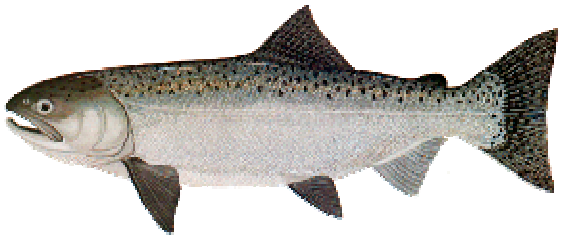
Sacramento River Spring-run Chinook Salmon



2001 Annual Report

Prepared for the Fish and Game Commission

by

California Department of Fish and Game
Habitat Conservation Division
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I. INTRODUCTION

The status of Sacramento River spring-run Chinook salmon (*Oncorhyncus tshawytscha*) and previous monitoring, restoration, and management activities have been documented by the Candidate Species Status Report (CDFG 1998) and Annual Reports to the Fish and Game Commission (Commission) (CDFG 2000, 2001). Scientific information related to spring-run Chinook salmon distribution, life history, and current issues has been reviewed by Moyle (2002). Conservation efforts of spring-run Chinook salmon stakeholders have also been reported (Bingham and Harthorn 2000). This document is the third annual Sacramento River spring-run Chinook salmon report to the Commission since its listing as a threatened species on February 5, 1999. This report describes population status, research and monitoring activities, and status of restoration and management. The report also provides an update on watershed conservancy activities on selected Sacramento River tributaries. Current issues, science, and research regarding spring-run Chinook salmon conservation are also discussed in this report.

II. POPULATION STATUS

METHODS

The adult fish population counts in this report were based primarily on snorkel surveys where fish were observed and counted, with the exception of Battle and Mill creeks and the Yuba River. For Mill Creek, the estimate was calculated by expanding the salmon redd counts by the total available spawning habitat. Battle Creek numbers were derived by combining the passage information gathered from both live trapping and underwater videography. Run timing, appearance, coded wire tags, spawning ground surveys, and genetic analysis were used to differentiate spring-run Chinook. Adult fish counts for the Yuba River were estimated by live trapping during the spring-run migration period of late-February through July. Additionally on the Yuba River, spawning surveys were conducted to estimate the spring-run Chinook population size, determine spawning time and location, and record redd depths. Methods specific for each tributary are described in the monitoring and research section below. The term "spawning escapement estimate" is not used in this report because the counts presented are based on various methods that do not yield actual escapement estimates based on conventional models (CDFG 2001).

Juvenile spring-run Chinook salmon were sampled by rotary screw trapping in Deer, Mill, and Butte creeks as well as the Yuba River. Outmigrant monitoring of spring-run salmon in Deer and Mill creeks is used to define their life history and to provide data on yearling salmon outmigration for use in Delta water management decisions. Outmigrant spring-run Chinook salmon from Deer and Mill creeks are not coded-wire tagged due to the low number of fish sampled at the trapping facilities.

Adult salmon returning in 2001 were assumed to be mostly three-year-old fish (CDFG 1998, 2001). The comparison of one spawning generation to the next is known as the Cohort Replacement Rate (CRR). This parameter is used to describe the number of current year spawners produced by the parental generation. This spawner-to-spawner ratio is defined by the

number of naturally produced and naturally spawning adults in one generation divided by the number of naturally spawning adults in the previous generation. The ratio describes the rate at which each subsequent generation, or cohort, replaces the previous one, hence is a measure of population change. When the rate is 1.0, the subsequent cohort exactly replaces the parental cohort and the population is in equilibrium. When the ratio is greater than one, there is a net increase in the number of fish surviving to reproduce and the population increases. When the rate is less than one, subsequent cohorts fail to replace their parents and the population declines.

CURRENT STATUS

A previous status review has documented the long-term overall population trend for spring-run Chinook salmon in the Central Valley (CDFG 1998). Baseline data from monitoring and research on selected Sacramento River tributaries included in this report are: adult spring-run Chinook salmon population counts from 1995 to 2001 (Table 1), cohort replacement rates based on population counts from 1998 to 2001 (Table 2), adult spring-run Chinook salmon redd and carcass survey data (Table 3), and juvenile spring-run Chinook salmon monitoring (Table 4). These baseline data measure spring-run Chinook population changes, which provide important information for management of Sacramento River tributary ecosystems.

Total adult spring-run Chinook salmon counts for 2001 were much higher than those for 2000, but still lower than those for the 1998 parental generation (Table 1). Most of the creeks supporting spatially isolated spring-run Chinook salmon showed higher fish counts in 2001 than in 2000.

Cohort replacement rates for selected Sacramento River tributaries are summarized in Table 2. The 1998 spawners produced most of the 2001 spawners, assuming that spring-run Chinook return as three-year-old fish. However, Brood-Year (BY) data (e.g. rates of grilse return, age structure, and sex ratio) is lacking for Central Valley spring-run. The CRRs from selected creeks ranged from 0.47 to 2.6 in 2001 (Table 2). Although most creeks in 2001 showed an increase in adult fish numbers from the mid-1990's (Table 1), their 2001 CRRs were less than one, the lowest since 1998 (Table 2). The 2001 CRR for Mill Creek was 2.6, the only stream where the CRR was larger than 1. These CRR changes indicate a decreasing abundance of spring-run Chinook salmon in most creeks from the 1998 to the 2001 generation, with the exception of Mill Creek.

Among these Sacramento River tributaries, Deer, Mill and Butte creeks are the principal streams still supporting spawning and rearing habitat for spring-run Chinook (Moyle 2002). Sampling on Deer Creek has been conducted according to consistent protocols since 1990 (Harvey 2002 personal communication; CDFG 1998, 2001). Adult spring-run Chinook population counts in Deer Creek from 1990 to 2001 (Figure 1) were selected as an index of status changes in Sacramento River tributaries. The status changes are better estimated with the CRR changes (Figure 2), which assume that spring-run return as three-year-old adults. However, spring-run populations may exhibit different age compositions. Since there are no age composition data, the CRRs used in this report do not represent other spring-run groups that return as two-year-old or four-year-old fish. Figure 2 shows four CRR points for each BY lineage (Cohort 1, 2, and 3) from 1990 to 2001. The CRRs in Deer Creek were highly variable for the three BY lineages over this time period, but were mostly greater than 1.0 (Figure 2).

The CRR for Cohort 1 (1990 BY lineage) exceeded 2.0 in all years except 1993, fluctuating from 2.3 (1990) to 0.6 (1993) and to 2.4 (1996) and 2.6 (1999). Cohort 2 (1991 BY lineage) has shown CRRs consistently higher than 1.0, ranging from 1.0 to 1.4. CRRs for Cohort 3 (1992 BY lineage) were variable, 2.7 (1992), 6.2 (1995), 1.5 (1998) and 0.86 (2001). Other assessments of adult spring-run spawning (Table 3) and juvenile spring-run abundance for selected Sacramento River tributaries (Table 4) are discussed in detail in the following section.

Table 1. Adult spring-run Chinook salmon population counts for Sacramento River tributaries, 1995-2001*

Tributary	2001	2000	1999	1998	1997	1996	1995
Antelope Cr.	8	9	40	154	0	1	7
Big Chico Cr.	39	27	27	369	2	2	200
Battle Cr.	See text	-	-	-	-	-	-
Butte Cr.	9,605	4,118	3,529-3,679	20,259	635	1,413	7,500
Clear Cr.	See text	-	-	-	-	-	-
Beegum/ Cottonwood Cr.	245	120	102	477	No estimate	6	8
Deer Cr.	1,622	637	1,591	1,879	466	614	1,295
Mill Cr.	1,104**	544	560	424	200	252	320
Yuba River	108***	No estimate	No estimate	No estimate	No estimate	No estimate	No estimate
Total	12,731	5,455	5,849	23,562	1,303	2,288	9,330

* Based on snorkel surveys unless otherwise indicated.
** Based on expanded salmon redd counts.
*** Based on the phenotypic migration period (Mar. through July); spring-and fall-run races cannot be differentiated in the Yuba River.

Table 2. Adult spring-run Chinook salmon cohort replacement rates for selected Sacramento River tributaries, 1998-2001

Tributary	2001	2000	1999	1998
Butte Cr.	0.47	6.5	2.7	2.5
Deer Cr.	0.86	1.4	2.6	1.5
Mill Cr.	2.6*	2.7	1.3	2.2

* Only Mill Creek had a Cohort Replacement Rate >1 in 2001.

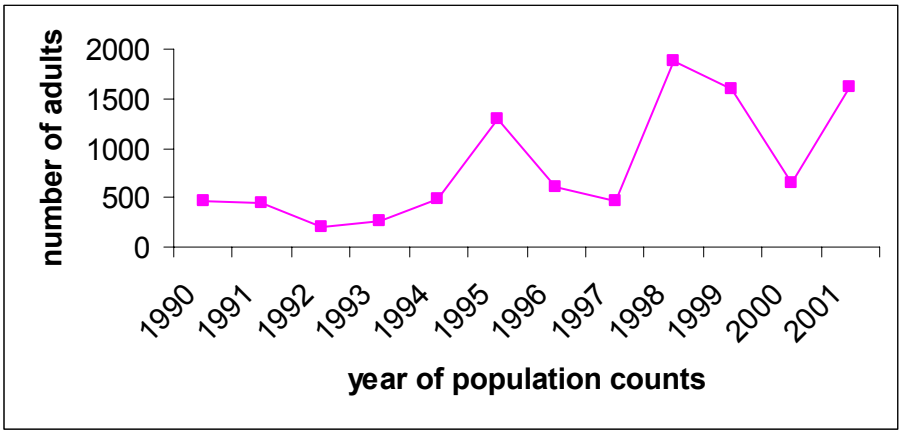

Figure 1. Deer Creek spring-run Chinook salmon abundance, 1990-2001.

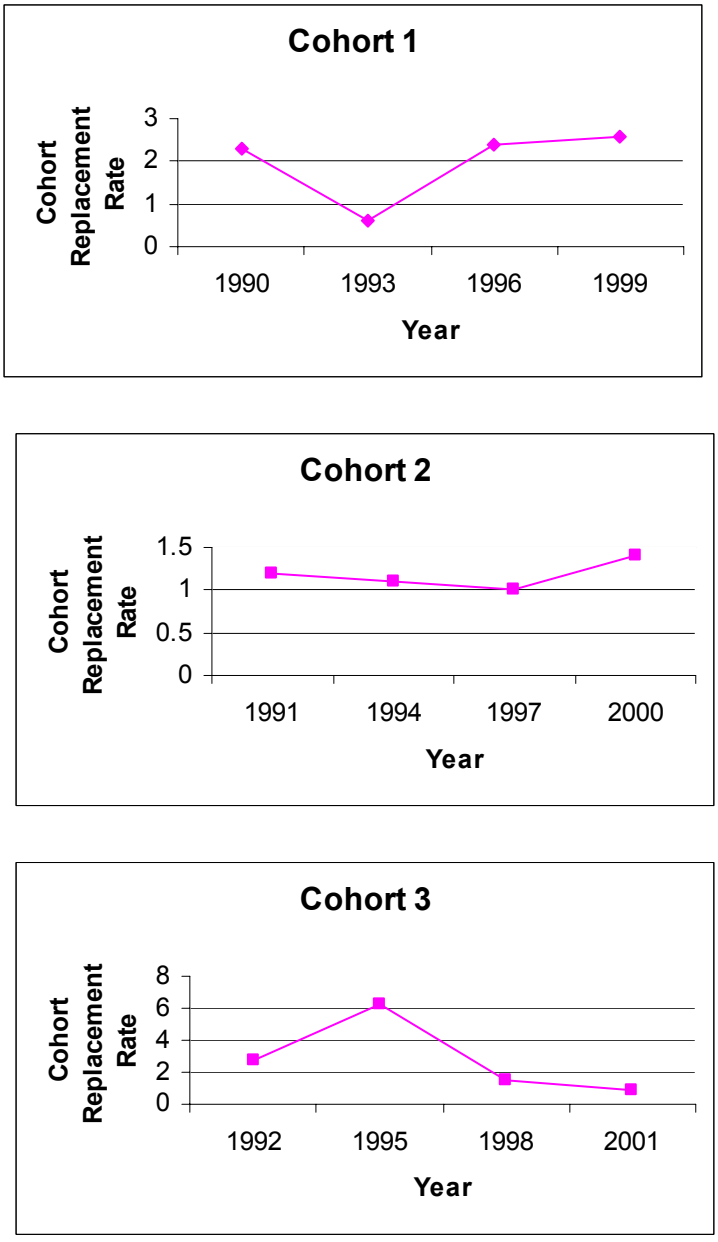

Figure 2. Deer Creek spring-run Chinook salmon cohort replacement rate (CRR).

Table 3. Adult spring-run Chinook salmon spawning surveys in Sacramento River tributaries

Tributary	Year	Redds	Carcasses	Other Assessments
Antelope Cr.	-	No data	No data	No data
Big Chico Cr.	-	No data	No data	No data
Battle Cr.	2001	See text	See text	Genetic study
Butte Cr.	2001	No data	See text	Archived tissues from carcass survey
Clear Cr.	2001	See text	See text	No data
Beegum/ Cottonwood Cr.	2001 2000	6	6 3	Archived pre-spawned carcasses tissues
Deer Cr.	2001 2000 1999 1998 1997	715 256 1495 793 275	239 25 220 137 43	No data
Mill Cr.	2001 2000 1999 1998 1997	552 272 280 212 100	54 21 14 26 13	Archived tissues for genetic and age composition studies
Yuba River	2001 2000	288 205	No data	No data
Sac. River mainstem	2001	29	No data	No data

Table 4. Juvenile spring-run Chinook salmon monitoring in Sacramento River tributaries

Tributary	Survey and Data collection	Yearlings size (mm FL)	1st yearling trapped date	1st fry trapped date
Antelope Cr.	No data	-	-	-
Big Chico Cr.	See text	-	12/16/01	-
Battle Creek	No data	-	-	-
Butte Cr.	See text	-	See text	-
Clear Creek	See text	-	-	11/14/01
Beegum/ Cottonwood Cr.	See text	45-80	-	-
Deer Cr.	See text	62-127	10/31/01	12/6/01
Mill Cr.	See text	59-126	10/10/01	12/7/01
Yuba River	See text	-	-	-

RESULTS OF 2001 MONITORING AND RESEARCH

Antelope Creek

A total of eight spring-run Chinook salmon were counted during the annual snorkel survey in 2001 (Table 1). This survey (approximately 15 miles) included sampling the known holding habitat of adult spring-run in Antelope Creek with participants from the Department, U.S. Forest Service and Sierra Pacific Industries. The count of eight salmon in 2001 (Table 1) represented a decrease in this cohort (154 counted in 1998). From 1989 through 2001, counts have ranged from zero to 154 salmon **(**Harvey 2002 personal communication). 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 3 to August 31, 2001. Of the 111 unmarked Chinook salmon that passed through the CNFH barrier weir, the USFWS estimated that about 100 were spring-run Chinook. The USFWS made the assumption that all Chinook salmon used the fish ladder to pass upstream of the barrier weir (i.e., no fish jumped over the barrier weir) in 2001 because low flow conditions made jumping the weir more difficult. Since the USFWS did not make an escapement estimate for spring-run Chinook salmon in 1998, in part due to extremely high flows and turbidity associated with construction activities, a cohort replacement rate could not be calculated for 2001. From live trapping March 3 through May 8, an estimated total of 29 unmarked Chinook salmon passed above the CNFH barrier weir. Tissue samples from 27 of the unmarked salmon were genetically analyzed and identified as non-winter-run Chinook salmon. All of the unmarked Chinook trapped were classified as spring-run based on collection date, phenotypic characteristics and genetic analysis. From May 8 through August 31, underwater videography was used to monitor passage at the CNFH barrier weir. An estimated total of 82 unmarked Chinook salmon passed above the CNFH barrier weir. Of these, 69 passed prior to July 1, and were considered to be spring-run Chinook salmon based on the timing of passage.

The USFWS conducted monthly spawning ground surveys (snorkel and walking) in all Battle Creek reaches above, and a three mile reach immediately below, the barrier weir from July through October 2001. A maximum count of 27 adults were observed in the survey, and 32 redds were counted the above barrier weir. One redd was observed in late September and the additional 31 redds were observed in mid-October. One of the carcasses found was a clipped spring-run Chinook salmon from the Feather River Hatchery. Genetic analysis of 35 fish was conducted by the Bodega Marine Lab of UC Davis, which confirmed the sample contained no winter-run fish, and identified 91% of the sample as spring-run Chinook.

Butte Creek

A snorkel survey was conducted from the Centerville Head Dam to the Parrott-Phelan Diversion Dam (PPDD) from August 13 through 16, 2001. The adult spring-run population estimate in 2001 was 9,605 fish (Table 1), representing a cohort replacement rate of 0.47

(Table 2). An extensive carcass survey that used a standard mark recapture protocol was also performed from September through October in the same reaches that were snorkel surveyed. The main purpose of the carcass survey was to recover coded-wire tags (CWT's) from returning adults. A total of 16 adults (Butte Creek origin) with CWT's were recovered during the survey, which revealed an age composition of two, three and four year-old fish from BY 99, BY 98, and BY 97, respectively. The carcass survey was also used to generate an alternate adult escapement estimate, which was significantly higher than the snorkel survey estimate (Ward et al. in preparation).

A total of 697,317 juvenile salmon were sampled in rotary screw traps from September 12, 2000 through June 29, 2001. Of the total captured, 166,570 were CWT'd and released in Butte Creek near Chico. The first young-of-the-year salmon (YOY) was captured on November 30, 2000. Juvenile monitoring in 2000 and 2001 collected a total of 169 yearlings at the PPDD site, a total of 902 juveniles near Karnak, and a total of 9,624 juveniles upstream of Maddock Rd. The first CWT recapture from all sites was on February 15, 2001, and the last on May 20, 2001. A total of 506 juveniles was recaptured. Additionally, there were three recaptures of CWT fish released at Coleman National Fish Hatchery between February 23, 2001 and March 5, 2001.

Big Chico Creek

A snorkel survey was conducted from Higgins Hole downstream to Salmon Hole on August 8, 2001. The survey was divided into three reaches. A total of 39 adult spring-run were observed (Table 1). A total of 1,057 juveniles was captured at the Bidwell Park Municipal Golf Course site from December 14, 2000 to May 31, 2001. The first yearling was sampled on December 16, 2001 (Table 4).

Clear Creek

The USFWS Red Bluff Office conducted snorkel surveys, live fish counts and redd counts, and rotary screw trapping. Adult spring-run were identified based on run timing, phenotype, and CWT recoveries. Snorkel surveys of Clear Creek were conducted once a month from April through November, 2001. A 16.4-mile reach was surveyed from Whiskey-town Dam downstream. Additional surveys of the lowest reach were made to supplement the monthly surveys. Based on run timing, nine spring-run Chinook were counted from April to July. Monthly survey counts, however, probably included multiple observations of the same fish. The large increase in salmon counts (656) in September reflects the immigration of fall-run Chinook which cannot be distinguished from spring-run in this month. Chinook redds were not observed prior to September snorkel surveys. The first redd was observed on September 13 in the lowermost reach. Two weeks later, 102 redds were observed, 98 of which were in the lowermost reach. Spring and fall-run redds could not be differentiated because of the overlap in spawn timing.

The USFWS operates a rotary screw trap at river mile 1.7 on Clear Creek, which is upstream of the sheet pile dam associated with the Anderson Cottonwood Irrigation District (ACID) canal siphon crossing. Based on length criteria developed for the upper Sacramento River, spring-run sized juvenile Chinook salmon (progeny of the 2001 adult escapement) was

first captured in the trap on November 14. The estimated number of potential juvenile spring-run captured in the trap was 1,083 in November and December 2001.

Cottonwood Creek

A total of 245 adult spring-run were counted during the 2001 snorkel surveys in Beegum Creek, a major tributary of Cottonwood 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 (approximately 7.5 miles) was surveyed monthly in 2001. High water temperatures in August and September (over 70º F) and black bear predation could have contributed to pre-spawning mortality (Harvey 2002 personal communication). Six redds were observed during spawning surveys in October (Table 3). Spawning surveys confirmed that spring-run in Beegum Creek remain spatially and temporally isolated from fall-run in Cottonwood Creek. 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 25 miles) were conducted on August 8 and 20, 2001. A total of 1,622 spring-run Chinook salmon were counted (Table 1). This annual survey was a joint effort by the Department, U.S. Forest Service, Sierra Pacific Industries, USFWS, and National Marine Fisheries Service. This 2001 count was higher than in the previous two years (637 in 2000, and 1,591 in 1999). Spring-run counts ranged from a high of 1,879 fish in 1998 to a low of 209 fish in 1992 during the previous 10 years of record (Figure 1). The average count over this time period was 900 salmon. In contrast, during the 1940 to1964 time periods, an average of 2,200 spring-run returned to Deer Creek **(**Harvey 2002 personal communication). The 2001 cohort replacement rate (0.86) was less than 1.0 (Table 2).

The U.S. Forest Service completed spring-run spawning surveys in October 2001, observing 715 redds and 239 carcasses. Fall-run spawning surveys verified that spring-run Chinook in Deer Creek remained spatially and temporally isolated from spawning fall-run Chinook.

A total of 575 BY 2000 spring-run yearlings were sampled in rotary screw traps from October 2001 through March 2002. Fish ranged in size from 62 mm to 127 mm (Fork Length-FL). In the same time period, 1,385 BY 2001 spring- and fall-run fry were collected, ranging in size from 31 mm to 54 mm FL. The first yearling was trapped on October 31, 2001 and the first fry was trapped on December 6, 2001.

Mill Creek

Using a combination of ground and aerial surveys, the spawning survey (approximately 25 miles) extended from the Highway 36 bridge crossing downstream to the steel transmission line crossing. An estimated 1,104 spring-run Chinook spawned in Mill Creek in 2001 (Table 1). This estimate was calculated by expanding redd counts by the available spawning habitat. The

2001 estimate of 1,104 returning salmon represented a cohort replacement rate of 2.6 from the 1998 parental cohort of 424 spawners (Table 2). In the previous 3 years, cohort replacement rates exceeded 1.0 (Table 2). The estimated population in 2001 was higher than the previous 10-year average of 364. An average of 1,900 spring-run Chinook salmon were estimated to spawn in Mill Creek annually from 1947 to 1964 **(**Harvey 2002 personal communication).

Spawning surveys were conducted below Little Mill Creek's confluence (approximately 25 miles) from October 3 through October 11. A total of 167 live salmon, 54 carcasses and 552 redds were observed during these spawning surveys. Fall-run spawning surveys verified that spring-run Chinook in Mill Creek remain spatially and temporally isolated from spawning fall-run Chinook.

A total of 795 (BY 2000) spring-run yearlings were sampled in rotary screw traps from October 2001 through March 2002. Fish ranged in size from 59 mm FL to 126 mm FL. A total of 1,493 BY 2001 spring- and fall-run fry was also trapped, measuring from 29 mm FL to 57 mm FL. The first yearling salmon was trapped on October 10, 2001 and the first fry was trapped on December 7, 2001.

Yuba River

Currently spring- and fall-run Chinook salmon are relegated 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) since they must pass the dam to access holding habitat up-river. Trapping occurred 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).

The Department continued Chinook spawning surveys on the Yuba River from the narrows pool downstream to DPD (approximately 10 miles) in August 31 through September 28, 2001. Currently spring- and fall-run Chinook salmon are restricted to spawning in the same reach of the lower Yuba River. Spawning activity in September could represent spring-run spawning based on historic information. A total of 288 redds were observed (Table 3), with the first redds observed on September 7, 2001. This number was higher than the 205 redds during the same time period in 2000.

Rotary screw trap operations were continued during the 2001-2002 season to document outmigration patterns of all juvenile salmonids on the Yuba River. Data collected included timing, duration, and size of all Chinook salmon at time of outmigration. Although spring- and fall-run spawning occurred in the same physical location, initial 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 salmon. Spring-run Chinook salmon were determined by size-at-date differences through the operation of the rotary screw trap. A total of 6,719 juvenile spring-run Chinook salmon were captured between November 10, 2001 and May 8, 2002. Juvenile spring-run Chinook salmon sizes ranged from 26mm FL to 108mm FL.

Sacramento River Mainstem

Spring-run Chinook on the mainstem Sacramento River historically have been reported upstream of Red Bluff (CDFG 1998). This population may still persist between RBDD and

Keswick Dam on the Sacramento River (CDFG 1998; Rectenwald 2002 personal communication). Genetic changes related to spring-run hybridization with fall-run fish in the mainstem Sacramento River were discussed by Moyle (2002) and CDFG (1998). On September 18, 2001, an aerial redd survey on the mainstem Sacramento River observed a total of 29 redds (Table 3).

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 salmon in the Delta. A Juvenile Chinook Salmon Protection Decision Process 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).

Significant movement of yearling spring-run Chinook salmon from Mill and Deer Creeks was detected in November and December 2001, coincident with storms and stream flow increases. Smaller numbers of yearlings were observed emigrating January through March. Small numbers of yearling spring run Chinook salmon were also observed emigrating from Butte Creek November through February. Yearling-size Chinook salmon were caught at Knights Landing from late November through February.

The potential effects of reverse flows in southern Delta channels on salmon migration were investigated by tracking the movements of radio tagged juvenile salmon released in the southern Delta. This study indicated an effect of higher pumping rates on the movement of juvenile salmon in southern Delta channels that could adversely affect their survival. Multi-disciplinary investigations related to operation of the Delta Cross Channel (DCC) and effects on water movement, juvenile and adult salmon movement, and Delta water quality were continued in 2001. One purpose was to determine if alternative DCC gate operation strategies could be developed to preserve most of migrating juvenile salmon survival of closing the gates, without diminishing the benefits to water quality and supply achieved when gates open. Results to date suggest that such gate operations may be possible.

CONCLUSIONS

Total adult spring-run Chinook salmon counts for 2001 (12,731) were much higher than those for 2000 (5,455), but still lower than those for the 1998 (23,562) parental generation. Other annual spring-run Chinook salmon counts from 1998 to 2000 showed slight increases from their parental generations. The counts between 1995 to 2001 ranged from a low of 1,303 (1997) to a high of 23,562 (1998). Overall population abundance from 1970 to 2001 for spring-run Chinook was still very low compared with historical population abundance before 1950 (CDFG 1998). Small populations of spring-run Chinook were still distributed in a few principle Sacramento River tributaries (Deer, Mill and Butte creeks) in 2001 as previously reported (CDFG 1998). Spring-run Chinook populations are not persistent in Antelope, Cottonwood, and Big Chico creeks, or lack spatial separation of spawning habitats in Clear Creek, and Sacramento, Yuba and Feather rivers. The results from field surveys conducted in 2001 were

limited in scope and were not particularly robust in detecting trends within specific watersheds.

Among the Sacramento River tributaries, Deer, Mill and Butte creeks are the principal streams still supporting persistent spawning populations of spring-run Chinook. CRR changes in Deer Creek from 1990 to 2001, used as an index for status of population changes in Sacramento River tributaries, indicate highly variable CRRs for the three BY lineages over this time period, but most were greater than 1.0. This indicates that the declining trend appears to be stabilized, and the population may have increased slightly since 1990 in Deer Creek. Although most principal creeks in 2001 showed an increase in adult fish numbers from the mid-1990's, their 2001 CRRs were less than one with the exception of Mill Creek. These CRR changes indicate a decreasing abundance of spring-run Chinook salmon from the parental generation in 1998 to the adults returned in 2001 in most principal creeks. There still was the large variability in CRR from generation to generation for the spring-run Chinook populations in Deer, Mill, and Butte creeks as reported previously, which indicates a great population fluctuation (CDFG 1998).

Low population abundance over many generations and relatively isolated subpopulations from a few tributaries are still risk factors to Sacramento River spring-run Chinook mainly because of the potential for reduced genetic diversity and increased inbreeding. The potential for hybridization of spring-run and fall-run Chinook in some tributaries such as Clear Creek or the Yuba River represents a threat to the genetic integrity of remaining Sacramento River spring run populations. These genetic risks can have significant impacts on the survival and reproduction of Sacramento River spring-run Chinook populations.

Overall, declining population sizes, low population abundance, fluctuating CRRs, the potential of reduced genetic diversity and altered genetic integrity, and restricted habitats are still great risk factors for Sacramento River spring-run Chinook.

III. HARVEST MANAGEMENT CONSERVATION MEASURES

Federal ocean fisheries management and restoration plans that reduce ocean harvest impacts on Sacramento River winter-run Chinook salmon provide some protection for Sacramento River spring-run Chinook salmon. Existing ocean harvest regulations likely reduce spring-run harvest (e.g. minimum size limits, reduced bag limits, reduced recreational salmon seasons). Inland sport fishing protective regulations include fishing method and gear restrictions, fishing hour and bait limitations, and special regulations (seasonal closures and zero bag) in several primary tributaries such as Deer, Big Chico, Mill, and Butte creeks. Enhanced enforcement activities continue to be implemented throughout spring-run 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 salmon in Sacramento River tributaries (CDFG 1998).

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 2002).

CALFED BAY-DELTA PROGRAM

The CALFED Bay-Delta Program, established in May 1995, 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 actions to restore ecological integrity of the Central Valley/Bay Delta ecosystems. 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 floodplains that 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, 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. From 1997 through 2001, the CALFED effort has led to ecosystem restoration grants for 326 projects, totaling $336 million. Additionally, in 2001, 50 projects for watershed stewardship were approved for $19 million. The majority of these projects benefited Central Valley salmon, including spring-run Chinook salmon, either directly or indirectly. The specific CALFED projects related to spring-run Chinook salmon restoration are described in other sections of this report.

CENTRAL VALLEY PROJECT/ STATE WATER PROJECT OPERATION

The Delta Cross Channel (DCC) gates were closed on November 21 to prevent juvenile salmon from migrating through the DCC into the interior Delta where their survival was relatively poor. The gates remained closed through January 2002 due to a combination of fishery protection objectives and flows exceeding 25,000 cubic feet per second (cfs). The DCC gates are always closed from February 1 until May 20 pursuant to the 1995 Bay-Delta Water Quality Control Plan.

Losses of yearling size Chinook salmon at the SWP/CVP diversions in the southern Delta were moderately low in November and December 2001 and no actions were taken to reduce export pumping. The export pumping rate was reduced for five days in early January, due primarily to concern over high numbers of pre-spawning adult delta smelt. Entrainment loss of Chinook salmon also was reduced during this pumping curtailment. Through the winter and early spring, juvenile Chinook salmon losses remained low. The loss at the SWP/CVP was also measured by using tagged hatchery late-fall run Chinook salmon as surrogates for spring-run Chinook salmon. Consequently, there were no further adjustments to SWP/CVP pumping until the Vernalis Adaptive Management Program (VAMP) experiment began in mid-April. Combined SWP/CVP pumping was approximately 2,250 cfs from April 15 to May 15 for the VAMP experiment and continued at that rate through May to improve Delta conditions related to emigrating juvenile salmonids, including BY 2001 spring-run Chinook salmon smolts.

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 a project purpose equal to 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.

NATIONAL MARINE FISHERIES SERVICE RECOVERY PLANNING

The National Marine Fisheries Service (NMFS) will initiate comprehensive recovery planning for listed salmonid species in the Central Valley in 2002. NMFS 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. The NMFS 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 (ESU) of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and also federal candidate species fall/late fall-run Chinook salmon.

V. RESTORATION AND MANAGEMENT ACTIONS

Restoration and management actions in the mainstem Sacramento River that benefit winter-run Chinook have been reported (CDFG 2002). Among these actions, temperature management in the upper Sacramento River, pollution control at Iron Mountain Mine, and Red Bluff Diversion Dam improvements related to safe passage of adult and juvenile anadromous fish are important for spring-run Chinook. 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 several Sacramento River tributaries.

RESTORATION AND MANAGEMENT ACTIVITIES ON SACRAMENTO RIVER TRIBUTARIES

The major activities that result in significant adverse effects to 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;
- 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 will be removed 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 rescreening water, flow fluctuations, and false attraction of returning adults to transbasin canal waters leading to poor egg survival. 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 2001 included the following activities:

- Funding was acquired and environmental permitting completed for fish screen and fish ladders at three water control structures in the Sutter Bypass reach of Butte Creek.
- Applications for CALFED grants were submitted for construction or modification of water control structures in the Butte Sink reach of Butte Creek. California Waterfowl Association (CWA), in coordination with Ducks Unlimited (DU), is the local sponsor for the projects. Final plans and specifications have been completed.
- Construction was completed at the Sanborn Slough overflow structure at the upper end of the Butte Sink. Modifications to the structure allow unimpeded fish passage and better control of flows through the Butte Sink.
- A draft technical/environmental evaluation was completed for the Department of Water

Resources (DWR) Sutter Bypass East Borrow Pumping Plants No. 1, 2, and 3. Preferred designs for fish screens and adult exclusion barriers were developed.

- The Department continues to work closely in partnership with DU and CWA to develop and complete spring-run Chinook salmon 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. DWR completed the final draft technical and environmental evaluation for modifications to the Iron Canyon fish ladder.

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. More advanced instream flow studies are in progress to better define biological needs and refine flow allocation processes. The Department participated in efforts lead by the U.S. Bureau of Reclamation (USBR) to evaluate gravel replenishment projects in Clear Creek and the Sacramento River. Gravel is being replenished on salmon spawning riffles to compensate for blockage of the supply by Shasta and Whiskeytown dams. The removal of McCormick-Saeltzer Dam in 2001 restored access to approximately 12 miles of cold-water habitat critical for spring-run Chinook salmon and steelhead. A three-mile reach of lower Clear Creek adversely affected by 30 years of instream gravel mining will be partially restored under a five-phase project (funded by the USBR, CALFED, and CVPIA), which is 50% completed. The channel restoration will fill in abandoned gravel pits in the floodplain using material excavated from above the floodplain, which will create wetlands in the process.

Yuba River

Evaluation and CEQA/NEPA documentation of fish passage alternatives at DPD was continued by the Fish Passage Improvement Program of DWR in 2001. This is a cooperative effort to improve adult and juvenile anadromous fish passage by the Department, in conjunction with the USFWS, NMFS, Army Corps of Engineers, South Yuba River Citizens League, Yuba County Water Agency, and other stakeholders. In 2001, the Department, along with the USFWS and NMFS, worked with Hallwood Irrigation Company and Cordua Irrigation District (H-C) to assume H-C ownership and responsibility to maintain and operate the fish screen.

Adult salmonids including spring-run Chinook salmon are attracted into the off-stream ponds of the Yuba Goldfields, where no suitable habitat is available for anadromous fish. The Goldfields (8,000 acres) are located along the Yuba River near DPD. The Goldfields have been the site of gold dredging for nearly 100 years and dredging continues today along with aggregate production. The Department, along with the USFWS, NMFS, and other

stakeholders, is continuing to work with owners of the Goldfields to construct a durable barrier to exclude adult salmonids from entering. A CALFED grant for this project was awarded for 2001.

The Upper Yuba River Studies Program (initiated by CALFED in 1998) is a collaborative effort to determine if introduction of wild Chinook salmon 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. A contractor has been selected to undertake the studies.

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 salmon, steelhead, and other anadromous fish populations; and (iii) implementation of near-term actions and studies that promote effective recovery of Chinook salmon 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.

WATERSHED GROUPS

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

VI. RESEARCH

More than one run of Chinook salmon occurs in many Sacramento River tributaries, including Antelope, Battle, Deer, Mill, Big Chico, and Butte creeks, as well as the Yuba River (Yoshiyama et al. 1996, 2000). However, the genetic relationships between runs within these drainages have not been determined and concerns regarding potential genetic interactions among these runs are increasing. For example, introgression of hatchery population genes into natural population through straying of hatchery fish, has been identified as an important risk factor (CDFG 1998; Myers et al. 1998). Phenotypic spring-run Chinook salmon have entered Clear, Battle, Antelope, Big Chico, Cottonwood, and Beegum creeks in recent years, but the origin and genetic composition of these runs are unknown.

Through genetic analysis of fish from these populations, the relationship of these runs to other spring and fall-run populations in the Central Valley can be determined and their importance to the Evolutionarily Significant Units (ESU) assessed. An important component of the recovery strategy for Central Valley Chinook is the Viable Salmonid Populations (VSP) framework developed by NMFS scientists (McElhany et al. 2000). Genetic analysis plays an

important role in assessing some of the key VSP parameters (population size, structure, and diversity). Once populations within the ESU have been identified, the extinction risk of each can be estimated, and various combinations of individual populations that produce a viable (i.e. recovered) ESU can be determined.

Molecular genetic research has demonstrated genetic differentiation of spring-run Chinook salmon 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 salmon populations in the Central Valley. General conclusions that can be drawn from this research include: (i) Central Valley Chinook salmon 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).

Two recent genetic studies in particular provide some insight into the genetic diversity that exists within the Central Valley spring-run Chinook ESU. Banks et al. (2000) detected a large genetic difference between spring-run fish from Butte Creek and Mill/Deer Creeks. Nielsen et al. (1999) noted that only 6.6% of observed genetic variation was attributable to spawning-run classifications. However, these studies were incomplete and not strictly compatible, which led to incomplete and sometimes conflicting pictures of genetic population structure and diversity.

NMFS, 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 CALFED, 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 salmon. 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.

Genetic studies are also important to distinguish among Chinook salmon populations in the San Joaquin River system. Currently, these studies are focused on fall-run Chinook. Small numbers of fish exhibiting typical spawning times of late fall-run (January through March) and spring-run (August through September) occur in the San Joaquin basin (Heyne, 2002 personal communication), but the origin and genetics of these fish are currently unknown. Further studies are needed to evaluate the presence of late fall and spring-run Chinook in the San Joaquin basin.

Other on-going interdisciplinary studies from several research teams include bioassement of Chinook salmon response to water quality, salmon stress response related to temperature changes, relationships of Chinook salmon survival with water flow related to ground water depletion, role of floodplains in juvenile Chinook salmon growth and survival, and changes in Chinook salmon sex ratios (Moyle, 2002 personal communication). These studies will provide some scientific basis for ecosystem restoration and management related to salmon conservation.

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VIII. APPENDICES

Appendix A. Spring-run Chinook salmon monitoring and conservation efforts in the Sacramento River mainstem and tributaries.

TRIBUTARY	MONITORING	RESTORATION AND MANAGEMENT	REPORT CONTRIBUTOR*
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 spawing survey -fish genetic study	Restoration activities to reestablish flow regimes, passage and stream channel process (see text)	Harry Rectenwald Matt Brown
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)	Harry Rectenwald Matt Brown
Beegum and Cottonwood Creeks	-snorkel survey -spawning survey -salmon carcasses and tissue archive for genetic research and age composition	No information	Doug Killam
Deer Creek	-snorkel survey -spawning survey -rotary screw trapping -outmigrant monitoring	Activities of the Deer Creek Watershed conservancy (see Appendix B)	Colleen Harvey Arrison Diane Gaumer
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 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
Bay Delta	-see text	See text	Jim White
Sacramento River mainstem	-aerial redd survey	See text	Harry Rectenwald

* Dr. Qinqin Liu is a lead person to coordinate all the report efforts, and Alice Low contributed information on sections IV and VI. Please see Appendix C for detailed information on each contributor.

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 salmon 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 4 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; 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 of Fish and Game 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 Assn 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 CDF&G trapping and tagging program.
- Support increased funding for local game wardens.
- Active in Cal-Fed Integrated Storage Investigations program in Butte County.
- Continued partnership with PG&E and Sierra Pacific Industries on restoration of lands donated to BCWC.

Deer Creek Watershed Conservancy (DCWC)

- The DCWC has requested funding thru the Cal Fed Ecosystem Restoration Program for the "Lower Deer Creek Restoration and Flood Management: Feasibility Study and Conceptual Design". This proposed project would redesign the flood channel of lower Deer Creek to a more natural stream process while providing for better flood protection.
- 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: Implementation of road-restoration to reduce sediment load is continuing on Collins Pine Company Almanor Forest Lands. A Grant Proposal has been submitted to Cal Fed for additional road restoration projects. Another action is implementation of the Highway 32 Hazardous Spill and Assessment Plan, completed in 2000. The Conservancy is coordinating with Cal Trans to locate deployment sites for HAZMAT team's equipment along Highway 32.
- The Conservancy is seeking funding and moving 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.
- The DCWC in continuing to implement a Watershed Management Plan strategy to manage rangeland for multiple resource protection and enhancement. After completing a Rangeland Water-Quality Management Plan and conducting educational workshops, the Conservancy is pursuing 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) has received funding for a bank stabilization Project on Highway 99 along lower Deer Creek and is working with the U.S. Forest Service on 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 Conservancy continues to hold an annual stakeholder meeting to discuss past and future projects that have been identified in the Watershed Management Strategy.

Mill Creek Conservancy (MCC)

- The MCC is implementing the Ishi Wilderness/Mill Creek Watershed Restoration Project. This 3-year project includes 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 will include trail inventories, watershed condition surveys, and forage utilization surveys.
- 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 continues to monitor the Lower Mill Creek revegetation Project. This project provided funding for restoration on sites damaged by flood waters.
- The Conservancy is actively 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

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