Comprehensive Assessment and Monitoring Program (CAMP)

Annual Report 2000

United States Department of Interior
Central Valley Project Improvement Act

U.S. Fish and Wildlife Service (Lead)

and
U.S. Bureau of Reclamation

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United States Department of Interior

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Acronyms and Abbreviations

AFRP	Anadromous Fish Restoration Program
CAMP	Comprehensive Assessment and Monitoring Program
CDFG	California Department of Fish and Game
cfs	Cubic feet per second
CNFH	Coleman National Fish Hatchery
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
EBMUD	East Bay Municipal Utility District
FERC	Federal Energy Regulatory Commission
IEP	Interagency Ecological Program
MRDUA	Mokelumne River Day Use Area
PFMC	Pacific Fishery Management Council
PG&E	Pacific Gas and Electric Company
PSC	Pacific Salmon Commission
RBDD	Red Bluff Diversion Dam
RM	River Mile
RST	Rotary Screw Trap
USBR	U.S. Bureau of Reclamation
USFWS	U.S. Fish and Wildlife Service
YOY	Young-of-the-year

Summary

The Comprehensive Assessment and Monitoring Program (CAMP), established by subsection 3406(b)(16) of the Central Valley Project Improvement Act (CVPIA), has two distinct goals:

- Goal 1: To assess the overall effectiveness of actions implemented pursuant to CVPIA Section 3406(b) in meeting restoration production targets.
- Goal 2: To assess the relative effectiveness of four categories of Section 3406(b) actions (water management modifications, structural modifications [excluding fish screens], habitat restoration, and fish screens) in meeting production targets.

This annual report of the CAMP presents the 2000 monitoring results and summarizes information for the first six years of anadromous fish population monitoring under the requirements of the CVPIA. This is the fourth report produced by the CAMP. The first report covered monitoring from 1995 –1997 (USFWS, 1998), the second covered 1998 monitoring results (USFWS and USBR, 1999), and the third covered 1999 monitoring results (USFWS and USBR, 2001). Adult anadromous fish monitoring results since 1995 have shown variable population estimates between years. Results of population estimates from the 2000 monitoring (Goal 1) are as follows:

- The fall-run chinook salmon estimate of overall natural production is higher than all previous monitoring years except 1995.The winter-run chinook salmon estimate of natural production is below estimates of natural production for all previous monitoring years except 1996.
- The spring-run chinook salmon estimate of overall natural production is higher than in 1999, but is still below the peak estimate in 1998. The American shad population estimate increased slightly in 2000 compared to 1999, but is still below estimates in all previously monitored years.
- The striped bass population estimate in 2000 is substantially higher than in 1996, the last year an estimate was available, but may be inaccurate based on limited recaptures.
- Abundance estimates for steelhead and sturgeon are unavailable for 2000 because the fish were not sampled, or sampling results were not obtainable.

The population estimates in this report were developed using Grandtab data from the California Department of Fish and Game (CDFG), and using individual watershed and delta species monitoring programs conducted and summarized by state, federal and local resource agency staff. Adult carcass counts and other estimating techniques, (e.g. ladder counts, aerial redd surveys), traditionally used to estimate spawning escapements tend to produce variable population estimates; however, over time, carcass counts and other methods provide trends of relative abundance and are a valuable tools for fishery management. Standardized protocols, such as those recommended in the Conceptual and Implementation Plans for CAMP serve to minimize, but not eliminate, sampling errors.

Progress continues to be made in standardizing CAMP data, and over time, these data serve as predictive and descriptive tools.

Assessment of the status of CAMP Goal 2 relies on a variety of monitoring and analysis techniques to distinguish among the effects of the four categories of restoration actions. The primary assessment tool of Goal 2 is the measurement of juvenile fall-run chinook salmon production using rotary screw traps (RSTs). Implementation of restoration actions contributes to natal stream conditions, and Goal 2 assessment necessitates that the results of site-specific restoration actions that affect those conditions be monitored and reported. The total juvenile production in the watershed then can be apportioned among the various categories of actions based on results from site-specific monitoring and RST results. To date, these site-specific monitoring data largely are not available.

SECTION 1

Introduction

This fourth annual report of the Comprehensive Assessment and Monitoring Program (CAMP) has been prepared for the U.S. Fish and Wildlife Service (USFWS) and the Bureau of Reclamation (USBR) pursuant to the Central Valley Project Improvement Act (CVPIA). The report summarizes anadromous fish population estimates for Central Valley watersheds in the context of progress toward achieving CVPIA restoration goals. Additionally, the report addresses the status of assessing the relative effectiveness of four categories of actions for restoring anadromous fish populations.

Background

CAMP

The CVPIA (Public Law 102-575, Title 34) of October 1992 amends the authority of the Central Valley Project (CVP) to include fish and wildlife protection, restoration, and mitigation as having equal priority with other CVP functions. Section 3406 (b) of the CVPIA directs the Secretary of 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 during the 1967 through 1991 baseline period.

The Anadromous Fish Restoration Program (AFRP) was established by Section 3406(b)(1) of the CVPIA. The AFRP, with help from other agencies and groups, established baseline production numbers for Central Valley streams for naturally produced chinook salmon (all races), steelhead, striped bass, American shad, white sturgeon, and green sturgeon. Baseline production estimates were developed using data from 1967 through 1991. Production targets for anadromous fish were determined by doubling the baseline production estimates.

The CAMP, established by Section 3406(b)(16) of the CVPIA, has two distinct goals:

- **Goal 1:** To assess the overall effectiveness of actions implemented pursuant to CVPIA Section 3406(b) in meeting production targets.
- **Goal 2:** To assess the relative effectiveness of four categories of Section 3406(b) actions (water management modifications, structural modifications [excluding fish screens], habitat restoration, and fish screens) in meeting production targets.

The 2000 CAMP Annual Report includes the results of monitoring performed to estimate the natural production of anadromous fish in target watersheds.

The recommended methods by which data are collected and analyzed to evaluate progress toward these goals are outlined in the CAMP Conceptual Plan (USFWS 1996). The CAMP Implementation Plan (USFWS 1997a) further refines recommendations for adult and juvenile production monitoring programs necessary to achieve CAMP's two primary goals and provides detailed data management protocols and data analysis methods.

Data Sources and Fishery Accounting Methods Related to CAMP

CAMP fits into a pre-existing and ongoing mix of fisheries assessments of Central Valley and Sacramento/San Joaquin Delta anadromous fish populations. CAMP was built on an extensive network of existing monitoring and assessment programs of the USFWS, California Department of Fish and Game (CDFG), East Bay Municipal Utility District (EBMUD), and others. These individual watershed and delta species assessments, conducted and summarized primarily by agency staff, are the basis for the annual CAMP tabulation. The adult and juvenile fish abundance estimates presented in the CAMP Annual Reports represent a compilation of the best estimates available at the time of report production. Abundance estimates provided by agency resource managers and field staff in the spring and summer represent estimates of the previous year's populations.

Other geographically widespread summaries of anadromous fish stocks include the "Grandtab" assessment by CDFG and USFWS staff and the annual "Review of Ocean Salmon Fisheries" by the Pacific Fishery Management Council (PFMC). Grandtab is a summary of the Annual Reports of Chinook Salmon Stocks in California's Central Valley as taken from the CDFG annual Administrative Reports of the Inland Fisheries Division. The PFMC reports include ocean commercial and recreational ocean harvest estimates and escapement numbers. Both Grandtab and the annual PFMC reports are limited to salmon assessments and include all counts of hatchery as well as naturally spawning fish as part of their totals. This is in contrast to CAMP, which separates out the naturally spawning adult fish numbers for five other anadromous fish species in addition to the four Central Valley chinook salmon races. In addition, CAMP reports incorporate data on restoration actions and juvenile chinook salmon outmigration assessments as a means of estimating the relative effectiveness of categories of restoration actions.

The CAMP Goals

Monitoring Measures

Progress toward meeting anadromous fish production targets (CAMP Goal 1) is assessed based on estimates of the production of naturally produced adults of all races of chinook salmon (*Oncorhynchus tshawytscha*), steelhead (*Oncorhynchus mykiss*), striped bass (*Morone saxatilis*), American shad (*Alosa sapidissima*), white sturgeon (*Acipenser transmontanus*), and green sturgeon (*Acipenser medirostris*). Data collected for adult fish monitoring programs are used to calculate annual production estimates for each species and race. Progress toward natural production goals for each species and race is determined by comparing the annual average adult production estimates to the 1967 through 1991 baseline period estimates for each targeted watershed. The CAMP adult monitoring program largely relies on existing monitoring programs that were in place prior to CAMP's implementation. Under the CAMP Implementation Plan, monitoring is to be conducted annually on a long-term (25 to 50 years) basis.

Juvenile chinook salmon production estimates, which are determined by monitoring selected watersheds, are used as part of an effort to evaluate the relative effectiveness of each of the four categories of restoration actions (water management modifications, structural modifications [excluding fish screens], habitat restoration, and fish screens) (CAMP Goal 2). Juvenile production is the most direct measure of the effectiveness of categories of actions because, unlike adult fish that have spent most of their lives in the ocean, juveniles have been exposed only to the conditions present in their natal stream. As a result, changes in juvenile production numbers should be attributable to changes in the natal stream caused, in part, by implementation of restoration actions. The relative effectiveness of the four categories of restoration actions is assessed through: 1) juvenile production estimates on tributaries provided by RSTs; and 2) site-specific monitoring results that assess the effects of individual restoration actions (USFWS in prep). In all cases, the evaluation of juvenile outmigrant success must be judged against standard environmental monitoring results such as temperature and flow regime, as year-to-year climatic changes in these basic hydrologic factors may confound the ability to detect project-related effects in natal streams. Evaluating both adult and juvenile production estimates for CAMP watersheds enables the effectiveness of restoration actions to be assessed relative to meeting the doubling goals for anadromous fish populations.

Reporting Assumptions

Most fish annual population estimates developed by resource agencies change throughout the year or over several years as data and estimating techniques are refined. For the abundance estimates compiled by CAMP, estimates may be assumed final when reported as part of the CDFG Stock Recruitment Reports. The CDFG (1994) method of estimating the percentage of naturally spawning Chinook Salmon for each watershed is a central component of the salmon estimating methods for CAMP. Pacific Fishery Management Council ocean harvest data are used every year in the CAMP Annual Report, but are only available as preliminary data at the time of report production. Changes in ocean harvest data that have occurred following CAMP report production are noted in the Results section of the report. Additional assumptions are noted in the Methods and Results Sections.

SECTION 2

Methods

CAMP Goal 1

Adult Fish Monitoring Programs

The monitoring programs used to assess adult anadromous fish natural production targets under CAMP Goal 1 are included in Table 1. Not all of the monitoring programs recommended in the CAMP Implementation Plan (USFWS 1997a) have been implemented, which could reduce the accuracy and precision of population estimates. This report presents the results of monitoring programs conducted for all AFRP target species in 2000, consistent with the protocols in the CAMP Implementation Plan (USFWS 1997a). Data from the 1995-1997, 1998 and 1999 annual reports also are provided for comparison.

TABLE 1
CAMP Recommended Adult Fish Monitoring Programs (USFWS 1997a)

Watershed	Species/Race	Adult Fish Monitoring Programs
Chinook Salmon		
American River	Fall-run Chinook Salmon	Carcass counts, hatchery marking, hatchery returns, in-river harvest
Battle Creek	Fall-run Chinook Salmon	Carcass counts, hatchery marking, hatchery returns
	Late Fall-run Chinook Salmon	Hatchery marking, hatchery returns
	Winter-run Chinook Salmon	Hatchery marking, hatchery returns
Butte Creek	Fall-run Chinook Salmon	Carcass counts
	Spring-run Chinook Salmon	Snorkel survey
Clear Creek	Fall-run Chinook Salmon	Carcass counts
Deer Creek	Fall-run Chinook Salmon	Carcass counts
	Spring-run Chinook Salmon	Snorkel survey
Feather River	Fall-run Chinook Salmon	Carcass counts, hatchery marking, hatchery returns, in-river harvest
Merced River	Fall-run Chinook Salmon	Carcass counts, hatchery marking, hatchery returns
Mill Creek	Fall-run Chinook Salmon	Carcass counts
	Spring-run Chinook Salmon	Redd counts
Mokelumne River	Fall-run Chinook Salmon	Ladder counts, hatchery marking, hatchery returns, in-river harvest[a]
	Late Fall-run Chinook Salmon	Hatchery returns[b]

TABLE 1
CAMP Recommended Adult Fish Monitoring Programs (USFWS 1997a)

Watershed	Species/Race	Adult Fish Monitoring Programs
Sacramento River	Fall-run Chinook Salmon	Ladder counts, carcass counts, aerial redd counts, in-river harvest
	Late Fall-run Chinook Salmon	Aerial redd counts, in-river harvest, carcass counts[a]
	Winter-run Chinook Salmon	Ladder counts, carcass counts, aerial redd counts
	Spring-run Chinook Salmon	Ladder counts, in-river harvest, carcass counts
San Joaquin River	Fall-run Chinook Salmon	In-river harvest[a]
Stanislaus River	Fall-run Chinook Salmon	Carcass counts, in-river harvest[a]
Tuolumne River	Fall-run Chinook Salmon	Carcass counts
Yuba River	Fall-run Chinook Salmon	Carcass counts, in-river harvest
Pacific Ocean	Fall-run Chinook Salmon	Ocean harvest
	Late Fall-run Chinook Salmon	Ocean harvest
	Winter-run Chinook Salmon	Ocean harvest
	Spring-run Chinook Salmon	Ocean harvest
Steelhead		
American	Steelhead	Hatchery returns
Battle Creek	Steelhead	Hatchery marking, hatchery returns
Mokelumne River	Steelhead	Hatchery returns[c]
Sacramento River	Steelhead	In-river harvest
Striped Bass		
Sacramento-San Joaquin Delta and Rivers	Striped bass	Mark-recapture program every other year
American Shad		
Sacramento-San Joaquin Delta	American Shad	Midwater trawl survey: juvenile abundance index[d]
White Sturgeon		
Sacramento-San Joaquin Delta	White Sturgeon	Mark-recapture program for 2 years, followed by 2 non-estimate years
Green Sturgeon		
Sacramento-San Joaquin Delta	Green Sturgeon	Estimate based on ratio of Green to White Sturgeon observed during tagging

[a] Data not collected prior to 1998.
[b] Data not collected prior to 1998 and not specifically recommended in CAMP Implementation Plan.
[c] Data collected in 1996 but not in 1997 and not specifically recommended in Implementation Plan.
[d] The juvenile abundance index from the midwater trawl survey conducted by CDFG is currently the best estimator of resulting adult American shad abundance.

Estimates of total production are calculated by summing in-river estimates (e.g., carcass survey estimates or ladder counts), hatchery returns, and in-river and ocean harvest estimates. Total production is multiplied by the proportion of natural production in each watershed (estimated by CDFG [1994]) to yield the watershed race-specific natural production estimates.

On the Mokelumne River, returning adults are counted at a downstream ladder and counted again as they enter the hatchery upstream of the ladder. For this report, hatchery counts are subtracted from the ladder counts to avoid double counting.

The watershed-specific component of the ocean harvest of fall-run chinook salmon is calculated by multiplying the total ocean harvest by the watershed-specific proportion of the total in-river run size. The ocean harvest of late fall-run, spring-run, and winter-run fish is assumed to be equivalent to the proportion of the total returning population of chinook salmon that those races represented that year. As described above, the ocean harvest totals are added to other components of adult production to yield total production by watershed and race.

Methods Associated with Sacramento River (Mainstem) Fall-run Chinook Salmon Production Estimates

Estimates of adult chinook salmon production for the mainstem Sacramento River are calculated using the same methods employed by CDFG for Grandtab:

1. The number of adult fish spawning in the mainstem upstream of the Red Bluff Diversion Dam (RBDD) is calculated by subtracting tributary escapement estimates (based on carcass surveys for Clear and Battle creeks), Battle Creek hatchery returns, and estimated in-river harvest from the expanded ladder count (representing the total number of fish passing the RBDD).
2. The number of fish spawning in the mainstem downstream of the RBDD is estimated by a carcass survey conducted in the mainstem below RBDD.
3. To calculate the CAMP estimate of total production, the in-river harvest and ocean harvest estimates are added to both the upstream and downstream mainstem spawning escapement estimates to produce an estimate of total mainstem production for the year.
4. The estimate of total production is multiplied by the expected percentage of natural fish (63 percent [from CDFG 1994]) to produce an estimate of the total natural production for the year.

As described in the CAMP Annual Report for 1998 (USFWS and USBR 1999), use of this method presents several potential complications. The estimate of the number of fish passing RBDD and the summation of upstream escapement, hatchery returns, and in-river harvest represent independent estimates of the same numbers of fish. Deriving an estimate of mainstem spawning escapement upstream of the RBDD by subtracting the estimates of upstream escapement, hatchery returns, and in-river harvest from the ladder count could, in some years, result in an escapement estimate that is negative because of the uncertainty associated with the various estimates.

In early 2000, CDFG and CAMP representatives reviewed the methods for estimating escapement in the mainstem Sacramento River. Several options were reviewed, and it was determined that the expanded ladder count at RBDD and information from the ongoing angler surveys will serve as the basis for calculating escapement in the mainstem

Sacramento River. CAMP will continue to use the method to estimate chinook salmon escapement in the mainstem Sacramento River developed by CDFG to generate estimates of natural production. This method is under review by CDFG.

The manner in which the in-river harvest estimates are applied in the escapement calculation also influences the estimate of adult production in the mainstem Sacramento River. Currently, the entire in-river harvest is assumed to represent only fish returning to the mainstem, even though a substantial number of the fish caught in the Sacramento River likely are destined for Battle and Clear creeks and other tributaries. Subtracting the entire in-river harvest estimate above RBDD from the estimated number of fish in the mainstem to arrive at an estimate of the spawning escapement in the mainstem above the RBDD may result in a negative estimate, as described above. Using the assumption that the entire in-river harvest spawns in the mainstem results in an underestimate of the production in Battle and Clear creeks and other tributaries because many of these fish likely spawn in those tributaries, thus should probably be included in the individual in-river production estimates.

Population Trend Assessments

Progress toward stream by stream production targets currently is assessed using a modification of the Pacific Salmon Commission's (PSC) rebuilding assessment methods (USFWS 1997a). The method of analysis involves comparing population estimates over a 5-year time period to trend lines between baseline and watershed-specific targets.

Natural abundance estimates that are above targets are identified as those with at least four of the last five estimates at or above the target and with the average abundance estimate of adult spawning fish in the previous five years equal to or greater than the target. For the CAMP 2000 Annual Report, population data from watersheds with natural abundance estimates at or above targets for at least four of the last five years were not further analyzed. The remaining populations that are below target levels, but may be rebuilding are identified using three tests:

- *Mean criterion*. The mean of the 1995–2000 calculated production values from the "rebuilding line" for each watershed is called the test value. The "rebuilding line" represents the linear trend from the 1992 baseline production value to the 2002 AFRP target. The test value is compared to the mean of the corresponding 1995–2000 abundance estimates for each watershed. Watersheds in which the average abundance estimate is greater than or equal to the test value are assigned a mean criterion score of +1. Otherwise, a mean criterion score of –1 is assigned. The mean criterion score evaluates whether the average abundance over the test period (5-years) is above or below the average abundance expected during the corresponding rebuilding period.

- *Line criterion*. The observed trend in abundance of naturally spawning adults is compared to the rebuilding line for each watershed. Watersheds in which three or more of the previous five monitored years of data are on or above the rebuilding line are assigned a line criterion score of +1. Otherwise a line score of –1 is assigned. The line criterion score evaluates whether the yearly population estimates are generally above or below the expected abundance during each year of the rebuilding period.

- *Short term trend criterion*. Watersheds in which at least four of the previous five monitoring years an estimate of abundance exceeded the previous year's estimate are assigned a trend score of +1. If four of the five years showed a decline from the previous year, a trend score of –1 is assigned. Others are given a trend score of 0. The short term trend criterion score evaluates whether the trend in abundance has been positive, neutral, or negative.
- The scores from all three tests (i.e., mean, line, and trend) are added together to determine the status of a population. If two or more of the tests are positive, a score of +2 or +3 is assigned and the population is considered to be "rebuilding." Conversely, if two of the three tests are negative, a score of –2 or –3 is assigned and the population is considered to be "not rebuilding." Intermediate scores on some of the tests or contradictory results of two tests (i.e., one positive, one negative) result in a cumulative score between –1 and +1 and the population status is considered "indeterminate."

CAMP Goal 2

Rotary screw trapping is the primary method by which juvenile salmon abundance is sampled. Results from RST are used, along with site-specific and other environmental data, to assess the relative effectiveness of the four categories of actions. Standard CAMP protocols, including the frequent estimate of trap efficiency are required for these data to be valid (USFWS 1997b). Table 2 lists the watersheds in which juvenile outmigrant abundance has been monitored in general accordance with CAMP protocols, including estimates of trap efficiency.

TABLE 2
CAMP Juvenile Salmon Monitoring Programs

Watershed	Chinook Salmon Race	Years Sampled
American River	Fall-run	1996, 1997, 1998, 1999, 2000
Battle Creek	Fall-, winter-, and spring–run	1999, 2000
Clear Creek	Fall-run	1999, 2000
Feather River	Fall-run	1996, 1998, 1999, 2000
Merced River	Fall-run	1998, 1999, 2000
Mokelumne River	Fall-run	1995, 1996, 1997, 1998, 1999, 2000
Stanislaus River	Fall-run	1996, 1997, 1998, 1999, 2000
Tuolumne River	Fall-run	1998, 1999, 2000

SECTION 3

Adult Fish Monitoring Program Results: 1995 - 2000

Adult Abundance Estimates: 2000

Chinook Salmon

Estimates of Natural Production

Year 2000 abundance estimates for naturally produced adult chinook salmon in each watershed are presented in Table 3. These estimates are based on monitoring methods described in the CAMP Implementation Plan (USFWS 1997a). In-river monitoring for fall-run chinook salmon in Deer and Mill creeks was not conducted in 2000.

The 2000 production estimates assume that all spring-run and winter-run chinook salmon are naturally produced. Late fall-run chinook salmon are not distinguished from fall-run fish in the in-river counts prior to 1998. Beginning in 1998, results from late fall-run salmon carcass surveys are available for the Sacramento River. Hatchery returns of fish identified as late fall-run in Battle Creek are presented in this report, but they do not contribute to the natural production estimate.

TABLE 3
2000 Adult Chinook Salmon Production Estimates

	In-River Estimates		Hatchery Returns						
Watershed	**Total**	**Hatchery Component**	**Total**	**Hatchery Component**	**In-River Harvest**	**Ocean Harvest[a]**	**Total Production**	**% Natural[b]**	**Natural Production**
Fall-Run Chinook Salmon									
American	101,679[c]		11,015		19,781	128,492	260,967	62%	161,800
Battle Creek	53,447[c]		21,659			72,848	147,954	10%	14,795
Butte Creek	714[c]					693	1,407	80%	1,125
Clear Creek	6,687[c]					6,486	13,173	80%	10,538
Deer Creek	NA[d]					NA[d]	NA[d]	80%	NA[d]
Feather River	107,834[c]		21,234		18,062	142,707	289,837	61%	176,800
Merced River	7,179[c]		1,954			8,858	17,991	91%	16,372
Mill Creek	NA[d]					NA[d]	NA[d]	81%	NA[d]
Mokelumne	1,894[e]		5,524		752	7,924	16,094	81%	13,036
Sacramento	96,688[f]				27,983	120,923	245,594	63%	154,724
Stanislaus	11,854[c]					11,498	23,352	100%	23,352
Tuolumne	16,420[c]					15,926	32,346	100%	32,346
Yuba River	14,852[c]					14,405	29,257	100%	29,257
Total	**419,248**		**61,386**		**66,578**	**530,761**	**1,077,973**		**634,147**

TABLE 3
2000 Adult Chinook Salmon Production Estimates

Watershed	In-River Estimates Total	In-River Estimates Hatchery Component	Hatchery Returns Total	Hatchery Returns Hatchery Component	In-River Harvest	Ocean Harvest[a]	Total Production	% Natural[b]	Natural Production
Late-Fall Run Chinook Salmon									
Battle Creek			2,564	2,564		2,487	5,051	**0%**	**0**
Sacramento	16,015[c]		0	0	4,251	19,657	39,923	**59%**	**23,554**
Total	**16,015[c]**		**2,564**	**2,564**	**4,251**	**22,144**	**44,974**		**23,554**
Winter-Run Chinook Salmon									
Sacramento	**1,270[e]**		**82**	**82**		**1,311**	**2,663**	**100%**	**2,663**
Spring-Run Chinook Salmon									
Butte Creek	4,118 [g]					3,994	8,112	100%	8,112
Deer Creek	637 [g]					618	1,255	100%	1,255
Mill Creek	544 [h]					528	1,072	100%	1,072
Sacramento	252 [e]					244	496	100%	496
Total	**5,551**					**5,384**	**10,935**	**100%**	**10,935**
Total 2000 Natural Production of Adult Chinook Salmon									**671,300**

[a] Individual watershed totals based on in-river count proportions.
[b] Watershed-specific percent natural component from CDFG (1994).
[c] Carcass survey.
[d] No estimate available.
[e] Ladder count.
[f] Estimate based on RBDD ladder counts, subtracting carcass counts for Battle and Clear creeks, hatchery returns and in-river harvest.
[g] Snorkel survey.
[h] Aerial redd count.

Revised Ocean Harvest Data

The ocean harvest estimates used to calculate adult chinook salmon production in 2000 are taken from the "Review of 2000 Ocean Salmon Fisheries" (PFMC 2001). In this document, values for 2000 are published as preliminary data subject to revision. Final data for the years prior to 2000 also are presented in the 2000 review. The final values differ by as much as 7.8 percent from the preliminary values used in the 1995 through 1999 CAMP Annual Reports. This translates into changes in total adult production of up to 3.2 percent. The updated final ocean harvest values for 1995 through 1999 and the revised total production estimates are presented in Table 4. Similar changes in the 2000 estimate of production and future production estimates could occur when the preliminary and final total ocean harvest values differ. To maintain consistency and timely reporting, CAMP annual reports will continue to develop production estimates using preliminary ocean harvest data.

Other Species

Natural production targets are also established for steelhead, striped bass, American shad, white sturgeon, and green sturgeon. In 2000, production estimates were available for American shad and striped bass, only. This information is presented in Table 5.

TABLE 4
Chinook Salmon Production Estimates Using Preliminary and Final Ocean Harvest Values

Year	Preliminary Total Ocean Harvest	Final Total Ocean Harvest	Harvest Percent Difference	Preliminary Total Natural Production	Final Total Natural Production	Production Percent Difference
1995	1,025,200	1,025,200	**0.00**	705,011	705,011	**0.00**
1996	462,900	478,200	**3.20**	427,341	435,713	**1.95**
1997	690,500	689,200	**0.19**	601,422	600,726	**0.12**
1998	324,900	336,000	**3.4**	376,563	302,651	**1.6**
1999	335,800	362,000	**7.8**	438,456	452,426	**3.2**

Ocean Harvest Values from *Review of 2000 Ocean Salmon Fisheries* (PFMC 2001).

TABLE 5
Steelhead, American Shad, Striped Bass, White Sturgeon, and Green Sturgeon Adult Spawner Estimates

Species	Restoration Target	Adult Spawner Abundance Estimate					
		1995	1996	1997	1998	1999	2000
Steelhead	13,000	NA	NA	NA	NA	NA	NA
American Shad	4,300	6,859	4,312	2,594	4,142	715	764
Striped Bass	2,500,000	NA	1,400,131	NA	NA	NA	2,300,000[a]
White Sturgeon	11,000	NA	NA	149,000[b]	NA	NA	NA
Green Sturgeon	2,000	NA	NA	2,041[c]	NA	NA	NA

a May be an overestimate as the age 3 estimate is based on only one recapture sample.
b Mark-recapture estimate changed from original report.
c 1.37% of white sturgeon total.

Trends in Population Abundance

Fall-Run Chinook Salmon

Following is a summary of 2000 natural production of fall-run chinook salmon in CAMP watersheds:

- Total production of naturally spawning fall-run chinook was estimated at 634,147 in 2000 (Table 6).
- The 2000 estimate of naturally spawning fall-run chinook was higher than in all previously monitored years except for 1995 (Figure 1).
- The 2000 estimates of natural production in the Merced River, Stanislaus River, and Tuolumne River watersheds are higher than estimates for all previous years.

- The 2000 estimates of natural production in the American River and Feather River watersheds are above all previous years estimates except for 1995.
- The 2000 estimates of natural production in the Battle Creek and Yuba River watersheds are below all previous years estimates.
- No estimates of natural production are available for the Deer and Mill Creek watersheds.

TABLE 6
Fall-Run Chinook Salmon Baseline Production Estimates, Production Targets and Estimates of Natural Production

Watershed	Baseline Production Estimates	CAMP Production Targets	Estimate of Natural Production					
			1995	1996	1997	1998	1999	2000
American River	81,000	160,000	211,123	121,278	107,559	86,184	88,476	161,800
Battle Creek	5,000	10,000	34,315	18,047	26,340	18,664	20,268	14,795
Butte Creek	760	1,500	1,468	981	1,662	3,797	2,704	1,125
Clear Creek	3,600	7,100	30,682	11,619	17,805	6,467	10,821	10,538
Deer Creek	760	1,500	1,861	1,056	2,500	410	871	NA
Feather River	86,000	170,000	189,214	87,132	89,963	92,195	76,264	176,800
Merced River	9,000	18,000	9,609	12,811	7,771	5,378	8,653	16,372
Mill Creek	2,100	4,200	5,062	2,871	1,220	840	1,399	NA
Mokelumne River	4,700	9,300	18,099	15,446	25,955	11,065	7,850	13,036
Sacramento River	120,000	230,000	116,176	70,235	219,729	18,234	129,534	154,724
Stanislaus River	11,000	22,000	2,520	412	4,265	3,966	7,606	23,352
Tuolumne River	19,000	38,000	3,065	8,834	15,833	14,494	15,211	32,346
Yuba River	33,000	66,000	62,255	69,752	69,631	59,797	40,265	29,257
Total	**370,000**	**737,600**	**685,450**	**420,474**	**590,233**	**321,491**	**409,922**	**634,147**

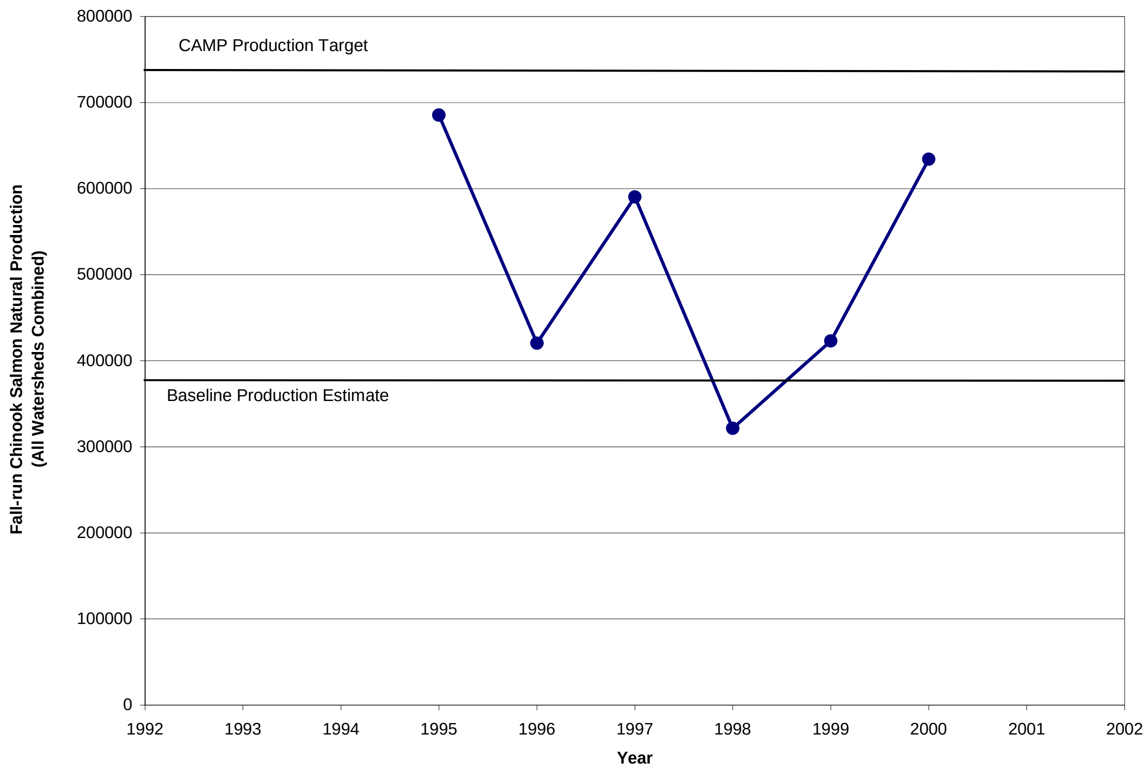

FIGURE 1
Fall-run Chinook Salmon Production Estimates (1995-2000)

The annual in-river escapement estimates (e.g., carcass surveys) and hatchery return data reflect year-to-year variation from climatic conditions and the variety of unknown causes affecting survival and reproduction (Tables 7 and 8). The 2000 estimate of in-river escapement is higher than all previous years (Table 7). Hatchery returns in 2000 were relatively high compared to other recent years (Table 8).

The estimates of in-river harvest (Table 9) showed substantial variability, particularly for the American, Feather, and Sacramento rivers, with large increases in harvest in recent years. Beginning in 1998, CAMP's harvest estimates have been based on angler surveys. CAMP's previous in-river harvest estimates (1995-1997) were based on the proportion of the total run harvested, estimated from angler surveys conducted in 1991-1994. In-river harvest during 1991-1994 may have been lower because of reduced fish abundance and angler effort as a result of drought conditions, and application of these estimates to subsequent years may have resulted in an underestimation of in-river harvest. Therefore, the increased in-river harvest estimates in 1998, 1999 and 2000 could be the result of the combination of both increased angler pressure and harvest and sampling error from underestimation of in-river harvest in previous years.

TABLE 7
Fall-Run Chinook Salmon In-River Escapement Estimates

Watershed	1995	1996	1997	1998	1999	2000
American River	70,096	65,915	56,000	43,000	53,619	101,679
Battle Creek	56,515	52,404	50,743	53,957	92,949	53,447
Butte Creek	445	500	800	2,500[a]	2,000[b]	714
Clear Creek	9,298	5,922	8,569	4,258	8,003	6,687
Deer Creek	564	538	1,203	270	644[b]	NA[c]
Feather River	59,893	46,301	38,193	43,000	35,903	107,834
Merced River	2,194	4,037	3,690	4,123	2,182	1,894
Mill Creek	1,515	1,445	580	546	1,022[b]	NA[c]
Mokelumne River[d]	2,194	4,037	3,690	4,123	2,182	1,894
Sacramento River	39,665	40,870	125,218	5,865	76,413	96,688
Stanislaus River	611	168	1,642	2,089	4,500	11,854
Tuolumne River	743	3,602	6,096	7,634	9,000	16,420
Yuba River	14,561	27,520	25,778	30,802	23,044	14,852
Total	**261,381**	**257,704**	**320,856**	**203,219**	**313,284**	**419,248**

[a] Estimate based on professional judgement of biologist working on Butte Creek during adult fall-run chinook salmon migration/spawning in 1998.
[b] Estimate is an average of 1995-1998 data.
[c] No estimate in 2000.
[d] May differ from previous reports, updated August 2002 (pers. comm., M. Workman, EBMUD)

TABLE 8
Fall-Run Chinook Salmon Hatchery Returns

Watershed	1995	1996	1997	1998	1999	2000
American River	6,498	7,838	6,142	10,581	9,760	11,015
Battle Creek	26,677	21,178	50,670	44,350	26,970	21,659
Feather River	11,719	8,710	15,066	18,699	12,384	21,234
Merced River	602	1,141	946	799	1,626	1,954
Mokelumne River[a]	3,323	3,883	6,485	3,090	3,153	5,524
Total	**48,819**	**42,750**	**79,309**	**77,0**	**53,893**	**61,386**

[a] May differ from previous repots, updated August 2002 (pers. comm., M. Workman, EBMUD)

TABLE 9
Fall-Run Chinook Salmon In-River Harvest

Watershed	1995	1996	1997	1998	1999	2000
American River	5,961	6,003	4,651	19,636[c]	21,053[c]	19,781[c]
Feather River	3,589	3,229	3,523	17,908[c]	25,684[c]	18,062[c]
Mokelumne River	-	-	-	14[c]	401[c]	752[c]
Sacramento River	5,042[a]	4,585	9,066	9,380[b]	45,238[c]	27,983[c]
Stanislaus River	-	-	-	0	0	0
Yuba River	532	920	1,031	694[c]	774[c]	0[c]
Total	**15,124**	**14,737**	**18,271**	**47,632**	**93,150**	**66,578**

[a] Revised estimate, 9/17/99, by K. Murphy, CDFG.
[b] Estimated as 8% of RBDD ladder count by CDFG.
[c] Estimate from angler surveys.

Late Fall-Run Chinook

For CAMP reports prior to 1999, adult late fall-run chinook salmon are included in the fall-run totals. Since 1999, separate in-river harvest and carcass count information for late fall-run chinook has been available, limited to the mainstem Sacramento River. The 2000 estimate of late fall-run abundance for the Sacramento River was 23,554 naturally-spawning adults (Table 3) as compared to the Sacramento River target of 44,000 and the system-wide target of 68,000 returning fish. As in previous years, the Battle Creek count of late fall-run hatchery returns does not contribute to the natural production estimate.

Winter-Run Chinook

The watershed-specific target for winter-run chinook salmon and estimates of natural winter-run production for 1995 through 2000 are presented in Table 10. The 2000 estimate is less than all previous estimates except for 1996.

TABLE 10
Winter-Run Chinook Salmon Baseline Production Estimate, Production Target and Estimates of Natural Production

Watershed	Baseline Production Estimate	Production Target	Estimate of Natural Production					
			1995	1996	1997	1998	1999	2000
Upper Sacramento River	54,000	110,000	5,614	2,317	5,332	10,444	5,422	2,663

Spring-Run Chinook Salmon

The watershed-specific targets for spring-run chinook salmon and the estimates of natural spring-run production by watershed for 1995 through 2000 are presented in Table 11. The estimate of total spring-run production in 2000 is similar to the 1999 estimate, but still substantially less than in 1998. The high estimate in 1998 is attributable almost entirely to Butte Creek (Table 11).

TABLE 11
Spring-Run Chinook Salmon Baseline Production Estimates, Production Targets and Estimates of Natural Production

Watershed	Baseline Production Estimate	Production Targets	Estimate of Natural Production 1995	1996[a]	1997[a]	1998	1999	2000
Butte Creek	1,000	2,000	5,321	1,557	3,636	38,351	6,218	8,112
Deer Creek	3,300	6,500	5,342	1,506	1,210	3,567	2,689	1,255
Mill Creek	2,200	4,400	1,787	687	519	805	946	1,072
Sacramento River	29,000	59,000	1,497	800	491	1,904	728	496
Total	**35,500**	**71,900**	**13,947**	**4,550**	**5,856**	**44,628**	**10,581**	**10,935**

Progress Toward Meeting Production Targets

Background

The AFRP developed watershed-specific restoration targets for chinook salmon and system-wide targets for all five species of anadromous fish monitored by CAMP. The CAMP watersheds represent approximately 97 percent of the total fall-run chinook production in California (USFWS 1997a). As specified in the CAMP Implementation Plan, progress towards meeting production targets will be assessed using a modification of the Pacific Salmon Commission's rebuilding assessment methods when a minimum of five years of monitoring data are available (USFWS 1997a). The minimum five years of monitoring data became available for the first time in 1999 and progress towards meeting production targets was assessed at that time. With the additional year of data collected in 2000, this methodology can again be applied. The CAMP assessment methods classify indicator races or species into two categories: (1) those meeting their rebuilding schedule; and (2) those not rebuilding. The analysis is based on a rolling five-year comparison of natural production to baseline and restoration target levels.

Several CAMP-monitored species were analyzed for evidence of rebuilding stocks and progress towards meeting population goals using these methods. The analysis included the previous five years of CAMP monitoring data (1996 through 2000) for four races of chinook salmon and for American shad. Other CAMP-monitored species possess a less complete record and could not be included in the analysis.

Results

The results of the population analyses are summarized in Table 12 and abundance estimates over the six year CAMP record are shown in Figure 2. Note that the PSC stock rebuilding assessment is restricted to the last five years of record, but all six CAMP years are shown in Figure 2 for completeness of presentation. Fall-run chinook salmon populations in the Battle Creek, Clear Creek, and Mokelumne River watersheds and spring-run chinook in the Butte Creek watershed were classified as rebuilding. Fall-run chinook salmon in the Yuba River watershed were classified as "Indeterminate". All other races and watershed-specific runs of chinook salmon were classified as "Not Rebuilding." Fall-run chinook salmon population estimates in the Butte Creek, Deer Creek, and Mill Creek watersheds were not analyzed using Pacific Salmon Commission methods because a minimum of five years of reliable monitoring data are not available. Previous estimates are based on "professional judgement" or averages of prior years, rather than on accepted survey methods (e.g., carcass surveys).

Progress towards meeting AFRP watershed-specific goals was variable across race and location. The Battle and Clear Creek fall-run chinook salmon population estimates are above their baseline to goal trend line for all of the five monitoring years. In contrast, the Tuolumne River fall-run salmon, the Deer Creek, Mill Creek, and Sacramento River spring-run, and the summed spring and winter-run population estimates all are below the baseline to goal trend line in all five monitoring years. When summed across watersheds, the CAMP-monitored populations of fall-run, spring-run, and winter-run chinook salmon all are classified as "Not rebuilding." Late fall-run salmon are incorporated in the fall-run totals by CAMP.

Trends for non-salmon CAMP Species

Although CAMP is tasked with assessing the progress towards meeting production goals for all CAMP-monitored species, population estimates for most species cannot be analyzed for trends yet because data remain insufficient. Green sturgeon and white sturgeon, striped bass, and steelhead populations are too infrequently assessed to allow analyses of trends in the estimates of naturally produced adults. No population estimates of steelhead for the CAMP streams other than as hatchery returns, are available. The other species are infrequently monitored as represented in Table 5. Five years of continuous record are needed to apply the PSC testing methods and more years of monitoring will be needed to assess the progress towards meeting the CVPIA doubling goal for these non-salmon species.

American shad, although classified as "Rebuilding" using the salmon-based methods in 1999 (USFWS and USBR 2001), can no longer be classified as rebuilding. Population estimates for American shad over the monitoring record, indicate a marked decline, moving from above to below the goal line. Shad are classified as "Not Rebuilding" for the 2000 assessment.

Watershed	Race	Assessment Scores				Status
		Mean	Line	Trend	Total	
American	Fall-run	-1	-1	0	-2	Not Rebuilding
Battle	Fall-run	1	1	0	2	Rebuilding
Butte	Spring-run	1	1	0	2	Rebuilding
Clear	Fall-run	1	1	0	2	Rebuilding
Deer	Spring-run	-1	-1	0	-2	Not Rebuilding
Feather	Fall-run	-1	-1	0	-2	Not Rebuilding
Merced	Fall-run	-1	-1	0	-2	Not Rebuilding
Mill	Spring-run	-1	-1	0	-2	Not Rebuilding
Mokelumne	Fall-run	1	1	0	2	Rebuilding
Sacramento	Fall-run	-1	-1	0	-2	Not Rebuilding
	Spring-run	-1	-1	0	-2	Not Rebuilding
	Winter-run	-1	-1	0	-2	Not Rebuilding
Stanislaus	Fall-run	-1	-1	0	-2	Not Rebuilding
Tuolumne	Fall-run	-1	-1	0	-2	Not Rebuilding
Yuba	Fall-run	-1	1	0	0	Indeterminate
Total (all CAMP streams)	Fall-run	-1	-1	0	-2	Not Rebuilding
	Spring-run	-1	-1	0	-2	Not Rebuilding
	Winter-run	-1	-1	0	-2	Not Rebuilding

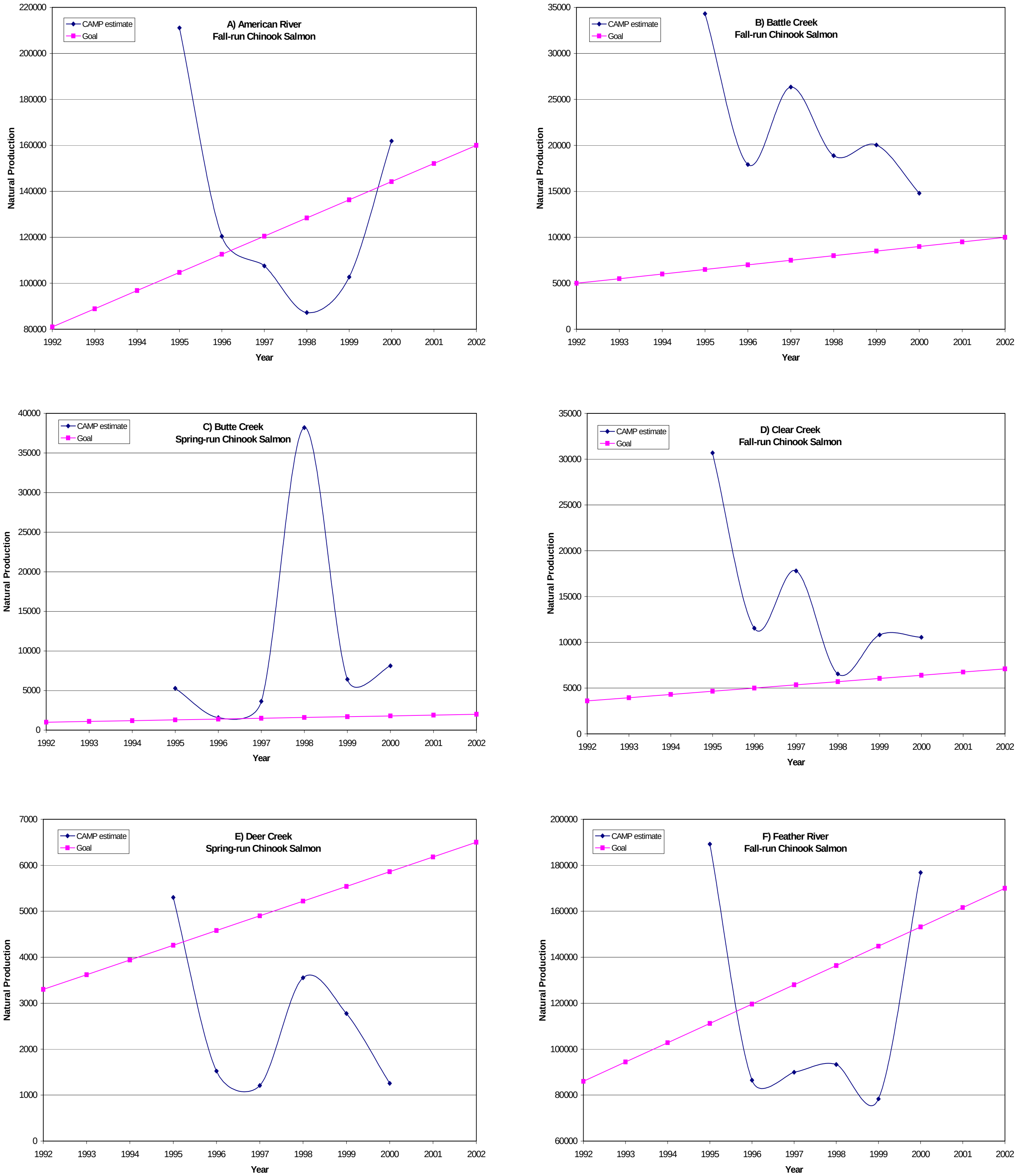

FIGURE 2
CAMP Adult Anadromous Fish Abundance Estimates, 1995-2000 Versus AFRP Baseline to Target Levels
Assessment Based on the Pacific Salmon Commission Assessment Methodology

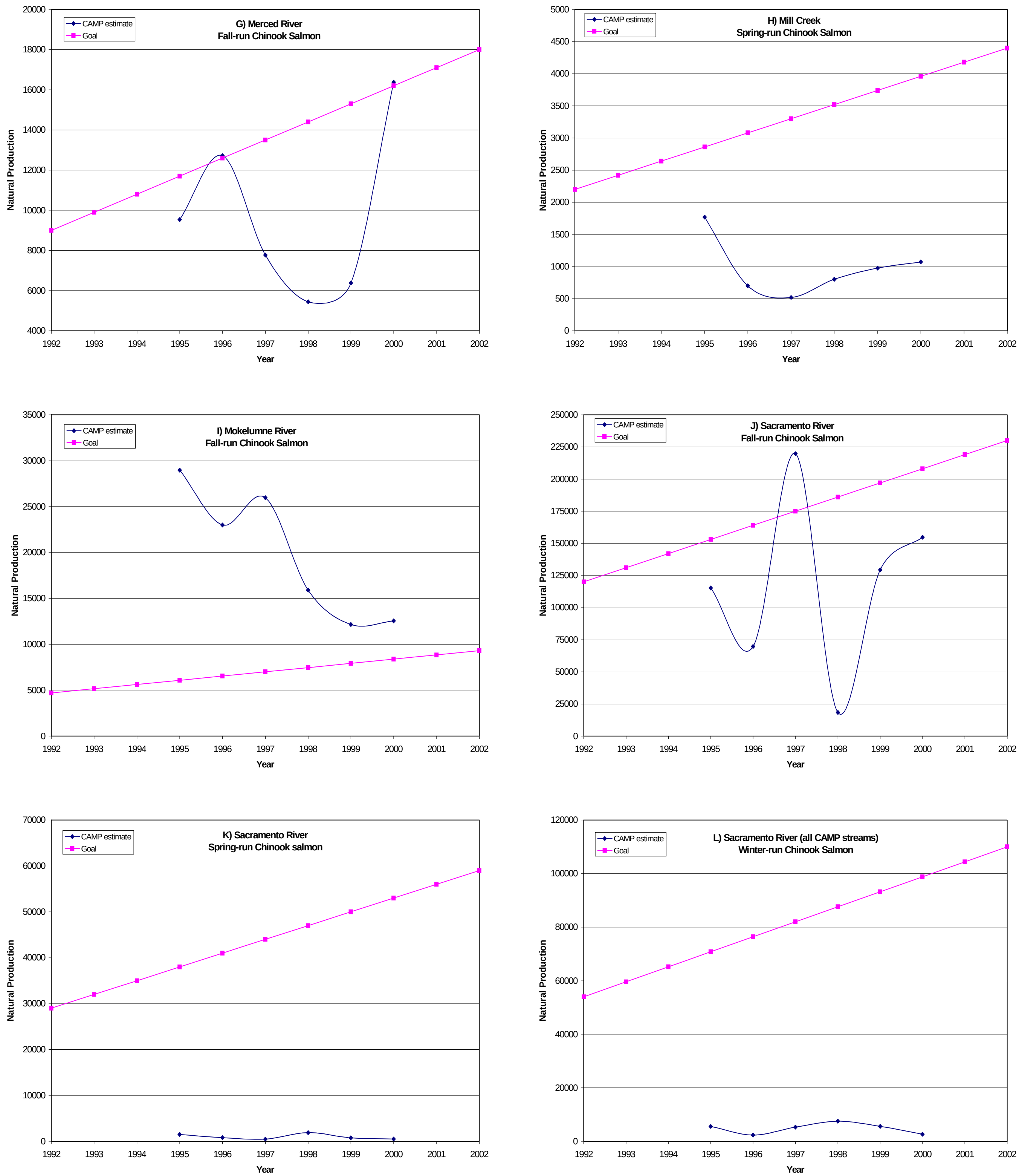

FIGURE 2
(*Continued*)

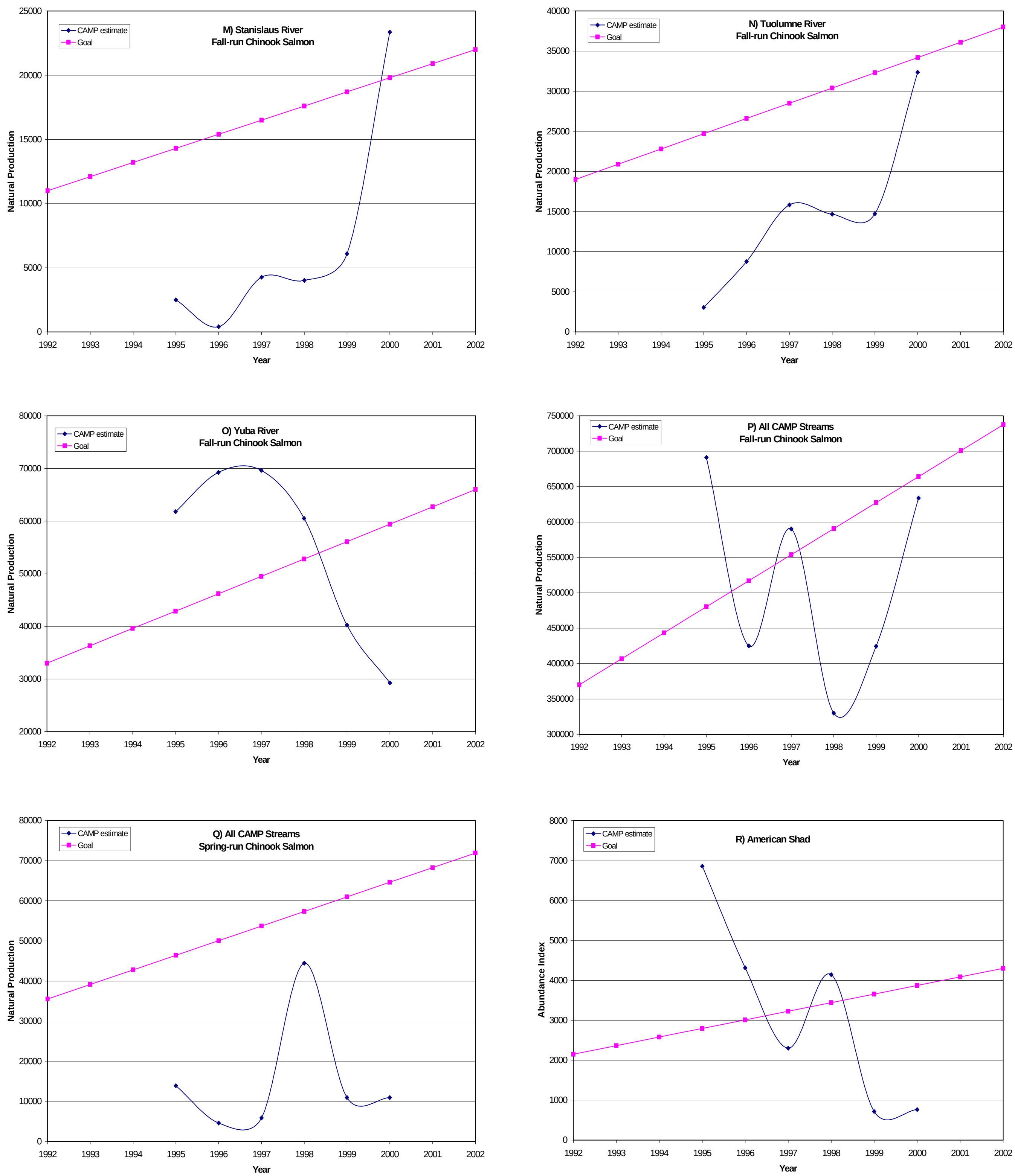

FIGURE 2
(*Continued*)

SECTION 4

Juvenile Fish Monitoring Program Results: 1995 – 2000

Juvenile Outmigration Estimates

This section reports results of RST sampling for fall-run chinook salmon in seven streams during 2000. Sampling protocol on these streams included methods that generally conform to the standardized protocol developed by CAMP. Estimated numbers of juvenile chinook salmon emigrating from each stream in 2000 are summarized in Table 13. These estimates are based on monitoring methods detailed in Appendix A. Juvenile outmigration has been monitored in several other streams using rotary screw traps; however, juvenile production estimates are not reported for these streams because trap efficiency tests were not conducted as part of the monitoring programs, or the data were unavailable for inclusion in this report.

TABLE 13
Summary of Estimated Numbers of Juvenile Fall-Run Chinook Salmon Emigrating from CAMP streams during 2000

Watershed	Estimated total number of juveniles emigrating	Estimated number of fry (< 50 mm)	Estimated number of juveniles >50 mm
American River	9,953,976	9,734,764	219,212
Feather River[a]	18,163,951[b]	NA	NA
Mokelumne River	168,525	107,134	61,391
Stanislaus River	1,619,593	631,460	988,133
Tuolumne River	139,024	90,064[c]	48,960[c]
Lower Battle Creek[d]	16,697,610	NA	NA
Clear Creek[d]	6,890,479	NA	NA

[a] Total of outmigrants at the Thermalito and Live Oak sites
[b] Estimate is low and unreliable because high flow impeded trapping at the Live Oak site
[c] Distinction between fry and other juveniles is at 65 mm
[d] Jan-Dec 2000 data, possibly including early 2001 migrants

Trends in Juvenile Outmigration

Estimated numbers of juvenile chinook salmon emigrating from each stream from 1995 through 2000 are summarized in Table 14. To normalize for the effects of adult population size on the number of resulting outmigrants, an index of juveniles per spawner (female) is calculated based on adult escapement from the previous year (Table 15). When normalized for the number of adult females, the relative changes in numbers of juvenile salmon serve as a primary indicator of habitat conditions in the natal streams. Only two watersheds have shown a statistically significant increase in the number of juvenile outmigrants or index values over time. The Mokelumne River outmigrant numbers and index values increased over time through 1999, but declined in 2000. The Stanislaus River outmigrant numbers increased through 2000.

TABLE 14
Estimated Total Numbers of Juvenile Fall-Run Chinook Salmon Emigrating From CAMP streams

Watershed	1995	1996	1997	1998	1999	2000
American River	NA	4,461,729	1,772,842	31,822,165	9,865,540	9,953,976
Feather River[a]	NA	641,000	NA	45,097,000	23,375,620	18,163,951[b]
Mokelumne River	434,206	184,014	540,466	1,848,539	1,535,439	168,525
Stanislaus River[c]	NA	115,258	67,344	593,819	1,321,054	1,619,593*
Tuolumne River[d]	NA	NA	NA	NA	1,133,887	139,024
Merced River	NA	NA	NA	NA	199,166	NA
Lower Battle Creek	NA	NA	NA	NA	4,909,700[e]	16,697,610[f]
Clear Creek[d]	NA	NA	NA	NA	7,586,097[e]	6,890,479[f]

* Statistically significant increase over time for linear or Log_e-transformed variable.
[a] Total of outmigrants at the Thermalito and Live Oak sites
[b] Estimate is low and unreliable because high flow impeded trapping at the Live Oak site
[c] From Demko et al. (2001)
[d] From Vasques and Kundargi (2001)
[e] Revised based on adjustment in RST efficiency (pers. comm., Phillip Gaines, USFUDS)
[f] Jan-Dec 2000 data, possibly including early 2001 migrants

TABLE 15
Index of Juvenile Fall-Run Chinook Salmon (Number per female) Emigrating From CAMP streams

Watershed	1995	1996	1997	1998	1999	2000
American River	NA	127.3	53.8	1136.5	458.9	371.3
Feather River	NA	21.4	NA	2361.5	1087.2	1011.8
Mokelumne River	NA	175.8	277.7	363.8	750.6	154.8
Stanislaus River	NA	377.3	801.7	723.3	1264.8	719.8*
Tuolumne River	NA	NA	NA	NA	297.1	30.9
Merced River	NA	NA	NA	NA	172.1	NA
Lower Battle Creek	NA	NA	NA	NA	182.0[a]	359.3
Clear Creek	NA	NA	NA	NA	3563.2[a]	1722.0

* Statistically significant increase over time for linear or Log_e-transformed variable.
[a] Revised based on adjustments in RST efficiency (pers. comm., Phillip Gaines, USFWS)

SECTION 5

Relative Effectiveness of Categories of Actions

The CAMP juvenile monitoring program is intended to provide long-term, watershed-specific monitoring of juvenile salmon production as part of the larger Goal 2 effort. Juvenile salmon abundance has been used by AFRP as a measurement of salmon production and survival attributable to AFRP actions. The focus on juvenile salmon avoids the need to account for many variables not related to AFRP actions, including: ocean conditions, ocean sport and commercial harvest, habitat conditions and water quality outside of the natal streams, in-river sport harvest, and predation and water project operations in the Sacramento-San Joaquin Delta and San Francisco Bay.

Rotary screw traps (RSTs) have been used as the primary means to evaluate trends in juvenile salmon abundance. Rotary screw traps do have limitations, such as capturing predominately smaller sized juvenile salmon, washing out or becoming miscalibrated in streams that are subject to large flow fluctuations, and misrepresenting population sizes because of low trap efficiency and high variability. Even with these limitations, RSTs can be an effective monitoring tool, and can provide a reliable estimate of juvenile production when used consistently over a number of years.

Screw trap monitoring data alone are not sufficient to distinguish the relative effectiveness of the four categories of actions to restore anadromous fish populations. Data from site-specific monitoring and long-term adult monitoring are also needed to help provide the critical link between the types of restoration actions implemented within a watershed and juvenile production and population growth. Without site-specific monitoring data, CAMP’s goal of assessing which categories of restoration actions are most effective in restoring fish populations cannot be effectively addressed. However, the cumulative effect of all restoration actions in each watershed is assessed, where possible, by examining the number of juvenile outmigrants.

Restoration Actions

Goal 2 of the Comprehensive Assessment and Monitoring Program (CAMP) relies on established watershed monitoring programs to estimate juvenile salmonid abundance, and site-specific monitoring of individual restoration projects to assess the relative effectiveness of four types of restoration actions:

- Water management modifications
- Structural modifications
- Habitat restoration
- Fish screens

The watersheds monitored to date are similar with respect to completed restoration actions (Table 16). Water management modifications have been made in most of the monitored watersheds and habitat restoration projects have been completed or are ongoing at several sites in the Mokelumne, Stanislaus, Tuolumne and American rivers. One structural modification, reconfiguration of the shutters at Folsom Dam, was completed on the American River in 1996. No fish screening projects have been completed in these rivers. Appendix B discusses restoration actions in detail.

TABLE 16
Summary of Restoration Actions Completed In Recent Years in the Watersheds with CAMP Goal 2 Assessments

Watershed	Year Implemented	Restoration Action Type	Action
American River	Fall, 1994 and Ongoing	Water Management	Change in flow releases from Folsom Dam
	Summer, 1996	Structural Modification	Reconfigured Folsom Dam shutters
	1999	Habitat Restoration	Spawning gravel restoration at several sites
Feather River	Ongoing	Habitat Restoration	Spawning gravel restoration at several sites
	Water Years 1996, 1997, 1998 and Ongoing	Water Management	Flows augmented in low flow channel
Mokelumne River	1992	Water Management	Change in flow releases from Camanche Dam
	Summer/fall 1992, 1993, 1994, 1996, 1997	Habitat Restoration	Spawning gravel restoration at several sites
Stanislaus River	Spring 1995, 1996 and Ongoing	Water Management	Flow release augmentations for steelhead and fall-run chinook salmon
	Summer 1994, 1997	Habitat Restoration	Spawning gravel restoration at several sites
Tuolumne River	Dates not available	Habitat Restoration	Spawning gravel restoration at several sites
Battle Creek	Since 1995	Water Management	Flow improvements for fish passage
	1999-2001	Habitat Restoration	Various project including dam removals
	Since 1998	Screening	Coleman Hatchery screening
Clear Creek	1996 - Ongoing	Habitat Restoration	Erosion control, spawning gravel restoration, channel bypass improvements, eventual dam removal

Evaluation of Effectiveness

With limited juvenile abundance data, natural environmental variations, such as extremely high flows in early 1997 and other climatic events, the ability to discern differences due to restoration actions is reduced. For all restoration actions, pre-project monitoring was either not available or not conducted using CAMP protocols. In some streams and years, sampling was not conducted over the entire fall-run emigration period.

As an initial evaluation of CAMP Goal 2, juvenile emigration data are shown in Table 17. For the current subset of CAMP watersheds, comparisons among watersheds are limited. Although there are differences among watersheds in total juvenile outmigrants and adult returns, the watersheds examined are not different in terms of types of restoration actions implemented. In estimating juvenile salmon abundance, the index of juveniles per spawner (females) must be used to normalize for population size and allow comparisons between watersheds. The juvenile index values are not statistically different among watersheds (Analysis of Variance, P> 0.10), therefore, no between-watershed comparisons are possible.

TABLE 17
Analysis of CAMP Juvenile Salmon Monitoring Data for Watersheds with Multiple Year Records

Watershed	Abundance Estimate	CAMP Mean	Standard Error of Mean	Significance of Change over Time (Linear regression)
American River	Total Outmigrants	12,190,742	6,933,461	NS
	Juveniles per female	452	251	NS
Feather River	Total Outmigrants	17,340,647	13,973,451	NS
	Juveniles per female	892	739	NS
Mokelumne River	Total Outmigrants	752,017	243,632	NS
	Juveniles per female	353	134	NS
Stanislaus River	Total Outmigrants	530,990	296,406	P<0.05*
	Juveniles per female	740	198	P<0.05*

* Statistically significant increase over time for linear or Log_e-transformed variable.
NS No statistically significant trend over time.

Within watersheds, it is apparent that the Mokelumne (through 1999) and Stanislaus Rivers (through 2000) have shown increases in the abundance of juvenile fall-run salmon emigrating over the CAMP monitoring record (Table 14). Estimated total number of juveniles and the number of juveniles/female has increased in the Stanislaus over time. These results suggest a positive effect of cumulative restoration actions in these watersheds. However, the error of these RST estimates is unknown and trends should be viewed as preliminary. These data suggest that the cumulative restoration actions in the Mokelumne and Stanislaus River watersheds have had positive effects on juvenile production and are improving natural production. Without site-specific monitoring information and more complete RST data, it is not possible to assess the relative success of categories of restoration actions in restoring anadromous fish populations over the CVPIA system

SECTION 6

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January 2002. Personal Communication between James Smith, East Bay Municipal Utility District, Lodi, and Neil Nikirk, CH2M Hill, Sacramento.

February/March 2002. Personal Communication between Michelle Workman, East Bay Municipal Utility District, Lodi, and Neil Nikirk, CH2M Hill, Sacramento.

February/March 2002. Personal Communication between Chrissy Sonke, S.P Cramer & Associates, Chico, and Neil Nikirk, CH2M Hill, Sacramento.

February 2002. Personal Communications between Trevor Kennedy, The Fish Foundation, Sacramento, and Neil Nikirk, CH2M Hill, Sacramento.

February 2002. Personal Communications between Bill Snider, California Department of Fish and Game, Sacramento, and Neil Nikirk, CH2M Hill, Sacramento.

March 2002. Personal Communications between Tim Heyne, California Department of Fish and Game, La Grange, and Neil Nikirk, CH2M Hill, Sacramento.

February/March/April 2002. Personal Communications between Karl Jacobs, California Department of Water Resources, Sacramento, and Neil Nikirk, CH2M Hill, Sacramento.

January/February 2002. Personal Communications between Karl Jacobs, California Department of Water Resources, Sacramento, and Earl Byron, CH2M Hill, Sacramento.

September 2002. Personal Communication between Phillip Gaines, U.S. Fish and Wildlife Service, Red Bluff, and Meri Miles, CH2M HILL, Sacramento. Memo re: Review of Draft CAMP Animal Report (2000).

August 2002. Personal Communication between Michelle Workman, East Bay Municipal Utility District, Lodi, and Neil Nikirk, CH2M HILL, Sacramento.