

# **Sacramento River Spring-run Chinook Salmon**



**2002-2003  
Biennial Report**

**Prepared for the Fish and Game Commission**

**by**

**California Department of Fish and Game  
Habitat Conservation Division  
Native Anadromous Fish and Watershed Branch**

**June 2004**

TABLE OF CONTENTS

<b>I. INTRODUCTION .....</b>	<b>3</b>
<b>II. POPULATION STATUS AND TRENDS .....</b>	<b>3</b>
ADULT RUN SIZE MONITORING .....	3
SUMMARY .....	3
STREAM-SPECIFIC MONITORING.....	8
<b>III. HARVEST MANAGEMENT CONSERVATION MEASURES.....</b>	<b>16</b>
<b>IV. CENTRAL VALLEY-WIDE RESTORATION PROGRAMS.....</b>	<b>17</b>
CALFED BAY-DELTA PROGRAM .....	17
CENTRAL VALLEY PROJECT IMPROVEMENT ACT PROGRAM.....	18
NATIONAL MARINE FISHERIES SERVICE RECOVERY PLANNING.....	19
<b>V. RESTORATION AND MANAGEMENT ACTIONS.....</b>	<b>19</b>
CENTRAL VALLEY PROJET/STATE WATER PROJECT OPERATION.....	20
RESTORATION AND MANAGEMENT ACTIVITIES ON SACRAMENTO RIVER TRIBUTARIES.....	20
WATERSHED GROUPS.....	25
<b>VI. RESEARCH .....</b>	<b>25</b>
<b>VII. LITERATURE CITED.....</b>	<b>26</b>

**TABLE OF CONTENTS (Continued)**

<b>VIII. APPENDICES.....</b>	<b>28</b>
A. SPRING-RUN CHINOOK SALMON MONITORING AND CONSERVATION EFFORTS IN THE SACRAMENTO RIVER MAINSTEM AND TRIBUTARIES.....	28
B. RESTORATION AND MANAGEMENT ACTIVITIES BY WATERSHED GROUPS.....	29
C. REPORT CONTRIBUTORS.....	35

## I. INTRODUCTION

The Sacramento River spring-run Chinook salmon (*Oncorhynchus tshawytscha*) was listed as a threatened species in February 1999 by the California Fish and Game Commission. Scientific information related to spring-run Chinook distribution, life history, and current issues has been reviewed by Moyle (2002). Conservation efforts of the spring-run Chinook stakeholders have also been reported by Bingham and Harthorn (2000). Spring-run Chinook population status and previous monitoring, restoration, and management activities have been documented by the Candidate Species Status Report (CDFG 1998), and following its listing, by annual reports to the Fish and Game Commission (Commission) (CDFG 2000, 2001, 2002). In 2002, the reporting frequency to the Commission was changed from an annual to a biennial basis. This document, therefore, describes spring-run Chinook population status, research and monitoring activities; status of restoration and management; and watershed conservancy activities in 2002 and 2003.

The Department's previous status review documented the reduction in range and distribution of Central Valley spring-run Chinook from historical conditions (CDFG 1998; Figures 1 and 2). Deer, Mill, and Butte creeks are now the principal streams still supporting spawning and rearing habitat for spring-run Chinook (Moyle 2002).

## II. POPULATION STATUS AND TRENDS

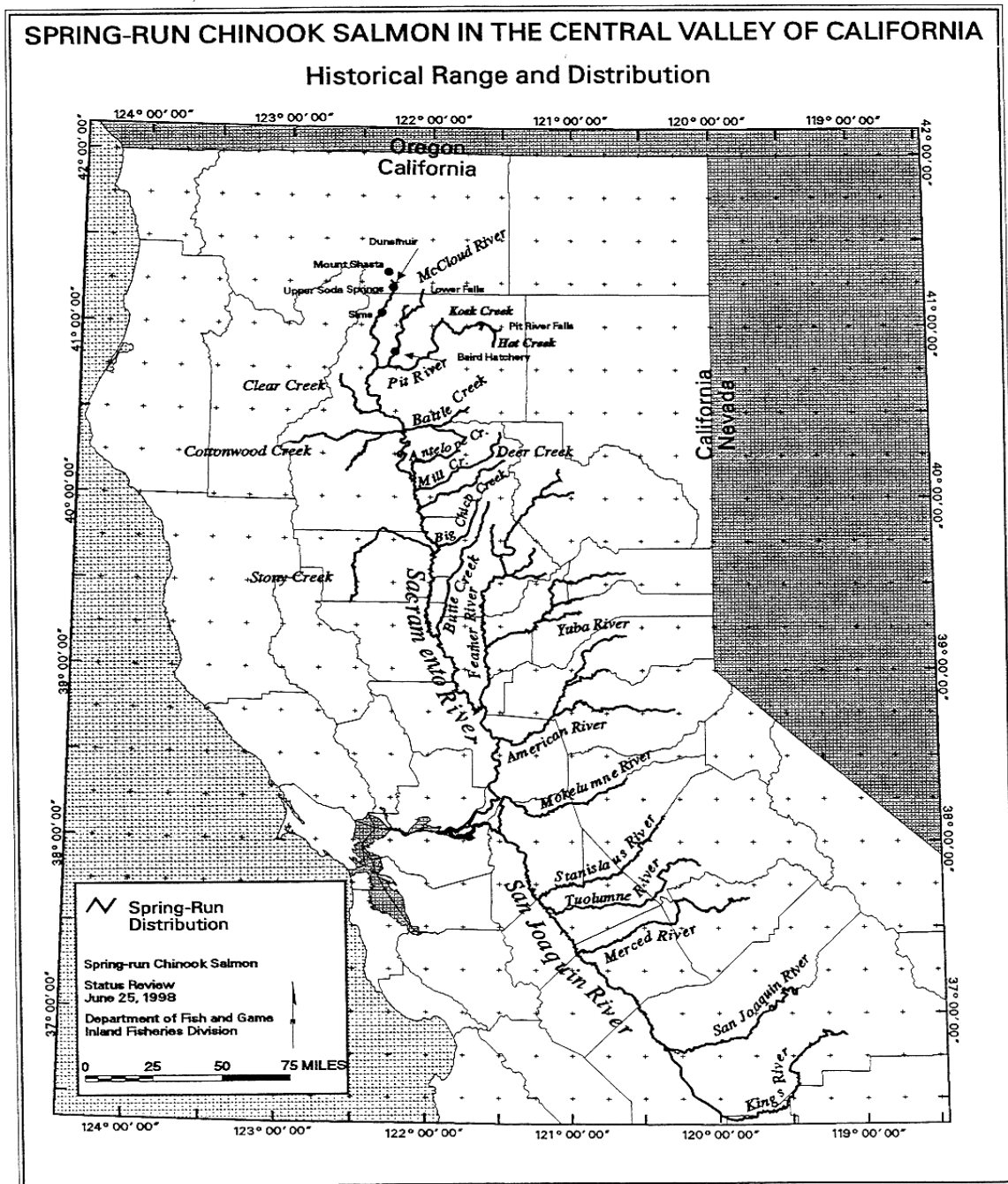
### ADULT RUN SIZE MONITORING

#### SUMMARY

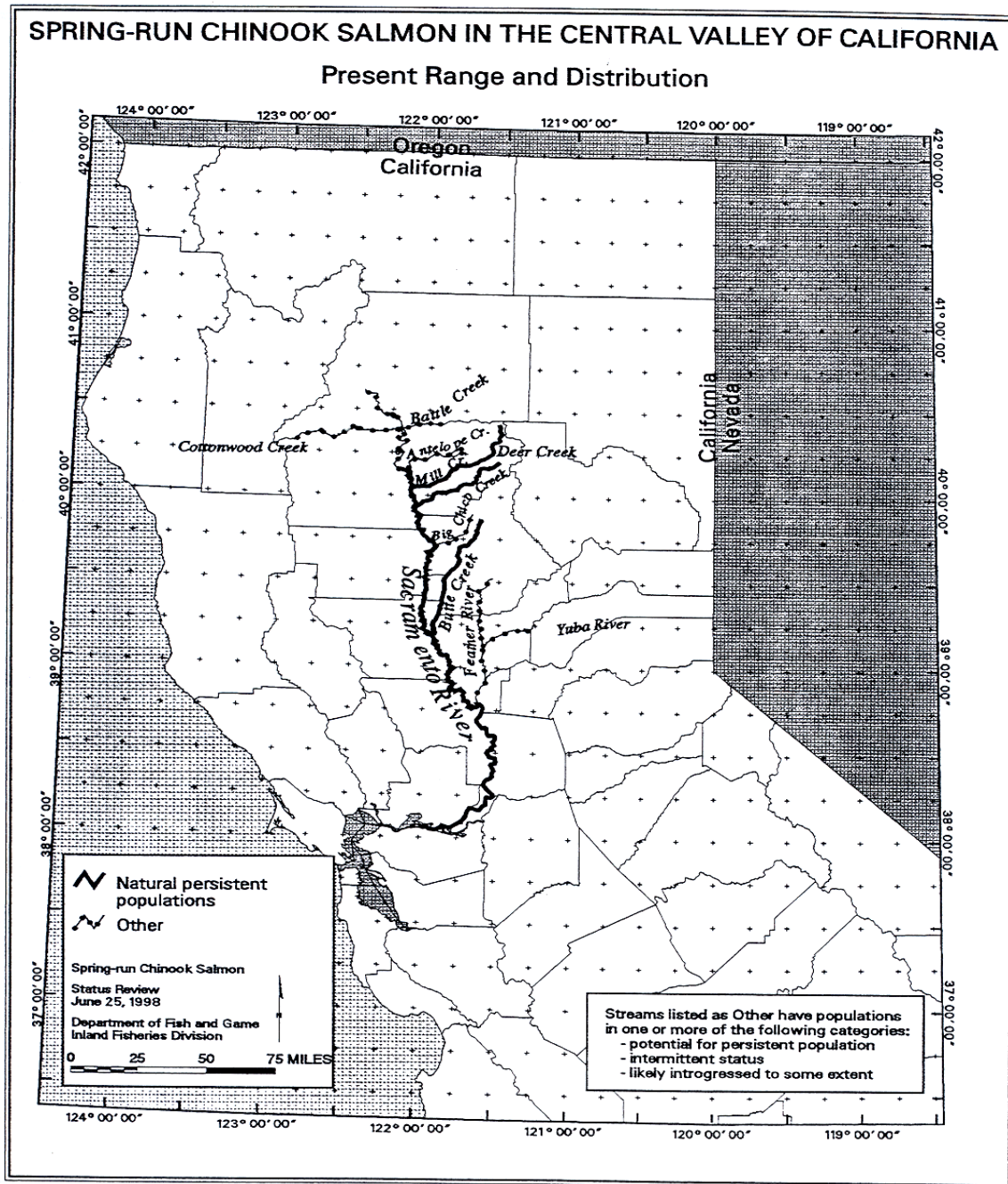
As in past years, adult spring-run Chinook returning to Central Valley streams were monitored by a variety of methods in 2002 and 2003. Snorkel surveys were the primary adult monitoring method used, with the exception of Battle and Mill creeks and the lower Yuba River. The term "spawning escapement estimate" is not therefore used in this report because most of the counts presented are based on various methods that do not yield escapement estimates based on conventional models. Summary data for all spring-run Chinook spawning streams are presented in this section; stream-specific survey methods and results are described in subsequent sections.

The Department's previous status review documented the long-term population trend for Central Valley spring-run Chinook (CDFG 1998). Table 1 presents monitoring data on Sacramento River tributaries from 1995 through 2003.

In Deer and Mill creeks, some population recovery is evident in recent years. In 2002 and 2003, numbers of spring-run Chinook counted in Deer Creek were the highest since snorkel surveys of the holding habitat were first made in 1992 (Figure 3). In 2002 and 2003, estimated spring-run returns in Mill Creek were the highest since the early 1970's (Figure 4).



**Figure 1. Historical Range and Distribution of Spring-run Chinook Salmon**  
 (Source: CDFG 1998).



**Figure 2. Present Range and Distribution of Spring-run Chinook Salmon in the Central Valley (Source: CDFG 1998).**



**Table 1. Adult spring-run Chinook population counts for Sacramento River tributaries, 1995-2003. Data based on snorkel surveys unless otherwise indicated.**

STREAM	1995	1996	1997	1998	1999	2000	2001	2002	2003
Antelope Creek	7	1	0	154	40	9	8	46	46
Big Chico Creek	200	2	2	369	27	27	39	0	81
Battle Creek <sup>1</sup>	-	-	-	-	-	40	100	144	94
Butte Creek	7,500	1,413	635	20,259	3,529- 3,679	4,118	9,605	8,785	4,398
	-	-	-	-	-	-	18,312 <sup>2</sup>	12,897 <sup>2</sup>	6,063 <sup>2</sup>
	-	-	-	-	-	-	0 <sup>3</sup>	3,431 <sup>3</sup>	11,231 <sup>3</sup>
Clear Creek	-	-	-	-	35	9	0	66	25
Beegum/ Cottonwood Creek	8	6	-	477	102	120	245	125	73
Deer Creek	1,295	614	466	1,879	1,591	637	1,622	2,195	2,759
Mill Creek <sup>4</sup>	320	252	200	424	560	544	1,104	1,594	1,426
Yuba River <sup>5</sup>	-	-	-	-	-	-	108	-	-

<sup>1</sup> Based on barrier weir passage.

<sup>2</sup> Estimate of number of spawners based on mark-recapture carcass survey (Schaefer model)

<sup>3</sup> Estimate of pre-spawning mortality based on mark-recapture carcass survey (Schaefer model)

<sup>4</sup> Based on electronic fish counts in 1995 and 1996. Based on expanded salmon redd counts in 1997-2003.

<sup>5</sup> Based on trapping; identification of run based on phenotypic migration period (Mar. through July).

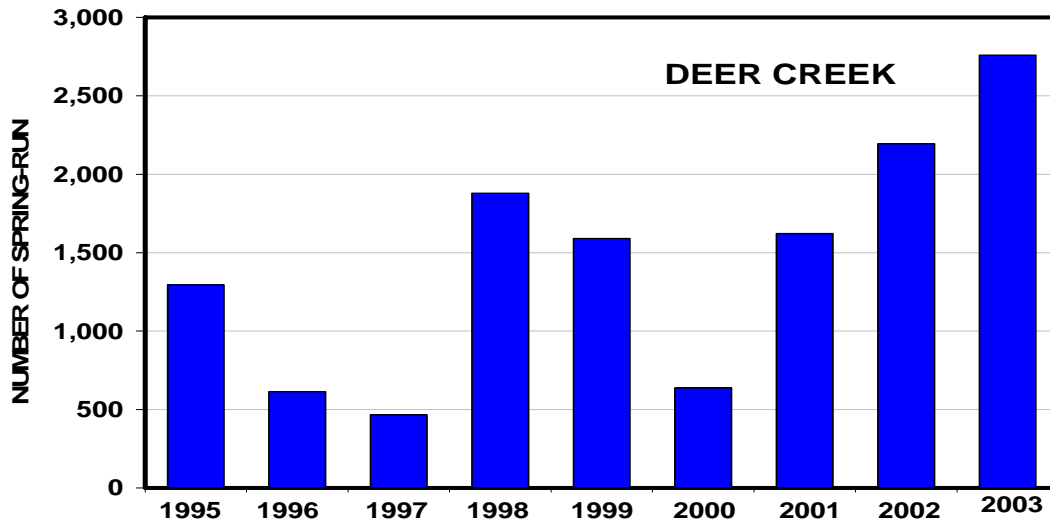


Figure 3. Adult spring-run Chinook population counts for Deer Creek, 1995-2003. Data based on snorkel surveys.

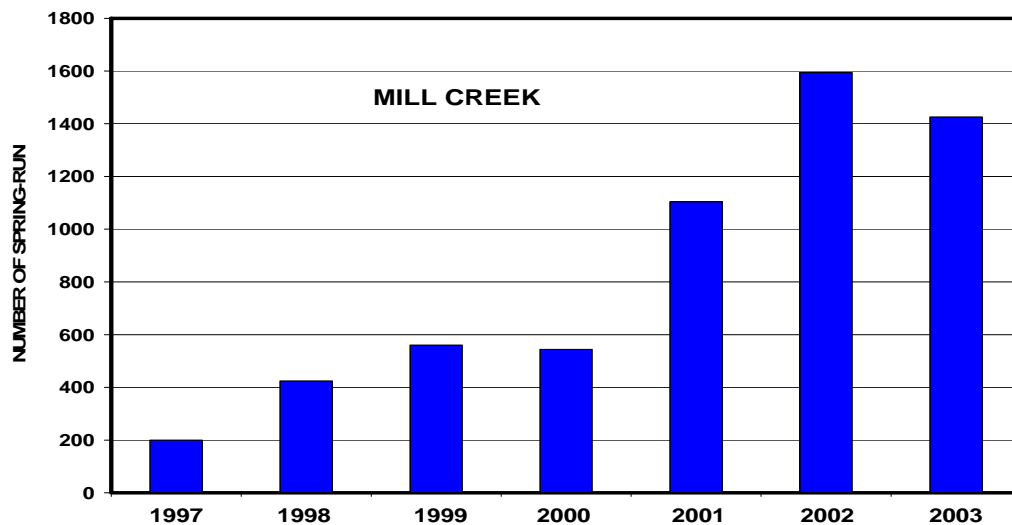
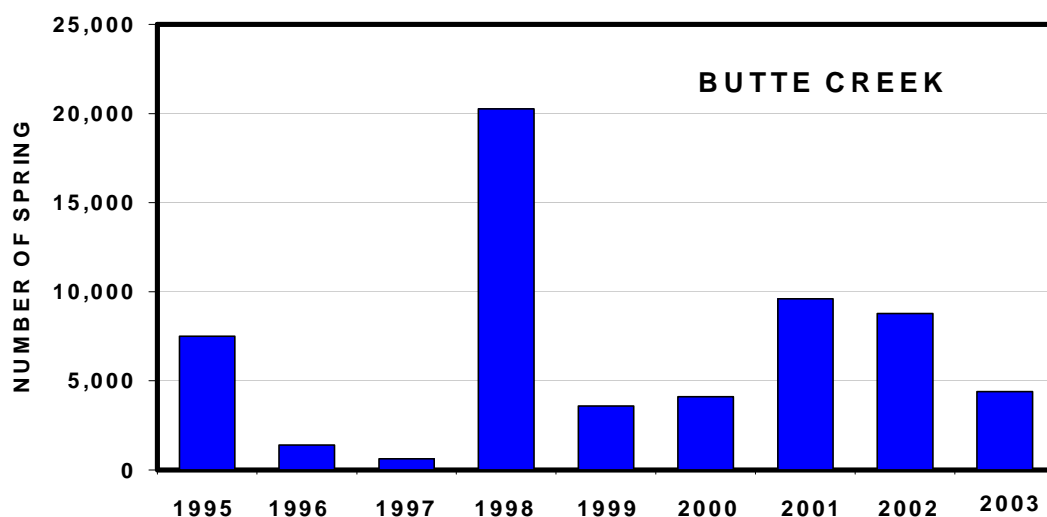


Figure 4. Adult spring-run Chinook population counts for Mill Creek, 1997-2003. Data based on expanded redd survey data.



In Butte Creek, some population recovery is evident in recent years (Figure 5). However, relatively high pre-spawning mortality in both 2002 and 2003 limited the number of fish successfully spawning. Snorkel counts occurred in each year following periods of high pre-spawning mortality.

In 2002 and 2003, Antelope, Big Chico, Battle, Clear, and Beegum creeks continued to support small populations of spring-run Chinook. No spring-run Chinook population data were collected in the Yuba River in 2002 or 2003.



**Figure 5. Adult spring-run Chinook population counts for Butte Creek, 1995-2003. Data based on snorkel surveys.**

## STREAM-SPECIFIC MONITORING

### Antelope Creek

Annual adult spring-run Chinook surveys are made using snorkel counts. These counts are consistently made the last week in July. This study includes surveying the known holding habitat of adult spring-run Chinook in the north fork, south fork and mainstem Antelope Creek (approximately 15 miles). Participants in this annual survey include the Department, U.S. Forest Service, NOAA Fisheries, and Sierra Pacific Industries. Counting methods have remained consistent from 1989 through 2003 and counts have ranged from 0 to 154 salmon. Currently, spawning distribution surveys are not made in Antelope Creek.

In 2002, a total of 46 adult spring-run Chinook were counted. In 2003, 46 adult spring-run

Chinook (coincidentally the same number) were counted.

Currently, juvenile outmigration of spring-run Chinook is not monitored in Antelope Creek.

### **Battle Creek**

The U.S. Fish & Wildlife Service (USFWS) Red Bluff Office monitored fish passage in Battle Creek using the Coleman National Fish Hatchery (CNFH) barrier weir from March 1 to August 31, 2002, and from March 3 to August 29, 2003. In 2002, of the 222 unclipped Chinook salmon that passed through the CNFH barrier weir, the USFWS estimated that about 144 were spring-run Chinook. Similarly, in 2003, of the 221 unclipped Chinook salmon, an estimated 94 were spring-run Chinook (Table 1). The USFWS made the assumption that most Chinook salmon used the fish ladder to pass upstream of the barrier weir (i.e., few fish jumped over the barrier weir) in 2002 because low flow conditions made jumping the weir more difficult. In 2003 however, flows were higher, and may have allowed some Chinook to jump the barrier weir.

The USFWS used two methods to monitor fish passage at the barrier weir: live trapping (early season) and underwater videography (late season). During live trapping, March 1 through May 27, 2002, a total of 129 unclipped Chinook salmon passed above the CNFH barrier weir. Between March 3 and May 30, in 2003, a total of 67 unclipped Chinook salmon passed above the CNFH barrier weir. Tissue samples from all of the unclipped salmon in 2002 and 2003 were genetically analyzed and identified. In 2002, two samples were designated winter-run, 73.7% spring-run and 25.4% fall and late fall-run Chinook, and in 2003, zero samples were designated winter-run, 68% spring-run, and 32% fall and late fall-run Chinook.

From May 27 through August 31, in 2002, underwater videography was used to monitor passage at the CNFH barrier weir. An estimated total of 77 unclipped Chinook salmon passed above the CNFH barrier weir. Of these, 39 passed prior to July 11. One was considered to be a winter-run Chinook based on an extrapolation of genetics during trapping, and the remaining 38 were considered to be spring-run Chinook based on the timing of passage. In 2003, during underwater videography, between May 30 and August 29, an estimated total of 154 unclipped and 13 clipped Chinook salmon passed above the CNFH barrier weir. Of these, 48 unclipped passed prior to July 13 and were considered to be spring-run Chinook based on timing of passage; however, an estimated 9 clipped Chinook also passed during this time.

The USFWS conducted spawning ground surveys twice a month (snorkel and walking) in all Battle Creek reaches above, and a three-mile reach immediately below, the barrier weir from May 6 through November 15, 2002, and from July 11 through November 14, 2003. A maximum of 88 adult Chinook and 78 redds were counted above the barrier weir in 2002. One redd was observed in late September and the additional 77 redds were observed in mid- to late October. In 2003, a maximum of 94 adults and 176 redds were counted above the barrier weir.

Many of these redds were probably the result of fall-run Chinook spawning. Spawning began in mid-September and continued until the end of October.

The USFWS' operation of rotary screw traps at river mile (rm) 2.8 and 5.9 continued in 2002 and 2003. Juvenile spring-run Chinook passage indices for the trap at rm 5.9 were 15,598 in 2002, and 121,260 in 2003. The time and location of spawning for spring and fall-run Chinook overlapped in upper Battle Creek, and is therefore impossible to distinguish juveniles of the two runs using length-at-date criteria. We included fish of both spring and fall-run Chinook length criteria in our indices of maximum potential spring-run Chinook. This is probably a reasonable assumption in 2002, when relatively fewer fall-run Chinook spawned in upper Battle Creek. In low water years, few fall-run Chinook are able to jump the barrier weir and enter upper Battle Creek. Therefore, rotary screw trap analysis assumed that in low water years most of the fall-run length Chinook produced in the upper watershed were spring-run Chinook. This approach was less reasonable in 2003 because more fall-run Chinook entered upper Battle Creek through the barrier weir fish ladder in August and a higher number of fall-run Chinook may have been able to jump the barrier weir. A barrier weir at Coleman National Fish Hatchery downstream of the upper trap blocks upstream movement of juvenile fall-run Chinook. The first fry of the year were captured on December 5, 2002 and November 25, 2003. Juvenile passage indices are preliminary and are based on data collected through March 7, 2004.

### **Butte Creek**

A snorkel survey was conducted from the Centerville Head Dam to Parrot Phelan Diversion Dam (PPDD) from August 12 -16, 2002. The adult spring-run Chinook population was estimated at 8,785 adults. An alternate estimate based upon the Schaeffer model carcass survey methodology was 12,597. An independent bi-weekly survey was conducted to monitor pre-spawning mortalities from June 16 through September 5, 2002. There were an estimated 3,431 pre-spawning mortalities that were not included in the escapement estimates. The pre-spawning and spawning carcass surveys recovered 19 Butte Creek coded-wire-tagged adults from brood year (BY) 1998 (2) and BY 1999 (17). Based upon the 19 recoveries, the year 2001 population included a minimum of 11% age-4 fish.

In the 2001- 2002 rotary screw trap sampling season, a total of 375,274 juvenile salmon was captured at PPDD near Chico, and 14,732 in the Sutter Bypass. There were 155,413 fish captured near Chico that were coded wire tagged, and 37 of the tagged fish recaptured in the Sutter Bypass traps. Average calculated growth rate for the Sutter Bypass recaptures was 0.38 mm/day, and the average time to recapture was 53 days. Juvenile Butte Creek spring-run Chinook were first captured in the Sutter Bypass trap on November 29, 2001.

A snorkel survey was conducted from Centerville Head Dam to Parrott-Phelan Diversion Dam from August 18 – 27, 2003. The annual adult escapement estimate for spring-run Chinook was 4,398. An alternate estimate based upon the Schaefer model carcass survey methodology was

6,063. A mark/recapture survey was conducted to evaluate pre-spawning mortality. A weekly pre-spawning survey was conducted from June 19 through early September, 2003, until the onset of spawning. Based upon the Schaefer model, there were an estimated 11,231 pre-spawn mortalities. A Department pathologist concluded that the pre-spawning mortality was due to an outbreak of two pathogens, *Flavobacterium columnare* (columnaris) and the protozoan *Ichthyophthirius multifiliis* (Ich), due to high water temperatures and density of fish. Maximum daily air temperatures during the last two weeks of July, 2003, exceeded 100°F for a total of 10 days, as measured at the nearby California Department of Forestry Cohasset Fire Station. Water temperatures in key holding pools reached average daily temperatures as high as 69.7°F during late July 2003.

The pre-spawn and spawning carcass surveys recovered 39 Butte Creek coded-wire-tagged adults from BY 1999 (17) and BY 2000 (21). Based upon the 39 recoveries, the year 2003 population included a minimum of 44% age-4 fish. Additionally, there was one Butte Creek coded-wire tag recovery from Clear Creek (BY 2000) and one recovered at the Feather River Hatchery (BY 1998). The FRH recovery was from the small release group (393 fish) of BY 1998 fish tagged as yearlings, thus bringing the total recovered to 4 (expanded to 10.34).

In the 2002-2003 juvenile sampling season, 50,953 juvenile Chinook were captured by rotary screw trapping at PPDD, near Chico, and 7,448 in the Sutter Bypass. There were 36,415 fish captured near Chico that were coded-wire-tagged, and two of the tagged fish recaptured in the Sutter Bypass trap. Juvenile Butte Creek spring-run Chinook were recaptured in the Sutter Bypass trap on March 12, 2003, and April 3, 2003, and the time to recapture was 74 and 33 days, respectively.

### **Big Chico Creek**

The adult spring-run Chinook count for 2002 and 2003 was 0 and 81 fish, respectively, based on the snorkel survey methodology.

In the 2001-2002 juvenile sampling season, 1,752 juveniles were captured near Chico. In the 2002-2003 sampling season, 173 juvenile salmon were captured near Chico.

### **Clear Creek**

The USFWS Red Bluff Office has conducted spring-run Chinook snorkel surveys in Clear Creek since 1999. A 16.4-mile reach was surveyed from Whiskeytown Dam downstream. Surveys occurred once a month from April through August and twice a month from September to November in 2002 and 2003. The number of live Chinook observed during August surveys was used as an index of annual adult spring-run Chinook abundance. August index survey counts were 66 in 2002 and 25 in 2003 (Table 1). Spring-run Chinook spawning began by September 9 and peaked in late September in both years. In 2003, a temporary picket weir was

installed from September 2 to November 3 to spatially separate spring-run (upstream) and fall-run Chinook (downstream). Surveys conducted during the weir installation period documented a minimum of 30 Chinook and a total of 55 redds upstream of the weir. One coded-wire tagged Butte Creek spring Chinook (BY 2000) was recovered in Clear Creek on October 1, 2003.

The USFWS' operation of a rotary screw trap at river mile (rm) 1.7 continued in 2002 and 2003. An additional trap at rm 8.2 was operated in 2003 and 2004, immediately upstream of the picket weir site. Juvenile spring-run Chinook passage indices for the trap at rm 1.7 were 7,722 in 2002 and 11,144 in 2003, based on length-at-date criteria developed for the upper Sacramento River. All juveniles captured in the upper trap above the picket weir were categorized as spring-run Chinook, regardless of length-at-date criteria, and the passage index was 57,695. Ninety-five percent of juveniles captured in the upper trap would have been misclassified as fall Chinook based on length-at-date criteria. A natural barrier downstream of the upper trap blocked upstream movement of juvenile fall Chinook. The first fry of the year were captured on November 5, 2002 and November 16, 2003. Juvenile passage indices are preliminary and are based on data collected through March 7, 2004.

### **Cottonwood Creek**

Beegum Creek, a major tributary of Cottonwood Creek, supports a small population of spring-run Chinook, under extreme environmental conditions. No dams impede salmon passage, and there is no significant human activity in the creek. However, the creek is the furthest from the ocean of all California salmon spawning streams, and fish experience some of the highest water temperatures there. The population arrives earlier instream than most spring-run Chinook, due to high water temperatures at the mouth of Cottonwood Creek which begin in May. Spawning begins in mid- to late October, later than most spring-run Chinook populations, due to high water temperatures.

A total of 125 adult spring-run Chinook were counted during the 2002 snorkel surveys in Beegum Creek (Table 1). This count was a decrease from 477 salmon in 1998 (Table 1). The Department has surveyed Beegum Creek periodically since 1973. Counts have ranged from a high of 477 in 1998 to a low of zero (1982, 1989, and 1997). Prior to 1998, fewer than 10 salmon were observed annually. Counts have ranged from 102 to 477 since 1998. The known holding and spawning habitat of adult spring-run Chinook (approximately 7.5 miles) was surveyed monthly in 2002. The first spring-run Chinook arrived in Beegum Creek on March 27, 2002, much earlier than previously assumed for spring-run Chinook. Fish were distributed throughout the holding reach, with no pre-spawning mortality observed. High water temperatures delayed spawning into late October, 2002. Thirty nine redds were observed during spawning surveys in October, 2002. Tissue samples for genetic analysis were collected from three carcasses. Spawning surveys confirmed that spring-run Chinook in Beegum Creek remain spatially and temporally isolated from fall-run in Cottonwood Creek.

In 2003, 73 adult spring-run Chinook were counted during the snorkel survey in Beegum Creek. Most fish survived the summer holding period, and spawning was estimated to start September 24, 2003. Redd surveys were not conducted in 2003.

Currently, juvenile outmigration of spring-run Chinook is not monitored in Cottonwood Creek.

### **Deer Creek**

Snorkel surveys from Upper Deer Creek Falls downstream to Dillon Cove (a distance of approximately 25 miles) are conducted annually the second week in August. This annual snorkel survey is a joint effort by the Department, U.S. Forest Service, Sierra Pacific Industries, NOAA Fisheries, and USFWS. Snorkel methodologies have remained consistent since 1992. During this time period, spring-run Chinook counts have ranged from a high of 2,759 fish in 2003 to a low of 209 fish in 1992. The average count over this eleven-year time period was 1,022 fish. In contrast, using a variety of counting methods in the 1940 – 1964 time period, an average of 2,200 spring-run Chinook was estimated to return to Deer Creek. Estimates during the earlier period are not directly comparable to counts since 1992, due to the differing methodologies used. In both 2002 and 2003, fall-run Chinook spawning surveys verified that spring-run Chinook in Deer Creek remain spatially and temporally isolated from spawning fall-run Chinook.

In 2002, a total of 2,185 spring-run Chinook were counted in snorkel surveys. Spawning surveys conducted by the U.S. Forest Service counted 1,022 redds and 290 carcasses. In 2003, a total of 2,759 spring-run Chinook were counted in snorkel surveys. Spawning surveys conducted by the U.S. Forest Service counted 1,087 redds, and 125 carcasses.

In the 2002-2003 outmigrant fish sampling season, a total of 193 BY 2001 spring-run Chinook yearlings were sampled using a rotary screw trap. Yearlings were caught from November 8, 2002, through March 29, 2003. Fish ranged in size from 50 millimeters fork length (mmfl) to 108 mmfl. The first BY 2002 young-of-year (YOY) was collected on January 10, 2003. A total of 1,640 BY 2002 YOY were collected between January 10, 2003, and May 28, 2003. These fish ranged in size from 29 mmfl to 85 mmfl. Due to the inability to effectively trap during high flow events (which coincide with peak outmigration periods), these numbers represent total numbers caught in the trap and not total production from the creek.

In the 2003-2004 outmigrant fish sampling season, a total of 114 BY 2002 yearlings have been sampled to date. Yearling outmigration began on November 13, 2003. Fish are ranging in size from 70 mmfl to 112 mmfl. The first BY 2003 YOY was collected on November 8, 2003. Outmigrant trapping for BY 2003 fish will continue through May 2004.



### **Mill Creek**

Redd surveys, extending from upstream of the Highway 36 bridge crossing on Mill Creek downstream to the steel tower transmission lines (a distance of approximately 25 miles), are conducted annually the first 2 weeks in October. The redd count is expanded to a population estimate using ratios of redds to female spawners and females to male spawners. Redd survey methodology has remained consistent since 1997. During this seven year period, the population has ranged from a high of 1,594 fish in 2002 to a low of 202 fish in 1997. The average count for this time period is 836 salmon. In contrast, an average of 1,900 spring-run Chinook was estimated to spawn in Mill Creek annually from 1947 to 1964. Counting methods during this historical time period included spawning surveys and ladder counts; therefore, estimates from this period are not directly comparable to estimates from redd counts conducted since 1997. In both 2002 and 2003, fall-run Chinook remained isolated from spawning spring-run Chinook.

In 2002, an estimated 1,594 adult spring-run Chinook returned to Mill Creek. Spawning surveys counted 797 redds and 60 carcasses. In 2003, an estimated 1,426 spring-run Chinook returned to Mill Creek. Spawning surveys counted 713 redds and 70 carcasses.

In the 2002-2003 outmigrant fish sampling season, a total of 127 BY 2001 spring-run yearlings were sampled using a rotary screw trap. Yearlings were caught from November 8, 2002, through April 18, 2003. Fish ranged in size from 74 mmfl to 171 mmfl. The first BY 2002 YOY was collected on February 5, 2003. A total of 681 BY 2002 YOY were collected between February and May 13, 2003. These fish ranged in size from 30 mmfl to 94 mmfl. Due to the inability to effectively trap during high flow events (which coincide with peak outmigration periods) these numbers represent total numbers caught in the trap and not total production from the creek.

In the 2003-2004 outmigrant fish sampling season, a total of 148 BY 2002 yearlings have been sampled to date. The first yearling was sampled on October 29, 2003. Fish are ranging in size from 75 mmfl to 132 mmfl. The first BY 2003 YOY was collected on December 9, 2003. Outmigrant trapping for BY 2003 fish will continue through May 2004.

### **Yuba River**

Currently spring and fall-run Chinook are restricted to the same physical location in the Yuba River. To quantify the number of adult spring-run Chinook salmon immigrating into the Yuba River, adult salmon were trapped in the fish ladders located on Daguerre Point Dam (DPD) in 2001, since they must pass the dam to access holding habitat upstream. Trapping was conducted from March 1, 2001, through July 31, 2001, the majority of the historical migration period. A total of 108 adult Chinook salmon were estimated during this period (Table 1).

No trapping occurred in 2002 or 2003; however, electronic monitoring equipment was installed on the north and south ladders during mid-summer 2003. A bank of infrared sensors now monitors up and downstream adult passage at Daguerre Dam. The system should provide



future spring-run Chinook salmon population information based upon known phenotypic run timing and observed passage at the dam.

The Department continued Chinook redd surveys on the Yuba River from the Narrows pool downstream to DPD (approximately 10 miles) from August 21, 2003, through October 3, 2003. Currently spring and fall-run Chinook are restricted to spawning in the same reach of the lower Yuba River below Englebright Dam. Spawning activity in September could represent spring-run Chinook spawning based on historic information. A total of 212 redds were observed, with the first redds observed on September 4, 2003. This number was lower than the 239 redds observed during the same time period in 2002. Redds were constructed in water depths ranging from 0.13 to 1.40 meters, with a modal depth of 0.40 meters. Although data were collected, redds were not marked on the last survey day due to significant redd superimposition. All individually marked redds were formed in glide, riffle, and pool habitat, 56%, 38%, and 6% respectively.

Rotary screw trap operations were continued during the 2003-2004 season to document outmigration patterns of juvenile salmonids in the Yuba River. Trapping is ongoing and is slated to terminate July 2004. Data collected include timing, duration, weight and size of Chinook salmon at time of outmigration. All captured Chinook were marked with a coded-wire tag (CWT) and external adipose fin clip as part of a life history study cooperatively administered by the Department, the South Yuba River Citizens League (SYRCL), and the USFWS (USFWS Agreement #11332-2-J007). Although spring and fall-run spawning occurred in the same physical location, length frequency data from juveniles captured in the rotary screw trap indicated the presence of both a dominant fall-run and a smaller population of spring-run Chinook. Spring-run Chinook were determined by size-at-date differences through the operation of the rotary screw trap. Calibration tests were conducted at two-week intervals to determine relative trapping efficiencies during varying flows. A total of 46,629 spring-run Chinook were captured from a total of 195,492 (including spring-run, fall-run and late fall-run) juvenile Chinook between October 15, 2003, and December 31, 2003. A total of 192 steelhead were also sampled. Coded-wire tagging operations began on November 20, 2003, with a total of 97,529 juvenile Chinook salmon successfully tagged and released as of December 31, 2003.

### **Mainstem Sacramento River**

The Department cannot make reliable carcass survey estimates of returning adult spring-run Chinook in the mainstem Sacramento River because of the overlap in spawn timing with fall-run Chinook. In 2002, an estimated 608 salmon showing spring-run Chinook characteristics passed RBDD. Of these fish, 125 were estimated by the Department to have entered Beegum Creek, a tributary to Cottonwood Creek. The remaining fish (485) may have spawned in the mainstem Sacramento River or entered other upstream tributaries such as Clear or Battle creeks. Aerial redd surveys showed no redds downstream of RBDD in the spring-run Chinook spawning period. In 2003, an estimated 145 salmon showing spring-run Chinook

characteristics passed RBDD. A greater number were estimated to enter Beegum, Clear, and Battle creeks; therefore, no adult spring-run Chinook were estimated to spawn in the mainstem river in 2003.

### **Sacramento-San Joaquin River Delta**

Monitoring, management activities, and actions play key roles in minimizing the impact of state and federal water project operations on spring-run Chinook in the Delta. A decision process for the protection of juvenile Chinook salmon was used as previously reported (CDFG 2001). In this process, biologists use information from various fisheries monitoring activities to make decisions related to operation of the Delta Cross Channel and modification to the State Water Project/Central Valley Project (SWP/CVP) export pumping using CVPIA b(2) water and the CALFED Environmental Water Account (EWA).

## **III. HARVEST MANAGEMENT CONSERVATION MEASURES**

Inland sport fishing protective regulations include fishing method and gear restrictions, fishing hour and bait limitations, and special regulations (seasonal closures and zero bag limits) in several primary tributaries such as Deer, Big Chico, Mill, and Butte creeks. Enhanced enforcement activities continue to be implemented throughout spring-run Chinook tributaries and adult holding areas, which reduce illegal harvest significantly. Detailed information on these harvest management conservation measures was documented in the 1998 status review of spring-run Chinook in Sacramento River tributaries (CDFG 1998).

The Pacific Coast Salmon Plan (FMP) was developed by the Pacific Fishery Management Council (PFMC) to manage west coast ocean salmon fisheries. The current FMP conservation objective for Sacramento River winter-run and spring-run Chinook is the consultation standard set out in the National Marine Fisheries Service's (NMFS<sup>1</sup>) 2002 Biological Opinion (BO). The BO, which covers the 2002 and 2003 fishing seasons beginning May 1 and ending April 30, requires that commercial and recreational seasons south of Point Arena not change substantially relative to the 2000 and 2001 season. NMFS will issue a new biological opinion prior to 2004 seasons that will also specify the commercial and recreational seasons south of Point Arena. Those specifications are anticipated to be similar to those in effect since 2000.

Cohort analysis of recoveries of coded-wire tagged wild Butte Creek spring-run Chinook indicate that ocean fishery impacts occur primarily on age 4 fish, south of Point Arena, California. Spawner reduction rates (the fraction of potential adult spawners taken by the fishery) are estimated to be 0.36 and 0.42 for 1998 and 1999 brood years, respectively (Interagency Workgroup Report to the PFMC February 19, 2004).

---

<sup>1</sup> National Marine Fisheries Service (NMFS) is currently NOAA Fisheries.

At the November 2001 PFMC meeting, NMFS proposed initiating an FMP amendment that would specify management objectives for Sacramento River winter and spring Chinook stocks. The Department has been actively engaged in this effort. The interagency workgroup, formed to analyze the available harvest data and develop management objective proposals, delivered a progress report to the PFMC at the March 2004 meeting. The ESA consultation standards for winter-run and spring-run Chinook set out in the NMFS' 2000 and 2002 biological opinions are expected to be extended with some minor modifications.

#### **IV. CENTRAL VALLEY-WIDE RESTORATION PROGRAMS**

Central Valley-wide restoration programs use ecosystem conservation approaches to recover endangered and threatened species. These programs directly or indirectly benefit Central Valley salmon species as documented in the winter-run Chinook salmon reports (CDFG 2004).

##### **CALFED BAY-DELTA PROGRAM**

The CALFED Bay-Delta Program, established in May 1995, has the ambitious goal of achieving recovery of at-risk native species dependent on the Delta and Suisun Bay as the first step toward establishing large, self-sustaining populations of these species; supporting similar recovery of at-risk native species in San Francisco Bay and the watershed above the estuary; and minimizing the need for future endangered species listings by reversing downward population trends of native species that are not listed.

The CALFED Bay-Delta Program consists of several key program elements that will help achieve ecosystem restoration and species recovery. One of these elements, the Ecosystem Restoration Program (ERP), was developed to guide restoration actions and ensure attainment of ecosystem health (also called ecological integrity). The strategy described in the ERP to restore ecological integrity is based on the restoration of ecological processes that are associated with streamflow, stream channels, watersheds, and flood plains, which in turn support habitats and associated species. In addition, the CALFED Program established the Environmental Water Account (EWA), Environmental Water Program (EWP), Multi-species Conservation Strategy (MSCS), and Science programs, which are designed to work in conjunction with the ERP to increase protection of listed species in the Delta, improve streamflow regimes, and ensure the application of sound scientific principles in ecosystem restoration actions.

The CALFED Program is following a three-phase process to achieve broad agreement on long-term solutions. In the first phase, the CALFED Program developed a range of alternatives, consisting of hundreds of actions. The Program conducted meetings and workshops to obtain public input, prepared a Notice of Intent and Notice of Preparation pursuant to NEPA and CEQA, and held public scoping sessions to determine the focus and content of the EIS/EIR. The first phase concluded in September 1996 with the development of a range of alternatives for

achieving long-term solutions to the problems of the Bay-Delta estuary. During Phase II, the Program conducted a comprehensive programmatic environmental review process. A draft programmatic EIS/EIR and interim Phase II Report identifying three draft alternatives and program plans was released on March 16, 1998. The release of the documents was followed by a 105-day public comment period. On June 25, 1999, CALFED again released a draft programmatic EIS/EIR followed by a 90-day comment period. The final programmatic EIS/EIR was released July 21, 2000, followed by the Record of Decision (ROD) on August 28, 2000. The ROD completed Phase II. Program implementation is occurring in Phase III.

Early implementation of CALFED ecosystem restoration projects began in 1996, even as the many elements of the CALFED Bay-Delta Program were being designed and debated. With extensive public participation, the CALFED agencies have established through the ERP and MSCS a “Single Blueprint” for restoration and species recovery within the geographic scope of the ERP. This blueprint is intended to ensure close coordination of future restoration efforts with a common goal and approach.

The ERP/MSCS has established a goal of “recovery” for spring-run Chinook. Recovery is achieved when the decline of a species is arrested or reversed, threats to the species are neutralized, and the species’ long-term survival is assured.

Various commitments were made in the CALFED ROD to ensure funding for ecosystem restoration. In Stage 1 (the first seven years of implementation following the ROD), CALFED plans to invest over \$1 billion in ERP projects, in accordance with the priorities established in the Strategic Plan, and in addition to funds necessary for the EWA program. The CALFED Conservation Agreement Regarding Multi-Species Conservation Strategy requires that the ERP must be funded in the amount of at least \$150 million annually through Stage 1. An additional \$50 million will be allocated annually for the EWA for the first four years. The ESA commitments described in the CALFED ROD include an operational EWA and benefits of the ERP. For the ERP, the CALFED Agencies have proposed a combination of state funding (including Proposition 204 funds), federal funding, and user fees.

The CALFED ERP has awarded more than \$476 million to date for more than 400 projects. Ecosystem restoration efforts continued to improve habitat and address the needs of key species in 2002 and 2003. Fish screening and passage projects received the highest level of funding compared to other project categories.

The CALFED ERP has funded adult and juvenile spring-run Chinook monitoring programs on Butte Creek since 2001. These programs provide valuable monitoring data on the size of the spawning population, and the relative abundance and timing of juvenile emigration.

## **CENTRAL VALLEY PROJECT IMPROVEMENT ACT PROGRAM**

The Central Valley Project Improvement Act (CVPIA), enacted in 1992, amended the authority of the Central Valley Project (CVP) to include fish and wildlife protection, restoration, and mitigation as having equal priority with other CVP purposes. Section 3406 (b) of the CVPIA directs the Secretary of the Interior to develop and implement programs and actions to ensure that by 2002, the natural production of anadromous fish in Central Valley streams will be sustainable, on a long-term basis, at levels at least twice the average levels of natural production in the 1967 through 1991 baseline period.

The Anadromous Fish Restoration Program (AFRP) was established in 1995 by Section 3406(b)(1) of the CVPIA. The AFRP staff, with help from other agencies and groups, established baseline production estimates for Central Valley streams for naturally produced Chinook salmon and other anadromous species. Baseline production estimates were developed using population data from 1967 through 1991. Production targets for anadromous fish were determined by doubling the baseline production estimates.

Numerous actions to improve the natural production of anadromous fish, including spring-run Chinook, have been funded by the CVPIA program since 1992. In each of fiscal years 2002 and 2003, the AFRP program provided \$2.8 million in funding for anadromous fish restoration projects.

## **NOAA FISHERIES RECOVERY PLANNING**

NOAA Fisheries initiated comprehensive recovery planning for listed salmonid species in the Central Valley in 2003. NOAA Fisheries is required under the Federal Endangered Species Act (ESA) to assess factors affecting the species, identify recovery (delisting) criteria, identify the entire suite of actions necessary to achieve these goals, and estimate the cost and time required to carry out the actions. In California, NOAA Fisheries has developed an approach, in coordination with NOAA Fisheries' Northwest Region, which is tailored to California recovery planning issues.

The Central Valley recovery planning domain includes the Sacramento River basin downstream from Keswick Dam, the Sacramento/San Joaquin Delta, and the San Joaquin River Basin, from the confluence of the Merced River downstream. This domain encompasses the Evolutionarily Significant Units (ESUs) for Sacramento River winter-run Chinook, Central Valley spring-run Chinook, and Central Valley steelhead.

NOAA Fisheries appointed a Central Valley Technical Recovery Team (TRT) to begin the recovery planning process in 2003, including two representatives from the Department. The team is composed of experts in salmon biology, population dynamics, conservation biology, ecology, and other relevant disciplines. The Central Valley TRT will work closely with existing technical teams.

## **V. RESTORATION AND MANAGEMENT ACTIONS**

An overview of conservation efforts in Sacramento River mainstem and tributaries is shown in Appendix A. The following sections describe important restoration and management activities in the Sacramento-San Joaquin Delta and several Sacramento River tributaries.

### **CENTRAL VALLEY PROJECT/ STATE WATER PROJECT OPERATION**

In early January 2002, high losses of older juvenile Chinook (winter and spring-run Chinook) coincided with a high loss of adult delta smelt, triggering an export curtailment at the State Water Project (SWP) facility for several days for fishery protection. Again from December 27, 2002, through January 2, 2003, an export curtailment was made at the SWP facility to reduce entrainment losses of older juvenile Chinook.

The Delta Cross Channel (DCC) gates can be closed for up to 45 days in the November through January period to prevent juvenile salmon from entering the DCC from the Sacramento River and passing into the interior Delta, where their survival is relatively poor. The gates also are closed when high river flow can cause scouring and increased flood risk. In 2001, the DCC gates were closed on November 21 for fish protection. With the exception of a five-day period, the gates remained closed through January 2002. In late 2002, the DCC gates were closed on December 3, and with the exception of a six-day period, remained closed through the end of January 2003. The DCC gates are always closed from February 1 through May 20.

### **RESTORATION AND MANAGEMENT ACTIVITIES ON SACRAMENTO RIVER TRIBUTARIES**

The major activities that result in significant adverse effects on spring-run Chinook in the upper Sacramento River tributaries include gravel mining, hydroelectric and agricultural diversions, and bank protection. The primary objectives of the restoration activities are reestablishing flow regimes, passage, and stream channel process as necessary to recover sensitive species, and using a cooperative approach to solve environmental problems in key watersheds.



Major restoration activities include:

- identifying priority streams to focus restoration actions;
- facilitating and participating in collaborative processes, among interested and affected parties, that are directed at gaining community acceptance and funding for restoration actions;
- increasing the quality and quantity of water flows;
- providing fish passage;
- restoring flood plain and gravel bed processes; and
- maintaining healthy ecosystem processes.

### **Battle Creek**

The Battle Creek Restoration Project is an example of a cooperative approach to solving environmental problems through CALFED's ecosystem restoration process. The stream reaches being restored are located in upper Battle Creek where Pacific Gas and Electric Company (PG&E) operates a series of nine hydroelectric dams and canals affecting 42 miles of habitat suitable for all five runs of native anadromous salmonids. Particularly, a 42-mile reach of Upper Battle Creek adversely affected by hydroelectric development will be fully restored under an agreement between the power company and resource agencies. Among the nine diversion dams affecting anadromous fish on Battle Creek, five are proposed for removal and their water rights dedicated to the environment. The remaining dams will have the required minimum instream flows increased 8 to 16 times above the current legal minimums yielding predicted habitat increases of 500 to 800%. The structures on the remaining dams will be modified to include optimally designed fish ladders and fish screens. The project is also designed to avoid rescreeing water, flow fluctuations, and false attraction of returning adults to transbasin canal waters. Other activities include a project to restore the meander belt and riparian forest on the lowest five miles of the creek and a USFWS hatchery reevaluation process that includes integrating operation of Coleman National Fish Hatchery with Battle Creek restoration.

### **Butte Creek**

The Department continued to monitor all fish passage structures in and along Butte Creek, and provided technical assistance to water diverters. The ecosystem restoration efforts in 2002-03 included the following activities:

- Fish screens and ladders were completed at three water control structures in the Sutter Bypass reach of Butte Creek.
- Fish ladders and modifications to three water control structures were completed at three sites in the Butte Sink.
- Draft technical/environmental evaluations were completed by the Department of Water Resources (DWR) for upgraded fish ladders at the Sutter Bypass Weir 2, and Willow Slough sites.



- The Department continues to work closely with Ducks Unlimited and California Waterfowl Association to complete spring-run Chinook restoration actions in the lower reaches of Butte Creek.

### **Big Chico Creek**

The Department continued to monitor and make modifications to the Iron Canyon fish ladder, and conducted regular surveys during the adult migration period to relocate adults that were stranded due to reduced flows.

### **Clear Creek**

Streamflow allocation and gravel replenishment are important restoration projects in Clear Creek. Flows are allocated on Clear Creek and the mainstem Sacramento River to meet biological needs and to provide stable habitat for salmon spawning, incubation, and rearing. Increased instream flows for Clear Creek restoration have been provided since 1999 through the CVPIA (b)(2) water program. More advanced instream flow studies are in progress to better define biological needs and refine flow allocation processes. In September 2002, an experimental pulse flow was released to test the ability to use flow management to separate fall-run from spawning with spring-run Chinook. In January 2003, a pulse flow was released in an attempt to create spring-run Chinook spawning areas by redistributing gravel placed below Whiskeytown Dam.

The Department is one of several technical advisors on the lower Clear Creek technical advisory team, which guides the restoration and monitoring efforts within the watershed. Western Shasta Resource Conservation District has been the primary entity involved with implementing restoration in the watershed, both in the floodplain and in the upland areas, and has been successful in obtaining grants to implement projects.

Funds provided via CVPIA (which are administered by BOR and the USFWS) have also been used for monitoring and implementation, as are funds from the U.S. Bureau of Land Management and the National Park Service, who manage a large portion of the floodplain and surrounding upland areas. For example, gravel continues to be replenished on salmon spawning riffles to compensate for blockage of the supply by Shasta and Whiskeytown dams (66,200 tons since 1996, 14,000 of which was placed in Fiscal Year (FY) 2002 to 2003). The removal of McCormick-Saeltzer Dam in 2001 restored access to approximately 12 miles of cold-water habitat critical for spring-run Chinook and Central Valley steelhead.

Restoration on a three-mile reach of lower Clear Creek and another site (Reading Bar), adversely affected by 30 years of instream gravel mining, was partially restored under a five-phase project (funded by the USBR, CALFED, and CVPIA). Two additional phases are yet to be completed, and funding is being sought to complete that component of restoration work on the stream. The channel restoration included filling in abandoned gravel pits in the floodplain;

revegetation (riparian and upland species), where applicable; and in one section, moving the stream channel into another area more suitable for spawning and for geomorphological stability. In FY 2002 and 2003, approximately 22 acres were reconstructed as part of this project, and approximately 28 acres were revegetated. Along with fish population monitoring, the restored areas were monitored for use by avian species and revegetation success.

Another project of interest was the replacement of a bridge over Clear Creek which entered an environmental educational camp. The bridge was a chronic problem, and was of a concern due to its location within listed species habitat (upper part of the creek). The bridge, which was being rebuilt by the Park Service, was near completion by the end of FY 2003. Revegetation and gravel placement were also components of the project.

Clear Creek has been identified as one of five Tier One streams by the CALFED Environmental Water Program (EWP). Presentations of the EWP program were held in the watershed in late FY 2003, as were discussions on the types of projects that could be implemented in the Clear Creek watershed with EWP funds.

Outreach and education also have played a large part in Clear Creek. The Western Shasta Resource Conservation District regularly leads field trips into the lower watershed and coordinates volunteers interested in helping with restoration, as well as keeps the local community up to date on restoration activities via its newsletter. The Horsetown Creek Preserve, which is made of up local landowners, continues to play a role in education and maintenance of trails, as well as volunteering in restoration activities. A video presentation on Clear Creek restoration activities and the successful collaboration of agencies and stakeholders was also prepared and was broadcast locally on the public television station (it is also available on CD).

The impacts of mercury continue to be an issue in the lower watershed. Mercury contamination is present in the watershed as a result of historic gold mining practices. Several recent studies on the distribution and potential impacts of mercury in lower Clear Creek are either underway or have been recently completed.

Finally, through a CALFED grant (and subsequent limited funding from CVPIA), the Clear Creek Decision Analysis and Adaptive Management model (or CCDAM) continues to be developed and refined. Since January 2000, ESSA Technologies (of Vancouver BC) has been working on a prototype computer model to assist managers and scientists in evaluating alternative flow management strategies for Whiskeytown reservoir and Clear Creek. This decision support tool has been developed with the financial assistance of the CALFED Bay-Delta Program, and the technical assistance of both local and independent experts. CCDAM has been structured to consider multiple objectives (e.g. fisheries, riparian ecosystems, channel restoration, power, recreation, flooding), and also the benefits and costs of different adaptive management approaches to reduce existing gaps in data and functional relationships. A more complete use of the model is expected to be available in FY 2004.

## **Yuba River**

Evaluation and CEQA/NEPA documentation of fish passage alternatives at Daguerre Point Dam (DPD) was continued by the Fish Passage Improvement Program of DWR in 2003. This is a cooperative effort to improve adult and juvenile anadromous fish passage by the Department and DWR, in conjunction with the USFWS, NMFS, Army Corps of Engineers, South Yuba River Citizens League, Yuba County Water Agency, and other stakeholders. The Department funded sediment studies for the project. The analysis is being conducted by the U.S. Geological Survey and is anticipated to be completed, with final report, in fall 2004. The CEQA/NEPA documentation is anticipated to be completed in early 2005 and will recommend a preferred alternative to improve fish passage over DPD.

An automated fish counter (VAKI Riverwatcher) was installed in each of the ladders at DPD. This will provide important information on further validation and population estimates (based on phenotypic migration period) of spring-run Chinook salmon in the Yuba River. The AFRP provided funding for the units which are operated and maintained by the Department.

The Upper Yuba River Studies Program, initiated by CALFED in 1998, is a collaborative effort to determine if introduction of wild Chinook and steelhead to the upper Yuba River watershed is biologically, environmentally, and socio-economically feasible over the long term. CALFED has approved \$6.7 million in funding to initiate the studies. The scope of work for the studies has been completed, and a study contractor has been selected.

The Department, with other stakeholders, has been working with a consultant to develop an implementation plan for lower Yuba River anadromous fish habitat restoration actions (funded by CALFED). This project's primary objectives include: (i) developing a detailed implementation plan that provides the conceptual framework and process that will guide development, implementation, and restoration actions; (ii) facilitating implementation of prioritized enhancement/restoration actions and studies leading to the recovery of fall-, late fall- and spring-run Chinook, steelhead, and other anadromous fish populations; and (iii) implementation of near-term actions and studies that promote effective recovery of Chinook and steelhead populations, while increasing knowledge of how key watershed structures, processes, operations, and related factors work together to affect anadromous fish habitat and populations in the lower Yuba River.

The AFRP has funded a study through the University of California at Davis to determine viability and placement of spawning gravel in the Yuba River, primarily below Englebright Dam. Englebright Dam is preventing the recruitment of gravel in the reach immediately below and available spawning gravel/habitat is being depleted over time. The study should be completed within 2004. It is anticipated that the U.S. Army Corps of Engineers will implement a gravel augmentation program based on the results of the study.

## WATERSHED GROUPS

The role of watershed groups in spring-run Chinook conservation was reviewed by Bingham and Harthorn (2000). Contributions to ecosystem restoration and management for spring-run Chinook in 2001 are reported in Appendix B for the following watershed groups: Big Chico Creek Watershed Alliance, Butte Creek Watershed Conservancy, Cottonwood Creek Watershed Group (CCWG), Deer Creek Watershed Conservancy, and Mill Creek Watershed Conservancy.

## VI. GENETICS RESEARCH

Molecular genetic research has demonstrated genetic differentiation of spring-run Chinook from other Chinook runs in the Central Valley (Bartley et al. 1992; Myers et al. 1998; Nielsen 1995; Nielsen et al. 1999; Banks et al. 2000; Kim et al. 1999). These studies provide a general understanding of the genetic structure of Chinook populations in the Central Valley. General conclusions that can be drawn from this research include (i) Central Valley Chinook are well differentiated from coastal Chinook salmon populations, (ii) differentiation between populations in the same river with different run times has apparently occurred independently in Central Valley and coastal areas, and (iii) within the Central Valley, major genetic units are generally congruent with adult run-time (fall, winter, and spring-run Chinook).

Banks et al. (2000), in particular, provided insight into the genetic diversity that exists within the Central Valley spring-run Chinook ESU. The study detected a large genetic difference between spring-run Chinook from Butte Creek and Mill/Deer Creeks.

NOAA Fisheries, in collaboration with the Department, is initiating a major new study of salmon population genetics in the Central Valley (Garza 2001). This project, funded by the CALFED ERP program, will provide a comprehensive assessment of genetic population structure and distribution of genetic diversity for Central Valley spring, fall, late fall, and winter-run Chinook. Results of the study will be used to help guide recovery and restoration efforts. A standardized population genetic database will be established, which will integrate existing data and be adequate in both geographic coverage and size to evaluate remaining questions about genetic population structure of Central Valley Chinook. The specific population parameters provided by this database will include (i) population boundaries and times of divergence among populations, (ii) levels of gene flow between populations, and (iii) straying rates and levels of hybridization with hatchery-raised fish. In 2002 and 2003, tissue samples were collected from spring-run Chinook throughout the Sacramento River system for analysis in this study.

## VII. LITERATURE CITED

- Banks, M.A., V.K. Rashbrook, M.J. Calavetta, C.A. Dean, and D. Hedgecock. 2000. Analysis of microsatellite DNA resolves genetic structure and diversity of Chinook salmon (*Oncorhynchus tshawytscha*) in California's Central Valley. *Canadian Journal of Fisheries and Aquatic Sciences* 57: 915-927.
- Bartley, D., B. Bentley, J. Brodziak, R. Gomulkiewicz, M. Mangel, and G.A.E. Gall. 1992. Geographic variation in population genetic structure of Chinook salmon from California and Oregon. *U.S. National Marine Fisheries Service Fishery Bulletin* 90:77-100 (authorship amended per errata, *Fishery Bulletin* 90[3]:iii).
- Bingham, N. and Harthorn, A., 2000. Spring-run Chinook salmon work group: A cooperative approach to watershed management in California. In *Sustainable Fisheries Management: Pacific Salmon*. Knudsen, E. E, Steward, C. R., MacDonald, D. D., Williams, J.E. and Reiser, D.W. eds. Lewis Publishers, Boca Raton and New York.
- California Department of Fish and Game (CDFG). 1998. Report to the Fish and Game Commission: A status review of the spring-run Chinook salmon (*Oncorhynchus Tshawytscha*) in the Sacramento River Drainage).
- California Department of Fish and Game (CDFG). 2000. Spring-run Chinook salmon annual report for the Fish and Game Commission.
- California Department of Fish and Game (CDFG). 2001. Spring-run Chinook salmon annual report for the Fish and Game Commission.
- California Department of Fish and Game (CDFG). 2002. Sacramento River winter-run Chinook salmon biennial report for the Fish and Game Commission.
- California Department of Fish and Game (CDFG). 2004. Sacramento River winter-run Chinook salmon biennial report for the Fish and Game Commission.
- Garza, J. C. 2001. Comprehensive assessment of genetic population structure and diversity for Central Valley Chinook salmon. Research proposal to CALFED.
- Interagency Workgroup. 2004. Progress Report to the Pacific Fishery Management Council: Recommendations for developing fishery management plan conservation objectives for Sacramento River winter Chinook and Sacramento River spring Chinook. March 2004.

- Kim, T.J., K.M. Parker, and P.W. Hedrick. 1999. Major histochemical complex differentiation in Sacramento River Chinook salmon. *Genetics*. 151:1115-1122.
- Moyle, P. B. 2002, *Inland Fishes of California*. University of California Press, Berkeley and Los Angeles, California.
- Myers, J.M., et al. 1998. Status review of Chinook salmon from Washington, Idaho, Oregon, and California. NOAA Technical Memorandum NMFS-NWFSC-35.
- Nielsen, J.L. 1995. Mitochondrial DNA frequency distributions in Chinook salmon from the Sacramento-San Joaquin basin and Guadalupe River 1992-1994. Report to California Department of Fish and Game.
- Nielsen, J.L., M.C. Fountain, D.R. Sundermeyer, E.L. Heine, C.L. Malone, and O.L. Avelino. 1999. Microsatellite variation in Chinook salmon spawning runs from the Central Valley, California, 1992-1997. Report to California Department of Fish and Game.

# **VIII. APPENDICES**

## **Appendix A. Spring-run Chinook salmon monitoring and conservation efforts in the Sacramento River mainstem and tributaries. (See Appendix C for report contributors.)**

<b>TRIBUTARY</b>	<b>MONITORING</b>	<b>RESTORATION AND MANAGEMENT</b>	<b>PROGRAM LEAD</b>
Antelope Creek	-snorkel survey	No information	Colleen Harvey Arrison
Big Chico Creek	-snorkel survey - rotary screw trapping	Activities of the Department Fish Screen Team, Department of Water Resources, and Big Chico Cr. Watershed Alliance (see Appendix B)	Paul Ward Roger Cole
Battle Creek	-fish passage monitoring -fish spawning survey -fish genetic study -juvenile emigration	Restoration activities to reestablish flow regimes, passage and stream channel process (see text)	Matt Brown Mike Berry
Butte Creek	-snorkel/swimming survey -carcass survey - tissue archive - rotary screw trapping -released coded-wire tagged juvenile salmon	Activities of the Department Fish and Game, partnership with Ducks Unlimited and California Waterfowl Association, Butte Creek Watershed conservancy (see Appendix B )	Paul Ward Ken Keller
Clear Creek	-snorkel survey -live Chinook and redd counts - rotary screw trapping	Stream flow allocation, spawning gravel restoration, and other restoration activities (see text)	Mike Berry Jess Newton Matt Brown Tricia Bratcher
Beegum and Cottonwood Creeks	-snorkel survey -spawning survey -salmon carcasses and tissue archive for genetic research and age composition	Activities of Cottonwood Creek Watershed Group (see Appendix B)	Doug Killam Vieva Swearingen
Deer Creek	-snorkel survey -spawning survey -rotary screw trapping -outmigrant monitoring	Activities of the Deer Creek Watershed conservancy (see Appendix B)	Colleen Harvey Arrison Tricia Bratcher Ken Roby
Mill Creek.	-snorkel survey -spawning survey - tissue archive for genetic research and age composition	Activities of the Mill Creek Watershed conservancy (see Appendix B)	Colleen Harvey Arrison Tricia Bratcher Kerry Burke
Yuba River	-escapement survey - outmigration survey -spawning survey	Fish passage program, fish screen and barriers work, CALFED Upper Yuba River Studies Program, and CALFED Lower Yuba River anadromous restoration project (see text)	John Nelson Duane Massa
Bay Delta	-see text	See text	Jim White
Sacramento River mainstem	-aerial redd survey	See text	Doug Killam



## **Appendix B. Restoration and management activities by watershed groups**

---

### **The Big Chico Creek Watershed Alliance**

- Completed an Existing Conditions Report, which is available at the Sacramento River Preservation Trust web site.
- Continued to work with and support efforts to improve the fish ladder in Iron Canyon.
- Supported and participated in acquisition of the Hennings Ranch along upper Big Chico Creek to provide additional protection for spring-run Chinook summer holding areas.
- Partnered with Streaminders Chapter of the Izaak Walton League on two restoration projects along Big Chico Creek.

### **The Butte Creek Watershed Conservancy (BCWC)**

- Implementing Watershed Management Strategy.
- Received grant and completed the Butte Creek Property Owners Manual emphasizing Best Management Practices for the 40-acre and smaller landowner.
- Received CALFED grant to complete the Butte Creek Watershed Floodplain Management Plan.
- Spearheaded glass bottle ban for Butte Creek that became law in late 2001.
- Conducted a bottle ban sign program as well as other outreach and educational efforts.
- Completed four quarterly newsletters with circulation of over 3000 and with one page devoted to CALTIP and salmon issues.
- Continued expansion of full service web page and email ([buttecreekwatershed.org](http://buttecreekwatershed.org); [creek@inreach.com](mailto:creek@inreach.com).)
- Held 12 Board meetings, one Spring-Run Salmon celebration and one general membership meeting with elections of directors to the board.
- Board of directors active on many other boards and commissions in watershed bringing a wealth of information to BCWC and representing BCWC outreach throughout the watershed.
- Supported Department carcass survey method to be used in the Butte Creek adult spring-run Chinook salmon population survey.
- Supported efforts of the Paradise Pines Property Owners Association in the solicitation of funds for the community-based Wildfire Prevention Grants Program to support the Greenbelt Fire Fuel Reduction Plan.

- Supported the Lassen National Forest Watershed Stewardship program within the Antelope Creek watershed.
- Supported the Western Canal Water District's AB 303 grant proposal for development of groundwater management plan.
- Supported the efforts of the Butte Fire Safe Council.
- Held Community Garbage Collection Day for the residents of Butte Creek Canyon.
- Supported the M & T Fish Screen Facility / City of Chico Wastewater Treatment Outfall Short-Term / Long-Term Protection Project affecting fish flows in Butte and Big Chico creeks.
- Active in recreation management and impact mitigation at abused access points along creek. This involves active contact with county, state and federal land managers regarding these impacts.
- Supporter of Adopt-A-Watershed and like programs in K-12 education.
- Supporter of Spring-run Salmon Workgroup and other local efforts.
- Supported the fluvial geomorphic study of Butte Creek completed in early 2002 with funding from the US Fish and Wildlife Service.
- Supported the Department's trapping and tagging program.
- Supported increased funding for local game wardens.
- Active in CALFED Integrated Storage Investigations program in Butte County.
- Continued partnership with PG&E and Sierra Pacific Industries on restoration of lands donated to BCWC.

#### **Cottonwood Creek Watershed Group (CCWG)**

- Environmental Education: CCWG received a grant from the CALFED Ecosystem Restoration Program (2001 solicitation) to promote environmental education in the watershed's public (including charter) schools. The project, Kids for our Creek, was initialized in late FY2003. Education about natural resources, including fisheries, will be a large part of the program, as well as providing locally applicable education materials for students, teachers, and families.
- Geomorphological monitoring: Due to a modification of an existing CALFED grant for lower Creek restoration granted to a local consulting hydrologist, geomorphological data on approximately 10 miles of mainstem Cottonwood Creek was collected in late FY2002. A report on the analysis is expected in early FY2004.
- Fire and Fuels management: Two grants received by CCWG are being used to comprehensively address fire and fuel loading concerns within the watershed. One grant was to prepare the Cottonwood Creek Fuels Management Plan, which was completed in FY2003. Funding was also received to implement a fuels management project in the mid- to upper watershed in the chaparral zone. This project occurred on private property and involved removing decadent brush to improve upland habitat, create defensible zones, and reduce the impacts of catastrophic fire.

- Aerial photo coverage: Through a grant, black and white aerial photos were taken of the entire watershed in 2000/2001. In FY2002, these photos were entered into a computer by Shasta College and can be used to assess habitat conditions, on a watershed scale, for a wide variety of species including anadromous fish.
- Central Valley Project Improvement Act (b)(1) (other) program funding: A grant was obtained from (b)(1) (other) to identify potential habitat for the federally Threatened California red-legged frog in the watershed. This analysis will also benefit listed species such as the spring-run Chinook because of the tools developed through this grant to identify habitat (specifically, digitized aerial photographs that were also orthorectified).
- U.S. Forest Service: The U.S. Forest Service (Shasta Trinity National Forests, Yolla Bolla Ranger District) implemented two projects that indirectly benefit spring-run Chinook: (1) A large fuels management project in the Knob Peak area (northwestern end of Middle Fork Cottonwood Creek) to reduce fuel loading and thereby reduce the effects of catastrophic fire; and (2) a watershed analysis of the Middle Fork Cottonwood Creek watershed (on federal land only). The analysis was prepared in order to address problematic fuel loading conditions in mixed conifer, which was caused by unusually high winds in the late 1990's. Habitat impacted by the "blowdown" included stream and riparian habitat.

#### **Deer Creek Watershed Conservancy (DCWC)**

- Funding through the CALFED ERP 2001 solicitation for the "Lower Deer Creek Restoration and Flood Management: Feasibility Study and Conceptual Design" was approved. This project will evaluate the re-design of the lower Deer Creek floodplain into a more natural stream, while providing for better flood protection and addressing landowner concerns. Due to a delay in notification of funding, a long contractual process, and a change of project administrators on the part of DCWC, the project was not yet implemented by the end of FY 2003. It is expected to start in FY 2004.
- The Conservancy continues to seek funding and move forward on a Deer Creek Water Exchange Program. This Program will provide instream flows during critical periods of adult salmon migration in exchange for ground water during critical irrigation periods. Deer Creek has been identified as one of five Tier One streams by the CALFED Environmental Water Program (EWP). Presentations of the EWP program were held in the watershed in late FY 2003, as were discussions on what types of projects could be implemented in the Deer Creek watershed with EWP funds.
- The DCWC continued to implement a Watershed Management Plan strategy to manage rangeland for multiple resource protection and enhancement through a CALFED Watershed Program grant. After completing a Rangeland Water Quality Management Plan and conducting educational workshops (which is anticipated to be completed in FY2004), DCWC will pursue a Rangeland Continuation Project to assist participants of the workshops in the design and implementation of Rangeland Monitoring Plans for their land.

- The Vina Resource Conservation District (RCD) completed a bank stabilization Project on Highway 99 along lower Deer Creek. The RCD also worked with the U.S. Forest Service and completed a meadow restoration project on Gurnsey Creek, tributary to upper Deer Creek. The RCD is also continuing to actively remove giant reed (*Arundo donax*) and prevent further encroachment of this invasive plant along the lower Deer Creek riparian corridor.
- The DCWC Management Plan identifies a strategy to maintain the high water quality of Deer Creek. Several actions are being implemented to address this strategy: in the upper watershed, on lands managed by the U.S. Forest Service (Lassen National Forest, Almanor Ranger District), restoration efforts were focused on meadow restoration and road management activities, all of which directly and/or indirectly benefited spring-run Chinook. Over 27 miles of road were treated at approximately 115 sites. Road treatments included road surface and drainage improvements, fixing road crossing problems, road relocation, road closures, and decommissioning. Other activities included water source placement/improvement, repairing trailhead problems, and completing the Gurnsey Meadow restoration project (as previously stated). Collins Pine, a private landowner/timber company in the upper watershed, also implemented road-related work on approximately three miles (stream crossing improvements) with CALFED grant funding. An additional grant for road-related work was submitted and approved by the CALFED Watershed Program in late FY 2002. The proposal was approved; however, funds were not yet available by the end of FY 2003 due to a long contractual process.
- The Conservancy continues to hold an annual stakeholder meeting to discuss past and future projects that have been identified in the Watershed Management Strategy. In late FY 2003, it submitted, along with its partner, the U.S. Forest Service, a concept proposal to the CALFED Watershed Program for funds to update its management strategy and continue water quality data collection and evaluation, as well as hire a watershed coordinator to oversee and coordinate watershed activities. Complete proposal submission will occur in early FY 2004, if DCWC is asked to do so.
- In 2003, the Department of Water Resources, in cooperation with the Deer Creek Irrigation District, implemented a pilot groundwater exchange program. The program would allow water to stay in the stream while meeting irrigators' needs through groundwater pumping. Wells were installed in early summer 2003 and were monitored until early fall. Ultimately, if the program is successful, groundwater supplies could be used, in combination with other water use efficiency projects, to keep flow in the creek at critical time periods, specifically spring (during spring-run Chinook migration) and fall (for fall-run spawning).

### **Mill Creek Conservancy (MCC)**

- The MCC continued to implement the Ishi Wilderness/Mill Creek Watershed

Restoration Project. This 3-year project included removing feral cattle within the Mill Creek Watershed. Full implementation of this project will reduce a chronic source of soil erosion and sedimentation, improve fish and wildlife habitat, maintain water quality at natural seeps and springs and provide increased protection of Native American cultural sites. Monitoring activities included trail inventories, watershed condition surveys, and forage utilization surveys.

- Discussions involving implementation of a Mill Creek fish passage study were initiated. Primary parties involved in this discussion were the USFWS, the Department, MCC, Los Molinos Mutual Irrigation District, and certain landowners. Finalization of the study plan was done in FY 2003; implementation will start in FY 2004, with funding from the CVPIA Anadromous Fish Restoration Program.
- Mill Creek has been identified as one of five Tier One streams by the CALFED Environmental Water Program (EWP). Presentations of the EWP program were held in the watershed in late FY 2003, as were discussions on what types of projects could be implemented in the Mill Creek watershed with EWP funds.
- In the upper watershed, on lands managed by the U.S. Forest Service (Lassen National Forest, Almanor Ranger District), restoration efforts were focused on meadow restoration and road management activities, all of which directly and/or indirectly benefited spring-run Chinook. Over fourteen miles of road were treated at approximately 82 sites. Road treatments included road surface and drainage improvements, fixing road crossing problems, road relocation, road closures, and decommissioning. Other activities included water source placement/improvement, repairing trailhead problems, and completing meadow restoration projects. Collins Pine, a private landowner/timber company in the upper watershed, also implemented road-related work on approximately 2 miles (stream crossing improvements) with CALFED grant funding. An additional grant for road-related work was submitted and approved by the CALFED Watershed Program in late FY 2002. The proposal was approved; however, funds were not yet available by the end of FY 2003 due to a long contractual process.
- The Conservancies' Fire Committee continues to monitor fire management and fire planning strategies of all involved agencies to reduce the impacts of catastrophic fires and protect resources within the watershed. An ongoing project is the standardized posting of all fire access roads to assist fire crews in the event of an emergency.
- The MCC continued to monitor the Lower Mill Creek Revegetation Project. This project provided funding for restoration on sites damaged by flood waters.
- The Conservancy continues to be involved with Los Molinos Unified School Districts Partners in Education Program. This community-based partnership gives local students the opportunity to participate in stream restoration activities and water quality monitoring while learning about watershed stewardship and land management.

## Appendix C. Report Contributors

---

Alice Low	Dept. of Fish and Game, Native Anadromous Fish and Watershed Branch (NAFWB)
Colleen Harvey-Arrison	Dept. of Fish and Game, Northern California-North Coast Region (NCNCR)
Dennis McEwan	Dept. of Fish and Game, NAFWB
Diane Gaumer	Deer Creek Watershed Conservancy
Doug Killam	Dept. of Fish and Game, NCNCR
Duane Massa	Dept. of Fish and Game, NCNCR
Harry Rectenwald	Dept. of Fish and Game, NCNCR
Jim White	Dept. of Fish and Game, Habitat Conservation Division
John Nelson	Dept. of Fish and Game, Sacramento Valley and Central Sierra Region (SVCSR)
Ken Keller	Butte Creek Watershed Conservancy
Kerry Burke	Mill Creek Conservancy
Matt Brown	U.S. Fish and Wildlife Service
Mike Berry	Dept. of Fish and Game, NCNCR
Patricia Bratcher	Dept. of Fish and Game, NCNCR
Paul Ward	Dept. of Fish and Game, SVCSR
Roger Cole	Big Chico Creek Watershed Alliance
Tracy McReynolds	Dept. of Fish and Game, SVCSR
Vieva Swearingen	Cottonwood Creek Watershed Group