate opportunities to improve the manner in which the water-release shutters at Folsom Dam are physically installed, removed, and maintained annually, as well as opportunities to improve their efficiency in releasing water from desired elevations.
  - Evaluate the potential for creating side-channels thermal refuges for juvenile steelhead rearing over-summer in the lower American River. Such habitat could provide habitat slightly cooler than peak daytime river temperatures.
  - Evaluate options to reduce releases of warmer surface waters of Lake Natomas through the turbines at Nimbus Dam into the lower American River. Options may include a temperature curtain in the lake near the turbine intakes. Operations of Nimbus Dam during occasional spill events should also be evaluated to minimize the release of warm surface waters from Lake Natomas.
- Establish and/or maintain a sustainable continuous, sustainable corridor of riparian habitat along the lower American River and American Basin creeks (◆◆).
  - Develop riparian corridor restoration and management plans for the American Basin and lower American River.
  - Protect riparian habitat along water courses of the American Basin.
  - Plant riparian vegetation along water courses of the American Basin.
- Enhance shaded riverine aquatic habitat in American Basin creeks and drainage canals and ditches and along the lower American River (◆◆◆).

- Terminate or modify current programs that remove woody debris from the river and creek channels.

- Restore side-channels along the lower American River to provide additional riparian corridors for increasing fish and wildlife habitat.

- Improve levee management practices to protect and enhance riparian and SRA habitat.

- Reduce losses of juvenile salmon and steelhead in the lower American River and American Basin creeks due to entrainment at water intakes structures (◆◆◆).

  - Upgrade the fish screens at the Fairbairn Water Treatment Plant to comply with DFG and NMFS fish screening criteria.

- Reduce the adverse affect of levees and bank protection on aquatic and terrestrial species and their habitats along the lower American River and American Basin canals and creeks (◆◆).

  - Identify locations in the lower American River and American Basin creeks and canals where existing revetments could be modified to incorporate habitat features such as scalloped embayments and associated hard points, multi-stage bench areas, SRA habitat, and other features to aid in preservation and/or reestablishment of both berm and bank vegetation

Cumulative Benefit Evaluation

American River fall-run chinook salmon will continue to be one of the most abundant naturally spawning population in the Sacramento Valley (ranking #3 behind the Sacramento and Feather River run). In view of the relatively high returns throughout the period of record, it is probably not necessary to attempt to significantly increase returns, although a moderate increase in abundance is likely. The proposed short-term and long-term actions will contribute to maintaining a healthy and robust naturally spawning population.

Chinook returns to the American River are bolstered by the operation of Nimbus Hatchery, which has contributed to the high returns and relatively high CRR. The majority of smolts produced at Nimbus Hatchery are trucked to the western Delta for release in an effort to increase survival. In the long-term program, trucking smolts may not be required as instream sources of mortality in the American and Sacramento Rivers will be reduced. Elimination of trucking would also reduce the likelihood of fish straying into non-natal streams.

The fall-run chinook abundance trend in the American River, when coupled with the proposed restoration actions, suggests that an increase in abundance is likely and that there is a high likelihood that restoration and recovery goals for this system will contribute to the overall basin-wide goal for fall-run chinook salmon.

Scoring

The cumulative benefits of proposed actions in the American River will likely provide an increase in naturally spawning fall-run chinook abundance and is scored as follows:

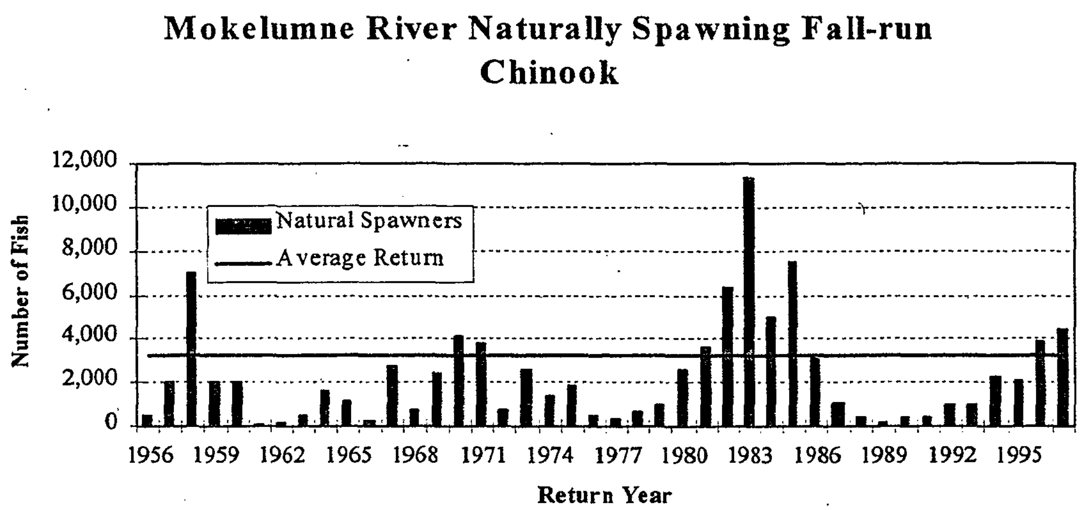
American River Cumulative Score		
Fall-run Chinook	**Score**	**Certainty**
Stage I Actions	+2	2
Long-term Actions	+5	2

There is a moderate certainty that Stage I Actions (hatchery management) will likely protect the genetic composition of fall-run chinook salmon in the American River and reduce straying to protect genetics of stocks outside of the basin. The long-term actions are more extensive and may achieving the goals of recovery. The Stage I action has a moderate level of certainty based on present knowledge of the system, and the longer-term program actions have a lower level of certainty due to the need to further evaluate and fine-tune restoration actions. The opportunities to restore fall-run chinook on the American River are highly constrained by the levee and flood control system.

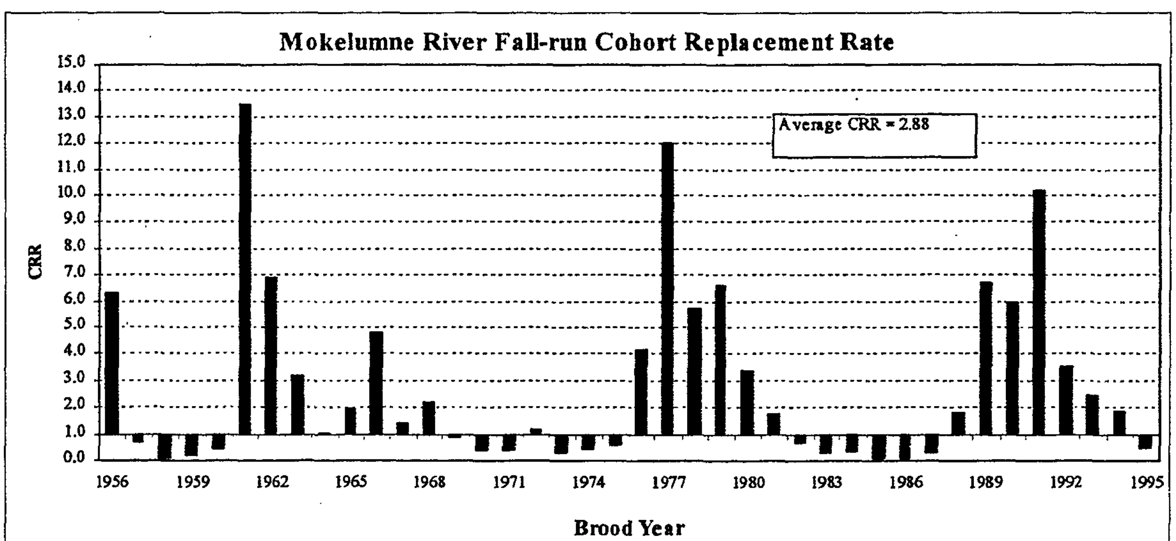
Still, the fall-run of the American River is largely supported by Nimbus Hatchery production. The role of hatchery fish in maintaining the naturally spawning population requires further evaluation.

Assessment of Restoration Actions in the Mokelumne River

The estimates of Mokelumne River naturally spawning fall-run chinook salmon during 1956 through 1997 have ranged from 100 in 1961 to 11,327 in 1983. The average return during this period was 3,218 fish including those fish that returned to the Mokelumne River hatchery.



Cohort replacement rates (CRR) during this period have ranged from a low of 0.08 in 1986 to a high of 13.5 in 1961. The average CRR during this period has been 2.88. Both the number of naturally spawning fall-run chinook salmon and the calculated CRR's are influenced by the production and return of fish to the Mokelumne River hatchery. Operation of the hatchery may be partly responsible for maintaining relatively abundant spawning populations and maintaining an average CRR above 1.0.



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Proposed CALFED Stage I Implementation Actions

Actions proposed by CALFED for Implementation during the first 7 years include:

- Improve Mokelumne River hatchery management and release strategies to maintain the genetic integrity of wild fish stocks.

- Reconfigure the Woodbridge Irrigation District diversion dam to improve fish passage.

Proposed CALFED Long-term Implementation Actions

The following programmatic actions will be further evaluated and refined for implementation during the full 30-year CALFED implementation program.

- Provide conditions in the Mokelumne River to maintain the fishery and riparian resources in good condition by implementing and evaluating the flow regime in the Joint Settlement Agreement (JSA) for the Mokelumne River. The JSA provides increased flows below Camanche Dam beyond present requirements, which will benefit the fishery and riparian resources of the lower Mokelumne River (◆◆◆).

    - Provide target flows for Mokelumne River storage releases, but only if there are sufficient inflows into storage reservoirs and carryover storage to meet target levels. The additional water would be obtained by developing new water supplies within the Central Valley basin, water transfers, and from willing sellers.

    - Maintain or enhance summer and fall base flows on the Mokelumne River by developing new water supplies and by purchases from willing sellers.

- The target also is to provide enhanced streamflows below Woodbridge Dam by providing minimum flows recommended by California Department of Fish and Game in dry years: 200 cfs from November 1 through April 14; 250 cfs from April 15 through April 30; 300 cfs in May; and 20 cfs from June 1 through October 31. In normal years, minimum flows should be 250 cfs from October 1 through October 14; 300 cfs from October 15 through February 29; 350 cfs during March; 400 cfs during April; 450 cfs during May; 400 cfs during June; 150 cfs during July; and 100 cfs during August and September. In wet years, minimum flows should be 300 cfs from June 1 through October 14; 350 cfs from October 15 through February 29; 400 cfs in March; and 450 cfs during April and May (◆).

    - Cooperatively evaluate the potential for minimizing water supply impacts by replacing the diversions at Woodbridge with other Delta diversions.

    - Cooperatively develop a program to minimize or eliminate unpermitted water diversions on the Mokelumne River.

- A flow event should be provided in late April or early May, averaging 500 to 1,000 cfs in dry years, 1,000 to 2,000 cfs in normal years, and 2,000 to 2,500 cfs in wet years (◆).
    - Develop a cooperative feasibility study of opportunities to provide spring flow events
- On the Mokelumne River below Camanche Dam, provide annual supplementation of 1,200 to 2,500 cubic yards of gravel into the active stream channel to maintain quality spawning areas and to replace gravel that is transported downstream (◆◆◆).
    - Cooperatively develop a program to protect all existing gravel recruitment sources to the river.
    - Develop a cooperative program to supplement gravel with artificial introductions.
    - Develop a cooperative program with the aggregate resource industry to improve extraction activities within the Mokelumne River floodplain.
    - Develop a cooperative program to evaluate, implement, and monitor sediment supplementation on the Mokelumne River, consistent with adaptive management.
- Restore gravel transport and cleaning processes to attain sufficient high quality salmon spawning habitat for target population levels (◆).
    - Develop a cooperative program to provide late winter or early spring flow events, as needed, to establish appropriate flushing/channel maintenance flows.
    - Facilitate fine sediment transport by restoring, as necessary, the river channel configuration so that it is consistent with planned flow regime and available sediment supply.
    - Develop a cooperative program to improve the flexibility of upstream reservoir management to minimize fine sediment inputs to the lower Mokelumne River.
    - Develop a cooperative evaluation of mechanically cleaning spawning gravel at selected sites in lower Mokelumne River.
- Restore and improve opportunities for rivers to seasonally inundate their floodplain (◆◆◆).
    - Conduct a feasibility study to construct setback levees in the Mokelumne River floodplain in the area from Elliot Road to Woodbridge and from Woodbridge to the mouth, including the Mokelumne forks below the river's mouth.
    - Restore, as needed, stream channel and overflow basin configurations within the floodplain.

- Minimize effects of permanent structures, such as bridges and diversion dams, on floodplain processes.

- Develop a floodplain management plan for the Mokelumne River.

- Maintain mean daily water temperatures at or below levels suitable for all life stages of fall-run chinook salmon and steelhead (◆◆).

  - Cooperatively evaluate the feasibility of releasing sufficient instream flows to improve temperature conditions for key resources in the Mokelumne River.

  - Manage Pardee and Camanche Reservoirs through October to maintain a cold water volume of 28,000 acre-feet when Pardee Reservoir volume exceeds 100,000 acre-feet.

- Restore upper watershed processes that maintain or improve water quality and quantity (◆◆).

  - Reduce excessive fire fuel loads in upper watersheds using natural processes.

  - Improve forestry management practices, including timber harvesting, road building and maintenance, and livestock grazing.

  - Cooperatively develop a watershed health-monitoring program.

- Restore a minimum of 1,240 acres of self-sustaining or managed diverse natural riparian habitat along the Mokelumne River, and protect existing riparian habitat (◆◆◆).

  - Develop a cooperative program to restrict further riparian vegetation removal, and establish riparian corridor protection zones.

  - Develop a cooperative program to implement riparian restoration activities.

  - Encourage improved land management and livestock grazing practices along stream riparian zones.

  - Purchase streambank conservation easements from willing sellers to widen riparian corridors.

  - Develop a cooperative program to restore riparian woodlands along the entire Mokelumne River.

- Install fish screens representing the best available technology and operational constraints, as necessary, to minimize losses in diversions that limits the recovery of fish populations (◆◆◆).

- Consolidate diversions, seek alternative water sources, and install a permanent fish screen at North San Joaquin Conservation District diversion on the lower Mokelumne River.
- Improve fish screens and the fish bypass system at Woodbridge Dam on the lower Mokelumne River.
- Evaluate the feasibility of installing state-of-the-art screens on small pump diversions.
- Develop a cooperative program to operate temporary screens at diversions where juvenile salmon rear or during seasons when they pass the diversion site.

- Reduce the adverse effects of invasive riparian plants on native species and ecosystem processes, water quality and conveyance systems, and major rivers and their tributaries (◆◆).
    - Develop and implement a coordinated control program to reduce or eliminate invasive plant species from the riparian corridor along the Mokelumne River.
- Reduce predation level on juvenile salmonids below Woodbridge Dam on the lower Mokelumne River (◆◆◆).
    - Develop a cooperative program to modify the stream channel and rebuild the Woodbridge Dam fish passage and diversion screening facilities.
    - Modify and improve the fish bypass discharge at Woodbridge Dam.
- Restore and maintain water quality in Camanche Reservoir on the Mokelumne River (◆◆).
    - Support EBMUD in developing operating procedures at Pardee and Camanche Reservoirs that optimize water quality below Camanche Dam.
    - Support implementation of the cooperative agreement for the long-term remediation of Penn Mine contamination.
    - Reduce the input of nonpoint source contaminants into the Mokelumne River.
    - Develop an integrated program to coordinate and minimize agricultural pesticide and herbicide use in areas that drain into the Mokelumne River.

Cumulative Benefit Evaluation

Mokelumne River fall-run chinook salmon will continue to be the most abundant naturally spawning population in the Eastside Delta Tributaries. This reflects the high spawner abundance from 1956 through the present and the contribution of the Mokelumne River hatchery. In view of the relatively high returns throughout the period of record, including the period after the construction of Camanche Dam, it is probably unnecessary to attempt to greatly increase returns, although an increase in abundance is likely. The proposed short-term and long-term actions will contribute to maintaining a healthy and robust naturally spawning population.

There will be a need to further balance the production level of hatchery fish with naturally produced fish. Presently, the majority of fall-run hatchery production is trucked to the Delta for release. We should anticipate that as conditions improve in the central and southern Delta, the need to truck smolts to release sites in the western Delta and San Pablo Bay to increase their survival and return will greatly diminish. The fall-run chinook abundance trend in the Mokelumne River, when coupled with the proposed restoration actions, suggests that an increase in abundance is likely and that there is a high likelihood that restoration and recovery goals for this system will contribute to the overall basin-wide goal for fall-run chinook salmon.

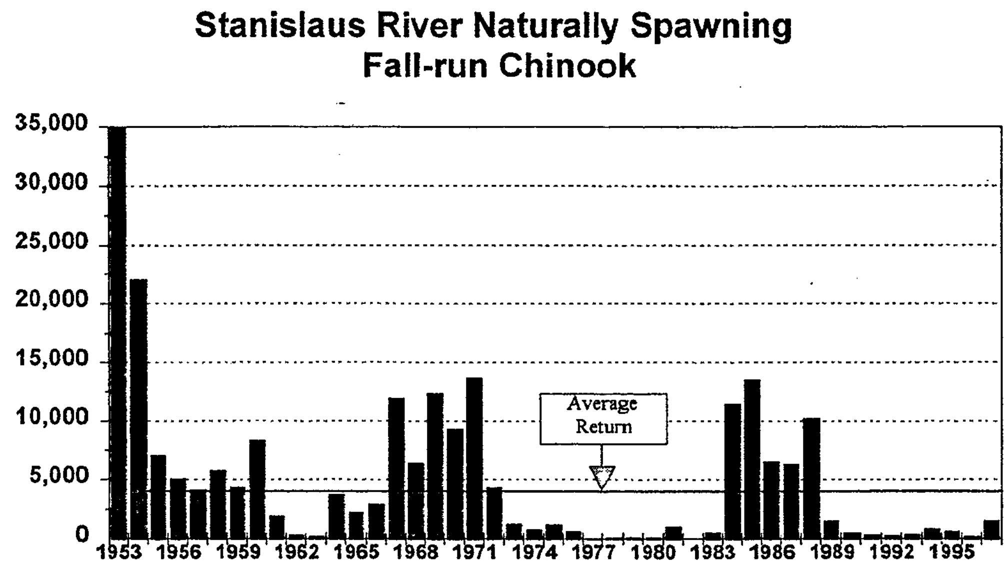
Some of the individual benefits of the proposed actions indicate small increases in abundance of naturally spawning stocks of Mokelumne River fall-run chinook salmon are likely. Although Mokelumne River fall-run chinook salmon are the most abundant naturally spawning population in the Eastside Delta Tributaries and these populations are similar to historic runs (1956-1997), these small increases are anticipated to result in a high likelihood that goals for restoration and recovery will be achieved.

Scoring

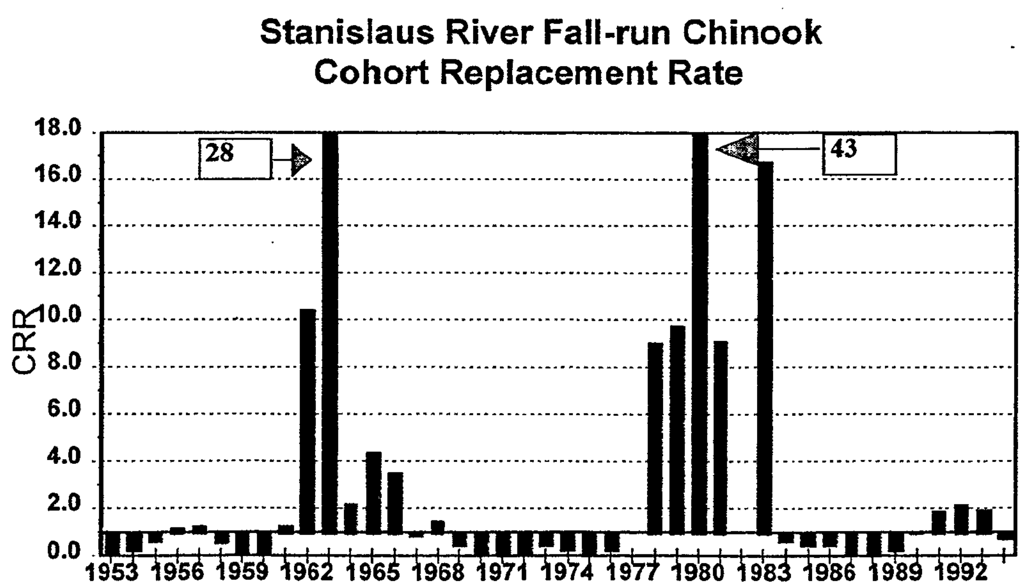
Mokelumne River Cumulative Score		
Fall-run Chinook	**Score**	**Certainty**
Stage I Actions	+4	2
Long-term Actions	+6	3

Assessment of Restoration Actions in the Stanislaus River

The Stanislaus River is the 7th most important producer of fall-run chinook salmon in the Central Valley and the 2nd most important in the San Joaquin basin. The estimates of Stanislaus River naturally spawning fall-run chinook salmon during 1953 through 1997 have ranged from zero fish in 1977 to 35,000 in 1953. The average annual return during this period was 3,772 fish including jacks and adults.



Cohort replacement rates (CRR) during this period have ranged from a low of 0.03 for the 1988 cohort to a high of 43 for the 1980 cohort. The average CRR during this period has been 3.9 but has fallen to 0.9 during 1985 to 1994.



Proposed CALFED Stage I Implementation Actions

Actions proposed by CALFED for implementation during the first 7 years which will benefit fall-run chinook salmon and other chinook runs in the San Joaquin basin include:

- Purchase 100,000 acre feet of water form management of stream flow (total includes water purchase in the Sacramento and San Joaquin basin combined).
- Screen all diversions over 250 cfs.

Proposed CALFED Long-term Implementation Actions

The following actions will be further developed and implemented during the long-term (30-year) implementation program for improving the ecological health of the Stanislaus River.

- Maintain the following base flows in the Stanislaus River below Goodwin Dam: (◆◆)
  - in critical, dry, and below-normal years, minimum flows should be 200 to 300 cfs, except for a flow event of 1,500 cfs for 30 days in April and May,
  - in above-normal years, minimum flows should be 300 to 350 cfs, except for 800 cfs in June and 1,500 cfs in April and May, and
  - in wet years, minimum flows should be 300 to 400 cfs, except for 1,500 cfs from April through June.

  - Develop a cooperative approach to coordinate flow releases to attain target levels.

- Provide the following 10-day spring flow events on the Stanislaus River: 2,500 to 3,000 cfs in late April or early May in normal years and 3,000 to 4,000 cfs in wet years. Such flows would be provided only when inflows to New Melones Reservoir are at these levels (◆◆).

  - Develop a cooperative approach to coordinate flow releases to attain target levels.

- Maintain existing levels of erosion and gravel recruitment in tributaries that sustain an adequate level of gravel recruitment, or restore desirable levels by directly manipulating and augmenting gravel supplies where the natural flow process has been interrupted by dams or other features that retain or remove the gravel supply (◆◆).

  - Evaluate the feasibility and need for establishing long-term sediment augmentation programs for streams below major impoundments in the East San Joaquin Ecological Zone.

  - Evaluate spawning gravel quality in areas used by chinook salmon in the Stanislaus River. If indicated, renovate or supplement gravel supplies to enhance substrate quality by importing additional gravel as conditions require.

- Evaluate spawning gravel quality in areas used by chinook salmon in the Tuolumne River. If indicated, renovate or supplement gravel supplies to enhance substrate quality.

- Evaluate spawning gravel quality in areas used by chinook salmon in the Merced River. If indicated, renovate or supplement gravel supplies to enhance substrate quality

- Preserve and expand the stream-meander belts in the Stanislaus, Tuolumne, and Merced Rivers by adding a cumulative total of 1,000 acres of riparian lands in the meander zones (◆◆◆).

  - Acquire riparian and meander-zone lands by purchasing them directly or acquiring easements from willing sellers, or provide incentives for voluntary efforts to preserve and manage riparian areas on private land.

  - Build local support for maintaining active meander zones by establishing a mechanism through which property owners would be reimbursed for lands lost to natural meander processes.

  - Develop a cooperative program to improve opportunities for natural meander by removing riprap and relocating other structures that impair stream meander.

- Restore and improve opportunities for rivers to inundate (flood) their floodplain on a seasonal basis (◆).

  - Conduct a feasibility study to construct setback levees in the Stanislaus, Tuolumne, and Merced River floodplains

  - Restore, as needed, stream channel and overflow basin configurations within the floodplain.

  - Minimize effects of permanent structures, such as bridges and diversion dams, on floodplain processes.

  - Develop a floodplain management plan for the Stanislaus River.

- Maintain maximum surface water temperatures on the lower Merced, Tuolumne, and Stanislaus Rivers to the downstream boundary of the salmon spawning area during fall and winter and to the mouth of the river during the spring as follows (◆◆◆):

  - October 15 through February 15, 56°F, and

  - April 1 through May 31, 65°F.

  - Cooperatively evaluate the use of temperature control devices/reservoir management options to reduce water temperatures during critical periods.

- Evaluate the impact of irrigation returns on stream temperature.

- Provide conditions for riparian vegetation growth along sections of rivers in the East San Joaquin Basin Ecological Zone (◆◆).

    - Purchase streambank conservation easements from willing sellers, or establish voluntary incentive programs to improve salmonid habitat and instream cover along the Stanislaus River

    - Evaluate the benefits of restoring aquatic and riparian habitats on the Stanislaus River, including creating side channels to serve as spawning and rearing habitats for salmonids.

- Reduce entrainment of fish and other aquatic organisms into diversions to a level that will not impair salmon and steelhead restoration by screening 50% of the water volume diverted in the basin (◆◆◆).

    - Evaluate the feasibility of installing state-of-the-art screens on small pump agricultural diversions along the three streams.

    - Provide alternative water sources to diverters who legally divert water from spawning and rearing areas of the three streams.

    - Purchase water rights from willing sellers whose diversions entrain significant numbers of juvenile salmon or steelhead.

- Reduce adverse effects of non-native fish species that have a significant effect on juvenile salmon production in the rivers (◆).

    - Eliminate gravel pits within or connected to the rivers.

Cumulative Benefit Evaluation

Stanislaus River fall-run chinook salmon will continue to be in important component of the overall salmon return to the system and a very important component of the San Joaquin returns. In view of the very cyclical return of spawners to this stream during the period of record, it is necessary to provide a minimum escapement each year instead of managing for an optimum return. The minimum should reflect the long-term average of about 3,800 fish. Many factors that influence the abundance of Stanislaus River fall-run chinook salmon a downstream in the San Joaquin River, the Delta, and the ocean.

The fall-run chinook abundance trend in the Stanislaus River, when coupled with the proposed restoration actions, suggest that an increase in abundance is likely and that the increase may be enough to contribute to recovery.

Scoring

The cumulative benefits of proposed actions in the Stanislaus River are likely to provide a minimal increase in naturally spawning fall-run chinook salmon and is scored as follows:

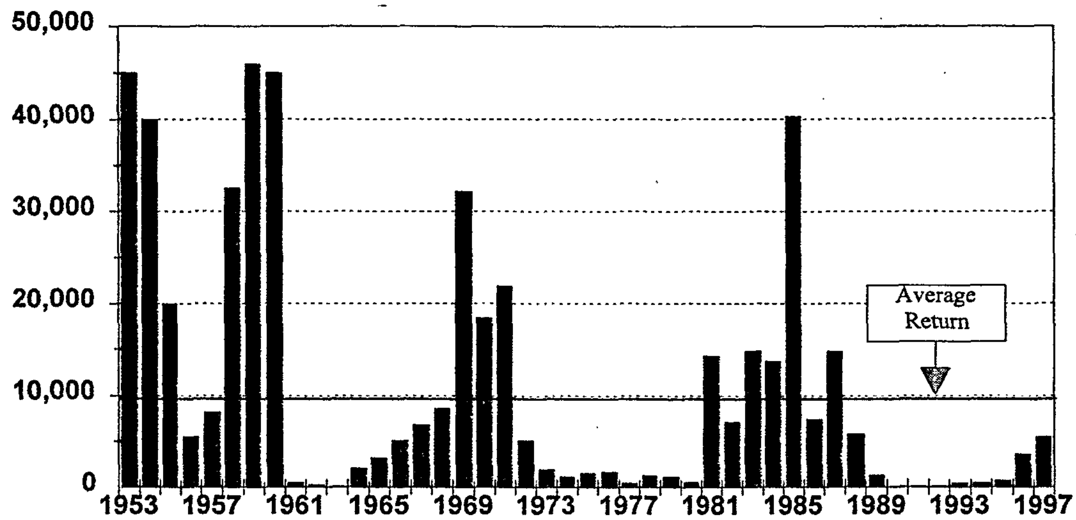
Stanislaus River Cumulative Score		
Fall-run Chinook	**Score**	**Certainty**
Stage I Actions	+2	3
Long-term Actions	+4	2

Stage I Actions will likely contribute to a small increase of fall-run chinook salmon in the Stanislaus River. The long-term actions are more extensive but still will not provide recovery of Stanislaus River chinook salmon. Stage I action has a high level of certainty based on present knowledge of the system, and the longer-term program actions have a lower level of certainty due to the need to further evaluate and fine-tune restoration actions.

Assessment of Restoration Actions in the Tuolumne River

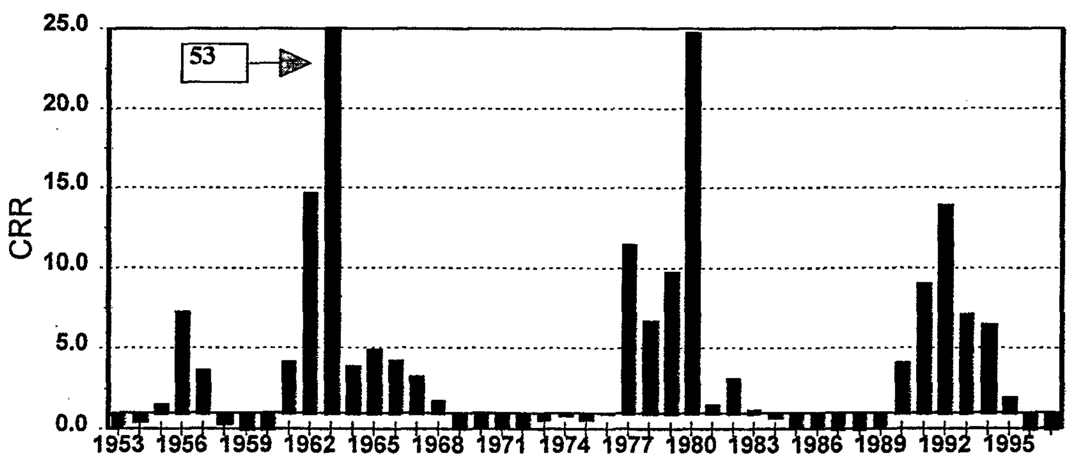
The Tuolumne River is the 5th most important producer of fall-run chinook salmon in the Central Valley and the 1st most important producer in the San Joaquin basin. The estimates of Tuolumne River naturally spawning fall-run chinook salmon during 1953 through 1997 have ranged from 77 fish in 1991 45,900 fish in 1959. The average annual return during this period was 9,176 fish including jacks and adults.

Tuolumne River Naturally Spawning Fall-run Chinook



Cohort replacement rates (CRR) during this period have ranged from a low of 0.01 for the 1959 cohort to a high of 53 for the 1963 cohort. The average CRR during this period has been 5.3 and has fallen to 4.1 during 1985 to 1994.

Tuolumne River Fall-run Chinook Cohort Replacement Rate



Proposed CALFED Stage I Implementation Actions

Actions proposed by CALFED for implementation during the first 7 years which will benefit fall-run chinook salmon and other chinook runs in the San Joaquin basin include:

- Improve base flow below Don Pedro
- Evaluate the quality of spawning gravel and renovate or supplement gravel supplies to enhance substrate quality of needed
- Preserve and expand the existing meander belt
- Conduct a feasibility study to construct setback levees
- Restore stream channel and overflow basin configurations within the floodplain
- Minimize effects of permanent in-stream structures on flood processes
- Evaluate the impacts of irrigation returns on stream temperature
- Evaluate the use of devices or reservoir operations for reducing stream temperature during critical periods
- Restore and enhance streamside riparian plants
- Evaluate the feasibility of screening small pump diversions, provide alternative water sources to diverters, and purchase water rights to reduce entrainment of fish
- Eliminate gravel pits connected to the channel
- Reduce the adverse affects of legal and illegal harvest on fish
- Adopt hatchery management practices designed to better protect the genetic integrity of wild stocks
- Evaluate the feasibility of constructing sediment detention basins.

Proposed CALFED Long-term Implementation Actions

The following actions will be further developed and implemented during the long-term (30-year) implementation program for improving the ecological health of the Tuolumne River.

- Maintain the following base flows in the Tuolumne River below Don Pedro Dam (◆◆):

- in critical and below years, flow release should be 50 cfs from June through September, 100 cfs from October 1-15, 150 cfs from October 16-May 31, plus an 11,091 acre-foot outmigration pulse flow,

- in median critical dry years, flow release should be 50 cfs from June through September, 100 cfs from October 1-15, 150 cfs from October 16- May 31, plus a 20,091 acre-foot outmigration pulse flow,

- in intermediate critical dry years, flow release should be 50 cfs from June through September, 150 cfs from October 1-15, 150 cfs from October 16- May 31, plus a 32,619 acre-foot outmigration pulse flow,

- in median dry years, flow release should be 75 cfs from June through September, 150 cfs from October 1-15, 150 cfs from October 16- May 31, plus a 37,060 acre-foot outmigration pulse flow,

- in intermediate dry-below normal years, flow release should be 75 cfs from June through September, 180 cfs from October 1-15, 180 cfs from October 16- May 31, plus a 35,920 acre-foot outmigration pulse flow and a 1,676 acre-foot attraction pulse flow,

- in median below normal years, flow release should be 75 cfs from June through September, 200 cfs from October 1-15, 175 cfs from October 16- May 31, plus a 60,027 acre-foot outmigration pulse flow and a 1,736 acre-foot attraction pulse flow,

- in all other year types (intermediate below normal/above normal, median above normal, intermediate above normal-wet, and median wet/maximum years), flow release should be 250 cfs from June through September, 300 cfs from October 1-15, 300 cfs

- Maintain existing levels of erosion and gravel recruitment in tributaries that sustain an adequate level of gravel recruitment, or restore desirable levels by directly manipulating and augmenting gravel supplies where the natural flow process has been interrupted by dams or other features that retain or remove the gravel supply (◆◆).

  - Evaluate the feasibility and need for establishing long-term sediment augmentation programs for streams below major impoundments in the East San Joaquin Ecological Zone.

  - Evaluate spawning gravel quality in areas used by chinook salmon in the Tuolumne River. If indicated, renovate or supplement gravel supplies to enhance substrate quality by importing additional gravel as conditions require.

- Preserve and expand the stream-meander belts in the Stanislaus, Tuolumne, and Merced Rivers by adding a cumulative total of 1,000 acres of riparian lands in the meander zones (◆◆◆).

- Acquire riparian and meander-zone lands by purchasing them directly or acquiring easements from willing sellers, or provide incentives for voluntary efforts to preserve and manage riparian areas on private land.

- Build local support for maintaining active meander zones by establishing a mechanism through which property owners would be reimbursed for lands lost to natural meander processes.

- Develop a cooperative program to improve opportunities for natural meander by removing riprap and relocating other structures that impair stream meander.

■ Restore and improve opportunities for rivers to inundate (flood) their floodplain on a seasonal basis (◆).

- Conduct a feasibility study to construct setback levees in the Stanislaus, Tuolumne, and Merced River floodplains

- Restore, as needed, stream channel and overflow basin configurations within the floodplain.

- Minimize effects of permanent structures, such as bridges and diversion dams, on floodplain processes.

- Develop a floodplain management plan for the Tuolumne River.

■ Maintain maximum surface water temperatures on the lower Tuolumne, Stanislaus and Merced Rivers to the downstream boundary of the salmon spawning area during fall and winter and to the mouth of the river during the spring as follows (◆◆◆):

- October 15 through February 15, 56°F, and

- April 1 through May 31, 65°F.

- Cooperatively evaluate the use of temperature control devices/reservoir management options to reduce water temperatures during critical periods.

- Evaluate the impact of irrigation returns on stream temperature.

■ Provide conditions for riparian vegetation growth along sections of rivers in the East San Joaquin Basin Ecological Zone (◆◆).

- Purchase streambank conservation easements from willing sellers, or establish voluntary incentive programs to improve salmonid habitat and instream cover along the Tuolumne River

- Reduce entrainment of fish and other aquatic organisms into diversions to a level that will not impair salmon and steelhead restoration by screening 50% of the water volume diverted in the basin (◆◆◆).
  - Evaluate the feasibility of installing state-of-the-art screens on small pump agricultural diversions along the three streams.
  - Provide alternative water sources to diverters who legally divert water from spawning and rearing areas of the three streams.
  - Purchase water rights from willing sellers whose diversions entrain significant numbers of juvenile salmon or steelhead.
- Reduce adverse effects of non-native fish species that have a significant effect on juvenile salmon production in the rivers (◆).
  - Eliminate gravel pits within or connected to the rivers.

Cumulative Benefit Evaluation

Tuolumne River fall-run chinook salmon will continue to be in the most important component of the overall salmon return to the system and a very important component of the San Joaquin returns. In view of the very cyclical return of spawners to this stream during the period of record, it is necessary to provide a minimum escapement each year instead of managing for an optimum return. The minimum should reflect the long-term average of about 9,200 fish. Many factors that influence the abundance of Tuolumne River fall-run chinook salmon a downstream in the San Joaquin River, the Delta, and the ocean.

The fall-run chinook abundance trend in the Tuolumne River, when coupled with the proposed restoration actions, suggest that an increase in abundance is likely and that it may contribute to the recovery of San Joaquin fall-run chinook.

Scoring

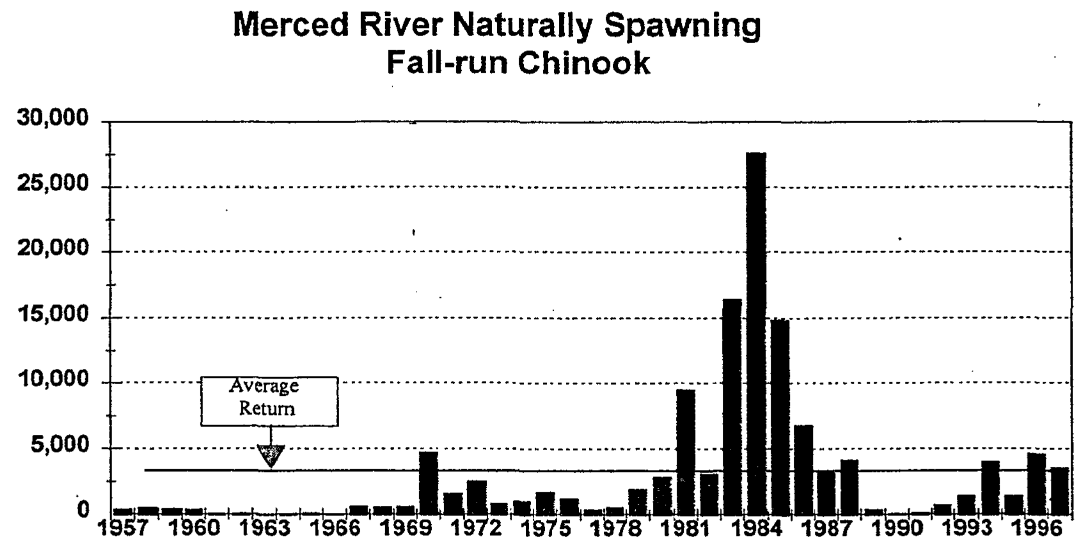
The cumulative benefits of proposed actions in the Tuolumne River are likely to provide an increase in naturally spawning fall-run chinook salmon and is scored as follows:

Tuolumne River Cumulative Score		
Fall-run Chinook	**Score**	**Certainty**
Stage I Actions	+4	3
Long-term Actions	+4	2

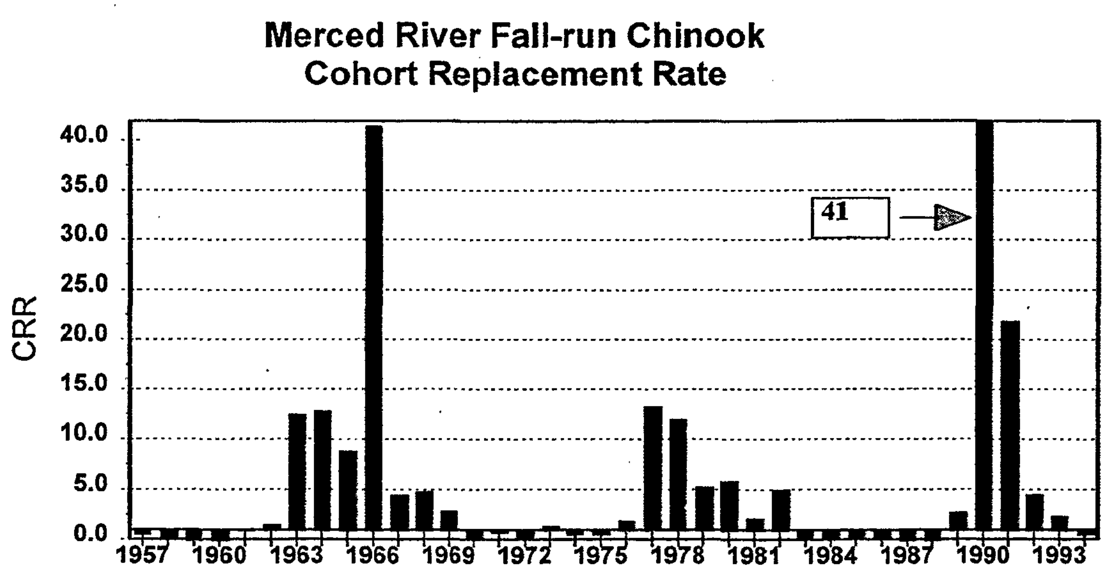
Stage I Actions will likely contribute to a small increase of fall-run chinook salmon in the Tuolumne River. The long-term actions are more extensive but still will not provide recovery of Tuolumne River chinook salmon. Stage I action has a high level of certainty based on present knowledge of the system, and the longer-term program actions have a lower level of certainty due to the need to further evaluate and fine-tune restoration actions.

Assessment of Restoration Actions in the Merced River

The Merced River is the 8th most important producer of fall-run chinook salmon in the Central Valley and the 3rd most important in the San Joaquin basin. The estimates of Merced River naturally spawning fall-run chinook salmon during 1957 through 1997 have ranged from 20 fish in 1963 to 27,600 fish in 1984. The average annual return during this period was 3,040 fish including jacks and adults.



Cohort replacement rates (CRR) during this period have ranged from a low of 0.05 for the 1987 cohort to a high of 41 for the 1966 cohort. The average CRR during this period has been 6.0 and has 8.8 during 1985 to 1994.



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Proposed CALFED Stage I Implementation Actions

Actions proposed by CALFED for implementation during the first 7 years which will benefit fall-run chinook salmon and other chinook runs in the San Joaquin basin include:

- Purchase 100,000 acre feet of water for management of stream flow (total includes water purchase in the Sacramento and San Joaquin basin combined).

- Screen all diversions over 250 cfs.

Proposed CALFED Long-term Implementation Actions

The following actions will be further developed and implemented during the long-term (30-year) implementation program for improving the ecological health of the Merced River.

- Maintain the following base flows in the Merced River below Lake McClure (◆◆):

  - in dry years, minimum instream flows at Shaffer Bridge should be 15 cfs from June through October 15, 60 cfs from October 16 through October 31 and January through May, and 75 cfs in November and December, and

  - in normal years, minimum instream flows at Shaffer Bridge should be 25 cfs from June through October 15, 75 cfs from October 16 through October 31 and January through May, and 100 cfs in November and December.

- Provide the following 10-day spring flow events on the Merced River: 1,000 to 1,500 cfs in late April or early May in dry years, 2,000 to 2,500 cfs in normal years, and 3,000 to 4,000 cfs in wet years. Such flows would be provided only when inflows to Lake McClure are at these levels (◆◆).

  - Develop a cooperative approach to coordinate flow releases to attain target levels.

- Maintain existing levels of erosion and gravel recruitment in tributaries that sustain an adequate level of gravel recruitment, or restore desirable levels by directly manipulating and augmenting gravel supplies where the natural flow process has been interrupted by dams or other features that retain or remove the gravel supply (◆◆).

  - Evaluate the feasibility and need for establishing long-term sediment augmentation programs for streams below major impoundments in the East San Joaquin Ecological Zone.

  - Evaluate spawning gravel quality in areas used by chinook salmon in the Merced River. If indicated, renovate or supplement gravel supplies to enhance substrate quality by importing additional gravel as conditions require.

- Preserve and expand the stream-meander belts in the Stanislaus, Tuolumne and Merced Rivers by adding a cumulative total of 1,000 acres of riparian lands in the meander zones (◆◆◆).
  - Acquire riparian and meander-zone lands by purchasing them directly or acquiring easements from willing sellers, or provide incentives for voluntary efforts to preserve and manage riparian areas on private land.
  - Build local support for maintaining active meander zones by establishing a mechanism through which property owners would be reimbursed for lands lost to natural meander processes.
  - Develop a cooperative program to improve opportunities for natural meander by removing riprap and relocating other structures that impair stream meander.
- On the Merced River between the towns of Cressey and Snelling, isolate gravel pits, reconfigure (rearrange) dredge tailings, and restore a more natural channel configuration to 5 to 7 miles of disturbed stream channel. On the Tuolumne River, between river miles (RMs) 25 and 51, isolate 15 to 30 gravel pits, reconfigure dredge tailings, and restore a more natural stream channel to 6 to 9 miles of disturbed stream channel. On the Stanislaus River, restore a more natural stream channel to 2.5 to 5 miles of disturbed stream channel (◆◆◆).
  - Develop a cooperative program, consistent with flood management, to restore more natural channel configurations to reduce salmonid predator habitat and improve migration corridors.
  - Work with permitting agencies to appropriately structure future gravel extraction permits. Coordinate the design and implementation of gravel pit isolation and stream channel configuration with the Corps, local water management agencies, and local governments.
  - Develop a cooperative program with the counties, local agencies, and aggregate (sand and gravel) resource industry to develop and implement gravel management programs for each of the three rivers.
  - Develop a cooperative program to implement a salmonid spawning and rearing habitat restoration program, including reconstructing channels at selected sites by isolating or filling in inchannel gravel extraction areas.
- Restore and improve opportunities for rivers to inundate (flood) their floodplain on a seasonal basis (◆).
  - Conduct a feasibility study to construct setback levees in the Stanislaus, Tuolumne and Merced River floodplains

- Restore, as needed, stream channel and overflow basin configurations within the floodplain.

- Minimize effects of permanent structures, such as bridges and diversion dams, on floodplain processes.

- Develop a floodplain management plan for the Merced River.

- Maintain maximum surface water temperatures on the lower Merced, Stanislaus and Tuolumne Rivers to the downstream boundary of the salmon spawning area during fall and winter and to the mouth of the river during the spring as follows (◆◆◆):

  - October 15 through February 15, 56°F, and

  - April 1 through May 31, 65°F.

  - Cooperatively evaluate the use of temperature control devices/reservoir management options to reduce water temperatures during critical periods.

  - Evaluate the impact of irrigation returns on stream temperature.

- Provide conditions for riparian vegetation growth along sections of rivers in the East San Joaquin Basin Ecological Zone (◆◆).

  - Purchase streambank conservation easements from willing sellers, or establish voluntary incentive programs to improve salmonid habitat and instream cover along the Merced River.

- Reduce entrainment of fish and other aquatic organisms into diversions to a level that will not impair salmon and steelhead restoration by screening 50% of the water volume diverted in the basin (◆◆◆).

  - Improve existing diversion screens on the lower Merced River.

  - Evaluate the feasibility of installing state-of-the-art screens on small pump agricultural diversions along the three streams.

  - Provide alternative water sources to diverters who legally divert water from spawning and rearing areas of the three streams.

  - Purchase water rights from willing sellers whose diversions entrain significant numbers of juvenile salmon or steelhead.

- Eliminate the loss of adult fall-run chinook salmon that stray into the San Joaquin River upstream of the Merced River confluence (◆◆◆).

- Develop a cooperative program to eliminate blockage of upstream-migrating fall-run chinook salmon and steelhead at temporary irrigation diversion dams erected during the irrigation season

- Continue annual installation of a temporary weir on the San Joaquin River immediately upstream of the confluence with the Merced River to block adult salmon migration.

- Evaluate the need to remove temporary diversion dams that block upstream salmon and steelhead passage into spawning grounds of three streams.

- Reduce adverse effects of non-native fish species that have a significant effect on juvenile salmon production in the rivers (◆).

  - Eliminate gravel pits within or connected to the rivers.

- Minimize the likelihood that hatchery-reared salmon and steelhead could stray into adjacent non-natal rivers and streams to protect naturally produced salmon and steelhead (◆◆◆).

  - Cooperatively evaluate the benefits of limiting stocking of MRH-reared salmon and steelhead to the Merced River.

- Employ methods to limit straying and loss of genetic integrity of wild and hatchery-supported stocks (◆◆◆).

  - Rear hatchery salmon and steelhead in hatcheries on natal streams to limit straying.

  - Limit stocking of salmon and steelhead fry and smolts to natal watersheds to minimize straying that may compromise the genetic integrity of naturally producing populations.

Cumulative Benefit Evaluation

Merced River fall-run chinook salmon will continue to be one of most important components of the overall salmon return to the system and a very important component of the San Joaquin returns. In view of the very cyclical return of spawners to this stream during the period of record, it is necessary to provide a minimum escapement each year instead of managing for an optimum return. The minimum should reflect the long-term average of about 3,000 fish. Many factors that influence the abundance of Merced River fall-run chinook salmon are downstream in the San Joaquin River, the Delta, and the ocean.

The fall-run chinook abundance trend in the Merced River, when coupled with the proposed restoration actions and the presence of Merced River Hatchery, suggest that an increase in abundance is likely but that recovery is unlikely based solely on restoration actions in the Merced River.

Scoring

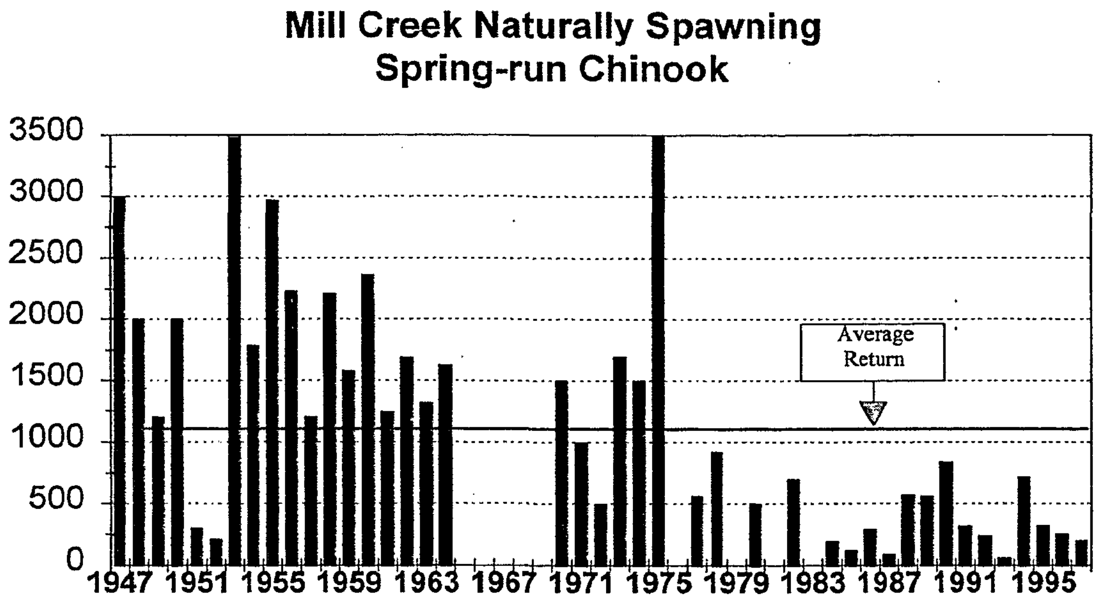
The cumulative benefits of proposed actions in the Merced River are likely to provide a minimal increase in naturally spawning fall-run chinook salmon and is scored as follows:

Merced River Cumulative Score		
Fall-run Chinook	**Score**	**Certainty**
Stage I Actions	+2	3
Long-term Actions	+4	2

Stage I Actions will likely contribute to a small increase of fall-run chinook salmon in the Merced River. The long-term actions are more extensive but still will not provide recovery of Merced River chinook salmon. Stage I action has a high level of certainty based on present knowledge of the system, and the longer-term program actions have a lower level of certainty due to the need to further evaluate and fine-tune restoration actions.

Assessment of Restoration Actions in Mill Creek

The estimates of spring run chinook salmon returning to Mill Creek between 1947 and 1997 have ranged from 61 in 1993 to 3,500 in 1975. Because adult spring run salmon hold in the tributary stream for several months prior to spawning, some mortality is inevitable. Thus, the number of spring run adults returning, estimated from counts of fish entering the creek in the spring, is greater than the number spawning which is usually determined from carcass surveys and other techniques during the spawning period. The average return during this period was 1,226. No estimates were made from 1964-1969, 1979, 1981 and 1983.



Population data for spring run are in most cases not adequate for cohort analysis. For Mill, Deer and Butte Creeks, the more recent data are most consistent and robust, but still should be used with caution for this purpose. For periods where data are available, cohort replacement rates for spring run salmon in Mill Creek apparently have fluctuated widely, from 0.1 to 9.5. All three brood year lineages have failed to replace themselves at least 50% of the time.

Proposed CALFED Stage 1 Implementation Actions

Actions proposed by CALFED for implementation during the first seven years include:

- Develop a watershed management plan for Mill Creek
- Eliminate the need to rebuild Clough Dam which was destroyed in January 1997 floods by providing an alternative water supply for users formerly dependent diversions at the Dam.

Proposed CALFED Long-term Implementation Actions

The following actions will be further developed and implemented during the long-term (30 year) implementation program for improving the ecological health of Mill Creek:

- Develop a cooperative approach to increase flow in the lower 8 miles of Mill Creek. This involves acquiring water from willing sellers or by providing alterative water supplies to diverters during the upstream migration of adult salmon and steelhead.

- Develop a cooperative program to improve fall-run chinook salmon spawning habitat in the lower 8 miles of Mill Creek by reactivating and maintaining natural sediment transport processes (restoring natural processes should also benefit spring run salmon)

- Preserve or restore the 50- to 100-year flood plain along the lower reaches of Mill Creek and construct setback levees to reactivate channel meander in areas presently confined by levees

- Develop a cooperative program to restore and maintain riparian habitat along the lower 10 miles of Mill Creek by acquiring conservation easements or by voluntary landowner participation

- Develop a cooperative approach to ensure unimpeded upstream passage of adult spring-run chinook salmon in Mill Creek

Cumulative Benefit Evaluation

Habitat in the upper Mill Creek watershed has not been severely degraded; actions related to the condition of this habitat are primarily to ensure that sound watershed management practices prevent such degradation from occurring in the future. Actions in this category will contribute to recovery only indirectly in that they will prevent new stressors from adversely affecting spring run production.

All water diversions on Mill Creek are screened. However, water diversions affect stream flows which in turn affect adult and juvenile salmon migration.

The primary needs of spring run in Mill Creek are: 1) improved upstream passage of adults, enabling timely migration in the spring from the Sacramento River to upstream summer holding areas, and 2) improved survival during downstream migration of juvenile salmon to the Sacramento River, predominantly of yearlings in the fall but also young-of-the-year juveniles and smolts in the spring. Proposed actions are to provide adequate flows for adult and juvenile passage in the valley floor reaches, modification or removal of facilities that prevent or delay upstream adult passage, and improved flows and instream and riparian habitat restoration and protection to increase juvenile survival during downstream migration. In combination, these actions should result in improved physical condition of adults reaching the holding habitat, potential increased production of juvenile salmon, and improved juvenile salmon survival during emigration from Mill Creek. Implementation of these actions should increase the likelihood of sustaining a viable spring run population in Mill Creek.

Scoring

Stage 1 Actions - Score 2, Certainty 1.

There is a high probability of successfully preventing degradation of habitat conditions in the upper watershed through watershed planning, reducing the likelihood of future adverse impacts on the spring run salmon population. Clough Dam was breached by flood water in 1997. The objective is to provide an alternative means of water diversion to those who relied on Clough Dam, and preserve unimpeded salmon passage past this location.

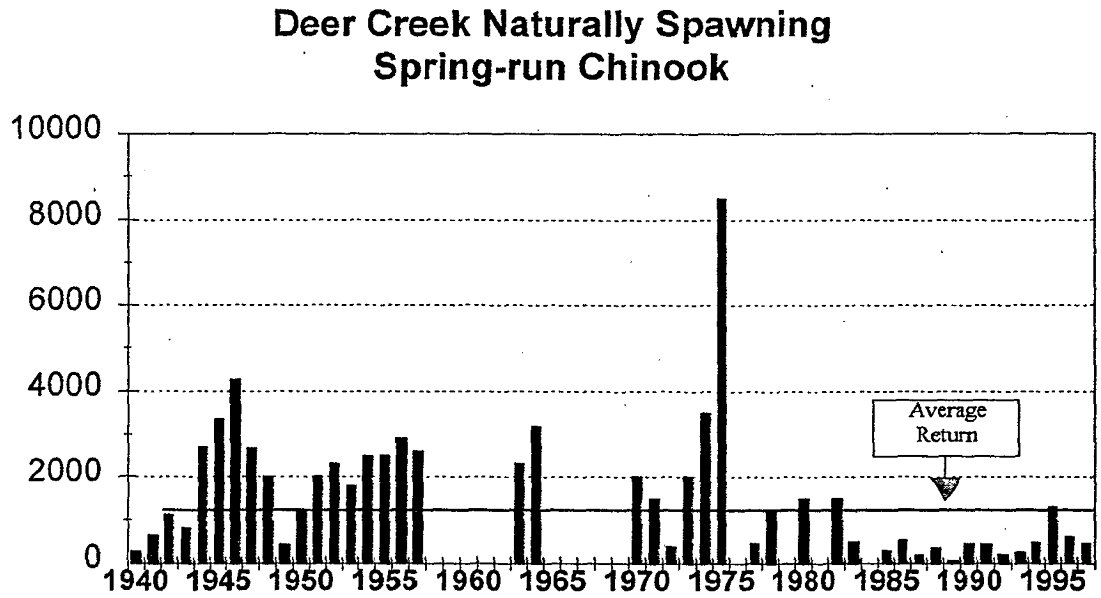
Long-term upstream actions - Score 5 , Certainty 1.

Actions to improve habitat conditions in the lower reach should provide moderate improvements in spring run survival and production. In addition to actions already taken, successful implementation of the Stage 1 and long-term actions reduce or eliminate most of problems for spring run in the Mill Creek basin.

Mill Creek Cumulative Score		
Spring-run chinook	**Score**	**Uncertainty**
Stage I Actions	+2	1
Long-term Actions	+5	1

Assessment of Restoration Actions in Deer Creek

Restoration potential for spring-run chinook salmon in Deer Creek is high. The ecological health of the Deer Creek Unit is rated above average. Habitat in the upper watershed is relatively intact (ERPP 1998). The estimates of spring run chinook salmon returning to Deer Creek between 1940 and 1997 have ranged from 77 in 1989 to 8,500 in 1975. Because adult spring run salmon hold in the tributary stream for several months prior to spawning, some mortality is inevitable and the number returning is somewhat greater than the number spawning. The average return for years when estimates were made during this period was 1,624. No estimates were made from 1957-1962, 1965-1969, 1976, 1979, 1981 and 1984.



In the 1990s, the CRR for spring run in Deer Creek has ranged from 0.6 to 6.2. The CRR has been near or below 1 for four cohorts and 2.3 or greater for four cohorts. Assuming spring run return at age 3, the brood year lineage returning in 1991, 1994 and 1997 accounts for all three CRR values equal to or only slightly greater than 1.

Proposed CALFED Stage 1 Implementation Actions

Actions proposed by CALFED for implementation during the first seven years include:

- Develop a cooperative approach to increase flow in the lower 10 miles of Deer Creek during the upstream migration of adult spring-run chinook salmon (also fall run chinook salmon and and steelhead trout) through innovative means to provide alternative supplies to water diverters.

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- Develop an interagency watershed management plan - Develop a cooperative program with landowners and land management agencies to facilitate watershed protection and restoration. The program would increase the survival of chinook salmon (and steelhead) in Deer Creek by implementing land use plans. It also would establish, restore, and maintain riparian habitats and create buffer zones to protect the creek from developments or other land use activities, such as timber harvest, road building and maintenance, and livestock grazing.

- Develop a cooperative program to restore and maintain riparian habitat along the lower 10 miles of Deer Creek - by acquiring conservation easements or by voluntary landowner participation

- Restore meadows

Proposed CALFED Long-term Implementation Actions

- A full scale demonstration project will be implemented on Deer Creek, hence, all identified actions are expected to be implemented in the first seven years.

Cumulative Benefit Evaluation

Habitat in the upper Deer Creek watershed has not been severely degraded; actions related to the condition of this habitat are primarily to ensure that sound watershed management practices prevent such degradation from occurring in the future. Actions in this category will contribute to recovery only indirectly in that they will minimize the probability of new stressors adversely affecting spring run salmon in the future.

All water diversions on Deer Creek are screened. However, irrigation water diversions affect flows which in turn affect adult and juvenile salmon migration.

The primary needs of spring run salmon in Deer Creek are: 1) improved upstream passage of adults, enabling timely migration in the spring from the Sacramento River to upstream summer holding areas, and 2) improved survival during downstream migration of juveniles to the Sacramento River, predominantly of yearlings in the fall but also young-of-the-year juveniles and smolts in the spring. Proposed actions will provide adequate flows for adult and juvenile passage in the valley floor reaches, modification or removal of facilities that impede (prevent or delay) upstream adult passage, and improved flows and instream and riparian habitat restoration and protection to increase juvenile survival during downstream migration. In combination, these actions should result in improved physical condition of adults reaching the holding habitat, potential increased production of juvenile salmon, and improved juvenile salmon survival during emigration from Deer Creek. In addition to actions already taken, successful implememtation of the Stage 1 and long-term actions reduce or eliminate most of problems for spring run in the Deer Creek basin. Implementation of these improvements should increase the likelihood of sustaining a viable spring run population in Deer Creek.

Scoring

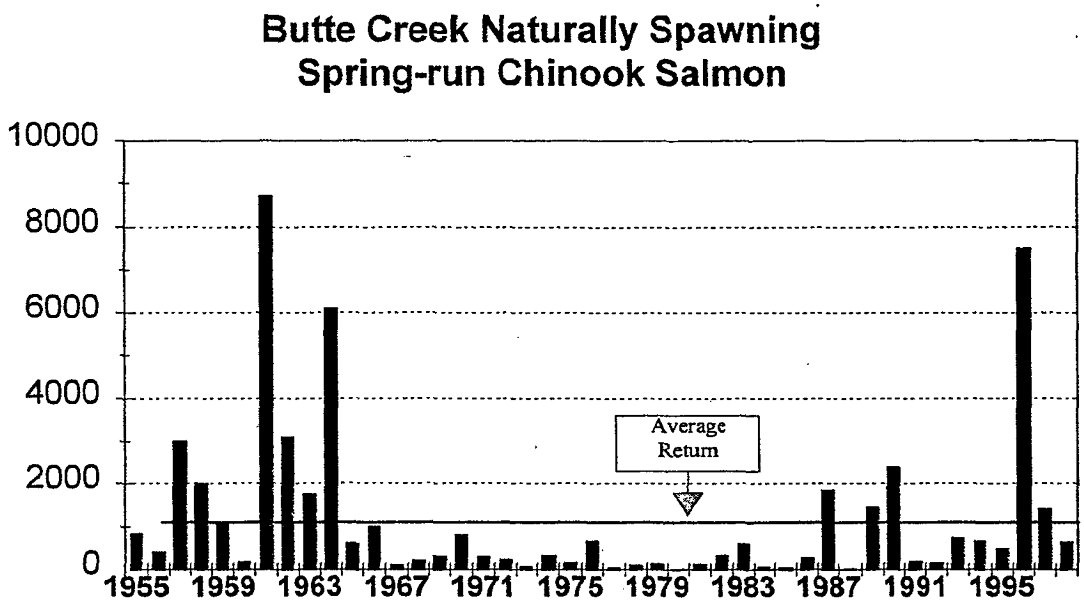
All proposed actions to be implemented in Stage 1 - score 6, certainty 2.

Actions to avoid degradation in the upper watershed and to improve habitat conditions especially related to passage in the lower reach of Deer Creek should provide moderate improvements in spring run salmon survival and production.

Deer Creek Cumulative Score		
Spring-run chinook	**Score**	**Uncertainty**
Stage I Actions	+6	2
Long-term Actions	NA	NA

Assessment of Restoration Actions in Butte Creek

The estimates of spring run chinook salmon returning to Butte Creek between 1954 and 1997, as determined by various census techniques, have ranged from 10 in 1979 to 8,700 in 1960. The average return during this period was 1,130.



Since 1993, CRR for spring run cohorts in Butte Creek have ranged from 1.3 (1997) to 10.3 (1995).

Proposed CALFED Stage 1 Implementation Actions

Actions proposed by CALFED for implementation during the first seven years include:

- remove barriers to fish passage
- protect and restore riparian habitat
- remove diversions
- screening all diversions of 100 cfs or sess (assumes CVPIA Anadromous Fish Screen Program will be screening diversions greater than 100 cfs)
- improve hatchery management and release strateties to maintain the genetic integrity of wild fish

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- develop a watershed management plan.

Several diversions have been screened (Parrott-Phelan, Adams, Gorrill) and some dams (two Western Canal dams) have been removed and removal of two others (McGowan Dam and McPherrin Dam) will be completed by the end of 1998.

Note: The actions on this list need to be reviewed and the list revised. Once the actions that are done are removed from the list, the score may need to be changed to reflect only the benefits expected from future actions, as distinct from the benefits of the current actions.

- Develop a cooperative program to restore and maintain riparian habitat along Butte Creek. Cooperate with local landowners to encourage re-vegetation of denuded stream reaches and to establish, restore, and maintain riparian habitat on Butte Creek.

- Develop a cooperative program to improve the upstream passage of adult spring-run chinook salmon and steelhead in Butte Creek to allow access to 100% of the habitat below the Centerville Head Dam

- Increase the opportunity for the successful upstream passage of adult spring-run chinook salmon and steelhead on Butte Creek by developing a cooperative program to evaluate the feasibility of removing diversion dams, providing alternative sources of water, or constructing new high-water-volume fish ladders.

- Improve chinook salmon and steelhead survival and passage in Butte Creek by cooperatively developing and evaluating operational criteria and potential modifications to the Butte Slough outfall.

- Increase chinook salmon survival in Butte Creek by cooperatively helping local interests to eliminate stranding at the drainage outfalls in the lower reach.

- Improve the survival of chinook salmon and steelhead in Butte Creek by helping to install positive-barrier fish screens.

    - install screened portable pumps as an alternative to the Little Dry Creek diversion (completed?)

    - install positive-barrier fish screens at the Durham-Mutual Diversion Dam (complete in 1998?)

    - install positive-barrier fish screens at Adams Dam (complete in 1998)

    - install positive-barrier fish screens at Gorrill Dam (complete in 1998)

    - install a positive-barrier fish screen at White Mallard Dam.

- Increase the survival of juvenile salmon and steelhead in the Sutter Bypass by evaluating the need to install positive barrier fish screens on diversions and install screens where needed

- Develop a watershed management plan, a cooperative program with landowners and land management agencies to facilitate watershed protection and restoration. The program would increase the survival of chinook salmon and steelhead in Butte Creek by implementing land use plans. Establish, restore, and maintain riparian habitats and create buffer zones between the creek and developments or other land use activities, such as timber harvest, road building and maintenance, and livestock grazing.

Proposed CALFED Long-term Implementation Actions

The following actions will be further developed and implemented during the long-term (30 year) program for improving the ecological health of Butte Creek:

- Develop a cooperative approach to increase flow in Butte Creek by acquiring water from willing sellers.

- Develop a cooperative program with PG&E to maintain a year-round minimum flow of 40 cfs in Butte Creek between the Centerville Diversion Dam and the Centerville Powerhouse.

- Develop a cooperative program to improve spawning habitat in Butte Creek by maintaining natural sediment transport processes

Cumulative Benefit Evaluation

Butte Creek is a highly modified system with many features that impair spring run passage, survival, and production. In recent years, efforts to improve spring run production in Butte Creek have been directed towards reducing entrainment of juveniles in unscreened water diversions, improving adult passage, providing increased flows, and protecting riparian habitat. Significant restoration projects have been completed , some with CALFED early implementation Category III funding. Substantial progress has been made; much remains to be done. Both the Stage 1 and long term CALFED actions are directed toward remediation of known problems affecting spring run salmon. Successful implemetation of Stage 1 actions should increase survival and production, improve spring run returns to Butte Creek and, thus, justify the long term actions to provide holding and spawning habitat for an increased number of adult salmon.

In combination with the actions already completed or underway, proposed Stage 1 and long-term CALFED actions should reduce or eliminate most problems for spring run salmon and increase the likelihood of sustaining a viable spring run population in Butte Creek.

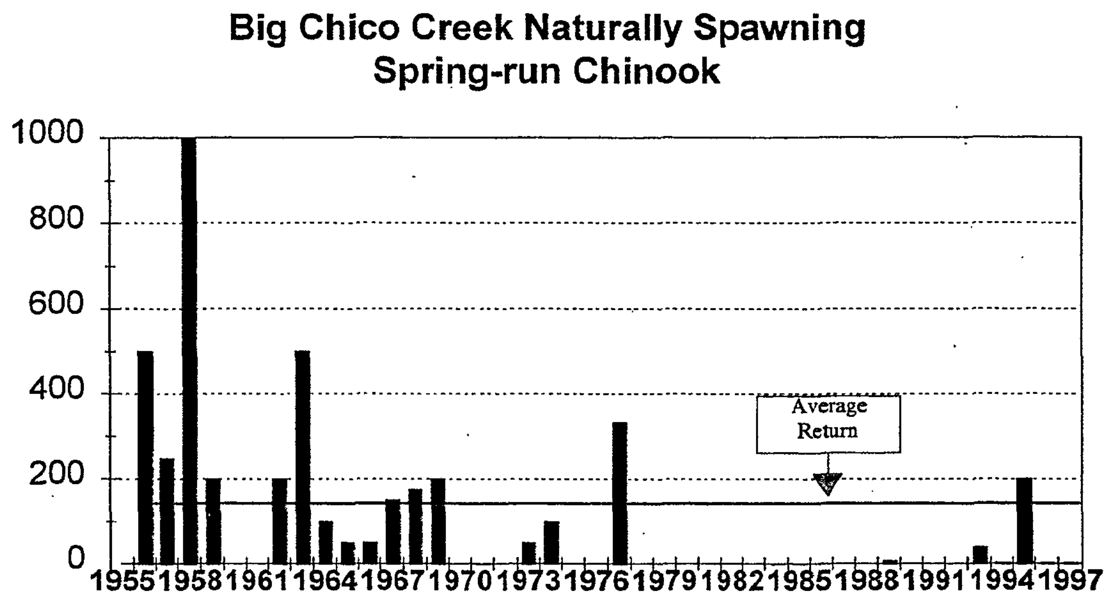
Scoring

The cumulative benefits of proposed actions in the Butte Creek will likely maintain naturally spawning spring-run chinook abundance and is scored as follows:

Butte Creek Cumulative Score		
Spring-run chinook	**Score**	**Uncertainty**
Stage I Actions	+5	1
Long-term Actions	+6	2

Assessment of Restoration Actions in Big Chico Creek

Estimates of spring run chinook salmon returning to Big Chico Creek are from inconsistent observation. During the 1950s and 1960s the estimated number of spring run returning to Big Chico Creek averaged less than 300. Since the 1970, returns have ranged from 0 in many years to 200 in 1995, however, during this period no estimates were made in 8 years.



Population data for spring run in Big Chico Creek are inadequate for CRR analysis.

Proposed CALFED Stage 1 Implementation Actions

- Develop A Watershed Management Plan - Develop a cooperative program with landowners and land management agencies to facilitate watershed protection and restoration. The program would increase the survival of chinook salmon Big Chico Creek by implementing land use plans. These would establish, restore, and maintain riparian habitats and create buffer zones between the creek and developments or other land use activities, such as timber harvest, road building and maintenance, and livestock grazing.

Proposed CALFED Long-term Implementation Actions

- Develop a cooperative program to replenish spawning gravel in Big Chico Creek. Especially target stream reaches that have been modified for flood control so that there is no net loss of sediments transported through the Sycamore, Lindo Channel, and Big Chico Creek split - Assist in the redesign and reconstruct the flood control box culvert structures on Big Chico Creek near the Five-Mile Recreation Area to allow the natural downstream sediment transport.

- Develop a program in cooperation with local landowners to encourage revegetation of denuded stream reaches and to establish, restore, and maintain riparian habitat on Big Chico Creek.

- Develop a cooperative program to improve the upstream passage of adult chinook salmon and steelhead in Big Chico Creek by providing access to 100% of habitat located below natural barriers. Repair or reconstruct the fish ladders in Big Chico Creek, including the Lindo Channel weir and fishway at the Lindo Channel box culvert at the Five Mile Diversion, to improve the upstream passage of adult spring-run chinook salmon and steelhead trout.

Suggest we need to add : Screen water diversion just downstream from Higgins Hole, the main holding and spawning reach.

Cumulative Benefit Evaluation

Spring run salmon production in Big Chico Creek has been very sporadic in recent decades due to impeded passage, marginal flows and water temperatures in the holding and spawning habitat, and poor juvenile survival. Relocation of the M&T Pumps from Big Chico Creek to the Sacramento River has been completed, reducing loss of emigrating juvenile spring run. Other actions also have been undertaken.

Implementation of Stage 1 and long term actions in Big Chico Creek should increase production of spring run. Although more consistent production may be expected, the number of spring run returning to Big Chico Creek will continue to vary and probably remain small relative to the other spring run tributaries.

Scoring

The cumulative benefits of proposed actions in the Big Chico Creek will likely maintain naturally spawning spring-run chinook abundance and is scored as follows:

Big Chico Creek Cumulative Score		
Spring-run chinook	**Score**	**Uncertainty**
Stage I Actions	+3	2
Long-term Actions	+5	2

Assessment of Restoration Actions Potentially Benefitting Spring Run in Other Streams

Spring run salmon occurred in many Central Valley river and stream historically. They have been extirpated from many of these stream systems. Their status in several systems, including the Upper Sacramento River, Clear Creek, Battle Creek, Feather River and Yuba River is clouded due to a variety of reasons, including diminished spatial isolation from fall run salmon due to loss of access to upstream habitat as well as hatchery and other fishery management practices. Salmon exhibiting the behavior characteristic of spring run are observed in these streams.

Clear Creek is a CALFED demonstration project stream where all proposed actions will be carried out in the first seven years. Actions proposed for other races of salmon and other species have the potential to improve habitat conditions and benefit any spring run salmon that exist there. Establishment of a spring run population in Clear Creek will require improving flow releases from Whiskeytown Dam, remedying channel degradation from past gravel mining, providing fish passage at McCormick-Saeltzer Dam, implementing an erosion control/stream corridor maintenance program, and replenishing spawning gravel.

Battle Creek also has recognized habitat potential for spring run salmon. Important actions include allowing passage of spring run salmon upstream of the Coleman National Fish Hatchery weir, providing flows through acquisition of water from willing sellers, and screening hydropower diversions as needed.