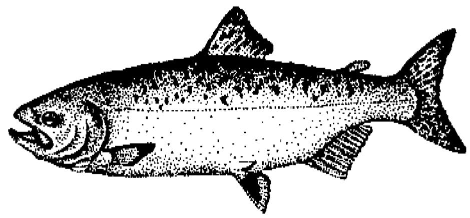
Comprehensive Assessment and Monitoring Program (CAMP) Implementation Plan



A Comprehensive Plan to Evaluate the Effectiveness of CVPIA Actions in Restoring Anadromous Fish Production

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TABLE OF CONTENTS

Section 3. Evaluation of Monitoring Program Results

Section 4. Data Management and Reporting

Section 5. Staffing and Budget Requirements

Section 6. Citations

Appendix A. Adult Production Calculations

Appendix B. Existing Adult and Juvenile Monitoring Programs

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGMENTS

IMPLEMENTATION PLAN DEVELOPMENT

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EXECUTIVE SUMMARY

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INTRODUCTION

The Central Valley Project Improvement Act (CVPIA) was enacted in October 1992. Section 3406(b) of the CVPIA directs the U.S. Fish and Wildlife Service (USFWS) to develop and implement a series of restoration programs and actions for fish and wildlife purposes. The Act specifies that these actions should ensure that by 2002 the natural production of anadromous fish in Central Valley streams will be sustainable, on a long-term basis, at levels not less than twice the average levels attained during 1967-1991.

The Anadromous Fish Restoration Program (AFRP) was initiated in response to Section 3406(b)1 of the CVPIA. The AFRP established baseline production numbers on Central Valley rivers and streams for naturally produced chinook salmon (all races), steelhead trout, striped bass, American shad, white sturgeon, and green sturgeon. The baseline fish production numbers were based upon monitoring information collected from 1967-1991. The AFRP established anadromous fish production targets based upon the baseline fish production numbers . The fish production targets represent a doubling of the baseline (1967-1991) numbers.

Section 3406(b)of the CVPIA provides the USFWS with the means to meet the anadromous fish production targets. This section of the Act [exclusive of (b)(16),(18),(22), and (23)] specifies a series of restoration actions that will be implemented over time throughout the Central Valley. The actions can be categorized as either water management modifications, structural modifications, habitat restoration, or fish screens. Figure S-1 illustrates the general locations where these categories of Section 3406(b) CVPIA actions will be implemented.

COMPREHENSIVE ASSESSMENT AND MONITORING PROGRAM

Section 3406(b)(16) of the Act specifies the development of a monitoring and assessment program to evaluate the effectiveness of implemented actions. The "Comprehensive Assessment and Monitoring Program (CAMP)" has been developed for this purpose.

CAMP is focused on meeting two distinct objectives:

(1) to assess the **overall** (cumulative) effectiveness of actions implemented pursuant to CVPIA Section 3406(b) in meeting AFRP production targets and

(2) to assess the **relative** effectiveness of categories of Section 3406(b) actions (e.g., water management modifications, structural modifications, habitat restoration, and fish screens) toward meeting AFRP production targets.

FIGURE S-1

Juvenile Chinook Salmon Monitoring Recommendations and Categories of CVPIA Restoration Actions

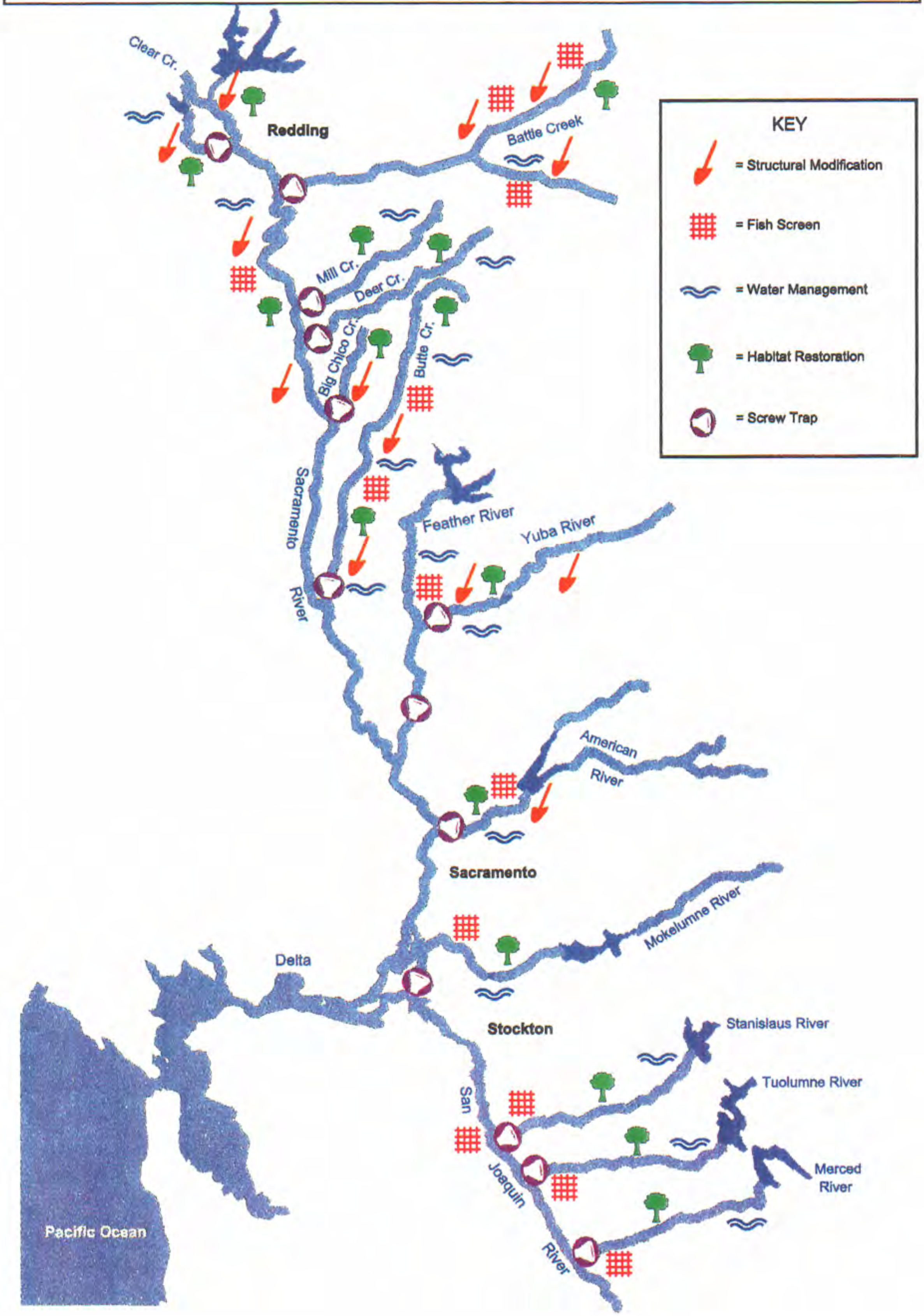
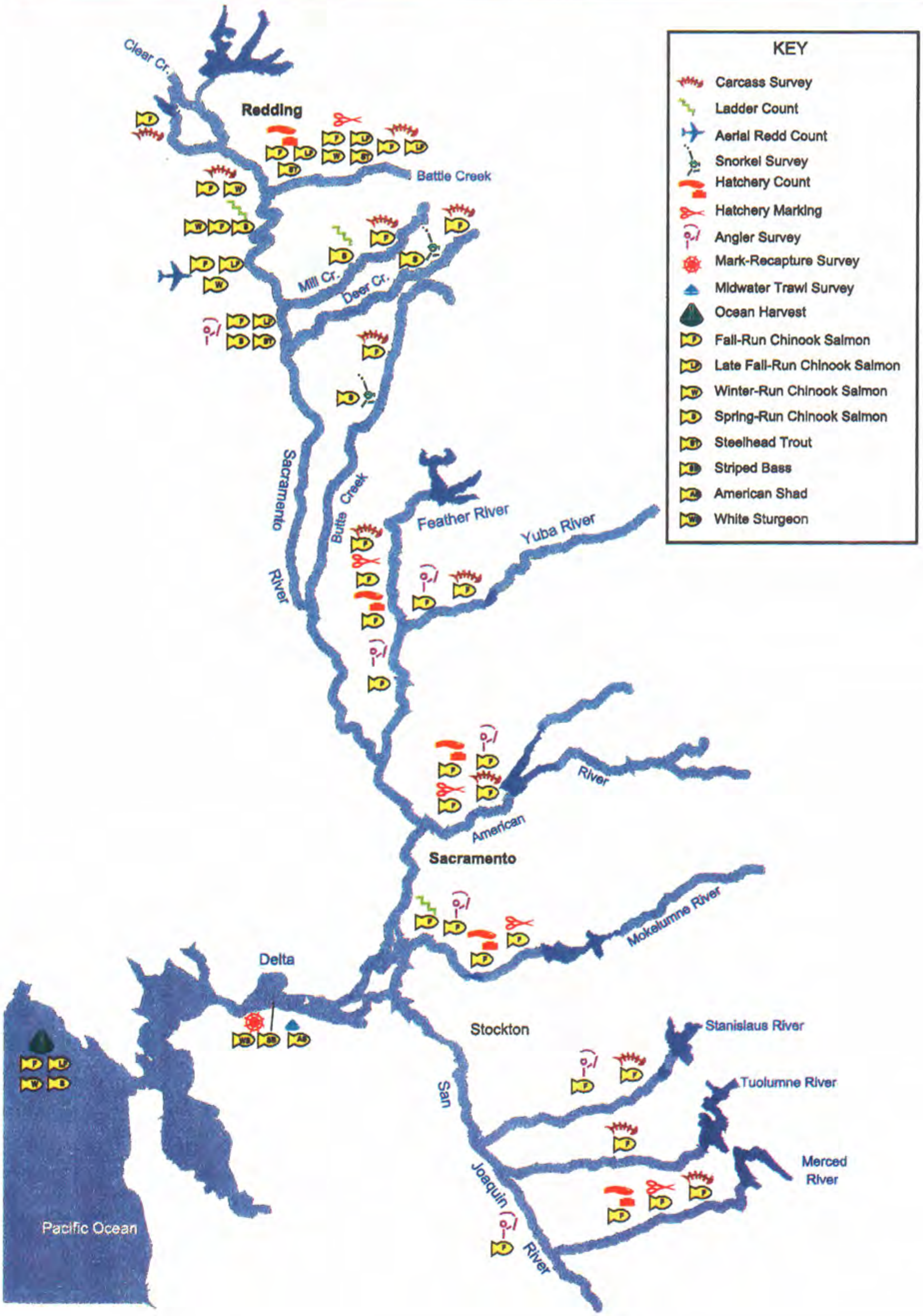


FIGURE S-2

Adult Monitoring Recommendations



CAMP is designed to be broad in scope and evaluate the general or system-wide results of the CVPIA rather than the performance of site-specific actions. The CAMP Conceptual Plan (CP) was released in 1995 for public review. The CAMP Implementation Plan (IP) has refined the Conceptual Plan's recommendations and added detailed watershed and system-wide adult production calculations, a recommended juvenile salmonid monitoring program, data analysis methods, data management protocols, and five-year budget and funding needs. The IP is the final phase in the CAMP planning process before implementation in 1997.

CAMP Recommended Monitoring Programs

Adult Monitoring

Progress toward meeting anadromous fish production targets will be based upon measurement of increases in adult production of chinook salmon (all races), steelhead trout, striped bass, American shad, white sturgeon and green sturgeon. The CAMP IP recommends a series of adult fish monitoring programs that will be used to calculate annual production estimates for each target species. The natural adult production of steelhead trout and chinook salmon (all races) in a watershed will be calculated as the sum of the in-river run, and the portions of the downstream harvest and ocean harvest associated with the watershed. Fish production trends will be developed by using the annual fish production numbers and comparing them to the 1967-1991 baseline fish production numbers. Because several generations of fish must be studied to get an accurate picture of their overall production status the adult monitoring program will need to be consistent and long-term (25-50 years). The adult monitoring programs recommended by CAMP are shown in Figure S-2.

Juvenile Monitoring

Juvenile chinook salmon were chosen to evaluate the relative effectiveness of the water management, structural, habitat restoration, and fish screen action categories in increasing anadromous fish production. Juvenile chinook salmon were selected for the following reasons:

- They will only be exposed to the categories of actions occurring in their natal streams,
- They are sufficiently abundant, and
- They are distributed widely throughout the Central Valley.

Rotary screw trapping is the recommended method for monitoring juvenile salmonids. Although several problems are associated with the use of screw traps, this method is more efficient over a relatively broad range of stream conditions than other available juvenile monitoring techniques (e.g., snorkel surveys, seining, electrofishing). CAMP recommended juvenile monitoring programs are shown in Figure S-1.

Evaluation of Monitoring Results

The adult monitoring programs will result in a single production estimate for each anadromous fish species on each watershed where an AFRP production target has been set. The production estimates will be used to evaluate progress toward AFRP production targets using a modified version of the Pacific Salmon Commission's (PSC) rebuilding assessment methods. Two of PSC's three criteria involve the use of a "base to goal line" that uses a straight line to connect the mean baseline production and the production goal over the rebuilding period. The third, short term, criterion examines the recent production estimate for a species by determining if recent production is greater than for the previous year. Scores are assigned for each criterion and the total is used to determine if the species or race may be classified as "rebuilding".

The juvenile monitoring program data will be analyzed to evaluate action category effectiveness using a variety of qualitative and quantitative techniques. These techniques will include:

- Changes in juvenile abundance over time within each watershed prior to and following action implementation.
- Changes in juvenile abundance among watersheds.
- Integration of AFRP site-specific monitoring results into the CAMP evaluation.
- Use of adult spawner/juvenile abundance relationships to link the impact of actions that increase juvenile abundance to adult production.
- Changes in abiotic environmental variables compared to juvenile abundance estimates.

Qualitative and quantitative results will be examined together to assess the effectiveness of actions within any given watershed. Action categories will be compared by their cumulative total positive, negative, or neutral effects on juvenile abundance and ranked in terms of their summed effectiveness.

Data Management System Recommendations

The recommended monitoring programs are designed to collect the data needed to meet CAMP's objectives. The data management process addresses data compilation and entry procedures, data availability and timing constraints, data processing calculations, data storage formats, and data accessibility to multiple data providers and users.

The availability of adult monitoring data for entry into CAMP calculations will be determined by the data reporting schedules of agencies and the migration/spawning period of each fish species/race. Adult fish monitoring data will be acquired in summary format from annual agency reports. In comparison to adult data juvenile data will be a combination of raw (e.g. daily screw-trap estimates) and summary formats. Juvenile data will require a detailed qualitative and quantitative analysis. A set of quality assurance and control procedures, developed by the

Interagency Ecological Program (IEP), will be followed to ensure that field data are recorded accurately, and data for CAMP calculations are formatted properly.

The data compiled and entered into the CAMP database will be made available to a wide array of users through the use of an Internet home-page interface. In addition to data access, the home-page will serve as a mechanism to access a variety of information related to the overall CAMP process.

CAMP Budget and Funding Requirements

Budget estimates including the one and five year projected funding requirements for the the CAMP adult and juvenile monitoring programs, data management system, and staffing needs are summarized in Table S-1.

Table S-1. CAMP Budget and Funding Requirements

	Projected Budget		
Project	**Program Costs (First Year)**	**CAMP Funding Requirements[1] (First Year)**	**CAMP Funding Requirements[1] (First 5 Years)**
Field Monitoring	$4,783,681	$2,435,923	$9,631,206
Data Management	$ 132,316	$132,316	$661,580
Total	**$4,915,997**	**$2,568,239**	**$10,292,786**

[1] CAMP Funding Requirements = Program Costs minus Existing Funded Programs

GLOSSARY

Following are working definitions of terms found throughout this document. This glossary is intended to facilitate the reader's understanding of CAMP and is designed for CAMP purposes only. It is not intended as a general scientific glossary of terms.

Abundance

Estimated number of juveniles outmigrating from a stream.

Adipose Fin

A small fleshy fin on the dorsal (top) surface of salmonids located midway between the dorsal fin and the caudal peduncle (tail fin). The adipose fin is clipped on hatchery fish (adipose-fin clip) to indicate the presence of a coded-wire tag in the snout of the fish.

Adult

Title 34, Section 3403(h) refers to "...fish produced to adulthood.." as part of the definition of natural production. However, adulthood is not defined within Title 34. To maintain consistency with AFRP production targets and baseline production numbers, CAMP will adopt the same definition as the AFRP. Specifically, the AFRP defines an adult fish as a fish capable of reproduction.

Aerial Redd Survey

A monitoring method used to estimate in-river spawner abundance by counting the number of redds visible from an airplane.

Alevin

Salmonid lifestage occurring after the egg hatches and before the fry stage.

Anadromous Fish

In general, anadromous fish are fish that rear in freshwater, migrate to the ocean and return to freshwater rivers to spawn. Title 34 specifically defines anadromous fish as "....those stocks of salmon (including steelhead), striped bass, sturgeon, and American shad that ascend the Sacramento and San Joaquin rivers and their tributaries and the Sacramento-San Joaquin Delta to reproduce after maturing in San Francisco Bay or the Pacific Ocean" (Section 3403(a)).

Angler Survey

Also known as a creel census, an angler survey is a monitoring method used to estimate the number of fish harvested by sport anglers.

Carcass Survey

A monitoring method used to estimate in-river spawner abundance of salmon, typically by tagging a representative number of carcasses, returning them to the river, and counting the number of tagged and untagged carcasses observed during subsequent surveys.

Delta

Refers to the Sacramento-San Joaquin Delta.

Downstream Angler Harvest

That portion of a watershed's in-river harvest that is harvested downstream of the watershed.

Electrofishing

An in-river fish sampling method that involves capturing fish using an electric shock technique.

Escapement

The number of adult salmon or steelhead that escape the ocean, downstream, and in-river fisheries and return upstream to spawn. For CAMP purposes, escapement is synonymous with spawner abundance. See spawner abundance.

Freshets

Increased flow following a recent rain.

Fry

Juvenile lifestage after the alevin and before the parr stage. Fry typically measure up to approximately 50 mm fork length.

Grilse

A two-year old adult salmon returning upstream. These fish are predominantly male; males are also referred to as "jacks".

Hatchery Returns

A monitoring method used to determine the number of naturally and hatchery produced adult fish returning to hatcheries. The number of naturally produced fish that enter hatcheries is added to the spawner abundance and in-river harvest to estimate the in-river run for a particular watershed.

Immigration

Adult salmon and steelhead migrating upstream from the ocean to spawn.

In-River Run

The number of fish migrating up a river as estimated by adding the spawner abundance, number of naturally produced fish entering a hatchery (if applicable), and the in-river harvest.

Juvenile

The young or immature life stage of a fish (i.e., a fish not capable of reproduction).

Ladder Count

A monitoring method used to estimate in-river spawner abundance by counting adult salmon returning upstream to spawn as they pass a fish ladder.

Mark-Recapture

For CAMP, this technique is associated with monitoring of chinook salmon, striped bass, and sturgeon. For chinook salmon, this technique is used during carcass surveys to estimate in-river spawner abundance. The technique involves tagging fresh carcasses, returning them to the river, and counting the number of tagged and untagged carcasses observed during subsequent surveys. For striped bass, the mark-recapture technique uses gill nets and fyke traps to capture, tag, and recapture striped bass during spring migration. The percentage of marked fish recovered during angler surveys and subsequent tagging provides the basis for a standard modified Petersen production estimate. For sturgeon, the mark-recapture technique is used in fall when white sturgeon and green sturgeon are captured in trammel nets. The sturgeon are tagged with $20-reward disk-dangler tags below the anterior end of the dorsal fin. Tagged sturgeon are released near the site where they are captured. Mark-recapture is synonymous with mark-recovery.

Meta-Data

Information used to characterize data that is entered into the CAMP database. Examples of meta-data include: monitoring program name, agency name, contact person, problems with the data, etc.

Natural Production

Title 34 defines natural production as "...fish produced to adulthood without direct human intervention in the spawning, rearing, or migration processes" (Section 3403(h)). Natural production does not include fish directly produced by hatcheries, but does include the offspring of hatchery fish that spawn naturally.

Ocean Harvest Survey

A monitoring method used by DFG and adapted by CAMP to estimate the number of adult fish harvested in the ocean by sport and commercial fishing.

Otolith

One of three (paired) structures in the inner ears of fishes that are formed from alternating layers of high and low-density calcium carbonate. These calcium rings can be used to estimate the approximate age of a fish.

Parr

Stream-rearing juvenile salmonids before the smolt lifestage. Parr are typically characterized by distinct parr marks and measure from approximately 50 mm to 70 mm fork length.

Population

For CAMP purposes, population is synonymous with production.

Production

Title 34 specifies "...fish produced to adulthood..." when defining natural production. Consistent with the AFRP, CAMP measures production by estimating the number of adult fish on individual watersheds and system-wide. For CAMP purposes, production is synonymous with population.

Race

A subgroup of a species. The AFRP has defined target production goals for four races of chinook salmon: fall-run, late fall-run, winter-run, and spring-run. As their names indicate, these races migrate up river and reproduce at different times of the year.

Redd

A gravel spawning nest formed in a river bed where eggs and sperm are deposited and fry rear to emergence. Surveys conducted by airplane to enumerate the number of redds are called aerial redd surveys.

Screw Trap

An in-river fish sampling tool for sampling outmigrating juvenile salmonids. Also called a rotary screw trap. Rotary screw traps consist of a six to eight foot funnel shaped core suspended between two pontoons. As water enters the funnel, the internal screw core rotates, and fish are trapped in pockets of water that are forced into a livebox at the rear of the trap.

Smolt

A juvenile anadromous fish that is physiologically ready to undergo the transition from fresh to salt water. Smolts typically measure from approximately 60 mm to 80 mm fork length.

Snorkel Survey

A monitoring method using divers with snorkels to estimate in-river spawner abundance. Divers visually survey adult salmon (normally spring-run chinook) prior to spawning. This underwater survey method is used as a relative measure of fish abundance, not an absolute count.

Spawner Abundance

An index of the number of spawning adult salmon or steelhead, not an absolute number of spawning fish. Spawner abundance data are provided by carcass surveys, ladder counts, aerial redd counts, and snorkel surveys. For purposes of this report, spawner abundance is synonymous with escapement and spawning escapement.

Species

A population or group of potentially interbreeding populations that is reproductively isolated from other such populations or groups.

Stock

A genetically distinct group of chinook salmon or steelhead trout. The AFRP defines a stock as a group of individuals which are more likely to mate with each other than with individuals not included within the group.

Target Species

For CAMP purposes, target species are those species identified by Title 34. In Section 3403(a), Title 34 identifies"...those stocks of salmon (including steelhead), striped bass, sturgeon, and American shad that ascend the Sacramento and San Joaquin rivers and their tributaries and the Sacramento-San Joaquin Delta to reproduce after maturing in San Francisco Bay or the Pacific Ocean". CAMP also targets four races of chinook salmon: fall-run, late fall-run, winter-run, and spring-run chinook salmon.

Target Watershed

The representative watersheds used by CAMP to estimate the natural production of target species.

Watershed

In this report, watershed is synonymous with stream or river.

LIST OF ABBREVIATIONS AND ACRONYMS

AFRP	Anadromous Fish Restoration Program
Bureau	U.S. Bureau of Reclamation (USBR)
CALFED	Consortium of state and federal agencies with management and regulatory responsibilities in the Sacramento-San Joaquin Bay-Delta
CAMP	Comprehensive Assessment and Monitoring Program
CCWD	Contra Costa Water District
CDFG	California Department of Fish and Game (DFG)
CNFH	Coleman National Fish Hatchery
CTC	Chinook Technical Committee
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act (Title 34)
CWT	Coded-Wire Tag
DWR	California Department of Water Resources
EBMUD	East Bay Municipal Utilities District
GCID	Glenn-Colusa Irrigation District
IEP	Interagency Ecological Program
MID	Merced Irrigation District or Modesto Irrigation District
MWT	Midwater Trawl
NMFS	National Marine Fisheries Service
NSJCD	North San Joaquin Conservation District
PG&E	Pacific Gas and Electric Company
PSC	Pacific Salmon Commission
PSMFC	Pacific States Marine Fisheries Commission
RBDD	Red Bluff Diversion Dam
SWP	State Water Project
TID	Turlock Irrigation District
USFWS	U.S. Fish and Wildlife Service (Service)
USGS	U.S. Geological Survey

SECTION 1. INTRODUCTION

SECTION 1
INTRODUCTION

BACKGROUND

The Central Valley Project Improvement Act (CVPIA) (Public Law 102-575, Title 34), enacted in October 1992, provides opportunities to restore anadromous fisheries and wildlife resources in California's Central Valley. Section 3406 of the CVPIA proposes comprehensive fish, wildlife, and habitat restoration provisions. Section 3406(b) directs the U.S. Fish and Wildlife Service (USFWS) to develop and implement a series of programs and actions for fish and wildlife purposes. According to the Act, the actions should ensure that by the year 2002, natural production of anadromous fish in Central Valley streams will be sustainable at levels not less than twice the average levels attained during 1967-1991.

CVPIA Actions

To enable the natural anadromous fish production targets to be met, the CVPIA directed that a series of restoration actions be implemented. Most CVPIA Section 3406(b) actions can be categorized as either water management modifications, structural modifications, habitat restoration or fish screening actions. A comprehensive list of Section 3406(b) actions except for:

- 3406(b)(1) which contains numerous Anadromous Fish Restoration Program actions covering all categories;
- 3406(b)(16) development of a comprehensive assessment and monitoring program;
- 3406(b)(18) striped bass management measures in the Bay-Delta estuary;
- 3406(b)(22) waterfowl habitat creation; and
- 3406(b)(23) in-stream releases of water to the Trinity River for 1992-96.

Monitoring for Section 3406(b)(22) will be covered under its own program (separate from CAMP) and will include an annual report that summarizes water use, participating acreage, locations, and wildlife benefits.

Water Management Modifications

(b)(1)(B) modify Central Valley Project (CVP) operations
(b)(2) manage 800,000 acre-feet of CVP yield for fish, wildlife, and habitat restoration
(b)(3) acquire supplemental water for fish and wildlife
(b)(7) meet CVP flow standards that apply to CVP
(b)(8) use pulse flows to increase migratory fish survival
(b)(9) eliminate fish losses due to CVP flow fluctuations
(b)(12) provide increased flows in Clear Creek
(b)(19) reevaluate carryover storage criteria

Structural Modifications
(b)(4) mitigate for Tracy Pumping Plant operations
(b)(5) mitigate for Contra Costa Canal Pumping Plant operations
(b)(6) install temperature control device at Shasta Dam
(b)(10) minimize fish passage problems at Red Bluff Diversion Dam (RBDD)
(b)(11) implement Coleman National Fish Hatchery Plan and modify Keswick Dam Fish Trap
(b)(14) install new control structures at Delta Cross Channel and Georgiana Slough
(b)(15) install a barrier at head of Old River
(b)(17) resolve fish passage and stranding problems at Anderson-Cottonwood Irrigation District Diversion Dam
(b)(20) mitigate for the Glenn-Colusa Irrigation District's Hamilton City Pumping Plant

Habitat Restoration
(b)(12) improve fish passage and restore habitat in Clear Creek
(b)(13) replenish spawning gravel and restore riparian habitat below Shasta, Folsom, and New Melones reservoirs

Fish Screens
(b)(21) develop measures to avoid fish losses resulting from unscreened or inadequately screened diversions

Anadromous Fish Restoration Program

The Anadromous Fish Restoration Program (AFRP) was initiated in response to Section 3406(b)(1) of the CVPIA. The AFRP established baseline production numbers on Central Valley rivers and streams for naturally produced chinook salmon (all races), steelhead trout, striped bass, American shad, white sturgeon, and green sturgeon. These numbers were based upon monitoring and other information from the 1967-1991 period. The AFRP established production targets based upon the baseline numbers. The production targets represent a doubling of the baseline (1967-1991) production numbers. The AFRP production baseline and targets are shown in Table 1-1.

Table 1-1. Baseline Production Estimates and Target Production Levels for Naturally Produced Anadromous Fish

Species/Race	AFRP Baseline Production Estimate	AFRP Production Target
Chinook salmon (all races)	500,000	990,000
Fall-run chinook	370,000	750,000
Late fall-run chinook	34,000	68,000
Winter-run chinook	54,000	110,000
Spring-run chinook	34,000	68,000
Steelhead trout	6546	13,000
Striped bass	1,252,259	2,500,000
American shad	2129	4300
White sturgeon	5571	11,000
Green Sturgeon	983	2000

COMPREHENSIVE ASSESSMENT AND MONITORING PROGRAM

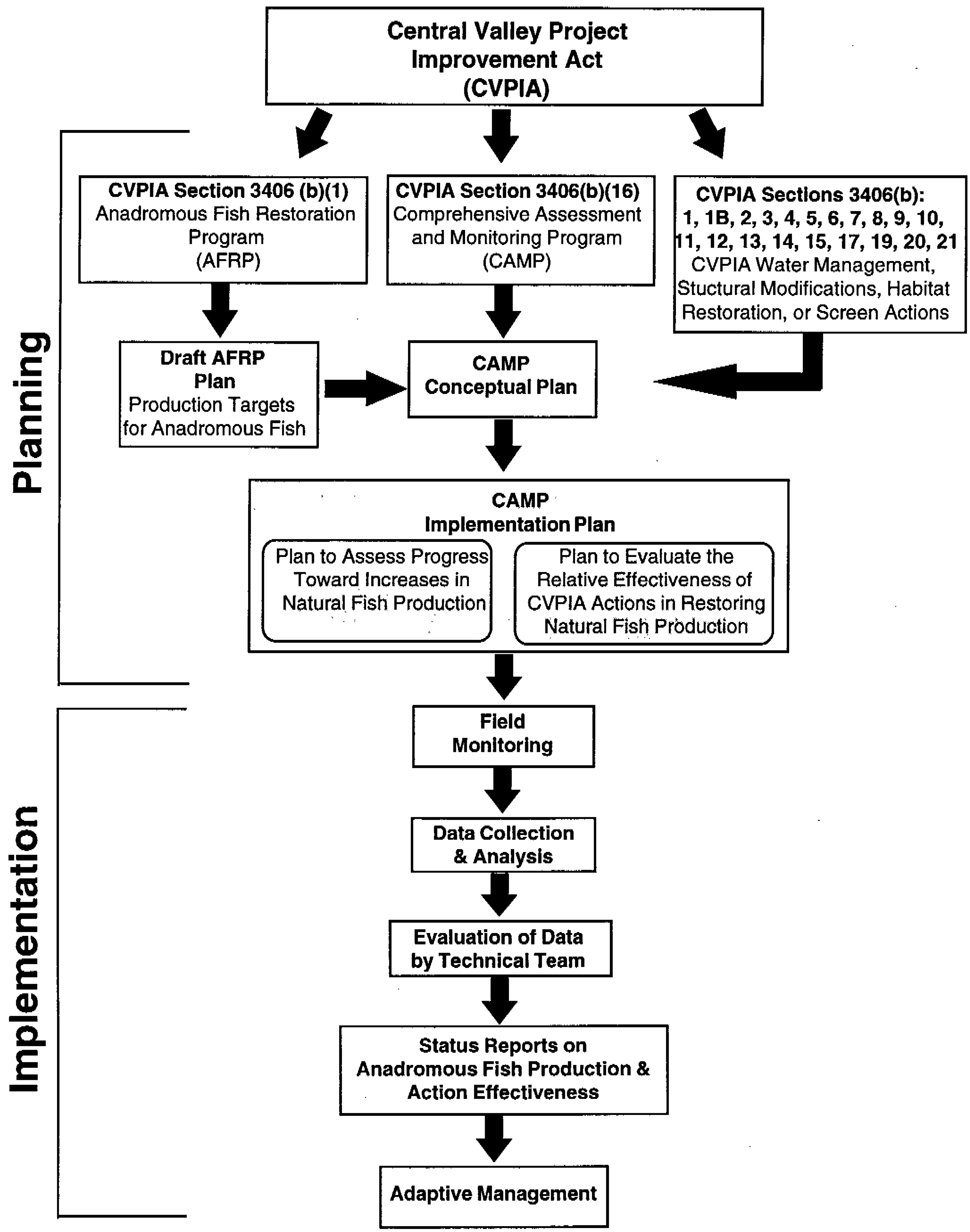
Section 3406(b)(16) of the CVPIA stipulates establishment of a comprehensive assessment and monitoring program (CAMP) to evaluate the success and effectiveness of Section 3406(b) actions (excepting (b)16, 18, 22 and 23) in meeting the AFRP natural fish production targets. CAMP has been developed under the direction of the USFWS, in cooperation with independent entities and the State of California. The two primary but distinct objectives of CAMP are:

(1) to assess the overall (cumulative) effectiveness of actions implemented pursuant to CVPIA Section 3406(b) in meeting AFRP production targets, and

(2) to assess the relative effectiveness of categories of Section 3406(b) actions (e.g., water management modifications, structural modifications, habitat restoration, and fish screens) toward meeting AFRP production targets.

A Conceptual Plan (CP), released in October 1995, contained recommendations for accomplishing these objectives. The CAMP Implementation Plan (IP) has refined recommendations in the Conceptual Plan and added detailed watershed and system-wide adult production calculations, a recommended juvenile salmonid monitoring program, data analysis methods, data management protocols, and five year budget and funding needs. As shown in Figure 1-1, the IP is the final step in the CAMP planning process before implementation in 1997.

Figure 1-1. Comprehensive Assessment and Monitoring Program Development



CAMP Assumptions

Several assumptions developed by the USFWS Central Valley Fish and Wildlife Restoration Program Office were used in developing the CAMP Implementation Plan.

- When possible, CAMP relies on other monitoring programs for data.
- CAMP generally does not provide basic research.
- CAMP does not employ rigorous statistical methods.
- CAMP does not evaluate the basis for AFRP production targets.
- CAMP evaluates only 3406(b) effectiveness (and not other CVPIA or non-CVPIA actions).

Although rigorous statistical methods have not been integral to CAMP to date, it is recommended that further research on the statistical significance of the different recommended monitoring programs be undertaken. This research will be necessary to quantify the statistical validity of the recommended monitoring programs and to understand the statistical significance of observed data and trends.

The First Five Years of CAMP Implementation

CAMP will be ongoing for a minimum of 25-50 years. The first five years of CAMP will be critical for establishing the program. The services of a full-time staff person will be required, for at least the first two years, to ensure that all facets of the program are implemented appropriately. The person to assume this role should be part of the CVPIA restoration staff. The tasks that should be accomplished in the first year include:

- Development of contracts for monitoring (programs not currently existing) and database management.

- Analysis of CAMP budgetary needs and constraints and development of a strategy for staged allocation of available funds.

- Development of standardized protocols for rotary screw trapping.

- Identification, coordination, and leadership of a technical review team.

- Coordination of supplemental information such as water quality data for review by the technical review team.

- Coordination of initial monitoring data (1992-1997) collection.

- Interface with agency staff to ensure knowledge of and cooperation with CAMP objectives.

- Coordination of CAMP with other agency monitoring activities (e.g., CALFED, etc.).

- Development of an initial status report. The report will serve as template for future reporting activities and may serve as input into the 1997 Report to Congress.

Technical Review

Periodically, the data gathered by CAMP should be reviewed and evaluated by technical experts. Existing Interagency Ecological Program (IEP) Project Work Teams (e.g., salmon, striped bass, etc.) should be used for this purpose. The recommendations of the individual Project Work Teams should then be forwarded to a CAMP Technical Review Team (TRT). The TRT should be composed of experts in the appropriate disciplines (including anadromous fish biology and biostatistics), who meet periodically to review and assess information generated as a result of CAMP implementation. Whenever possible, the TRT should rely on existing technical agency management teams for its membership. Fish production trends will be difficult to isolate in the short term (i.e., due to CVPIA actions versus those due to natural hydrological and biological variability). The committee should meet on a regular basis (i.e, a minimum of every three years) to evaluate trend data. The committee may need to meet more frequently to review the adequacy of specific monitoring methods, evaluate whether CAMP as designed is producing sufficient data to meet its objectives, and to ensure that CAMP is functioning properly. An initial set of meetings/workshops in 1997 should be planned to ensure that CAMP is functioning as expected and that the data gathered is adequate for evaluation.

CAMP IMPLEMENTATION PLAN ORGANIZATION

The Implementation Plan is organized into six sections and five appendices:

- Section 1 presents the background to CAMP, a description of CAMP and the planning process to date, CAMP implementation needs for the first five years, and an overview of the IP report's organization.

- Section 2 identifies a detailed set of watershed-specific recommended programs to monitor and evaluate the production of **adult** chinook salmon (all races), steelhead trout, striped bass, American shad, white sturgeon and green sturgeon. Section 2 also recommends a consistent, system-wide program to consistently monitor and evaluate fall-, late fall-, winter-, and spring-run **juvenile** chinook salmon abundance on selected watersheds throughout the Central Valley. Existing programs that meet CAMP's recommended adult and juvenile monitoring programs are identified.

- Section 3 describes methods to use the monitoring data to assess progress toward AFRP production targets and compare effectiveness of action categories.

- Section 4 describes methods for data management, analysis and reporting (internally and public access).
- Section 5 provides detailed budget information and funding requirements to implement the recommended monitoring programs and data management system.
- Section 6 lists citations.
- Appendices A-E provide detailed supplemental information for the above sections.

SECTION 2. RECOMMENDED MONITORING PROGRAMS

SECTION 2
RECOMMENDED MONITORING PROGRAMS

INTRODUCTION

One of CAMP's primary objectives is to assess progress toward meeting AFRP production targets for chinook salmon (all races), steelhead trout, striped bass, American shad, white sturgeon, and green sturgeon. To measure progress toward meeting this objective, CAMP has recommended a monitoring program for each target species. Recommended programs were selected to provide the best source of data for use in calculations that generate species-specific, annual, and system-wide production estimates. CAMP production estimates will be compared to AFRP production targets to assess progress.

Most CAMP recommended monitoring programs can be accomplished by continuing existing federal, state, and local programs. Information from existing programs formed the basis for the AFRP production numbers and restoration targets. Continuation of existing programs, whenever possible, will provide the best comparison of current production numbers with AFRP production targets. In some instances, existing programs contain elements that are not essential to CAMP. In other cases, some elements of existing programs will need to be expanded to meet CAMP needs. New methods for sampling fish populations may also be developed and implemented during CAMP's time-frame. In these instances, existing methods must be continued concurrent with the new methods until the relationship between the population estimates can be established.

Variability in historical estimates of production from 1967-1991 was used to assess the duration of CAMP monitoring needed to detect progress toward AFRP goals. Based on this historical variability and the assumption that future variability in production estimates under CAMP will be comparable, the recommended duration of the program includes multiple generations of fish to distinguish between natural between-year variability in fish production and actual progress toward AFRP goals. Preliminary statistical analysis indicates that the effect of decreasing the measurement error associated with individual abundance estimates is less important than the effect of increasing the monitoring period. CAMP proposes monitoring for 25-50 years (with the exception of white sturgeon and green sturgeon monitoring, which is recommended to continue for 50 to 100 years because of the longevity of these species), or until it is determined that natural fish production is being sustained at not less than twice the average levels during the baseline period (1967-1991). This duration is recommended as a minimum to achieve CAMP goals.

CAMP recommends monitoring all races of chinook salmon and other species annually. Less frequent monitoring will increase the length of time needed to detect fish population doubling. A detailed statistical power analysis (Vaughan and Van Winkle 1982; Peterman 1990) is necessary to determine the optimal monitoring duration for the targeted species. The likelihood of detecting population doubling in 25 years could be as low as 25% in some cases. An analysis of the statistical power of pre- and post-CVPIA comparisons of abundance would need to be performed as a part of the monitoring program to determine the specific likelihood of detecting a doubling of anadromous fish populations.

A thorough examination of statistical variability of production estimates has not been included in the CAMP Conceptual or Implementation Plans. However, it will be important to identify the sources of variability contributing to adult production and juvenile abundance estimates as a means of evaluating the effectiveness of monitoring methods. Specific studies and analyses of data sets, as they become available, will be needed to quantify the statistical variation of estimates. We recommend such studies be conducted to quantify the variability of CAMP production estimates as a necessary step toward confirming the attainment of production goals.

Section 2 is organized into two parts: adult monitoring programs to assess progress toward increases in natural production of anadromous fish and juvenile monitoring programs to evaluate the relative effectiveness of different types of CVPIA actions. Although each program is distinct, each will supplement and complement the other by providing information on juvenile and adult population trends and a greater understanding of anadromous fish population dynamics.

RECOMMENDED ADULT MONITORING PROGRAMS

Chinook Salmon

The AFRP's population goals are defined as the level of natural production corresponding to at least twice the average estimated natural production during the baseline period (1967-1991). Natural production, as defined by AFRP, is the number of fish not produced in hatcheries that reach adulthood, including adults that are harvested before they spawn. Accordingly, AFRP developed watershed-specific estimates of natural chinook salmon production by summing each of the major adult production components, including spawning escapement (natural instream spawners and hatchery returns), inland sport harvest, downstream sport harvest, and ocean sport and commercial harvest. This total was then multiplied by the fraction of total production attributed to natural production. This general AFRP formula forms the basis for CAMP recommended monitoring programs.

For CAMP purposes, monitoring of chinook salmon races is divided into three components:

- In-River Run
- Downstream Harvest
- Ocean Harvest

When added together, data from these three monitoring components provide a production estimate, by watershed, for each race (fall-, late-fall, winter-, and spring-run) of chinook salmon. Figure 2-1 provides an example of how these components are integrated to provide a production estimate for fall-run chinook salmon on the American River.

In this section a general description of the chinook salmon recommended sampling methods is described. This is followed by a description of recommended programs for each of the target species, races, and watersheds. Species- and watershed-specific equations used to estimate production are presented in Appendix A. These equations will be used to calculate production estimates for each targeted species. Only programs that provide data necessary for these equations are recommended.

In-River Run

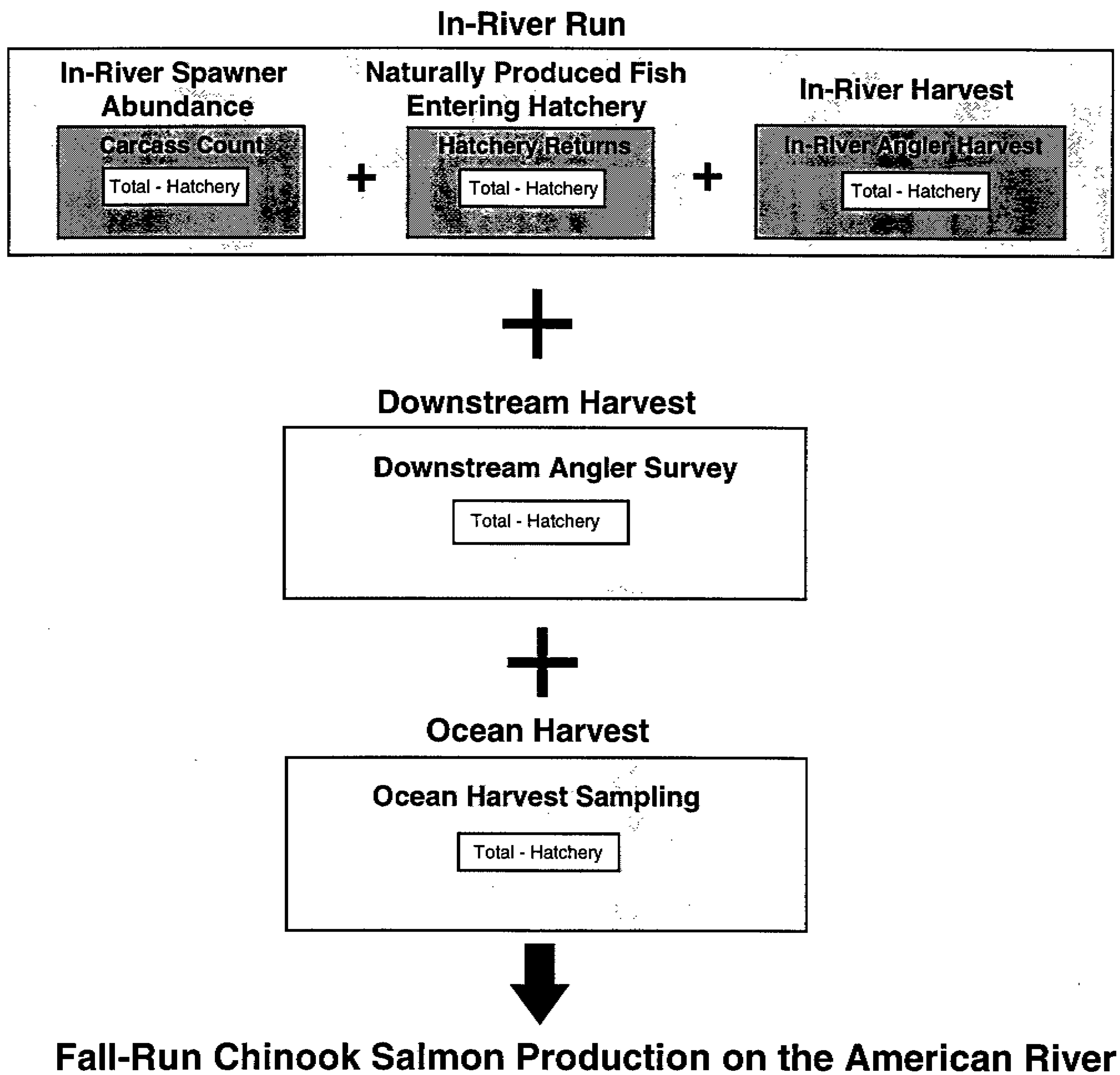
In-river monitoring includes estimates of spawner abundance (estimated by carcass surveys, ladder counts, snorkel surveys, and aerial redd counts), naturally produced fish entering hatcheries (estimated by hatchery returns), and in-river angler harvest.

A number of potential sources of uncertainty affect production estimates and must be considered when assessing production goals in the future. Methods for estimating ocean and inland harvest are intended to produce estimates that are within 20% of the actual harvest. Estimates of spawner abundance using Schaefer mark-recapture carcass surveys have been shown to be within this range of accuracy (Boydstun 1994). Simulations, however, show that much greater error can be associated with these estimates, particularly under conditions of low survival and catch rates (Law 1994). Ladder counts are likely the least biased method of estimated spawner abundance if counts are properly conducted. Aerial redd counts are probably the most biased.

Spawner Abundance

Carcass Surveys. A modified form of the Schaefer mark-recapture method was the primary method used by CDFG to estimate Central Valley chinook salmon spawning populations during the AFRP baseline period. The method relies on weekly surveys of spawning grounds during which field personnel tag fresh salmon carcasses, return them to the river, and record the number of recovered carcasses tagged during previous surveys. Weekly estimates of spawner abundance are computed based on the proportion of tagged carcasses recovered relative to the total number at large and the total number of carcasses observed. Although the assumptions and sampling requirements of carcass mark-recapture methods are often violated on large rivers, this approach is often the most practical for estimating total in-river spawner abundance of chinook salmon in the Central Valley. Consistency with baseline estimates will be maintained through continued use of this method on streams where it has been used in the past. Nonetheless, there is ongoing interest and debate regarding the most appropriate mark-recapture technique, particularly as they relate to flow, stream size, and other physical characteristics of sampling streams. As stated previously, CAMP can readily adopt new methods as long as the methods proposed herein

Figure 2-1. Components of CAMP Calculations for Estimating Natural Production of Fall-Run Chinook Salmon on the American River



are continued until the relationship between the two population estimates can be firmly established.

Ladder Counts. Ladder counts generally are considered the most reliable direct method for assessing run size (J. Smith, USFWS, pers. comm.). They do however, involve sampling methods or interpolation procedures to account for fish passage during periods of darkness or turbidity, and lack of passage during periods of ladder in-operation. For some races, ladder counts will provide essential data on spawner abundance in a given watershed. For example, ladder counts of fall-run chinook salmon on the Mokelumne River will be used to estimate the spawner abundance and in-river run. In this way, the ladder count data, spawner abundance, and in-river run are equivalent.

The CDFG currently is conducting a program in the Sacramento River above Red Bluff Diversion Dam (RBDD) to estimate adult winter-run chinook salmon abundance as an augmentation and comparison to the annual escapement estimate generated from partial counts at the RBDD fish ladder. The RBDD counts should be continued until it is conclusively shown that carcass surveys are satisfactory replacements for ladder counts (McKee, CDFG, pers. comm.).

Aerial Redd Counts. This method involves direct counts of redds over the entire spawning area. Accuracy can be reduced by high flows, poor visibility, and redd superimposition. Redd counts are used also to focus areas for carcass survey work and to provide a qualitative comparison to ladder count estimates. Most important, redd counts are used to determine the spatial and temporal distribution of spawning for annual water temperature control planning (McKee, CDFG, pers. comm.). For some races, aerial redd counts are used to complement estimates of spawner abundance based on other methods. For example, for fall-run chinook salmon on the Sacramento River, aerial redd counts in conjunction with carcass surveys provide data for spawner abundance and in-river run estimates throughout the entire spawning area. Redd counts are transposed into an estimate of spawner escapement by multiplying the redd count by 3.9 spawners (Tribal Fish Program 1994).

Snorkel Surveys. Snorkel surveys provide the most effective and practical means of counting adult spring-run chinook salmon during their summer residence in the upper reaches of small, clear tributary streams of the Sacramento River. For spring-run chinook salmon, snorkel surveys will provide the essential data to estimate spawner abundance and in-river run size on Deer and Butte creeks.

Naturally Produced Fish Entering Hatchery

Currently all chinook salmon entering Central Valley hatcheries are counted. Some of these adult salmon are of natural origin. It is recommended that these salmon be accounted for by adding them to the total number of naturally produced in-river spawners. Adjustments in the number of naturally produced fish in the river and in hatchery returns should be made if adults are turned back to the river from a hatchery. When hatcheries are present hatchery return data are essential components of in-river run calculations for fall- and late fall-run chinook salmon.

In-River Harvest

In-river harvest refers to harvest that occurs in those target watersheds where spawning also occurs, as opposed to harvest that occurs downstream of these watersheds. In-river harvest is differentiated from downstream harvest since it represents part of total in-river run size. A comprehensive, long-term, in-river harvest monitoring program is recommended to estimate the portion of adult chinook salmon production that is harvested by anglers in the inland sport fishery. A comprehensive angler survey program currently does not exist. The recommended program includes estimating annual in-river harvest of chinook salmon in the target watersheds where sport fisheries exist (e.g., Sacramento River, Feather River, Yuba River, American River, Stanislaus, Mokelumne and San Joaquin rivers). The recommended monitoring reaches and periods are based on run timing (Table 2-1) of the target races and current angling regulations/season closures for each reach. Methods for estimating inland harvest are intended to produce estimates that are within 20% of the actual harvest.

Table 2-1. Run Timing of Chinook Salmon

	Race			
Activity/Location	**Fall-run**	**Late Fall-run**	**Winter-run**	**Spring-run**
In-River Harvest	July-December	October-January	NA	July-September

Downstream Harvest

Downstream harvest will be estimated using angler surveys. The recommended angler survey program would provide estimates of inland harvest of chinook salmon in the reaches downstream of the target watersheds. These reaches include the Sacramento River above the Feather River confluence (applies only to Battle, Butte, Deer, and Mill Creek), the Sacramento River below the Feather River confluence, the San Joaquin River downstream of Vernalis, and the Mokelumne River downstream of the junction of the North and South forks. These reaches are major migration routes for target races of chinook salmon from target watersheds. However, uncertainty regarding the race and watershed of origin usually exists for individual chinook salmon harvested in these reaches (with the exception of coded-wire tagged hatchery fish). Therefore, race- and watershed-specific estimates of downstream harvest should be developed by apportioning total annual downstream harvest based on the proportion of total in-river run size represented by each race and watershed. For example, the downstream harvest component of American River fall-run chinook salmon is equal to the total annual harvest of chinook salmon (all races) in the lower Sacramento, San Joaquin, and Mokelumne Rivers multiplied by American River in-river run size as a fraction of total in-river run size (all target races and watersheds). The apportioning of downstream harvest by total in-river run size may need to be adjusted to account for differences in run timing by watershed, flow conditions, and variability in the distribution, magnitude, and timing of angler catch.

Not all salmon harvested in downstream reaches originated from the target watersheds selected by CAMP for monitoring, but this is not considered a major source of error because the target watersheds collectively accounted for over 95% of the total Central Valley spawner abundance during the 1967-1991 AFRP baseline period.

For those stocks originating in Sacramento River tributaries above the Feather River confluence (Battle Creek, Butte Creek, Deer Creek, and Mill Creek), an additional downstream inland component is added to represent fish that were harvested in the mainstem Sacramento River above the Feather River confluence. Because this reach includes in-river spawning and harvest of chinook salmon in the mainstem Sacramento River, a modified form of the equation for estimating downstream harvest for these tributary streams is recommended. For example, the portion of inland harvest of Battle Creek fall-run chinook salmon caught downstream in the mainstem Sacramento River above the Feather River confluence would be computed by multiplying total in-river harvest of chinook salmon (all races) in this reach by the ratio of in-river run size in Battle Creek to total spawner abundance of chinook salmon in the upper mainstem Sacramento River, Battle, Butte, Deer, and Mill Creeks. The remainder of the downstream harvest would be computed in the manner described for American River fall-run chinook salmon. Again, some adjustment in downstream harvest of specific stocks may be needed to account for variability in the distribution, magnitude, and timing of angler catch.

For some chinook salmon races, downstream harvest data are essential to calculate watershed production estimates. For example, the natural production calculation for fall-run chinook salmon on the American River includes downstream harvest data.

Escapement and harvest are not independent and not necessarily linearly related. For example, low escapement might be attributable to a large harvest or conversely, a large escapement might be attributable to a low harvest. These potential sources of bias should be evaluated and treated in harvest and escapement estimates or reported as potential sources of bias that may influence the accuracy of estimates (J. Smith, USFWS, pers. comm.).

Ocean Harvest

Continuation of the DFG/PSMFC ocean harvest sampling program is recommended. This program is needed to provide annual estimates of ocean harvest of Central Valley chinook salmon based on total commercial and recreational landings south of Point Arena, California. Although a small portion of these landings probably originate from watersheds outside the Central Valley, it is generally assumed by the Pacific State Marine Fisheries Management Commission (PSMFC) that this portion is similar in magnitude to the number of Central Valley chinook salmon harvested north of Point Arena. Chinook salmon from different watersheds become mixed in the ocean, and generally cannot be distinguished from each other. Therefore, like downstream inland harvest, race- and watershed-specific ocean harvest should be developed by apportioning total annual ocean harvest based on the proportion of total in-river run size represented by each race and watershed.

For example to estimate the portion of annual ocean harvest of naturally produced fall-run chinook salmon originating in the American River, the natural portion of total annual ocean harvest in the year of spawning of Central Valley chinook salmon is multiplied by the ratio of American River run size to total in-river run size of all target races and watersheds in that calendar year. The ocean harvest data are essential to calculate a production estimate for fall-run chinook salmon on the American River.

Hatchery Marking

Since the AFRP production targets apply only to natural production of anadromous fish, CAMP recommends a hatchery marking and recovery program designed to estimate the contribution of hatchery fish (and thereby, natural production) to total chinook salmon production. To estimate the contribution of hatchery-produced chinook salmon to total spawner abundance, in-river harvest, downstream harvest, and ocean harvest, CAMP recommends expanding and coordinating existing marking efforts so that a relatively large, constant fraction of total hatchery produced juveniles are marked. A sufficient proportion of hatchery-produced juveniles should be tagged to ensure that the numbers of tagged fish recovered as adults are adequate to estimate their total contribution to adult populations with reasonable accuracy and precision. This marking program will also identify naturally produced fish that return to the hatcheries.

CAMP's recommendation is limited to estimating the number or proportion of hatchery-produced fish in the adult population. Therefore, it requires only that hatchery fish be distinguished from naturally produced fish by some external mark (assuming a constant fraction of hatchery fish are marked annually). To avoid confusion with existing or proposed coded-wire tagging programs, this mark should be something other than an adipose fin clip unless a coded-wire tag is also applied. A different mark will need to be applied to naturally produced fish that are coded-wire tagged to distinguish them from tagged hatchery fish.

The natural components of in-river spawner abundance, hatchery returns, in-river harvest, downstream harvest, and ocean harvest should be computed by multiplying total adult numbers by the fraction of naturally produced fish.

Fall-run Chinook Salmon

The recommended monitoring program for fall-run chinook salmon represents a subsample of the watersheds for which specific goals were established by the AFRP. These watersheds, selected because they account for most (97%) of the total average 1967-1991 Central Valley spawning escapement of fall-run chinook salmon, are considered representative of all of the major geographic areas for which targets have been established or have potential for increased salmon escapement resulting from implementation of AFRP actions. Consequently, for CAMP assessment purposes, the overall fall-run chinook salmon production goal is 737,600 adults, reflecting only those watersheds selected for monitoring. For clarity, AFRP baseline production estimates and differences between AFRP and CAMP production targets, by watershed, are shown in Table 2-2. Table 2-3 summarizes the recommended monitoring program for fall-run chinook salmon.

Table 2-2. AFRP Baseline Production Estimates and AFRP vs. CAMP Production Targets for Fall-run Chinook Salmon

Watershed	AFRP Baseline Production Estimates	AFRP Production Targets	CAMP Production Targets
American River	81,000	160,000	160,000
Antelope Creek	360	720	NA
Battle Creek	5000	10,000	10,000
Bear River	220	450	NA
Big Chico Creek	400	800	NA
Butte Creek	760	1500	1500
Clear Creek	3600	7100	7100
Cow Creek	2300	4600	NA
Cottonwood Creek	3000	5900	NA
Cosumnes River	1600	3300	NA
Deer Creek	760	1500	1500
Feather River	86,000	170,000	170,000
Merced River	9000	18,000	18,000
Mill Creek	2100	4200	4200
Miscellaneous Creeks	550	1100	NA
Mokelumne River	4700	9300	9300
Paynes Creek	160	330	NA
Sacramento River	120,000	230,000	230,000
Stanislaus River	11,000	22,000	22,000
Tuolumne River	19,000	38,000	38,000
Yuba River	33,000	66,000	66,000
Total	**370,000**	**754,800**	**737,600**

Table 2-3. Recommended Monitoring Program for Fall-run Chinook Salmon

Watershed	Monitoring Method	Geographic Area Covered	Monitoring Parameter	Monitoring Period	Implementing Agency	Program Status	Existing Program No.
American River	Carcass Survey	Sailor Bar to Watt Ave.	In-river Spawning Escapement	Weekly, 15 Oct. - 31 Jan.	CDFG	existing	1
American River	Hatchery Counts	Nimbus Hatchery	Returns to Hatchery	Daily, 1 Nov. - 31 Dec.	CDFG	existing	17
American River	Hatchery Marking	Nimbus Hatchery	NA	Variable	CDFG	existing	12
American River	Angler survey	Discovery Park to Nimbus Dam	In-river Harvest	Random Days, 1 Jul. - 31 Dec.	CDFG	proposed	NA
Battle Creek	Carcass Survey	Mouth to CNFH barrier dam to mouth	In-river Spawning Escapement	Weekly, 1 Oct. - 15 Dec.	CDFG	existing	2
Battle Creek	Hatchery Counts	Coleman National Fish Hatchery	Returns to hatchery	Daily, 1 Oct. - 15 Dec.	USFWS	existing	18
Battle Creek	Hatchery Marking	Coleman National Fish Hatchery	NA	Variable	USFWS	proposed	13
Butte Creek	Carcass Survey	Parrott-Phelan Dam to Gorrill Dam	In-river Spawning Escapement	Weekly, 1 Oct. - 31 Dec.	CDFG	existing	3
Clear Creek	Carcass Survey	McCormick-Saeltzer Dam to mouth	In-river Spawning Escapement	Weekly, 1 Oct. - 31 Dec.	CDFG	existing	NA
Deer Creek	Carcass Survey	USGS Gaging station to mouth	In-river Spawning Escapement	Weekly, 1 Oct. - 31 Dec.	CDFG	existing	4
Feather River	Carcass Survey	Oroville fish barrier dam to Gridley boat ramp	In-river Spawning Escapement	Weekly, 1 Oct. - 15 Dec.	CDFG	existing	5
Feather River	Hatchery Counts	Feather River Hatchery Annex	Returns to hatchery	Daily, 1 Oct. - 31 Dec.	CDFG	existing	19
Feather River	Hatchery Marking	Feather River Hatchery Annex	NA	Variable	CDFG	proposed	14
Feather River	Angler survey	Verona to Thermalito River outlet	In-river Harvest	Random Days, 1 Jul. - 31 Dec.	CDFG	proposed	NA
Merced River	Carcass Survey	Crocker-Huffman Dam to Bettencourt Ranch	In-river Spawning Escapement	Weekly, 15 Oct. - 31 Dec.	CDFG	existing	6
Merced River	Hatchery Counts	Merced River Hatchery	Returns to hatchery	Daily, 1 Oct. - 31 Dec.	CDFG	existing	20
Merced River	Hatchery Marking	Merced River Hatchery	NA	Variable	CDFG	proposed	15
Mill Creek	Carcass survey	Little Mill Creek confluence to mouth	In-river Spawning Escapement	Weekly, 1 Oct. - 31 Dec.	CDFG	existing	4

Table 2-3. Recommended Monitoring Program for Fall-run Chinook Salmon

Watershed	Monitoring Method	Geographic Area Covered	Monitoring Parameter	Monitoring Period	Implementing Agency	Program Status	Existing Program No.
Mokelumne River	Ladder Counts	Woodbridge Dam	Run size above Woodbridge Dam	Daily, 15 Sep. - 31 Dec.	EBMUD	existing	10
Mokelumne River	Hatchery Counts	Mokelumne River Hatchery	Returns to hatchery	Daily, 1 Nov. - 31 Dec.	CDFG	existing	21
Mokelumne River	Hatchery Marking	Mokelumne River Hatchery	NA	Variable	CDFG	proposed	16
Mokelumne River	Angler survey	Junction of North and South Fork Mokelumne to San Joaquin River	In-river Harvest	Random Days, 1 Jul. - 31 Dec.	CDFG	proposed	NA
Pacific Ocean	Ocean Harvest Sampling	California ports south of Point Arena	Ocean Landings	1 May - 30 Sept. (commercial); 15 Feb. - 15 Nov. (sport)	CDFG	existing	25
Sacramento River	Ladder Counts	Red Bluff Diversion Dam (RBDD)	Run-size above RBDD	Daily, 1 Jul. - 31 Dec.	CDFG	existing	11
Sacramento River	Carcass survey	Keswick Dam to RBDD	In-river Spawning Escapement	Weekly, 1 Oct. - 15 Dec.	CDFG, USFWS	existing	26
Sacramento River	Aerial redd counts	Keswick Dam to Princeton	Number and proportion of redds above and below RBDD	Weekly, 1 Oct. - 15 Dec.	CDFG	existing	11
Sacramento River	Angler survey	Carquinez Bridge to Redding	In-river Harvest	Random Days, 15 Jul. - 31 Dec.	CDFG	proposed	NA
San Joaquin River	Angler survey	Pittsburg to Vernalis	In-river Harvest	Random Days, 1 Jul. - 31 Dec.	CDFG	proposed	NA
Stanislaus River	Carcass survey	Goodwin Dam to Riverbank Bridge	In-river Spawning Escapement	Weekly, 15 Oct. - 31 Dec.	CDFG	existing	7
Stanislaus River	Angler survey	Goodwin Dam to mouth	In-river Harvest	Random Days, 1 Jul. - 31 Dec.	CDFG	proposed	NA
Tuolumne River	Carcass survey	La Grange Dam to Reed Rock Plant near Waterford	In-river Spawning Escapement	Weekly, 15 Oct. - 31 Dec.	CDFG	existing	8
Yuba River	Carcass survey	Narrows to E St. bridge in Marysville	In-river Spawning Escapement	Weekly, 15 Oct. - 15 Dec.	CDFG	existing	9
Yuba River	Angler survey	Rose Bar to Marysville	In-river Harvest	Random Days, 1 Jul. - 31 Dec.	CDFG	proposed	NA

In-River Run

Spawner Abundance

For fall-run chinook salmon the three primary methods for estimating abundance (carcass surveys, ladder counts, and aerial redd counts) should be used to complement each other. In some years, three separate estimators of abundance may need to be developed. The hierarchy of confidence for these methods is as follows: ladder counts, Jolly-Seber, modified Schaefer, RBDD ladder counts, and aerial redd surveys. Indices of abundance based on angler surveys would also be used to complement these estimates by confirming trends. Following are specific recommendations.

Carcass Surveys. The continuation of carcass mark-recapture estimates of fall-run chinook salmon spawning abundance is recommended for the Feather, Yuba, American, Stanislaus, Tuolumne, and Merced rivers, and Battle, Clear, Mill, Deer, and Butte creeks. Recent changes in RBDD operations (e.g., raising the gates for passage of winter-run chinook salmon) permit only partial counts of fall-run chinook salmon passing RBDD. Annual carcass surveys are recommended as a supplement to ladder counts for monitoring adult fall-run chinook spawner abundance in the mainstem Sacramento River above RBDD.

Ladder Counts. Carcass surveys generally are not successful on the Mokelumne River (John Nelson, CDFG, pers. comm.). Continued ladder counts of fall-run chinook salmon are recommended at Woodbridge Dam. Video monitoring of salmon passing through the Woodbridge fishway should be used to identify the contribution of hatchery fish to spawner abundance. Continued ladder counts of fall-run chinook salmon at RBDD are recommended to support estimates derived from carcass and aerial redd surveys. With gates in from 15 May to 15 September, 25% of fall-run chinook are counted passing through the RBDD ladders. High flows and turbidity will hamper efforts to conduct carcass and aerial surveys in late October and November in some years, leaving ladder counts as the only method to estimate escapement (J. Smith, USFWS, pers. comm.).

Aerial Redd Counts. It is recommended that aerial redd counts above and below RBDD be conducted to estimate spawner abundance in the mainstem Sacramento River. These counts will augment carcass survey estimates of fall-run chinook above RBDD. Carcass surveys multiplied by the ratio of redd counts below RBDD to redd counts above RBDD should be used to estimate spawner abundance below RBDD.

Naturally Produced Fish Entering Hatchery

Continuation of annual counts of returning adult chinook salmon is recommended at all Central Valley salmon hatcheries (e.g., Coleman National Fish Hatchery, Feather River Hatchery, Nimbus Hatchery, Mokelumne River Hatchery, Merced River Hatchery).

In-River Harvest

The recommended angler survey program includes estimating annual in-river harvest of fall-run chinook salmon in the target watersheds where major sport fisheries exist (mainstem

Sacramento River above the Feather River confluence, Feather River, Yuba River, American River, Stanislaus River). The harvest of fall-run chinook salmon in the mainstem Sacramento River above the Feather River confluence includes fish that otherwise could have spawned in the mainstem Sacramento River, Battle, Butte, Clear, Deer, or Mill creeks. Therefore, the in-river harvest of fall-run chinook salmon in the mainstem Sacramento River will be calculated by assuming that harvest is proportional to the relative contribution of mainstem spawners to the total in-river run size in the upper Sacramento River and tributaries (above the Feather River confluence).

Downstream Harvest

The recommended angler survey program would provide estimates of total inland harvest of chinook salmon in the reaches downstream of the target watersheds. These reaches include the Sacramento River above the Feather River confluence (applies only to Battle, Butte, Clear, Deer, and Mill creeks), the Sacramento River below the Feather River confluence, the San Joaquin River downstream of Vernalis, the Mokelumne River downstream of the junction of the North and South forks, and the Stanislaus, Tuolumne, Yuba, and Merced rivers. The annual downstream harvest of all target runs can be computed by assuming that harvest is proportional to the relative contribution of these runs to total in-river run size.

Ocean Harvest

Continuing the existing ocean harvest monitoring program is recommended to estimate the ocean harvest component of fall-run chinook salmon production. For assessment purposes, watershed-specific estimates of the contribution of each target fall-run chinook salmon run to ocean harvest can be computed by assuming that harvest is proportional to the relative contribution of the each target run to total in-river run size (all target races and watersheds combined).

Hatchery Marking

An expanded hatchery marking program at Coleman National Fish Hatchery, Feather River Hatchery, Nimbus Hatchery, Mokelumne River Hatchery, and Merced River Hatchery is recommended for improving estimates of the direct contribution of hatchery fish to total adult chinook production, and thereby providing estimates of natural chinook production for assessing the AFRP goals.

Table 2-3 describes the monitoring program for fall-run chinook salmon with respect to monitoring methods, parameters measured, geographic reaches or areas, monitoring periods, implementing agencies, and current program status.

Late Fall-run Chinook Salmon

The recommended programs for assessing whether late fall-run chinook salmon AFRP production targets have been achieved are limited to Battle Creek and the upper Sacramento River, where baseline production levels have been established (Table 2-4).

Table 2-4. AFRP Baseline Production Estimates and Targets for Late Fall-run Chinook Salmon

Watershed	AFRP Baseline Production Estimate	AFRP Production Target
Battle Creek	270	550
Upper Sacramento	22,000	44,000
Total	**22,270**	**44,550**

Following are specific recommendations for monitoring of late fall-run chinook salmon.

In-River Run

Spawner Abundance

Carcass Surveys. Continuing carcass surveys in Battle Creek is recommended.

Aerial Redd Counts. Aerial redd counts as a replacement for ladder counts at RBDD for monitoring spawner abundance of late fall-run chinook salmon in the upper Sacramento River. During periods of high flow and turbidity, aerial redd counts will be inaccurate. Supplemental methods may need to be developed to estimate spawner abundance during these periods.

Naturally Produced Fish Entering Hatchery

Continuing annual counts of late fall-run chinook salmon returning to CNFH is recommended, although this run is probably largely of hatchery origin (J. Smith, USFWS, pers. comm.). Returns in 1997 will provide additional information since all 1994 brood-year, late-fall chinook salmon released from CNFH were tagged (J. Smith, USFWS, pers. comm.).

In-River Harvest

The recommended angler survey program includes estimating annual in-river harvest of chinook salmon in the mainstem Sacramento River above the Feather River confluence. The harvest of late fall-run chinook salmon in this reach potentially includes fish that otherwise would have spawned in the mainstem Sacramento River and Battle Creek. However, in-river harvest in this reach applies only to mainstem spawners; harvest of Battle Creek late fall-run in this reach is considered to be part of the downstream harvest for this watershed. Therefore, in-river harvest of late fall-run chinook salmon can be computed by assuming that harvest is proportional to the relative contribution of mainstem spawners to total in-river run size (all target races and watersheds) in the mainstem Sacramento River above the Feather River confluence. Adjustments may be needed depending on the intensity, distribution, and timing of angling effort on the mainstem Sacramento River.

Downstream Harvest

The recommended angler survey program includes estimating annual harvest of chinook salmon in the Sacramento River above the Feather River confluence and the Sacramento River below the Feather River confluence. The downstream harvest of Sacramento River mainstem and Battle Creek late fall-run populations can be computed by assuming that harvest is proportional to the relative contribution of these watersheds to total in-river run size (all target races and watersheds represented in the reaches listed above). Some adjustments will likely be necessary depending on the intensity, distribution, and timing of angling effort during the primary late fall-run immigration period (October through January). Additionally, watersheds with hatchery programs see greater fishing effort directed toward hatchery stocks and therefore an increase in effect on natural stocks.

Ocean Harvest

The ocean harvest monitoring program for late fall-run chinook salmon is consistent with the program for fall-run chinook salmon.

Hatchery Marking

Currently, all late fall-run chinook salmon produced at CNFH are marked. This program should be continued as part of an expanded hatchery marking program recommended by CAMP.

Table 2-5 summarizes the monitoring program for late fall-run chinook salmon with respect to monitoring methods, parameters measured, geographic reaches or areas, monitoring periods, implementing agencies, and current program status.

Winter-run Chinook Salmon

The recommended programs for assessing progress toward winter-run chinook salmon AFRP production goals are on the mainstem Sacramento River. The AFRP baseline production estimate for winter-run is 54,000 adults and target production is 110,000 adults. Following are specific recommendations for monitoring of winter-run chinook salmon.

In-River Run

Spawner Abundance

Carcass Surveys. Annual carcass surveys are recommended as a complementary method for supporting estimates of adult winter-run chinook salmon abundance in the mainstem Sacramento River above RBDD based on ladder counts. Ladder counts have been used historically at RBDD, but these provide only partial estimates of winter-run chinook salmon run size.

Ladder Counts. Continued ladder counts of winter-run chinook salmon are recommended at RBDD to support estimates derived from carcass and aerial redd surveys. Carcass surveys may be hampered in large rivers with low escapements, hence low recovery rates (J. Smith, USFWS, pers. comm.). Additionally, winter-run chinook can spawn in deep water, out of the visual range for aerial surveys, and carcasses may be out of the visual range of survey crews (J. Smith, USFWS, pers. comm.).

Table 2-5. Recommended Monitoring Program for Late Fall-run Chinook Salmon

Watershed	Monitoring Method	Geographic Area Covered	Monitoring Parameter	Monitoring Period	Implementing Agency	Program Status	Existing Program No.
Battle Creek	Carcass Survey	Mouth to Coleman National Fish Hatchery barrier dam and diversion	In-river Spawning Escapement	Weekly, 15 Dec. - 15 Mar.	USFWS	proposed	NA
Battle Creek	Hatchery Counts	Coleman National Fish Hatchery	Returns to Hatchery	Daily, 15 Dec. - 31 Mar.	USFWS	existing	18
Battle Creek	Hatchery Marking	Coleman National Fish Hatchery	NA	Variable	CDFG	proposed	13
Sacramento River	Aerial Redd Counts	Keswick Dam to Princeton	Number and proportion of redds above and below RBDD	Weekly, 1 Jan. - 15 Mar.	CDFG	existing	11
Sacramento River	Angler Survey	Carquinez Bridge to Redding	In-river Harvest	Random Days, 1 Oct. - 15 Jan.	CDFG	proposed	NA
Pacific Ocean	Ocean Harvest	California ports south of Point Arena	Ocean Landings	1 May - 30 Sept. (commercial), 15 Feb. - 15 Nov. (sport)	CDFG	existing	25

Aerial Redd Counts. Continuation of aerial redd surveys of the mainstem Sacramento River is recommended as a qualitative tool in the spawner abundance estimation process.

Naturally Produced Fish Entering Hatchery

Monitoring of hatchery returns of adult winter-run chinook salmon at CNFH is not a major component of CAMP. Rather, the focus will be monitoring natural production of winter-run in the mainstem Sacramento River on which AFRP baseline production estimates and target production levels were established. The number of naturally produced winter-run chinook salmon taken into CNFH currently is based on terms and conditions within the USFWS Section 10 Permit No. 747. Fish destined for CNFH are collected at RBDD and at the Keswick Fish Trap. Adjustments to the annual estimate of adult escapement to the upper Sacramento River must account for these naturally produced fish removed from the wild to CNFH.

In-River Harvest

Monitoring of in-river harvest of winter-run chinook salmon is not specifically recommended since current angling regulations prohibit the take of chinook salmon in the mainstem Sacramento River when winter-run chinook adults are present. These regulations are assumed to prevent harvest of winter-run chinook; incidental mortality from sport fish harvest is assumed negligible.

Downstream Harvest

Monitoring of downstream harvest of winter-run chinook salmon is not needed since current angling regulations prohibit the take of chinook salmon in the mainstem Sacramento River when winter-run chinook adults are present.

Ocean Harvest

The ocean harvest monitoring program for winter-run chinook salmon is the same as the program for fall-run chinook salmon.

Hatchery Marking

Currently, all winter-run chinook salmon juveniles produced at CNFH are marked. Continuation of this program is recommended to account for the contribution of hatchery-produced winter-run to annual spawner abundance in the upper Sacramento River.

Table 2-6 summarizes the monitoring program for winter-run chinook salmon with respect to monitoring methods, parameters measured, geographic reaches or areas, monitoring periods, implementing agencies, and current program status.

Spring-run Chinook Salmon

The recommended programs for monitoring spring-run chinook salmon populations are on the mainstem Sacramento River, Butte Creek, Deer Creek, and Mill Creek, where AFRP baseline production estimates and goals have been established (Table 2-7).

Table 2-6. Recommended Monitoring Program for Winter-run Chinook Salmon

Watershed	Monitoring Method	Geographic Area Covered	Monitoring Parameter	Monitoring Period	Implementing Agency	Program Status	Existing Program No.
Battle Creek	Hatchery Marking	Coleman National Fish Hatchery	NA	Variable	USFWS, CDFG	existing	13
Sacramento River	Carcass Survey	Keswick Dam to RBDD	In-river Spawning Escapement	Weekly, 15 Apr. - 15 Aug.	USFWS, CDFG	existing	NA
Sacramento River	Aerial Redd Counts	Keswick Dam to Princeton	Number and proportion of redds above and below RBDD	Weekly, 1 May - 15 July	CDFG	existing	11
Sacramento River	Ladder Counts	RBDD	Run-size above RBDD	Daily, 30 Mar. - 30 Jun.	USFWS	existing	11
Pacific Ocean	Ocean Harvest	California ports south of Point Arena	Ocean Landings	1 May - 30 Sept. (commercial), 15 Feb. - 15 Nov. (sport)	CDFG	existing	25

Table 2-7. AFRP Baseline Production Estimates and Targets for Spring-Run Chinook Salmon

Watershed	AFRP Baseline Production Estimate	AFRP Production Target
Butte Creek	1000	2000
Deer Creek	3300	6500
Mill Creek	2200	4400
Sacramento River	29,000	59,000
Total	**35,500**	**71,900**

Following are specific recommendations for monitoring of spring-run chinook salmon.

In-River Run

Spawner Abundance

Ladder Counts. Continued ladder counts of spring-run chinook salmon at RBDD are recommended because the ladders will continue to operate over much of the spring-run immigration period. Although ladder counts at RBDD do not occur over the entire spring-run immigration period (April through September), carcass and aerial redd surveys are ineffective for monitoring spring-run populations because of substantial overlap in the timing and location of spring-run and fall-run chinook salmon spawning in the upper Sacramento River. Ladder counts are also recommended at Clough Dam on Mill Creek where poor visibility often precludes successful snorkel or carcass surveys.

Snorkel Surveys. The continuation of summer snorkel surveys to estimate annual spring-run chinook salmon populations in Butte and Deer creeks is recommended.

Naturally Produced Fish Entering Hatchery

Monitoring of hatchery returns of spring-run chinook salmon at Feather River Hatchery is not recommended since AFRP baseline production estimates and CAMP target production levels could not be established for Feather River spring-run chinook salmon. Accurate monitoring of in-river spawner abundance and hatchery returns of spring-run chinook salmon in the Feather River was not possible during the baseline period because of difficulty in observing adults in summer holding areas, overlap in the timing and location of naturally spawning spring-and fall-run chinook salmon, and an inability to accurately distinguish spring-and fall-run chinook salmon entering the hatchery in the fall.

In-River Harvest

The recommended angler survey program includes estimating annual in-river harvest of chinook salmon in the mainstem Sacramento River above the Feather River confluence. The harvest of spring-run chinook salmon in this reach potentially includes fish that otherwise would have spawned in the mainstem Sacramento River, Butte, Deer, and Mill creeks. However, in-river harvest in this reach applies only to mainstem spawner; harvest of Butte Creek, Deer Creek, and Mill Creek spring-run in this reach is considered to be part of the downstream harvest for these watersheds. In-river harvest of spring-run chinook salmon and of fall-run chinook salmon is computed similarly. Adjustments may be needed depending on the intensity, distribution, and timing of angling effort on the mainstem Sacramento River.

Downstream Harvest

The recommended angler survey program includes estimating annual harvest of chinook salmon in the Sacramento River above the Feather River confluence and the Sacramento River below the Feather River confluence. The downstream harvest of Sacramento River mainstem, Butte Creek, Deer Creek, and Mill Creek spring-run populations can be computed by assuming that harvest is proportional to the relative contribution of these watersheds to total in-river run size (all target races and watersheds represented in the reaches listed above). Some adjustments may be necessary depending on the intensity, distribution, and timing of angling effort during the primary spring-run immigration period (April through September).

Ocean Harvest

The ocean harvest monitoring program for spring-run chinook salmon is the same as the program for fall-run chinook salmon.

Hatchery Marking

An expanded marking program is recommended for spring-run chinook salmon at Feather River Hatchery to account for the contribution of hatchery-produced spring-run to adult populations in the Feather River and to streams where straying may occur (e.g., Yuba River).

Table 2-8 describes the monitoring program for spring-run chinook salmon with respect to monitoring methods, parameters measured, geographic reaches or areas, monitoring periods, implementing agencies, and current program status.

Steelhead Trout

The AFRP baseline production estimate for steelhead trout is 6,546 adults and the target production is 13,000 adults. The recommended program for monitoring steelhead trout production is limited to angler surveys in the mainstem Sacramento River, hatchery counts at CNFH on Battle Creek, and a hatchery marking program at CNFH.

CAMP's recommendation for the steelhead trout monitoring program is limited to the upper Sacramento River above RBDD. Ladder counts at this location have provided the only long-term record of steelhead abundance. These counts were used to establish baseline production levels and targets. Ladder counts provide only partial estimates of run size at RBDD, therefore an inland harvest monitoring program is recommended to provide a means of

Table 2-8. Recommended Monitoring Program for Spring-run Chinook Salmon

Watershed	Monitoring Method	Geographic Area Covered	Monitoring Parameter	Monitoring Period	Implementing Agency	Program Status	Existing Program No.
Butte Creek	Snorkel survey	Centerville Head Dam to Parrott-Phelan Dam	Number of adults in summer holding areas	Two surveys, 1 July - 31 Aug.	CDFG	existing	3
Deer Creek	Snorkel survey	Upper Deer Creek Falls to Dillon Cove	Number of adults in summer holding areas	Two surveys, 1 July - 31 Aug.	CDFG	existing	4
Mill Creek	Ladder counts	Clough Dam	Run Size above Clough Dam	Daily, 1 Mar. - 30 Sep.	CDFG	existing	4
Sacramento River	Ladder counts	Red Bluff Diversion Dam	Annual estimate of run size above RBDD	Daily, 1 Apr. - 15 Sep.	CDFG, USFWS	existing	11
Sacramento River	Angler Survey	Carquinez Bridge to Redding	In-river Harvest	Random Days, 15 Jul. - 1 Oct.	CDFG	proposed	NA
Pacific Ocean	Ocean Harvest	California ports south of Point Arena	Ocean Landings	1 May - 30 Sep. (commercial), 15 Feb. - 15 Nov. (sport)	CDFG	existing	25

monitoring steelhead trout abundance in the upper Sacramento River on a consistent, long-term basis. Harvest data are subject to interpretation in evaluating abundance trends: therefore, the historic relationship between annual steelhead harvest above RBDD and total annual ladder counts at RBDD may permit general conclusions in the future.

The AFRP's steelhead production target is based on the combination of annual run size estimates based on RBDD counts, sport harvest estimates above RBDD, hatchery counts at CNFH, and the assumption from angler surveys that hatchery-produced steelhead contributed an average of 29% of the total natural escapement and sport harvest of steelhead in the upper Sacramento River during the 1967-1991 baseline period. The ratio of naturally produced to hatchery produced steelhead trout is expected to increase in the future in response to restoration actions proposed in the upper Sacramento River. An expanded marking program for juvenile steelhead at CNFH, therefore, is recommended in conjunction with efforts to recover marked steelhead in the angler harvest to improve estimates of naturally produced steelhead in adult returns.

Although steelhead monitoring was recommended on Deer and Mill creeks in the CAMP Conceptual Plan (U.S. Fish and Wildlife Service 1996), CAMP goals cannot be established because of lack of AFRP baseline data, and these programs are not recommended here.

Table 2-9 describes the monitoring program for steelhead trout with respect to monitoring methods, parameters measured, geographic reaches or areas, monitoring periods, implementing agencies, and current program status.

Striped Bass

The AFRP baseline production estimate for striped bass is 1,252,259 adults and the target production is 2,500,000 adults. The recommended program for monitoring striped bass production is adult mark-recapture in the Delta, and the lower Sacramento and San Joaquin rivers. An existing IEP program fills this need and CAMP recommends it be continued. Data for CAMP calculations will be provided by the existing program.

Table 2-10 describes the monitoring program for striped bass with respect to monitoring methods, parameters measured, geographic reaches or areas, monitoring periods, implementing agencies, and current program status.

American Shad

The AFRP baseline production estimate for American shad is 3,212 and the target production is 4,300 (juvenile index of abundance). The recommended program for monitoring American shad is to continue the existing IEP mid-water trawl survey (MWT). Calculation of the juvenile shad MWT index is recommended for assessing progress toward American shad AFRP production targets. Data for CAMP calculations will be provided from the existing programs.

Table 2-9. Recommended Monitoring Program for Steelhead Trout

Watershed	Monitoring Method	Geographic Area Covered	Monitoring Parameter	Monitoring Period	Implementing Agency	Program Status	Existing Program No.
Battle Creek	Hatchery Counts	Coleman National Fish Hatchery	Returns to Hatchery	Daily, 1 Jul. - 31 Mar.	USFWS	existing	18
Battle Creek	Hatchery Marking	Coleman National Fish Hatchery	NA	Variable	USFWS	proposed	13
Sacramento River (above RBDD)	Angler Survey	RBDD to Redding	In-river Harvest	Random Days, 15 Jul. - 15 Mar.	CDFG	proposed	NA

Table 2-10. Recommended Monitoring Program for Striped Bass

Watershed	Monitoring Method	Geographic Area Covered	Monitoring Parameter	Monitoring Period	Implementing Agency	Program Status	Existing Program No.
Sacramento-San Joaquin Delta and rivers	Mark-recapture program	Tagging: Broad Slough to Colusa (Sacramento River) and to Venice Island (San Joaquin River); Angler Survey: Pacific Ocean to Colusa (Sacramento River) and Mossdale (San Joaquin River)	Adult striped bass abundance estimates every other year	Tagging every other year, 15 Mar. - 30 Jun.; Creel survey year round	CDFG	existing	22

Table 2-11. Recommended Monitoring Program for American Shad

Watershed	Monitoring Method	Geographic Area Covered	Monitoring Parameter	Monitoring Period	Monitoring Period	Program Status	Existing Program No.
Sacramento-San Joaquin Delta	Midwater Trawl Survey	San Pablo and Suisun Bays, Delta	Juvenile abundance index	Monthly, 1 Sept. - 31 Dec.	CDFG	existing	24

Table 2-12. Recommended Monitoring Program for White Sturgeon

Watershed	Monitoring Method	Geographic Area Covered	Monitoring Parameter	Monitoring Period	Implementing Agency	Program Status	Existing Program No.
Sacramento-San Joaquin Delta	Mark-recapture program	San Pablo and Suisun Bays	Abundance estimates for 2 successive years, followed by 2 non-estimate years	Daily, 1 Sep. - 15 Nov.	CDFG	existing	23

Additional information on abundance of American shad will be available from the angler survey. However, these data will not be used directly in assessing progress toward meeting AFRP targets.

Table 2-11 describes the monitoring program for American shad with respect to monitoring methods, parameters measured, geographic reaches or areas, monitoring periods, implementing agencies, and current program status.

White Sturgeon

The AFRP baseline production estimate for white sturgeon is 5,571 and the target production is 11,000 adults. Continuation of the existing IEP sturgeon mark-recapture program is recommended for assessing progress toward AFRP production goals for white sturgeon. Data for CAMP calculations will be provided from the existing programs. Additional information on white sturgeon abundance will be available from the angler survey.

Table 2-12 describes the monitoring program for white sturgeon with respect to monitoring methods, parameters measured, geographic reaches or areas, monitoring periods, implementing agencies, and current program status.

Green Sturgeon

The AFRP baseline production estimate for green sturgeon is 983 and the target production is 2,000 adults. Currently, green sturgeon production is estimated by dividing white sturgeon production estimates by the ratio of white sturgeon to green sturgeon observed during tagging. It is recommended that CAMP production goals for green sturgeon continue to be calculated as an index of white sturgeon. Additional information on green sturgeon abundance will be available from angler surveys.

Table 2-13 summarizes the recommended monitoring methods for all species/races on all watersheds that will be used to assess progress toward increasing the natural production of anadromous fish.

Table 2-13. Recommended Monitoring Programs for all Target Species/Races by Watershed

Watershed	Species/Race with Restoration Goal	Monitoring Method: Carcass Surveys	Snorkel Surveys	Ladder Counts	Aerial Redd Counts	Hatchery Marking	Hatchery Counts	Angler Survey	Mark-Recapture	Mid-Water Trawl	Ocean Harvest[c]
American River	F	F				F	F	F			F
Battle Creek	F,LF	F,LF				F,LF,W, ST	F,LF,ST				F,LF
Butte Creek	F,S	F	S								F, S
Clear Creek	F	F									F
Deer Creek	F,S	F	S								F,S
Bay/Delta	SB,AS,WS,GS[b]								SB,WS	AS	
Feather River	F	F				F	F	F			F
Merced River	F	F				F	F				F
Mill Creek	F,S	F		S							F, S
Mokelumne River	F			F		F	F	F			F
Sacramento River[a]	F,LF,W,S,ST	F,W		S,F,W	F,LF,W			F,LF,S, ST			F,LF,W, S
San Joaquin River[a]								F			F
Stanislaus River	F	F						F			F
Tuolumne River	F	F									F
Yuba River	F	F						F			F

F = Fall-run chinook salmon
LF = Late fall-run chinook salmon
W = Winter-run chinook salmon
S = Spring-run chinook salmon

ST = Steelhead trout
SB = Striped Bass
AS = American Shad
WS = White Sturgeon

GS = Green Sturgeon

[a] Includes Delta reaches
[b] Green sturgeon calculated as an index of white sturgeon
[c] Amount of each chinook salmon race harvested in ocean estimated by apportioning harvest by race based on annual percent contribution to in-river run size total

Note: Additional data on striped bass, American shad, and white sturgeon may be available from angler surveys on the lower San Joaquin, Feather, and American rivers.

RECOMMENDED JUVENILE MONITORING PROGRAM

Key considerations in developing the recommended monitoring program for assessing the relative effectiveness of water management, structural modifications, habitat restoration, and screening actions in achieving Section 3406(b) doubling goals include:

- the need to isolate 3406(b) actions geographically or temporally;
- the need to select appropriate target species and races that are also sufficiently segregated within the basin to evaluate and compare population responses to individual action categories;
- the need to select appropriate life stages that provide the most direct measure of the effectiveness of action categories;
- the need to select appropriate target watersheds that provide opportunities to evaluate individual action categories and compare their effectiveness to actions implemented in other watersheds or in the same watershed at different times;
- the availability of control watersheds as a basis for evaluating the success of action categories;
- the presence of AFRP baseline monitoring population data for the target species, races, lifestages, and watersheds;
- the existence of applicable monitoring programs.

The following section utilizes the considerations listed above to identify the elements and general structure for the Implementation Plan.

TARGET SPECIES AND RACES

The CAMP Conceptual Plan (USFWS 1996) recommended fall-, spring-, and winter-run chinook salmon as target species and races for assessing the relative effects of action categories in watersheds upstream of the Delta, and striped bass as the target species for assessing the relative effectiveness of action categories in the Delta. Upon further review, the CAMP development team determined that the ability to compare action categories in the Delta using striped bass was very limited and therefore would not be addressed by CAMP. The rationale used by CAMP for selection of target species and races is presented below.

Criteria Used for Selection of Target Species/Races

Species/races considered most desirable to evaluate the relative effectiveness of structural, water management, habitat restoration, and fish screens in restoring anadromous fish production are those that possess the following characteristics.

- Broadly distributed in watersheds throughout the Central Valley to facilitate comparison of effects of different action categories among watersheds;
- Present in sufficient numbers to facilitate sampling and to detect significant changes or trends in abundance;
- Present in mainstem reaches or tributaries that are sufficiently isolated to minimize exposure to environmental variables not associated with action categories and allow segregation of effects among different populations;
- Existing adult and juvenile programs that can provide baseline information for evaluating population responses to restoration actions;
- Baseline (1967-1991) adult abundance estimates that can be used to relate changes in adult abundance to changes in juvenile abundance and establish a link between individual action categories and achievement of adult production goals;
- Long-term monitoring programs are already in place to minimize the need to develop additional monitoring programs solely for CAMP; and
- Not substantially supplemented by hatchery stocking programs which may impair the ability to evaluate changes or trends in natural production.

The results of applying these criteria to the principal anadromous species/races in the Central Valley are summarized in Table 2-14.

Table 2-14. CAMP Target Species Selection Criteria for Evaluating Effectiveness of Action Categories

	Selection Criteria						
Species/Race	Distributed in Several Watersheds	Abundant	Discrete Populations in Mainstem Rivers or Tributaries	1967-1991 Baseline Adult Estimates	Existing Adult and/or Juvenile Monitoring Programs	High Level of Existing/Future Monitoring	Minimal/No Artificial Production
Chinook salmon	X	X	X	X	X	X	
Fall-run	X	X	X	X	X	X	
Late fall-run			X	X			
Winter-run			X	X	X	X	X
Spring-run	X		X	X	X	X	
Steelhead trout	X		X	X[a]	X[a]		
Striped bass	X	X		X	X	X	X
American shad	X	X			X		X
White sturgeon				X	X		X
Green sturgeon							X

[a] Baseline estimates of adult steelhead limited to 1967-1991 counts at RBDD; current monitoring limited to partial counts of adults passing RBDD.

Chinook Salmon

In general, chinook salmon were determined to be the most appropriate species for assessing the relative effectiveness of action categories. Fall-run chinook salmon are the most numerous and widely distributed race of chinook salmon in the Central Valley. This distribution throughout many watersheds in the Central Valley allows the greatest number of opportunities to isolate the effect of actions in different watersheds and assess the effects of individual action categories on juvenile abundance. Relatively large population sizes improve the ability to sample fall-run chinook salmon and detect changes in abundance over time. Fall-run chinook salmon have been the focus of extensive, long-term monitoring of adult populations (spawning escapement) in the Central Valley. Juvenile monitoring programs currently are underway in a number of watersheds.

Although not as widespread or abundant as fall-run chinook salmon, spring-run chinook salmon offer special opportunities to evaluate population responses to restoration actions currently proposed for tributary streams. For example, dam removal or modifications to existing fish ladders (structural modifications) at several diversion dams on Butte Creek currently are being planned or implemented to improve passage of spring-run chinook salmon to summer holding, spawning, and rearing areas above the dams. Spring-run populations on Butte, Deer, and Mill creeks are not directly supplemented with hatchery fish.

Sacramento winter-run chinook salmon, currently listed as endangered under the federal and state endangered species acts, also were selected as a target race because they are considered to be the best indicator of the success of restoration actions in the upper mainstem Sacramento River. Other considerations for the selection of winter-run were the opportunities provided by the high level of monitoring needed to evaluate the success of numerous existing and recommended recovery actions (NMFS 1996a), the existence of long-term monitoring of adult spawning populations, and a minimal level of hatchery augmentation. Winter-run chinook salmon spawn and rear primarily in the mainstem Sacramento River; therefore, little or no opportunity is available to spatially isolate the effects of action categories. However, some level of temporal isolation of actions may be possible depending on the sequence and duration of various actions in the upper Sacramento River.

Late fall-run chinook salmon are not recommended as a target species/race because of their limited distribution and general lack of existing or proposed monitoring efforts.

Striped Bass

A major constraint in evaluating the relative effectiveness of actions in the Delta is the inability to spatially isolate and compare the effects of individual action categories. The Conceptual Plan selected striped bass as a target species because they exhibited some of the desired criteria, including long-term records of juvenile and adult abundance. Upon further review, however, the CAMP development team has decided that CAMP's ability to compare action categories using striped bass is very limited. Other ongoing programs in the Delta are conducting extensive evaluations of striped bass. One example of this is the juvenile monitoring conducted by IEP. The CAMP team believes that these programs may be more appropriate to analyze the effect of actions on striped bass populations. CAMP recommends that these programs continue to collect information on striped bass in the Delta.

Steelhead Trout

Steelhead trout are a candidate for listing as a federally endangered species (NMFS 1996b). Steelhead trout were not considered as a target species for evaluating the relative effectiveness of CVPIA actions at this time for the following reasons: a general lack of baseline information on Central Valley populations (long-term records of adult abundance are limited to RBDD counts), a high degree of hatchery supplementation, and a lack of current or planned monitoring programs aimed at steelhead trout. However, incidental data on steelhead trout will be collected as a result of CAMP monitoring programs for chinook salmon and will be analyzed for effects of restoration actions on recovery of the species in the Central Valley.

American Shad

American shad are not recommended as a target species for evaluating the relative effectiveness of CVPIA actions. American shad spawn primarily in lower Sacramento River tributaries, the lower San Joaquin River, the mainstem Sacramento River, and the Delta. Although adult shad segregate into different tributaries or basin areas during their spawning migrations, these populations are not sufficiently distinct to permit spatial comparisons of action categories among different watersheds or basin areas; their use of tributaries is largely flow-dependent, and eggs and larvae are transported to downstream rearing areas where mixing of juveniles occurs. Much less is known of shad ecology in California compared with other anadromous species.

White Sturgeon and Green Sturgeon

White strugeon and green sturgeon meet few of the defined criteria for evaluating the relative effectiveness of CVPIA actions. Monitoring of both species has been limited to adult abundance estimates of white sturgeon only from sampling in San Pablo Bay. Little is known about the distribution, life history, and ecology of these species in the basin as a whole. Similar to American shad, it is believed that sturgeon do not segregate into distinct geographic spawning populations, thus preventing comparisons of action categories among watersheds or basin areas.

TARGET JUVENILE LIFESTAGES

Monitoring efforts to assess the success of CVPIA actions in achieving anadromous fish production targets focus on numbers of naturally produced **adult** fish. Distinguishing the relative effectiveness of action categories will be best accomplished by focusing on measures of **juvenile** abundance. Although increased adult production is the ultimate goal, adult populations include individuals that, while produced in streams where CVPIA actions are implemented, have spent much of their lives in the estuary or ocean where they have been subjected to many factors unrelated to the actions being implemented (e.g., ocean conditions, predation, harvest). Moreover, adults returning in any one year include multiple age classes (each representing a different set of conditions affecting their abundance) and do not always return to the stream in which they reared. Juveniles, however, are exposed only to the actions or conditions occurring in their nursery areas, and provide the best opportunity to directly assess the effectiveness of action categories.

For chinook salmon, juvenile outmigrant abundance is considered the most appropriate lifestage to evaluate the relative effectiveness of CVPIA actions because it integrates the effects of the freshwater environment during the period of stream residence, including the effects of restoration actions. Juvenile chinook salmon may emigrate from Central Valley watersheds as fry, parr, or smolts. These relatively distinct life stages emigrate in response to various biotic and abiotic factors, including those factors that are affected by the recommended restoration actions. Typically, most juvenile chinook salmon emigrate from their natal streams as fry, with parr, smolts, and yearlings constituting a much smaller fraction of the total emigrant population (Cannon 1982, Snider and Titus 1995). Since each of these life stages represents a distinct component of total juvenile abundance from a watershed, monitoring of emigrating juveniles should include all juvenile life stages to facilitate an understanding of the relative effects of restoration actions on the abundance and composition of the emigrant population. Accordingly, standard size or morphological criteria for distinguishing juvenile life stages should be developed and applied to all juvenile monitoring efforts.

Monitoring juvenile outmigrant abundance is also consistent with the need to evaluate population responses at the watershed level. Reeves et al. (1991) recommended watershed-level monitoring for evaluating habitat modification projects because anadromous salmonids generally use all parts of the stream system during the freshwater phase of their life history. Focusing only on small, treated reaches or individual structures may lead to erroneous conclusions because fish may simply redistribute themselves in response to habitat modifications with no increase in total population numbers. Watershed-level evaluations are needed for flow modifications which can affect the entire stream and a number of life stages.

Monitoring the abundance of juvenile salmonids during stream residence is less desirable than monitoring juvenile outmigrants due to difficulties in producing comparable estimates of juvenile abundance among streams. Extensive sampling effort is required to obtain accurate estimates of total juvenile abundance at the appropriate time (i.e., as close as possible to the time of smolt emigration). Large variations may occur in fish densities during the rearing period and no direct relationship may exist between juvenile abundance at one life history stage and abundance at a later stage, particularly if the limiting factor affects a later life stage.

Valid comparisons will require that standard definitions of lifestages, such as those presented by Snider and Titus (1995), be applied in each watershed selected for juvenile monitoring. Smolt abundance is considered the best measure of the success of habitat restoration projects because it reflects the degree to which habitat modifications have been successful in reducing or eliminating factors that were limiting at earlier stages (Reeves et al. 1991). Estimating abundance of juvenile outmigrants at a particular life stage also provides a standard variable for comparing population responses to various actions within or among watersheds over time.

TARGET WATERSHEDS

Ideally, a watershed approach to evaluating fish response to restoration actions is best accomplished through analysis of paired treatment and control watersheds (Reeves et al. 1991). Therefore, an optimal sampling design for evaluating the effectiveness of individual action categories would be to monitor juvenile abundance in one or more watersheds before and after implementing a single type of action, and compare changes in juvenile abundance in these watersheds with those occurring in a suitable control stream or streams. Green (1979) emphasized the need for control in both space and time to effectively detect or measure the effect of a given treatment on a response variable. As discussed in the CAMP Conceptual Plan (USFWS 1996), such a design will be very difficult to achieve since more than one action category has been proposed for individual watersheds, implementation of these actions may overlap in time or otherwise not allow sufficient time to evaluate any one action category, and evaluation of a single action category may be confounded by the effects of other concurrent actions. It may also be physically impossible to find suitable control watersheds because even adjacent subbasins can be quite different in terms of geologic, geomorphologic, and biologic

FIGURE 2-2

Juvenile Chinook Salmon Monitoring Recommendations and CVPIA Restoration Actions

Status of CVPIA Restoration Actions on CAMP Target Watersheds

Structural Modifications

Watershed	Action No.	Action Description	Status
American River	29	Reconfigure Folsom Dam shutters	I(complete)
Battle Creek	11	Chinook passage above CNFH[a]	I(complete)
Battle Creek	12	Gover Diversion dam barrier racks	N
Battle Creek	41	Rebuild fish ladder on Wildcat Diversion Dam	N
Battle Creek	42	Rebuild fish ladder on Eagle Canyon Diversion Dam	N
Big Chico Creek	14	Relocate and screen M&T Ranch diversion	I(complete)
Big Chico Creek	15	Repair Iron Canyon fish ladder	I(ongoing)
Big Chico Creek	16	Repair Lindo Channel weir and fishway	N
Butte Creek	17	Build new fish ladder at Durham Mutual Dam	L
Butte Creek	18	Remove Western Canal Dam	L
Butte Creek	19	Remove McPherrin and McGowan Dams	L
Butte Creek	20	Build new fish ladder at Adams Dam	L/N
Butte Creek	21	Build new fish ladder at Gorrill Dam	L/N
Butte Creek	22	Rebuild culvert at Drumheller Slough outfall	N
Butte Creek	23	Install a fish ladder at White Mallard Dam	N
Clear Creek	7	McCormick-Saeltzer fish passage	N
Sacramento River	1	RBDD operations	I(ongoing)
Sacramento River	2	Keswick Dam stilling basin escape channel	I(ongoing)
Sacramento River	3	GCID structural and operational modifications	I(ongoing)
Sacramento River	4	ACID operational modifications	I(ongoing)
Yuba River	24	Improve and construct bypasses	N
Yuba River	25	Modify fish ladder at Daguerre Point Dam[b]	N
Yuba River	26	Modify Daguerre Point Dam face[b]	N
Yuba River	27	Provide adequate water temperatures	N

[a]Has been partially implemented and will be further implemented once disease issues at CNFH are addressed.
[b]These actions are in the planning stages and are anticipated for implementation in 1998-1999.

I = Has been or Will be Implemented in 1997
L = Will Likely be Implemented in 1997
N= Not Likely to be Implemented in 1997 but may be in the planning and development stages

Status of CVPIA Restoration Actions on CAMP Target Watersheds

Fish Screens

Watershed	Action No.	Action Description	Status
American River	14	Improve fish screen	N
Battle Creek	4	Screen Orwick diversion	I(ongoing)
Battle Creek	5	Screen Coleman Powerhouse tailrace	N
Battle Creek	6	Screen PG&E diversions	N
Battle Creek	30	Rebuild fish screen on Wildcat Diversion Dam	N
Battle Creek	31	Rebuild fish screen on Eagle Canyon Diversion Dam	N
Butte Creek	7	Install fish screens at Durham Mutual Dam	L
Butte Creek	8	Install fish screens at Adams Dam	L/N
Butte Creek	9	Install fish screens at Gorrill Dam	L/N
Butte Creek	10	Install fish screen at White Mallard Dam	N
Merced River	20	Screen all diversions	N
Mokelumne River	15	Screen all diversions	N
Sacramento River	1	Anadromous Fish Screen Program	N
San Joaquin River	32	Install fish screen at Banta-Carbona, West Stanislaus, and El Soyo diversions	L
Stanislaus River	23	Screen all diversions	N
Tuolumne River	22	Screen all diversions	N
Yuba River	12	Improve and construct screens[a]	L

[a] Only the Browns Valley Irrigation District diversion will be screened in 1997.

I = Has Been or Will be Implemented in 1997
L = Will Likely be Implemented in 1997
N = Not Likely to be Implemented in 1997 but may be in the planning and development stages

Status of CVPIA Restoration Actions on CAMP Target Watersheds

Water Management

Watershed	Action No.	Action Description	Status
American River	31	Develop and implement river regulation plan	I(ongoing)
American River	32	Reduce flow fluctuations	I(ongoing)
American River	33	Modify timing and rate of diversions	N
American River	34	Improve flows for shad migration	N
Battle Creek	8	Increase flows past PG&E diversions	I(ongoing)
Butte Creek	13	Obtain additional instream flows	I(ongoing)
Butte Creek	14	Maintain minimum 40 cfs below Centerville D.D.[a]	N
Butte Creek	15	Purchase water rights	L
Butte Creek	16	Acquire water rights	I(ongoing)
Butte Creek	17	Adjudicate water rights	N
Butte Creek	18	Operational criteria for Sanborn Slough bifurcation	L
Butte Creek	19	Operational criteria for East and West Barrow pits	L
Butte Creek	20	Establish operational criteria for Nelson Slough	L
Butte Creek	21	Eliminate chinook stranding[b]	N
Clear Creek	5	Whiskeytown releases	I(ongoing)
Deer Creek	12	Improve instream flows	I(ongoing)
Feather River	22	Improve flows for chinook and steelhead	N
Feather River	23	Improve flows for shad migration	N
Merced River	42	Supplement flows	I(ongoing)
Merced River	43	Reduce adverse effects of flow fluctuations	N
Mill Creek	11	Provide instream flows	I(ongoing)
Mokelumne River	35	Improve flows for chinook and steelhead	N
Mokelumne River	36	Reduce flow fluctuations	N
Mokelumne River	37	Maintain suitable water temperatures	N
Mokelumne River	62	Establish and enforce water quality standards	N
Sacramento River	1	Flow regulation plan	I(ongoing)
Sacramento River	2	Flow change schedule	I(ongoing)
Sacramento River	3	Maintain water temperature	I(ongoing)
Sacramento River	4	Water quality amelioration	I(ongoing)
Stanislaus River	46	Supplement flows	I(ongoing)
Tuolumne River	44	Supplement flows	N
Tuolumne River	45	Reduce adverse effects of flow fluctuations	N
Yuba River	24	Improve flows for chinook and steelhead	N
Yuba River	25	Improve flows for shad migration	N
Yuba River	26	Reduce flow fluctuations	N
Yuba River	27	Maintain instream flows for temperature control	N

[a] PG&E is not obligated to maintain 40 cfs during summer months.

[b] As additional structural and operational projects are implemented chinook salmon stranding will be proportionally reduced.

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Status of CVPIA Restoration Actions on CAMP Target Watersheds

Habitat Restoration

Watershed	Action No.	Action Description	Status
American River	28	Develop a long-term water allocation plan	L
American River	29	Replenish spawning gravel[a]	L
American River	30	Improve and protect riparian habitat	N
American River	31	Terminate woody debris removal	N
Battle Creek	9	Improve fish passage in Eagle Canyon	N
Battle Creek	44	Develop regional conservation plan	L
Big Chico Creek	22	Replenish spawning gravel	N
Big Chico Creek	23	Improve cleaning procedures at One-Mile Pool	L
Big Chico Creek	24	Protect spring-run chinook summer holding pools	N
Big Chico Creek	25	Protect and revegetate riparian habitat	L
Butte Creek	26	Create buffer zones for urban development	L/N
Butte Creek	43	Develop comprehensive watershed management strategy	L
Clear Creek	3	Restore channel conditions	L/N
Clear Creek	4	Erosion control and stream protection	L/N
Clear Creek	5	Replenish gravel	L
Deer Creek	18	Protect and restore habitat	I(ongoing)
Deer Creek	19	Improve spawning habitats	N
Deer Creek	20	Maintain and restore riparian habitats	I(ongoing)
Deer Creek	21	Coordinate flood management activities	I(ongoing)
Deer Creek	42	Develop comprehensive watershed management strategy	L
Merced River	39	Restore and protect instream and riparian habitat	N
Merced River	48	Modify channel to isolate predators at Ratsloff Ranch	N
Merced River	49	Modify channel to isolate predators at Robinson Ranch	N
Mill Creek	12	Preserve habitat productivity	I(ongoing)
Mill Creek	13	Improve spawning habitats	I(ongoing)
Mill Creek	14	Restore riparian habitat	L
Mokelumne River	32	Replenish spawning gravel	I (ongoing)
Mokelumne River	33	Cleanse spawning gravel and prevent sedimentation	I (ongoing)
Mokelumne River	35	Enhance and maintain riparian corridor	N
Mokelumne River	36	Eliminate or restrict gravel mining	N
Sacramento River	1	Meander belt	I(ongoing)
Sacramento River	2	Spawning gravel restoration	I (ongoing)
Stanislaus River	41	Restore and protect instream and riparian habitat	N
Stanislaus River	45	Modify channel to isolate predators at Willms Pond	N
Stanislaus River	46	Replenish gravel below Goodwin Dam	N
Tuolumne River	40	Restore and protect instream and riparian habitat	N
Tuolumne River	47	Modify channel to isolate predators at Special Run Pool 9 & 10	N
Yuba River	27	Purchase streamband conservation easements	N

[a] Starting in 1997 DFG will be evaluating salmonid spawning habitat improvement procedures.

I = Has Been or Will be Implemented in 1997
L = Will Likely be Implemented in 1997
N = Not Likely to be Implemented in 1997 but may be in the planning and development stages

characteristics. Even with an optimal sampling design, natural temporal and spatial variability in the stream environment, including differences in flows and habitat conditions among streams, will limit the ability to detect and compare effects among action categories.

Criteria for Selection of Target Watersheds

Use of Tributaries

Given these limitations, assessment of the relative effectiveness of action categories can be best accomplished by seeking opportunities to spatially isolate the effects of actions among tributary streams of the Sacramento and San Joaquin rivers. Tributaries offer the best opportunity for comparing action categories since they provide a potentially large number of isolated reaches in which to evaluate individual action categories or establish controls. Juvenile populations in tributaries may also be affected by fewer actions than those in mainstem reaches.

Presence of Target Races

As discussed earlier, use of tributary streams to isolate the effects of individual actions is most applicable to fall-run chinook salmon, which are broadly distributed and spend a substantial portion of their freshwater rearing phase in natal streams. Therefore, watershed selection was based primarily on the presence of fall-run chinook salmon. Watersheds supporting spring-run chinook salmon were also included for their value relative to specific action categories. As discussed earlier, spatial separation of actions is not possible for winter-run chinook salmon, which spawn and rear primarily in the mainstem Sacramento River. Nevertheless, because much of the restoration and monitoring efforts will focus on the upper Sacramento River and because of the value of winter-run chinook salmon as an indicator species for this area, the upper Sacramento River was retained as a target watershed for monitoring.

AFRP Recommendations

Key considerations in selecting target watersheds are the geographic distribution and implementation schedule for action categories currently proposed in the draft Anadromous Fish Restoration Plan (USFWS 1995b). As discussed earlier, evaluating the relative effectiveness of action categories will best be accomplished by implementing only one action category in one or more test watersheds and maintaining one or more watersheds as controls. Unfortunately, two or more action categories are proposed in all watersheds targeted by CVPIA for anadromous fish restoration (Figure 2-2). Although the schedule for implementing many of these actions has not been defined, the AFRP assigned a high priority to some actions (based on their potential to increase natural fish abundance) and identified those actions with a high potential to be implemented prior to the end of fiscal year (FY) 1997. This prioritization may provide opportunities to temporally isolate action categories in a given watershed. Lags in implementing actions in a given watershed may also provide an opportunity to obtain baseline population data or provide a control for other watersheds. The value of the monitoring effort will depend on whether the monitoring period is of sufficient duration to detect effects on juvenile abundance (or establish a suitable baseline or control) before implementing subsequent actions. Water management modifications are particularly difficult to analyze because implementation of flow modifications will vary from year to year depending on water availability (i.e., even though the action was implemented it may not occur). An effort was made to use existing information on priority level and funding status for various actions to guide preliminary selection of target watersheds.

The draft AFRP (USFWS 1995) provided an initial prioritization of watersheds for implementing restoration actions based on the capacity of the watershed to increase fish abundance, the watershed's potential to support special-status species or races, and the degree to which the watershed is influenced by CVP operations. The highest priority for restoration was assigned to the Sacramento-San Joaquin Delta because it is highly degraded and all anadromous fish in the Central Valley must pass through it as both juveniles and adults. Second priority was assigned to the upper Sacramento River since it provides habitat for endangered winter-run chinook salmon, is the primary area for production of most species and races, and is strongly influenced by the CVP. A third priority was assigned to upper Sacramento River tributaries (downstream of Shasta Dam), especially Clear, Battle, Butte, Deer, and Mill creeks due to their high potential for production of spring-run chinook salmon and steelhead trout, and for promoting genetic diversity. A fourth priority was assigned to San Joaquin River tributaries because fall-run chinook salmon there may be distinct from fall-run in the Sacramento River, production of San Joaquin River fall-run chinook salmon often falls to very low levels, and tributaries are highly degraded.

Existing Monitoring Programs

While long-term, watershed-level monitoring of juvenile abundance is recommended for evaluating action categories under CAMP, funding limitations require that CAMP rely as much as possible on AFRP required site-specific monitoring of actions and existing juvenile monitoring programs, especially those that focus on estimating or indexing the abundance of juvenile outmigrants. Therefore, other considerations in selecting target watersheds were the ability of proposed AFRP and existing monitoring programs to completely or partially meet CAMP needs, the feasibility of adapting existing programs to meet CAMP needs, and the ability of these programs to contribute to evaluation of action categories.

Existing Adult Population Monitoring

As discussed earlier, the primary monitoring objective of CAMP is to produce watershed-level estimates or indices of juvenile outmigrant abundance for use in comparing the relative effectiveness of action categories among watersheds. It is therefore highly desirable to have watershed-level estimates of adult abundance in these watersheds so that the results of juvenile monitoring can be related to trends in adult population numbers, thereby providing a means of evaluating the success of specific restoration actions or action categories relative to adult production goals. Therefore, the availability of 1967-1991 baseline adult chinook salmon abundance estimates and continuation of these estimates in the future as part of the CAMP adult fish monitoring program were also considered in selecting target watersheds for the juvenile monitoring program.

Influence of Hatchery Production

Stocking of hatchery juveniles poses a potential constraint to evaluating action categories based on natural production. Streams that receive direct plants of hatchery juveniles of the target species are considered less desirable for monitoring than those that receive little or no direct hatchery influence, unless hatchery juveniles are distinctively marked. Under the CAMP adult monitoring program, a constant fraction of hatchery juveniles will be marked.

Recommended Target Watersheds

CAMP recommends that target watersheds for juvenile monitoring include the American River, Battle Creek, Big Chico Creek, Butte Creek, Clear Creek, Deer Creek, Feather River, Merced River, Mill Creek, Mokelumne River, Sacramento River (upper mainstem), Stanislaus River, Tuolumne River, and the Yuba River. The rationale for selecting these watersheds is discussed below.

Upper Mainstem Sacramento River

All restoration action categories except fish screens are scheduled to be implemented in the upper mainstem Sacramento River (mainstem above Feather River confluence) in 1997 (Figure 2-2). Therefore, there may be little opportunity to spatially isolate the effects of individual action categories in the upper mainstem Sacramento River. Furthermore, fall- and spring-run juvenile chinook salmon abundance in the upper Sacramento River will not only be affected by multiple actions in the mainstem Sacramento River but also by actions implemented in upper Sacramento River tributaries. Large releases of unmarked hatchery juveniles from CNFH may also confound efforts to estimate or index natural juvenile chinook salmon abundance in the upper Sacramento River.

The AFRP assigned a high priority to the upper mainstem Sacramento River since it provides habitat for endangered winter-run chinook salmon, contributes substantially to total basin abundance of most anadromous species and races, and is strongly influenced by CVP operations. Monitoring of outmigrating winter- and fall-run chinook salmon in the Sacramento River would be most effective at GCID's Hamilton City Pumping plant because of its protected location off of the main river and the ability to operate traps at high flows, and because it is downstream of most mainstem Sacramento River chinook salmon spawning areas. Furthermore, this site will likely continue to be an important location for monitoring other chinook salmon races and other anadromous species. A long-term record of adult winter-run chinook salmon abundance is available also for use in evaluating overall success of restoration actions. It has also been the practice to mark all winter-run chinook salmon produced and released at CNFH (Rich Johnson, USFWS, pers. comm.).

Upper Sacramento River Tributaries

Upper Sacramento River tributaries offer the advantage of being geographically isolated and their relatively small size facilitates effective sampling and accurate population estimates through various methods (e.g., mark-recapture, removal/depletion, direct observation). These streams receive periodic plants of hatchery juveniles that could affect evaluations of natural production if planted fish are unmarked. Annual estimates of adult abundance are available for most of these tributaries for the 1967-1991 period, although records for some of the smallest tributaries are sporadic or limited to only a few years.

All of the upper Sacramento River tributaries have been targeted for multiple action categories, although opportunities to temporally isolate actions may occur as specific implementation plans and schedules are developed. All four action categories are scheduled to be implemented in various upper Sacramento River tributaries in 1997 (Figure 2-2). Opportunities to evaluate the effects of action categories in these tributaries may occur depending on the location, timing, and duration of site-specific restoration actions.

AFRP has assigned high restoration priority to Clear, Battle, Butte, Deer, and Mill Creeks, due to their value for sustaining spring-run chinook salmon and steelhead trout and because their relative isolation which helps to maintain genetic diversity among stocks. CDFG currently is monitoring juvenile fall- and spring-run chinook salmon outmigrants in Butte, Deer, and Mill creeks (Mills, draft 1995).

Lower Sacramento River Tributaries

Lower Sacramento River tributaries are generally larger than upper Sacramento River tributaries, are influenced to a large degree by major storage reservoirs, and most support both natural and hatchery runs of chinook salmon (primarily fall-run). All of these tributaries have 1967-1991 estimates of adult abundance from which goals were established by the AFRP.

Like upper Sacramento River tributaries, these streams are isolated from one another but no opportunities are available to spatially isolate the effects of individual action categories among watersheds. Potential opportunities to temporally isolate the effect of individual action categories may occur. For example, water management and structural restoration actions are currently scheduled to be implemented on the American River in 1997 to improve instream flows for chinook salmon and steelhead trout in 1997. If implementation of other action categories does not occur for several years, an opportunity to evaluate responses of fall-run chinook salmon juvenile populations to modified instream flows may occur. Other opportunities to evaluate individual action categories may occur depending on the location, timing, and duration of various actions that are ultimately implemented.

San Joaquin River Tributaries

The AFRP assigned high restoration priority to the Stanislaus, Tuolumne, and Merced rivers since fall-run chinook salmon there may be distinct from fall-run in the Sacramento River, abundance of San Joaquin River fall-run chinook salmon often falls to very low levels, and tributaries are highly degraded. Similar to lower Sacramento River tributaries, there are potential opportunities to temporally isolate the effect of individual action categories.

Sacramento-San Joaquin Delta

The difficulties associated with isolating the relative effects of action categories among tributary streams are further magnified in the Delta because (1) the unique and complex characteristics of the Delta preclude the use of a control or any spatial comparison of actions with other watersheds or basin areas, (2) the spawning and rearing habitat of most anadromous fish occurs or extends beyond the Delta, resulting in juvenile populations in the Delta that reflect the effect of environmental conditions outside the Delta (including effects of restoration actions in upstream spawning and rearing areas), and (3) many of the proposed Delta actions are currently underway or scheduled to be implemented within the next few years, limiting any opportunities for temporal comparison of actions.

Because of the reasons stated above, the Delta was **not** selected as a target "watershed" for evaluating the relative effectiveness of CVPIA actions.

It should be reiterated that the value of these and other tributaries for juvenile salmon monitoring will have to be reassessed regularly as implementation plans and schedules are developed over the next few years. Since suitable control watersheds will probably not be available, it is critically important that juvenile salmon monitoring be continued or initiated as soon as possible to collect baseline abundance data before actions are implemented.

RECOMMENDED JUVENILE MONITORING METHODS

Comparison and Selection of Monitoring Methods

The overall strategy for evaluating the relative effectiveness of CVPIA actions is to obtain data on juvenile abundance that can be compared broadly among streams or reaches where various actions are proposed or are being implemented. Ideally, juvenile chinook salmon should be monitored in terms of the same variable(s) in all target streams or watersheds using a standard monitoring method. Comparison of the effects of various actions on juvenile chinook salmon will, therefore, be facilitated by employing a standard monitoring method that is broadly applicable to as many target streams as possible, and targets juvenile chinook salmon at a particular point in their life history.

For juvenile chinook salmon monitoring, the CAMP team recommends the use of rotary screw traps to index abundance of juvenile chinook salmon. This recommendation is based on the selection of juvenile outmigrants as the target lifestage, an evaluation of various sampling methods and gear types with respect to effectiveness, applicability to all target streams, sampling effort requirements, statistical reliability, and cost. Key literature on various sampling methods and input from biologists familiar with the application of these methods to Central Valley streams provided the basis for this recommendation.

No comprehensive or long-term efforts have been made to estimate juvenile chinook salmon outmigrant abundance in Central Valley streams. In general, juvenile salmon and steelhead monitoring efforts in the Central Valley have been under-funded, sporadic, short-term, and insufficient to provide managers with adequate data for decision-making (Mills draft 1995). However, efforts are currently underway in a number of tributary and mainstem reaches to develop juvenile chinook salmon abundance indices from rotary screw trapping.

The abundance of juvenile fish in streams is commonly estimated by means of mark-recapture, removal, or direct observation techniques. Mark-recapture and removal techniques involving the use of electrofishing or seines have been found to be the least biased methods of obtaining juvenile abundance estimates in small streams (Rodgers et al. 1992). However, accurate estimates of juvenile abundance requires extensive sampling over the affected reach, and habitat is either unsuitable for these techniques or inaccessible in portions of several Central Valley tributaries (Kathy Hill, CDFG, pers. comm.). Seining is most effective in shallow water over smooth substrate (Hubert 1983), conditions which are not common in most tributaries. Moreover, these methods are not suitable for estimating juvenile abundance on large streams such as the American River. Bias associated with population estimates obtained by electrofishing increases with river size (Riley and Fausch 1992); electrofishing would be impractical in all but the smallest streams.

Visual estimation of adult salmon abundance using snorkeling is currently conducted in several of the tributaries where monitoring is proposed; juveniles also are counted and there are some past data for comparison. However, several variables (including temperature, turbidity, discharge, depth, and cover) may bias visual counts (Hillman et al. 1992). Observer bias is also a potential problem associated with visual estimates.

Several methods of trapping outmigrant fish are available (e.g., the operation of a fish weir, Hubert 1983; Whelan et al. 1989), but most are too expensive, time-consuming, or impractical to be recommended for CAMP. For example, fyke nets (Hubert 1983) would not be suitable because they would be impossible to maintain at the high flows commonly occurring during juvenile outmigration.

Rotary screw traps are used widely to sample juvenile salmonids in the Sacramento-San Joaquin Basin and throughout the Northwest. Trap efficiency for wild fish has been shown to be reasonably constant in one limited study (Roper and Scarnecchia 1996). Screw traps currently are used to sample outmigrating salmonids on a number of Central Valley tributaries and could be used for CAMP monitoring with some changes in methods to standardize data collection. Recent experience with rotary screw traps in the upper Sacramento River, however, has revealed that these traps are subject to operational difficulties at high flows, fouling from algae, calibration problems, and inadequate sample sizes to allow accurate population estimation (Sam Williamson, NBS, Fort Collins, CO, pers. comm.).

For juvenile chinook salmon, CAMP recommends that rotary screw traps be used to obtain estimates of juvenile outmigrant abundance in the Sacramento-San Joaquin River Basin tributaries. Although several problems are associated with the use of screw traps, this method has been applied successfully over a relatively broad range of stream conditions and, therefore, can be applied to many streams in the Central Valley. Placement of traps on individual watersheds, standardization of monitoring protocols, and other monitoring details should be coordinated with agency staff and stakeholders prior to implementation.

Recommended Sampling Design, Level of Effort, Timing, and Data

Chinook salmon juveniles may migrate to sea at any time of year, although the majority of fry and smolts emigrate in late winter through spring (Healey 1991). The most important period to sample emigrating juveniles in Central Valley streams is from January to June of each year. Although year-round sampling would produce a better estimate of total outmigrants, the cost associated with year-round sampling is prohibitive. Moreover, because the majority of the fry and smolts emigrate during freshets that occur in winter and early spring, this sampling period is adequate to capture the majority of the outmigrants. For juvenile salmon monitoring, all tributaries selected by CAMP should be sampled during the same period, 1 January to 30 June of each year. This would require the operation of a screw trap for six months each year on each target watershed. For Deer and Mill Creek, the current sampling period (1 September to 30 June) should continue to sample subyearling spring-run chinook salmon that emigrate in the fall and winter. Year-round sampling should continue in the upper Sacramento River where current efforts are aimed at developing abundance indices for both winter- and fall-run chinook salmon that emigrate during the July through December and January through June periods, respectively.

To estimate abundance of outmigrating juveniles from an entire watershed, screw traps should be located downstream from major spawning and rearing areas or as close to the mouth of the tributary as possible. The exact location of the trap will depend on habitat present in the lower reaches of the tributary (screw traps require certain habitat and hydraulic conditions to be effective). Tests will need to be conducted to determine the most effective location for the traps, which may vary depending on channel morphology, hydraulic conditions, and the size and behavior of juveniles during the emigration period.

To ensure that data collected are comparable, the operation of the screw traps should be standardized at all sampling sites. Once a suitable trap location is found, the trap location should remain fixed throughout the sampling period and from year to year unless changes in channel configuration or hydraulic conditions occur. During the sampling period, the traps should be checked at least twice daily, preferably early in the morning and at dusk (to separate fish caught during the day from those caught at night). Each time the trap is checked, several variables should be recorded, including the water temperature, turbidity, flow, and trap rotation rate. Continuous temperature and light penetrance recording devices should be installed and operated at each rotary screw trap site during the monitoring period. All fish collected at each trap should be identified and counted by species. A sample of 150 to 250 chinook salmon per trap period (or all chinook salmon if numbers are less than 150) should be measured and classified as fry, parr or smolts.

Trap efficiency tests should be performed weekly or as often as needed to account for flow, turbidity, and other effects on capture efficiency, and these effects should be quantified and used to calibrate trap catches during the season and from year to year. A target number of 1,000 trap-caught salmon should be marked each week with a distinctive dye, and released upstream of the trap site. All marked fish should be released between 2100 and 2300 hours. Natural migrants are preferred for efficiency testing, but hatchery fish may be needed to augment the number of marked fish and assure adequate sample sizes at the trap. If hatchery fish are used, tests to evaluate any differences in capture probabilities between hatchery and natural emigrants are recommended. In some streams, the use of hatchery fish may conflict with management goals, so the use of hatchery fish may not be an option. A minimum trap efficiency should be determined to evaluate the need to improve efficiency using channel modifications or devices designed to direct fish to the trap.

RECOMMENDED JUVENILE ABUNDANCE ESTIMATION METHODS

The simplest method of estimating juvenile outmigrant abundance with rotary screw traps involves the use of 'trap efficiency' tests with a single trap (e.g., Thedinga et al. 1994). In this case, fish are captured at a single trap and a portion of these are marked, transported upstream and released. The proportion of the total number of fish marked that is recaptured at the trap is an estimate of the trap efficiency:

$$E = R/M$$

where: E = trap efficiency
R = number of fish recaptured
M = number of fish marked and released upstream

The total emigrating population is estimated as:

$$N = U/E$$

where: N = total estimated number of fish
U = total unmarked catch
E = trap efficiency

Since single rotary traps are used to sample juvenile chinook in a number of Sacramento River tributaries, this method could be used to estimate juvenile outmigrant abundance with minimal extra effort or expenditure. The results obtained with this method should be stratified by lifestage (i.e., separate estimates should be produced for fry, parr, smolts and yearlings).

Darroch (1961) developed a maximum-likelihood method for estimation of abundance from stratified populations. This method, which addresses the problem of variable capture probability by stratifying releases over time, has been adapted by Dempson and Stansbury (1991) for the estimation of smolt populations and is recommended for CAMP. Although Warren and Dempson (1995) suggest that temporal stratification has little effect on the estimate, more recent work has shown that temporal stratification may decrease bias in mark-recapture estimates (J. Brian Dempson, Department of Fisheries and Oceans, Science Branch, St. John's, Newfoundland, personal communication). This method requires that the mark that is applied to fish at the upstream trap be varied over time (i.e., fish are given one mark for a period, and then the mark is changed for a similar period). In this way, capture probabilities can be independently estimated for shorter periods, which may improve the estimates if variable capture probabilities are a problem. Further details of estimation procedures for stratified methods may be found in Darroch (1951), Seber (1982), Dempson and Stansbury (1991), and Schwarz and Dempson (1994).

EXISTING MONITORING PROGRAMS CONSISTENT WITH CAMP JUVENILE CHINOOK SALMON MONITORING NEEDS

Juvenile chinook salmon and steelhead monitoring programs involving the use of seines and rotary screw traps currently are conducted by the USFWS and CDFG. Efforts have focused on emergence timing, growth, rearing location and duration, and emigration timing. In addition to life history information, CDFG has identified development of juvenile abundance indices for fall-run chinook salmon as a high priority for American, Feather, Merced, Mokelumne, Tuolumne, Stanislaus, and Yuba rivers and Battle Creek and for fall- and spring-run chinook salmon on Butte, Deer, Mill, and Big Chico creeks (Mills, draft, 1995). Efforts are currently underway to evaluate the utility of the trap data for developing indices of juvenile salmon abundance.

Downstream migrant monitoring is conducted at the Tehama-Colusa Canal diversion and fish screen facility at RBDD and at the GCID diversion facility and fish screen near Hamilton City. Although of limited value in assessing the relative effectiveness of different action categories, continued monitoring of juvenile chinook salmon outmigrant abundance in the upper Sacramento River may provide insight into the relative effectiveness of action categories if some level of temporal isolation is possible and population responses are large.

On the Mokelumne River monitoring of juvenile outmigrants passing through the Woodbridge Irrigation District's bypass facility or captured at Woodbridge Dam has been conducted since 1991, thus providing a potential source of baseline population data as well as data for evaluating future restoration actions. Other potential sources of baseline data are salvage records of juvenile fall-run chinook salmon captured during the spring diversion period at the Hallwood-Cordua canal fish screen on the Yuba River since 1975. Although an evaluation has been made of the utility of these data for indexing abundance, efficiency tests are needed to calibrate the trap for various flow conditions.

CAMP recommends that existing juvenile outmigration monitoring programs be continued but modified to include estimation or indexing of juvenile abundance as a primary objective. Table 2-15 summarizes juvenile monitoring programs that are consistent with CAMP Objective 2 requirements.

CAMP-recommended monitoring programs for evaluating the relative effect of the action categories on juvenile chinook salmon are summarized in Table 2-16.

Availability of Data on Limiting Factors

This section discusses the availability of data on the major factors limiting abundance of juvenile anadromous fish in Central Valley streams. These data will be used to distinguish effects of implemented restoration actions from the variable effects of other limiting factors on juvenile abundance.

Instream Flow

Table 2-17 identifies existing USGS flow gauging stations selected for juvenile chinook salmon monitoring. USGS stations measure daily mean flows in cubic feet per second. USGS monitors flow on all streams included in the juvenile monitoring program, except for Big Chico Creek which will be included in another program (see next section). No additional flow monitoring will be conducted by CAMP.

Water Temperature

Table 2-18 identifies real-time flow/water quality monitoring proposed by the USFWS on streams supporting spring-run chinook salmon. Water temperature is measured as minimum and maximum daily temperatures in degrees Celsius, except as noted.

Various agencies monitor water temperature on the remainder of the streams included in the juvenile monitoring program where water temperatures problems have been identified as a limiting factor to anadromous fish in the draft AFRP. On Clear Creek, USBR plans to add water temperature monitoring at the existing USGS gauge site at Igo, using CVPIA funds (Jim Smith, USFWS, pers. comm.). Water temperature will be measured hourly in degrees Celsius.

The AFRP program will fund several real-time flow, temperature, and turbidity monitoring gauges on streams supporting spring-run chinook salmon (Mill, Deer, Big Chico, and Butte creeks) (Table 2-18). At some sites, monitoring capabilities will be added at existing DWR or USGS gauge sites. At other sites, new gauges will be installed. Each station will be operated and

Table 2-15. Existing Juvenile Monitoring Programs Employing Rotary Screw Traps

Watershed Name	Monitoring Program Name	Target Species	Target Life Stages	Location of Screw Trap(s)	Monitoring Period	Lead Agency	Funding Source	Year Began
American River	Lower American River Emigration Survey	Fall-run chinook	Emigrating juvenile	Near Watt Avenue	15 Nov. - 15 Jul.	CDFG	CDFG	1992
Butte Creek	Butte Creek Spring-run Chinook Salmon Juvenile Lifestage History and Emigration Study	Spring-run chinook	Emigrating juvenile	One trap at Parrott-Phelan Dam (Weir #1) and one trap in Sutter Bypass	1 Oct. - 30 Jun.	CDFG	USFWS	1994
Deer Creek	Central Valley Salmon and Steelhead Program	Spring-run chinook	Emigrating juvenile	Upper Dam	1 Sep. - 30 Jun.	CDFG	CDFG	1994
Feather River	Feather River Outmigration Study	Fall-run chinook	Emigrating juvenile	One trap at lower end of low-flow channel, one trap at Honcut Creek confluence	1 Dec. - 30 Jun.	DWR	DWR	1995
Merced River	Merced River Juvenile (smolt) Production Indices and Estimates	Fall-run chinook	Emigrating juvenile	One trap near Stevinson, one trap near Shaffer Bridge	15 Apr. - 15 May	CDFG	MID	1996 (planned)
Mill Creek	Central Valley Salmon and Steelhead Program	Spring-run chinook	Emigrating juvenile	Upper Dam	1 Sep. - 30 Jun.	CDFG	CDFG	1993
Mokelumne River	Mokelumne River Chinook Salmon and Steelhead Monitoring Program (Task 3)	Fall-run chinook	Emigrating juvenile	At Woodbridge Dam		EBMUD	EBMUD	1993
Stanislaus River	Stanislaus River Juvenile (smolt) Production Indices and Estimates	Fall-run chinook	Emigrating juvenile	One trap near Oakdale, two traps near Caswell	1 Feb. - 30 Jun.	USFWS	USBR	1993
Tuolumne River	Tuolumne River Juvenile (smolt) Production Indices and Estimates	Fall-run chinook	Emigrating juvenile	One trap at Shiloh Bridge, one trap near Roberts Ferry Bridge	15 Apr. - 15 May	CDFG	TID/MID/ SF	1995
Upper Sacramento River	Red Bluff Research Pumping Plant Studies	All salmon races, steelhead	Emigrating juvenile	Four traps at RBDD	Year-round	USBR, USFWS	USBR	1995
Upper Sacramento River	Glenn-Colusa Irrigation District Studies	All salmon races, steelhead	Emigrating juvenile	One trap in GCID in bypass channel	Year-round	CDFG	DWR, GCID	1991
Upper Sacramento River	Sacramento River Emigration Survey	All salmon races, steelhead	Emigrating juvenile	One trap near Cow Creek, two traps at Balls Ferry	1 Mar. - 30 Jun.	CDFG	CDFG	1995

Table 2-16. CAMP Recommended Monitoring Programs for Juvenile Chinook Salmon

Target Watershed	Target Race	Trap Location(s)	Monitoring Period	Existing Program
American River	F	Near Watt Ave.	1 Jan - 30 June	Yes
Battle Creek	F	Near Mouth	1 Jan - 30 June	No
Big Chico Creek	F,S	Near Mouth	1 Sept. - 30 June	No
Butte Creek	F,S	Parrott-Phelan Dam	1 Sept. - 30 June	Yes
Clear Creek	F	Near Mouth	1 Jan - 30 June	No
Deer Creek	F,S	Upper Dam	1 Sept - 30 June	Yes
Feather River	F	Near Live Oak	1 Jan - 30 June	Yes
Merced River	F	Near Stevinson	1 Jan - 30 June	Yes
Mill Creek	F,S	Upper Dam	1 Sept - 30 June	Yes
Mokelumne River	F	Woodbridge Dam	1 Jan - 30 June	Yes
Stanislaus River	F	Near Caswell State Park	1 Jan - 30 June	Yes
Tuolumne River	F	Near Shiloh Bridge	1 Jan - 30 June	Yes
Upper Sacramento River	W,F	Hamilton City Pumping Plant (GCID)	Year-round	Yes
Yuba River	F	Near Hallwood Ave.	1 Jan - 30 June	No

F = Fall-Run
W = Winter-Run
S = Spring-Run

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Table 2-17. Existing USGS Flow and Water Temperature Gauges on Stream Reaches Included in the CAMP Juvenile Chinook Salmon Program

Stream	Station Description	USGS Station ID	Flow Monitoring	Temperature Monitoring
American River	American River at Fair Oaks	11446500	X	NA
Battle Creek	Battle Creek below Coleman Fish Hatchery	11376550	X	NA
Butte Creek	Butte Creek near Chico	11390000	X	NA
Clear Creek	Clear Creek near Igo	11372000	X	NA
Deer Creek	Deer Creek near Vina	11383500	X	NA
Feather River	Thermalito Afterbay release to Feather River	11406920	X	NA
Feather River	Feather River at Oroville	11407000	X	NA
Merced River	Merced River below Merced Falls Dam, near Snelling	11270900	X	NA
Merced River	Merced River near Stevinson	11272500	X	X
Mill Creek	Mill Creek near Los Molinos	11381500	X	NA
Mokelumne River	Mokelumne River below Camanche Dam	11323500	X	NA
Mokelumne River	Mokelumne River at Woodbridge	11325500	X	quarterly
Sacramento River	Sacramento River above Bend Bridge, near Red Bluff	11377100	X	NA
Sacramento River	Sacramento River at Delta	11342000	X	NA
Sacramento River	Sacramento River at Keswick	11370500	X	bimonthly
Sacramento River	Sacramento River at Butte City	11389000	X	NA
Sacramento River	Sacramento River at Colusa	11389500	X	NA
Sacramento River	Sacramento River below Wilkins Slough near Grimes	11390500	X	X
Sacramento River	Sacramento River at Verona	11425500	X	NA
Sacramento River	Sacramento River at Freeport	11447650	X	X
San Joaquin River	San Joaquin River near Newman	11274000	X	X
San Joaquin River	San Joaquin River near Vernalis	11303500	X	X
Stanislaus River	Stanislaus River below Goodwin Dam	11302000	X	X
Stanislaus River	Stanislaus River at Oakdale	11302500	NA	X
Stanislaus River	Stanislaus River at Ripon	11303000	X	monthly
Tuolumne River	Tuolumne River below La Grange Dam, near La Grange	11289650	X	X
Tuolumne River	Tuolumne River at Modesto	11290000	X	X
Yuba River	Yuba River near Marysville	11421000	X	X

Table 2-18. Real-Time Flow/Water Quality Monitoring on Streams Supporting Spring-Run Chinook Salmon, Funded through AFRP Program

Stream	Name/Site	Existing Gauge	Operating Agency	ID Number	Proposed Data	Proposed Telemetry Type	Gauge Priority	Proposed Federal FY of Installation
Big Chico Creek	Near Chico	Yes	DWR	A42105	flow/temp/turb	CDEC	1	96 - 97
Butte Creek	Near Chico	Yes	USGS	11390000	flow/temp/turb	CDEC	1	96 - 97
Butte Creek	Near Durham	Yes	DWR	A04265	flow/temp	CDEC	1	97 - 98
Butte Creek	Below Western Canal	Yes	DWR	A04158	flow/temp	CDEC	1	96 - 97
Butte Creek	Near Gridley	Yes	DWR	A04150	flow/temp	CDEC	2	97 - 98
Butte Creek	Butte Slough Outfall	Yes	DWR	A02967	flow/temp	CDEC	2	97 - 98
Deer Creek	At Highway 32	No	--	--	flow/temp/turb	CDEC	3	97 - 98
Deer Creek	Near Vina	Yes	USGS	11383500	flow/temp/turb	CDEC	1	96 - 97
Deer Creek	Below Vina Dam	Yes	DWR	A04325	flow/temp	local	1	96 -97
Mill Creek	At Highway 36	No	---	---	flow/temp/turb	CDEC	3	97 - 98
Mill Creek	Near Los Molinos	Yes	USGS	11381500	flow/temp/turb	CDEC	1	96 - 97
Mill Creek	Below Highway 99	Yes	DWR	A04420	flow/temp	local	1	96 - 97

maintained by DWR or USGS and would collect hourly flow and water temperature data. At most sites, these real-time data will be made available through DWR's California Data Exchange Center (CDEC) telemetry.

On the lower American River, daily water temperatures are recorded by CDFG at the Nimbus Fish Hatchery located below Nimbus Dam. A continuous recording temperature device is currently operated by CDFG at the rotary screw trap site near Watt Avenue.

On the lower Feather River, DWR has monitored water temperature at three gauge sites since 1991, located at Thermalito Afterbay, at Gridley, and at White Oaks Ranch. Data are recorded at 15-minute intervals and are summarized as daily mean, maximum, and minimum temperatures (Howard Mann, DWR, pers. comm.). Funding for this monitoring was provided by DWR Environmental Services Office for calibration of a temperature model. At least one or two of these sites will continue to be monitored following completion of the model (Randy Brown, DWR, pers. comm.).

On the lower Mokelumne River, EBMUD operates several temperature gauging facilities (Steve Boyd, personal communication). The Pardee Area Control Center conducts real-time water temperature monitoring of releases at Camanche and Pardee dams. District hydrographers operate three Campbell monitoring units, located one mile downstream of Camanche Dam, at the Victor site (between Lockeford and Lodi), and at Mackville Road (at Clements). Three Omnidata datapods are used by District biologists to collect water temperature data, located downstream of Camanche Dam (100 yards), at Frandy (downstream of Woodbridge at tidal influence), and at New Hope Landing (at Walnut Grove Road and the South Fork Mokelumne).

With the existing and proposed gauging facilities, adequate water temperature monitoring is available for all streams included in the juvenile monitoring program where water temperature has been identified as a limiting factor in the draft AFRP (Table 2-19). No additional gauging facilities will be monitored as part of the CAMP program.

Water temperature data will be obtained by the CAMP program from USGS, USBR, DWR, CDFG and EBMUD on an annual basis. Data for relevant time periods for each race will be included in the analyses of juvenile monitoring data. Natural variation in flow and temperature may be unrelated to restoration actions being implemented in a watershed.

<u>**Hatchery Practices**</u>

Information on changes in hatchery practices potentially affecting juvenile abundance will be obtained on an annual basis from CDFG and USFWS hatcheries. Any significant changes in hatchery practices, such as significant increases or decreases in numbers stocked or change in stocking location, will be taken into consideration in data analyses.

Table 2-19. Summary of Existing and Proposed Water Temperature Gauging Sites on Streams Included in the CAMP Juvenile Chinook Salmon Program with Identified Water Temperature Problems

Stream	Gauge Site(s)	Monitoring	Operating Responsibility	Funding
American River	Nimbus Fish Hatchery below Nimbus Dam	Daily water temperature	CDFG	CDFG
Big Chico Creek	Near Chico	Hourly flow/water temperature	DWR	USFWS -
Butte Creek	Near Chico	Hourly flow/water temperature	DWR, USGS	USFWS -
Butte Creek	Near Durham	Hourly flow/water temperature	DWR, USGS	Proposed
Butte Creek	Below Western Canal Near Gridley	Hourly flow/water temperature	DWR, USGS	
Butte Creek	At Butte Slough Outfall	Hourly flow/water temperature	DWR, USGS	
Clear Creek	Near Igo	Hourly water temperature	USGS	USBR -
Deer Creek	At Highway 32	Hourly flow/water temperature	DWR, USGS	USFWS -
Deer Creek	Near Vina	Hourly flow/water temperature	DWR, USGS	Proposed
Deer Creek	Below Vina Dam	Hourly flow/water temperature	DWR, USGS	
Feather River	At Thermalito Afterbay	15-minute intervals,	DWR	DWR
Feather River	At Gridley	summarized as daily mean/max/min	DWR	DWR
Feather River	At White Oaks Ranch		DWR	DWR
Merced River	Near Stevinson	Daily min/max	USGS	USGS
Mill Creek	At Highway 36	Hourly flow/water temperature	DWR, USGS	USFWS -
Mill Creek	Near Los Molinos	Hourly flow/water temperature	DWR, USGS	Proposed
Mill Creek	Below Highway 99	Hourly flow/water temperature	DWR, USGS	
Mokelumne River	Camanche Dam release	Real-time water temperature	EBMUD - Pardee Area CC	EBMUD
Mokelumne River	Pardee Dam release	Real-time water temperature	EBMUD - Pardee Area CC	EBMUD
Mokelumne River	Downstream of Camanche Dam	Hourly water temperature	EBMUD - hydrographers	EBMUD
Mokelumne River	Victor (between Lockeford and Lodi)	Hourly water temperature	EBMUD - hydrographers	EBMUD
Mokelumne River	Mackville Road (Clements)	Hourly water temperature	EBMUD - hydrographers	EBMUD
Mokelumne River	Downstream of Camanche Dam	Hourly water temperature	EBMUD - biologists	EBMUD
Mokelumne River	Frandy	Hourly water temperature	EBMUD - biologists	EBMUD
Mokelumne River	New Hope Landing	Hourly water temperature	EBMUD - biologists	EBMUD
Sacramento River	Below Wilkins Slough Near Grimes	Daily min/max	USGS	USGS
Sacramento River	At Freeport	Daily min/max	USGS	USGS
San Joaquin River	Near Newman	Daily min/max	USGS	USGS
San Joaquin River	Near Vernalis	Daily min/max	USGS	USGS
Stanislaus River	Below Goodwin Dam	Daily min/max	USGS	USGS
Stanislaus River	At Oakdale	Daily min/max	USGS	USGS
Tuolumne River	Below La Grange Dam	Daily min/max	USGS	USGS
Tuolumne River	At Modesto	Daily min/max	USGS	USGS
Yuba River	Near Marysville	Daily min/max	USGS	USGS

Contaminants

Water quality problems attributable to contaminants have been identified as limiting factors to salmon abundance on many of the watersheds identified for CAMP juvenile monitoring. Summary data on contaminant levels are collected annually by the State and Regional Water Resources Control Boards. This information should be accessed through procurement of annual reports and facts sheets and taken into account in analyses of the juvenile abundance data. CAMP will not collect or store data on contaminants.

Number of Spawners/Adult Harvest

The number of adults returning to spawn will be determined each year by the CAMP adult monitoring program. These data will be used to evaluate the relative effectiveness of CVPIA actions by analyzing the effects of adult numbers on subsequent juvenile abundance. Adult harvest and ocean conditions will be reflected in the number of returning spawners.

Physical Habitat Quality/Fish Passage/Predation/Riparian Habitat Loss

No long-term monitoring programs have been established to evaluate year-to-year variation in the effects of factors such as physical habitat quality, fish passage, predation, and riparian habitat on juvenile abundance. However, evaluations of the effects of restoration actions should include consideration of the potential effects of these and other factors on juvenile abundance based on existing information, relationships between these factors and other variables (e.g., flow and temperature) and professional judgement.

SECTION 3. EVALUATION OF MONITORING PROGRAM RESULTS

SECTION 3
EVALUATION OF MONITORING PROGRAM RESULTS

METHODS FOR ASSESSING PROGRESS TOWARD AFRP PRODUCTION TARGETS

As discussed in Section 2, several sampling methods will be used to develop estimates of anadromous fish production and assess progress toward AFRP production targets. The result of sampling with these methods will be a single estimate of production for each race or species in each targeted stream or reach for which production targets were specified by AFRP. These production estimates will be used to evaluate progress toward AFRP production targets using a modified version of the Pacific Salmon Commission's (PSC) rebuilding assessment methods.

The PSC rebuilding assessment methods classify indicator races or species into three categories: (1) those that are at or above their production target, (2) those that are meeting their rebuilding schedule, and (3) those that are not rebuilding. The classification of races or species into these categories is accomplished using recent production data compared to each race's or species' baseline production data and its production target. Races or species that are classified as "above goal" are those for which at least four of the last five years of production estimates are at or above goal and for which the most recent 5-year average production is equal to or greater than the goal.

The PSC methods for identifying races or species that are meeting their rebuilding schedule involve three separate criteria that evaluate different aspects of each race's or species' production estimates. Two of these criteria involve the use of a "base to goal line," which is a straight line that connects the mean baseline production and the production goal over the rebuilding period. A mean criterion compares the mean observed production for a given period (say 1992-1997) to the mean of the points on the base to goal line for that period. A line criterion compares individual production estimates to the base to goal line for the same period. A short term trend criterion examines the recent production estimate for a race or species by determining if recent production is greater than for the previous year. Scores are assigned for each criterion and the total is used to determine if the species or race may be classified as "rebuilding." Those species or races that are not identified as rebuilding are classified as "indeterminate" or "not rebuilding."

The PSC rebuilding assessment method is a simple analysis to determine whether or not AFRP production targets are being met. The method does not require an estimate of variance of the mean and assumes that changes in precision of estimates over time produce no bias in the trend. Error associated with CAMP production estimates currently is unknown and is potentially large. Future studies should quantify sources of error in CAMP monitoring techniques.

METHODS TO COMPARE EFFECTIVENESS OF ACTION CATEGORIES

This section describes how watershed monitoring of juvenile abundance will be used as a tool to help assess the relative effectiveness of structural, water management, habitat restoration, and fish screen actions in restoring anadromous fish populations.

Abundance estimates for the juvenile life-stages (fry, parr, smolt, and yearlings) generated by the CAMP program could be highly variable between years. A variety of qualitative and quantitative analytical techniques will be needed to evaluate these data. The qualitative and quantitative results will be examined together to assess the effectiveness of specific actions within any given watershed. All of these analyses are indicative, in their own way, of relationships between juvenile abundance and actions. However, none of the analyses will be able to demonstrate causal relationships. Analytical evaluation techniques will include:

- Changes in juvenile abundance over time within watersheds prior to and following action implementation.
- Comparing juvenile abundance among watersheds.
- Integrating AFRP and other CVPIA site-specific monitoring results into the CAMP evaluation.
- Using adult spawner/juvenile abundance relationships to link the impact of actions that increase juvenile abundance to adult production.
- Effects of changes in abiotic environmental variables on juvenile abundance.
- Qualitative and quantitative assessment of relative effectiveness of different categories of actions by assessment of results over individual watersheds.

Compare Changes in Juvenile Abundance Over Time Within a Watershed

The annual estimates of juvenile abundance in CAMP watersheds will be conducted as described in Section 2. Juvenile abundance for fall-, winter-, and spring-run chinook salmon in the upper Sacramento River tributary watersheds will be estimated using a mark-recapture method with rotary screw traps. The hatchery component will be estimated given the constant fraction of marked fish.

Juvenile life-stages (fry, parr, smolts, and yearlings) will be measured as outmigrants in the screw traps. Variation between years and among streams in the ratio of these stages in the outmigrant population is a potentially confounding problem to interpreting the effect of actions on juvenile production. For those stages with adequate numbers, the complete set of analyses for effects of actions will be conducted, as described below. However, outmigrating smolt are considered most representative of juvenile exposure to natal stream conditions. Smolts are exposed to natal stream conditions longer than outmigrating fry, parr, or yearlings. As a result, analyses of smolt production will be considered the most important juvenile life-stage for interpreting the effects of CVPIA actions.

The timing of implementation of actions will be considered in relation to the timing of screw trap captures in all analyses. For example, in cases where juveniles are outmigrating early, primarily as fry, flow management actions enacted later in the season cannot be considered as having influenced the number of fry observed.

The juvenile abundance sampling program will generate daily counts of the number of fry, parr, yearlings and/or smolts captured at each rotary screw trap over the course of each sampling season. In addition to daily sums by lifestage category, a complete length-frequency distribution for juveniles collected over the sampling period will be available, as lengths will be recorded for juvenile salmon collected.

A relational database (e.g., Microsoft Access, see Section 4) will be used to retrieve data records for reduction, analysis, summary, and graphing. Various statistical software may be used on downloaded data, as well. The retrieved data will include:

- Daily catch data of fry, parr, and smolts for each trap (following the application of trap efficiency factors)
- Annual summary of length/frequency data for all juveniles captured at any given trap
- Daily average flow and water temperature data for each trap from a gauging location determined to be most representative of the trap location
- Weekly average temperatures and monthly average flows from the same gauging locations

Qualitative Comparison Between the Sequence of AFRP Actions and Changes in Juvenile Abundance

As discussed in Section 2, actions representing at least two action categories are anticipated to be implemented in all CAMP-monitored watersheds. Actions will be implemented according to established priorities based on need, funding, and project readiness. As a result, successive annual juvenile abundance estimates may reveal responses to specific actions as they are sequentially implemented over the course of several years. Comparison of fry, parr, and smolt abundance estimates over time with flow, temperature, and adult production data to specific dates noted for the implementation of each action can be used to illustrate potential relationships between juvenile abundance, adult production, and implemented actions. Mean monthly flows and mean weekly temperature data will be used in the analyses.

Trend Analysis

Nonparametric trend analysis methods may be used to analyze juvenile abundance within watersheds over time. The Kendall's Tau test may be used to determine if a time series is trending upwards, downwards, or remaining level. The basic technique consists of observing the upward or downward trend between any 2 sequential years and compiling the observations over the period of record. The resulting Mann-Kendall statistic is then tested for significance (EPA 1993, Gilbert 1987). For CVPIA reporting purposes, the juvenile production data for each watershed will be analyzed over the period of record for significance trend, upward or downward. These results can be correlated with the sequence and timing of implementation of actions in various action categories.

Comparisons of "Before" and "After" Data

Most actions will be implemented sequentially, although some may be implemented simultaneously or during a single year within watersheds. As a consequence, juvenile abundance estimates in most cases may be categorized as occurring before or after implementation of any given action. The usefulness of this comparison will be enhanced as the number of baseline years and post-action years is increased.

A simple nonparametric test may be used to assess the similarities of before and after data. The Wilcoxon-Mann-Whitney test can be used to compare juvenile abundance data before and after implementation of a particular action. The test is a nonparametric alternative to the t-test as a means of testing whether the two groups are statistically similar.

Similar Wilcoxon-Mann-Whitney tests will be applied to the temperature and flow data for the same periods that were tested for juvenile abundance data. These results can be used to assess associations between the degree of significance of changes in fish abundance and any flow or temperature changes that may have occurred at the same time (whether likely to have been caused by the action(s) or not).

Summary of Results

Results of statistical tests can be summarized in a table along with information on implemented actions by year for each watershed. Each watershed summary table can be used along with the annual comparisons among watersheds (see below) to employ a "weight of evidence" approach using professional judgment to assess the relative effectiveness of action categories. Information from CVPIA site-specific monitoring and critical limiting factors also will be employed to assess relative action effectiveness. **Although these analyses cannot unequivocally demonstrate causal relationships between changes in juvenile abundance and implementation of actions, they can provide good evidence for relative effectiveness when used in combination with all quantitative and qualitative data available.**

Compare Juvenile Abundance Among Watersheds

Although an effort has been made to standardize monitoring methods for estimating juvenile abundance by proposing the use of screw traps, total annual juvenile abundance estimates cannot be compared directly among watersheds. The watersheds are very different in size, flow, and spawning area and naturally are very different in the age structure and total number of juveniles produced (independent of actions). Instead, the within-watershed results can be listed for all watersheds to provide a summary of evidence for the relative effectiveness of categories of actions.

Juvenile abundance data for each watershed can be presented with associated timing of implementation of actions. The resulting table will reveal categories of actions that are consistently associated with positive effects on juvenile abundance. Actions may be compared by their cumulative total positive, negative, or neutral effects on juvenile abundance and ranked in terms of summed effectiveness (see example table in Section 3, below). In addition, the AFRP action-specific monitoring results may be used as an indication of the contribution of individual actions to the juvenile abundance total in any given year.

Integration of CVPIA Site-Specific Monitoring with CAMP Juvenile Watershed-Level Monitoring

The draft AFRP plan recognizes that a diverse array of data collected using standardized and validated methods will be required to fully evaluate the effectiveness of restoration actions in Central Valley streams and the Delta. The AFRP plan proposes a hierarchical approach to monitoring, from fine to coarse spatial and temporal scales (e.g., action-specific, watershed-specific, and system-wide scales, and short- versus long-term temporal scales). Monitoring at all scales is needed so that restoration can be adaptively modified and refined.

The juvenile monitoring program will provide long-term watershed-specific and system-wide monitoring for juvenile anadromous fish. AFRP and other CVPIA site-specific monitoring programs will provide short-term monitoring of site-specific restoration actions. Data from the juvenile and site-specific programs will be integrated to assess the effectiveness of the various classes of actions in restoring anadromous fish populations.

CVPIA site-specific monitoring program details were not available prior to completion of the CAMP Implementation Plan. Therefore, assumptions have been made about the structure of the site-specific monitoring programs and the integration of CAMP and these programs. These assumptions are presented in Table 3-1. No assumptions have been made for aspects of the CVPIA not directly related to assessment of action category effectiveness. The assumptions are presented by action and project type (when appropriate). Also presented are methods proposed to integrate CVPIA site-specific monitoring into the CAMP assessment process. Effectiveness of water management, temperature control, and habitat restoration actions can be assessed using watershed-level juvenile monitoring (the basic CAMP juvenile program) as the appropriate site-specific monitoring technique. In those cases, CVPIA site-specific and CAMP juvenile monitoring can overlap and could be assessed together.

CAMP assumes that CVPIA programs responsible for implementation of actions (e.g., AFRP, anadromous fish screening program) will be responsible for set-up and maintenance of a database for the site-specific monitoring program information. These data will be entered into the

IEP database established for CAMP.

Table 3-1. Summary of CAMP Assumptions for CVPIA Site-Specific Monitoring

Action Category - Project Type	Monitoring Technique	Monitoring Duration	Timing	Study Controls
Water Management Modifications	Flow, temperature gauging Watershed-level juvenile survival rate indices monitoring	Stream monitoring - minimum 10 years	Stream monitoring - period of smolt outmigration	Not applicable
Structural Modifications - Water Temperature Control	Temperature gauging Watershed-level juvenile survival rate indices monitoring	Minimum 10 years	Period of smolt outmigration	Not applicable
Structural Modifications - Fish Passage Facilities/ Barrier Removal	Adult passage studies Redd counts	Minimum 2 years pre- and post-project	Adult monitoring - period of upstream migration Redd counts - spawning period	Similar streams or stream reaches where barriers will not be modified
Structural Modifications - Diversion Removal or Reduction	Fish entrainment studies	Minimum 2 years pre- and post-project (for complete closure, 2 years pre-project)	Period when species/races/size classes of juveniles vulnerable to entrainment are present in project area	Similar diversion sites which will not be modified
Fish Screens	Screening efficiency studies	Variable, depending on flow and diversion conditions	Period juvenile fish are vulnerable to entrainment in project diversion	Similar diversion sites which will not be screened
Habitat Restoration - Gravel Replacement or Addition	Non-engineered projects - Monitor area and quality of spawning riffles Engineered projects - redd counts and fry emergence studies	Redd counts/fry emergence studies - minimum 2 years pre-project, ten years post-project	Redd counts - spawning period Fry emergence studies - period of fry emergence from gravel	Similar spawning riffles which will not receive restoration treatment
Habitat Restoration - Stream Channel Rehabilitation/ Modification	Adult fish passage studies; hydraulic conditions for fish passage (velocity/depth) Juvenile fish use of treated areas; hydraulic and physical conditions for juvenile rearing (velocity/depth/cover)	Passage and rearing studies - minimum 2 years pre- and post-project	Adult passage studies - period of upstream migration Juvenile rearing studies - period of juvenile rearing in project area	Similar stream reaches which do not receive channel restoration
Habitat Restoration - Riparian Rehabilitation/ Protection, Stream Fencing	Revegetation studies Watershed-level juvenile survival rate indices monitoring	Revegetation studies - appropriate duration to determine vegetation reestablishment Watershed-level juvenile monitoring - minimum 10 years	Revegetation studies - appropriate to monitor revegetation success Juvenile monitoring - period of smolt outmigration	Similar stream reaches which do not receive riparian area restoration

Relationship of Juvenile Abundance to Adult Production

Although the primary lifestage recommended for evaluating effectiveness of categories of actions is juveniles, translation of changes in juvenile abundance to changes in adult spawner abundances is necessary to associate the effectiveness of action categories to achieving AFRP production targets.

Juvenile abundance estimates (i.e., the estimated number of outmigrating juveniles) will be compared to estimates of the number of returning adults in the appropriate year-class (e.g., the number of 3 year-old adults returning 2.5 years later, etc.), and estimates of survival between the outmigrant lifestage and adult can be calculated. Since adult production estimates are not age-specific, estimates of the numbers in each cohort will need to be made based on the average proportion of the returning adults made up by each age-class. This analysis will allow assessment of whether changes in juvenile populations are reflected in adult production.

Alternatively, juvenile abundance and adult production data can be related by determining the number of adult spawners that produced a given year-class. This approach allows a more direct analysis of juvenile data. The relationship between juvenile and adult abundance in watersheds where data on both life-stages are collected is most appropriately expressed in terms of a stock-recruitment relationship. Stock-recruitment analysis is a common technique in fishery science that examines the relationship between the abundance of spawning adults and the abundance of a given lifestage ('recruits') produced by those spawning adults. The study of these relationships requires that data be collected on the abundance of each lifestage under consideration. For fall-run chinook salmon, watershed-specific stock-recruitment analyses are therefore limited to those watersheds where both juveniles and adults are monitored.

Many years of data are necessary to conduct a stock-recruitment analysis, and results, therefore, will not be available for some time. The results of these analyses will provide insight into the relative importance of freshwater and marine factors in controlling stocks, and will provide a useful method of relating changes in juvenile to adult abundance. Good reviews of the theory and techniques of stock-recruitment relationships may be found in Hilborn and Walters (1992), Ricker (1954, 1975), Beverton and Holt (1957), and Cushing (1988).

Consideration of Limiting Factors in Juvenile Outmigration Assessment

In the analysis of juvenile monitoring data, changes in all limiting factors identified in each watershed will be taken into account to explain changes in abundance. For example, if a fish ladder is installed at a water diversion and there is a subsequent decrease in juvenile abundance in the watershed, changes in other limiting factors identified for the stream will also be considered to account for the effects which may be unrelated to the restoration action. In particular, flow, water temperature, adult escapement, predation, and water quality in any particular year may have effects on juvenile abundance which will override the effects of other restoration actions. Through analysis of the effects of all limiting factors on juvenile abundance over time, the true effects of the restoration actions may be distinguished.

Evaluating the Relative Effectiveness of Action Categories

The within- and among-watershed evaluation techniques described previously will yield qualitative and quantitative evidence for the relative importance of the four categories of actions in affecting juvenile salmon abundance.

In this final analysis, it will be important to relate annual adult production estimates for each watershed as a relative weighting for the watershed-specific results. For example, it may be relatively unimportant to achieving system-wide production targets that structural modifications were associated with significant increases in juvenile abundance in small watersheds which are relatively minor contributors to overall salmon abundance. In addition, the estimated percentage contribution of the action to total juvenile abundance as determined by the CVPIA site-specific monitoring results can be averaged by action category. All results can be summed across watersheds to yield total number of actions implemented in each action category and the number of actions associated with a particular type of positive result. Table 3-2 shows how results will be summarized using hypothetical example results.

Table 3-2. Summary of Effects of Actions on Juvenile Salmon Abundance

Watershed	Action	Effects on Juvenile Abundance				
(Examples...)	(Examples...)	Adult Spawner: Juvenile Abundance	CVPIA Site-Specific Results: % of Total Abundance	Qualitative Analysis	Before/After	Trend Analysis
Upper Sacramento	Flow enhancement	750:150,000	50	Positive	Significant (P<.05)	Significant (P<.05)
	Spawning gravel additions	(once per stream)	2	Neutral	Not significant	Not significant
Clear Creek	(etc.)	#:#...etc.	?	(etc.)	(etc.)	(etc.)
(etc.)...						
SUMMARY Demonstrating Weight of Evidence (by action category)						
Water management	# of actions	Total #/# by actions	Average %for action category	# of positive trends /action	# of significant effects/action	# of significant trends /action
Structural	# of actions	Total #/# by actions	Average %for action category	# of positive trends /action	# of significant effects/action	# of significant trends /action
Habitat restoration	# of actions	Total #/# by actions	Average %for action category	# of positive trends /action	# of significant effects/action	# of significant trends /action
Fish screens	# of actions	Total #/# by actions	Average %for action category	# of positive trends /action	# of significant effects/action	# of significant trends /action

The bottom section of the table demonstrates the "weight of evidence" for action category effectiveness by providing a summary of the number of positive effects by action category. The categories of actions with a preponderance of positive effects or significant trends should be obviously different from categories with minimal, negative, or non-existent effects. However, the results should be viewed in terms of the relative importance to salmon abundance as a whole and to the adult spawner abundance results from individual watersheds. Individual watersheds and certain actions are likely to dominate the potential improvements to the fishery, and the actual numerical contribution from individual watersheds should be considered before drawing conclusions concerning the relative effectiveness of action categories.

The size-frequency distribution of emigrating juvenile fish can be summed across watersheds by action category both as the cumulative size-frequency distribution and as cumulative proportions of each subcategory of juvenile fish. This result is likely to indicate differences associated with categories of actions but it must be interpreted along with the conclusions derived from the analyses based on abundance. A shift in size-frequency of outmigrants does not necessarily indicate a positive or negative impact on the salmon population. However, it is assumed that older outmigrants experience a greater degree of effect associated with the natal stream and, therefore, increased age at outmigration could be viewed as a weak positive benefit to the population (assuming net positive effects of actions in the natal stream).

SECTION 4. DATA MANAGEMENT AND REPORTING

SECTION 4
DATA MANAGEMENT AND REPORTING

INTRODUCTION

Monitoring programs recommended in Section 2 are designed to collect the data needed to meet CAMP objectives (i.e., determine the overall and relative effectiveness of anadromous fish restoration actions). In general, the *overall* effectiveness of anadromous fish restoration actions will be determined by using *adult* monitoring data to estimate anadromous fish production throughout the Central Valley and on individual rivers. Similarly, the *relative* effectiveness of action categories will be determined by using *juvenile* monitoring data to estimate changes in juvenile abundance associated with action categories.

This section builds on the recommended monitoring programs described in Section 2 by detailing how the recommended monitoring data for adults and juveniles should be managed to meet CAMP objectives. Specifically, this section explains how the data management process should address the types of data needed for CAMP, data compilation and entry procedures, data availability and timing constraints, data processing calculations, data storage formats, and data accessibility to multiple data providers and users. The reader should note that the following discussion relies on a thorough understanding of Section 2. It should not be read in isolation from the remainder of the document.

DATA TYPES

Adult Data

As described in Section 2, the natural production of adult steelhead trout and each race of chinook salmon in a watershed should be calculated as the sum of the in-river run, and the portions of the downstream harvest and ocean harvest associated with the watershed (Figure 2-1). The data for each of these components are provided by a group of monitoring methods recommended for each species/race. Each monitoring method should provide a *single* annual estimate for entry into CAMP calculations (see Appendix A for calculations). For example, the adult fall-run chinook salmon monitoring program includes monitoring methods to obtain annual carcass counts, inland harvest estimates, and hatchery return counts of naturally produced fish for each watershed included in the CAMP study area. For fall-run chinook salmon on the American River, each year a *single* carcass count estimate should be provided to CAMP data managers for entry into CAMP calculations.

Similarly, the natural production of American shad, striped bass, white sturgeon and green sturgeon should be estimated from a *single* annual monitoring value. For American shad, monthly mid-water trawl survey data that are compiled by agency staff on an annual basis should be provided to the CAMP data managers as a *single* annual juvenile abundance index. This index should be used as the comparison value to the AFRP production target for American shad. For striped bass, mark-recapture data collected every two years and year-round angler survey data should form the basis of adult striped bass production estimates. Years with no mark-recapture data for striped bass should rely solely on angler survey data for estimating adult striped bass production. These angler survey data should be provided to CAMP data managers as a *single* annual value. For white sturgeon, mark-recapture data collected for two years consecutively followed by two years with no data collection should form the basis of white sturgeon production estimates. For years in which mark-recapture data are collected, the agency collecting the data should provide a *single* annual value to CAMP data managers for estimating production of white sturgeon. This production estimate for white sturgeon should then be used to estimate green sturgeon production as explained in Section 2.

Annual reports associated with each monitoring method (i.e., carcass counts, angler surveys, etc.) should include the *single* annual estimates needed for each CAMP calculation. Figure 4-1 shows the types of data that should be compiled and entered into CAMP calculations to estimate adult production for chinook salmon. Figure 4-2 shows the types of data that should be compiled and entered into CAMP calculations to estimate adult production for steelhead trout, striped bass, American shad, white sturgeon, and green sturgeon.

Juvenile Data

Monitoring data for juvenile chinook salmon should include daily screw trap estimates, flow data, and temperature data (Figure 4-3). Juvenile screw trap data should be compiled as daily data for each life-stage (i.e., fry, parr, smolt, and yearling). Although field crews collect screw trap data twice per day, a single daily value, representing an addition of the two daily values, should be provided to CAMP data managers. Daily screw trap estimates should be adjusted based on trap efficiency estimates by the appropriate monitoring program before these data are compiled for CAMP purposes.

DATA COMPILATION AND ENTRY

Adult Data

The Interagency Ecological Program (IEP) should coordinate the compilation of adult data from the various monitoring programs and should enter these data into CAMP calculations. As the CAMP data coordinator and manager, the IEP should contact appropriate agency staff associated with each monitoring program to obtain annual adult data and associated "meta-data". The "meta-data" should identify the data sources, describe each monitoring event, and contain the assumptions applied in the development of the summary estimates. Once compiled, the data should be entered into a set of worksheets for each species to provide watershed and system-wide

Figure 4-1. Compilation and Entry of Adult Chinook Salmon Data into the CAMP Database

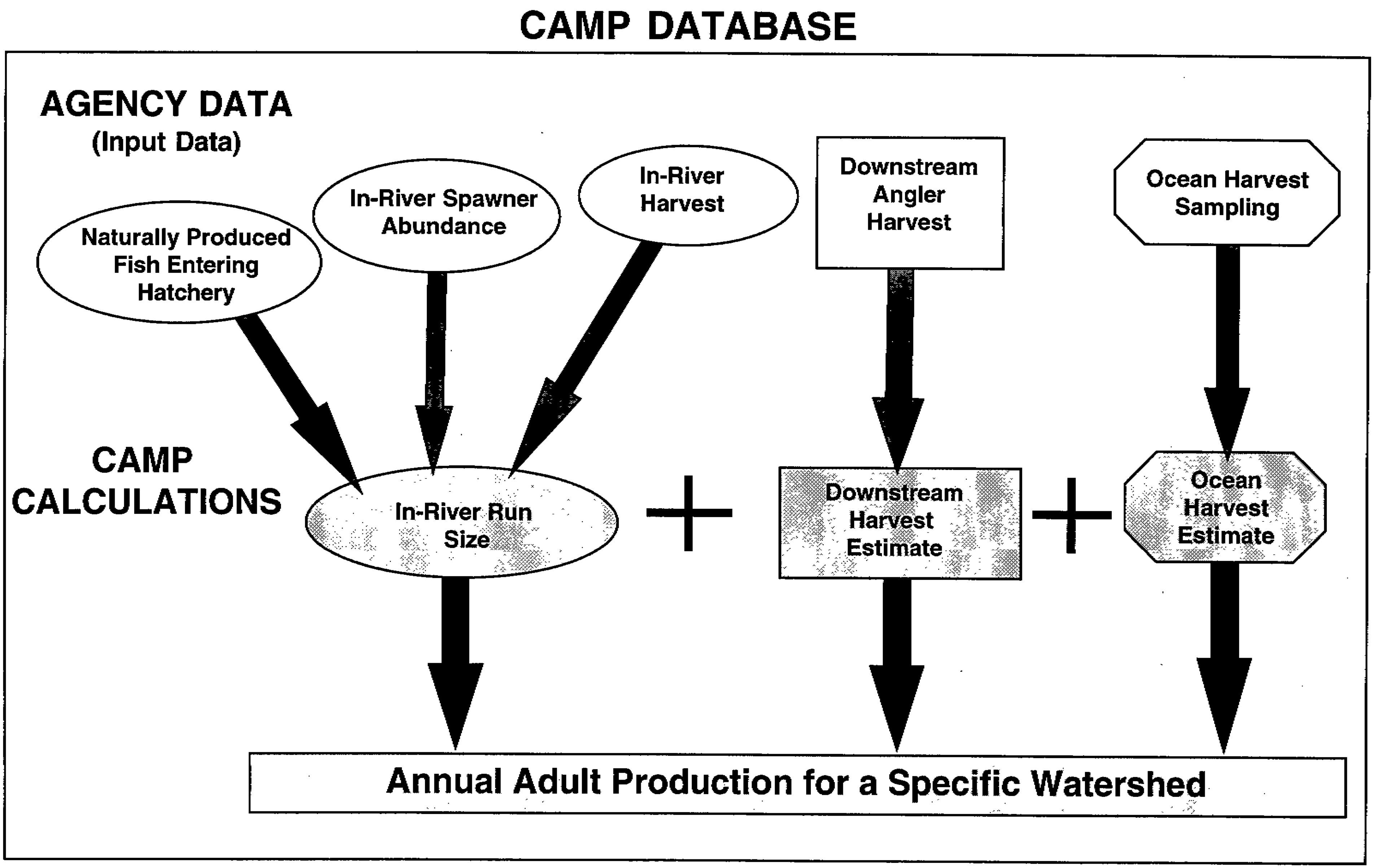


Figure 4-2. Compilation and Entry of Striped Bass, American Shad, White Sturgeon and Green Sturgeon Data into the CAMP Database

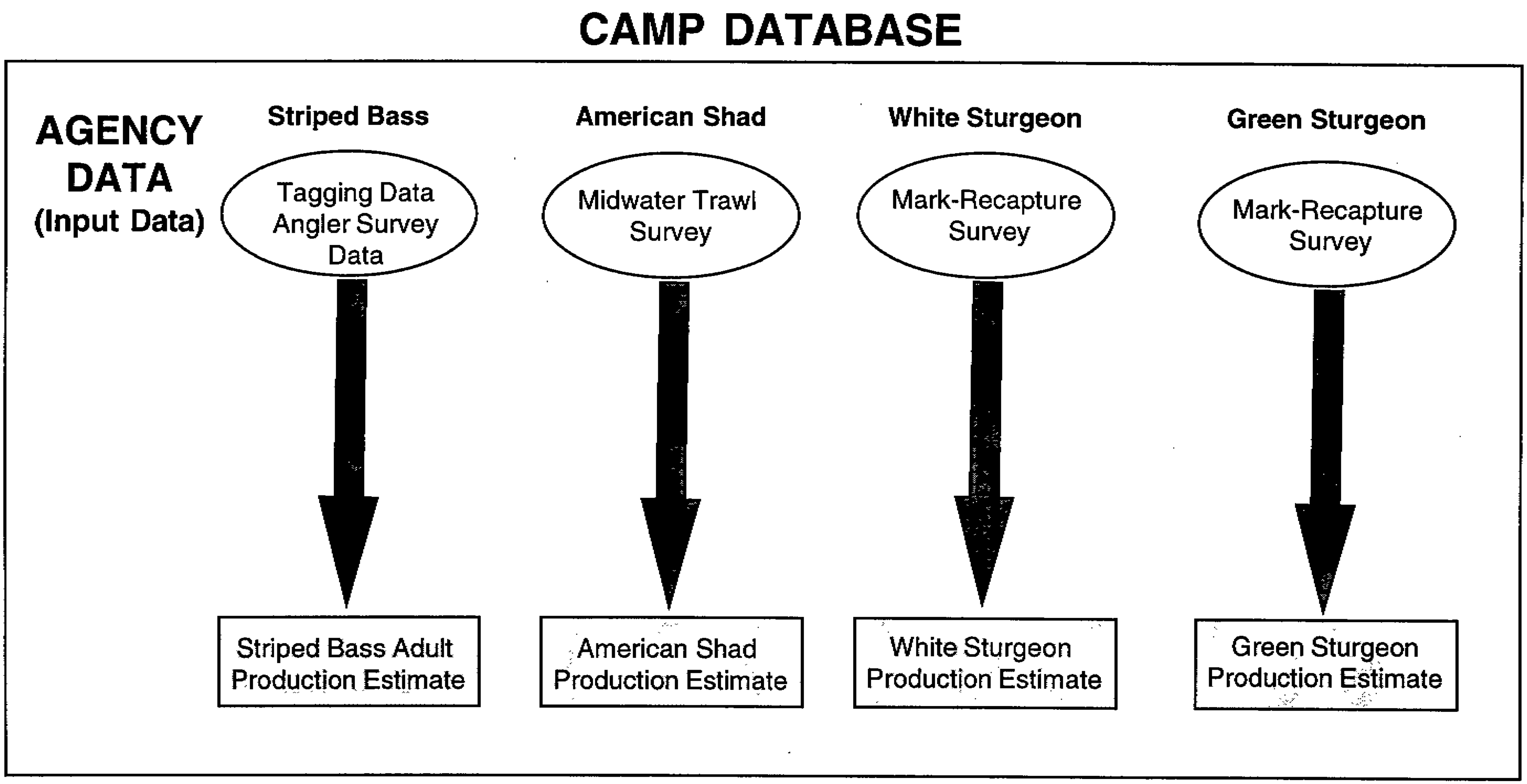
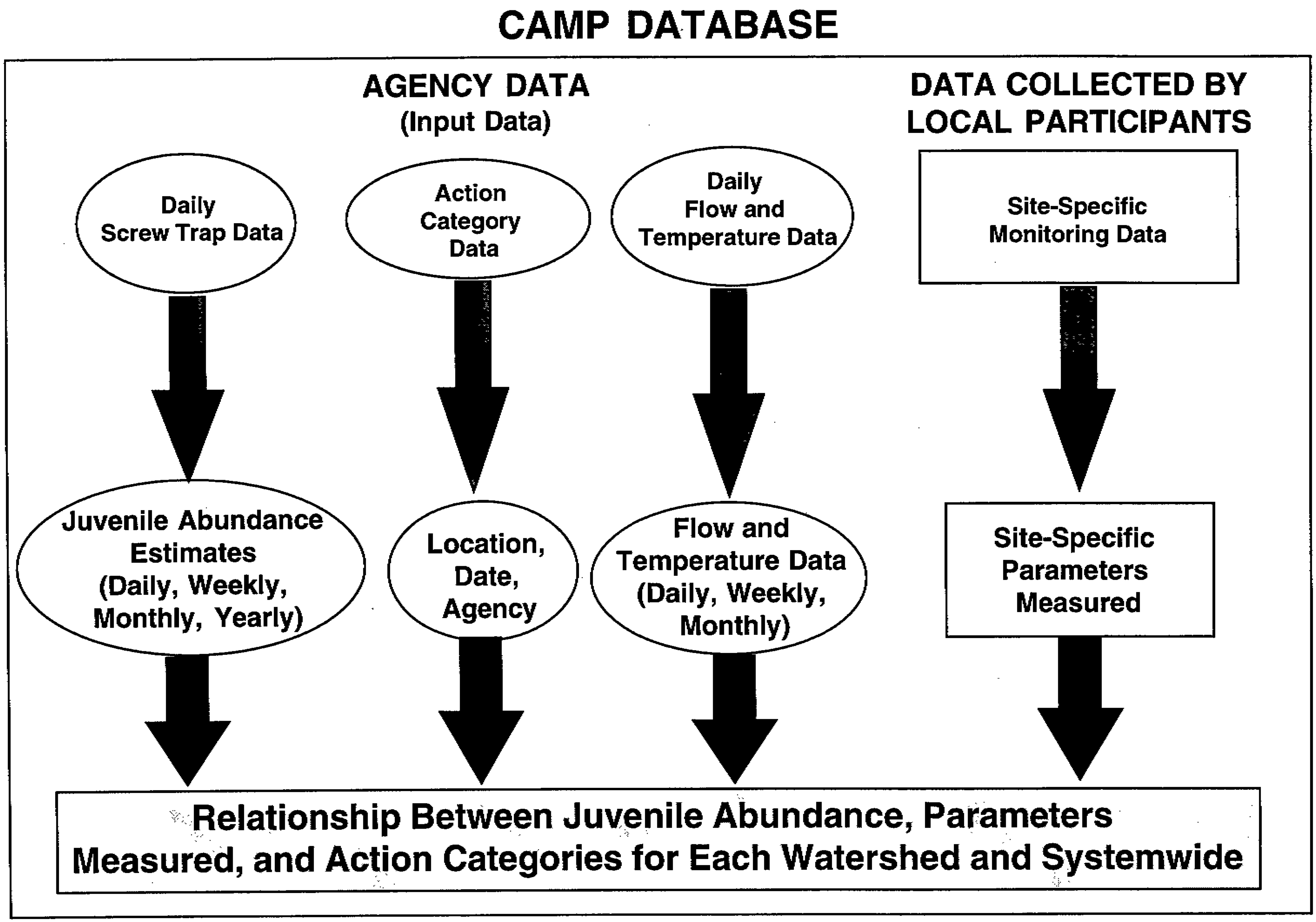


Figure 4-3 Compilation and Entry of Juvenile Salmonid Data into the CAMP Database



estimates of natural production for a particular spawning year. A detailed description of the calculation worksheets is provided in the Data Processing subsection that follows.

Juvenile Data

The IEP should also be responsible for coordinating the compilation and entry of data for juvenile chinook salmon. These data include daily screw trap estimates, flow, and temperature data from various agencies (see Tables 2-17, 18, 19). Because the CVPIA site-specific monitoring programs were not fully developed at the time of this report, details on the types of site-specific data and how that data should be integrated into the CAMP database should be addressed during implementation.

IEP Quality Assurance and Quality Control Guidelines

The IEP should be responsible for coordinating the compilation and entry of both adult and juvenile data for CAMP production estimates. A set of quality assurance and control (QA/QC) procedures should be followed to ensure that field data are recorded accurately, and data for CAMP calculations are formatted accurately. For field data, CAMP data managers should not be responsible for overseeing or auditing data collection and analysis techniques of individual monitoring programs; however, a summary of quality control procedures should be included by each monitoring program in its annual report. IEP staff should review these procedures and provide a summary of the quality control process in the "meta-data" associated with each entered value. The data used for CAMP calculations should be subject to IEP quality assurance and control guidelines to assure that compiled data are accurately entered into CAMP calculations. The IEP quality assurance and quality control guidelines are designed to minimize the possibility of compromising the integrity of data during the reformatting process.

Specific procedures are followed by the IEP staff when data are converted into the IEP specified ASCII data file format (see Appendix E for data file specifications). These same procedures should be used when reformatting CAMP data. In general, reformatted data are placed on the IEP file server and made available to the public after review and approval by the individual(s) responsible for the data collection. Changes to data on the IEP file server are not allowed without the consent of the individual(s) who collect the data. Updates to data follow these same procedures. Following are the steps that the IEP follows when it reformats data for entry into the IEP database.

1. Create working copies of the computer generated data file(s) obtained by the data collector and retain the original file(s) in a secure area. If data are on hard-copy, key-enter the the data twice, compare it to the original and correct discrepancies. Load the data into the appropriate computer software program.

2. Rearrange the data as specified by the IEP, using the software program native to the data file(s), or if not available, another appropriate computer software program. Once rearranged,

export the data into ASCII comma separated file(s). If the computer software program cannot export data into the this format, export the data into an ASCII format (i.e., tab delimited, space delimited, etc).

3. If the resulting exported ASCII data file(s) are not in the specified IEP format, use an ASCII text editor (i.e., Norton Editor, AWK, DOS Editor, etc.) and reformat the data file(s) into the IEP specified format.

4. Upon completion of data reformatting, visually inspect the reformatted data file(s) for abnormalities. Verify the total number of records and total number of columns for each reformatted data file(s) against the original data file(s). Verify the first and last five records of each reformatted data file(s) against the original data file(s). Randomly verify 20 records within each reformatted data file(s) against the original data file(s).

5. Import the reformatted data file(s) and the working copy of the original data file(s) into a computer spreadsheet program. Using the columnar summation function, generate a total for a few columns of numeric data and compare the results to that of the original data file(s). If the original data file is a database file, use the columnar summation function to generate a total for a few sets of numeric data records.

6. Place the reformatted and verified data file(s), maps, meta-data, and cross-reference files on the IEP file server, in an area not accessible to the public. Provide web access to the data collector to review the data before public release.

7. Once approved, make the data available to the public in the appropriate section on the IEP file server.

DATA AVAILABILITY AND TIMING CONSTRAINTS

Adult Data

The availability of adult monitoring data for entry into CAMP calculations will be constrained by the migration/spawning period of each fish species/race. The biological timing of in-river migration, spawning, and ocean migration for each anadromous fish species/race is slightly different (Figure 4-4). Some races of chinook salmon, such as late fall-, winter-, and spring-run, spawn during the calendar year following ocean harvest and instream migration. As a result, the data needed for each component of the adult production estimate for chinook salmon should be obtained from monitoring reports for the applicable calendar year. For example, in 1998 late fall-run chinook salmon that spawn during January and February would have been in the ocean from March 1997 to September 1997, and would have migrated upstream from October 1997 to January 1998. Therefore, the 1998 production estimate for late fall-run chinook salmon requires spawning data from 1998, instream harvest data from 1997, and ocean harvest data from 1997 (Figure 4-4).

Figure 4-4. Data Collection and Reporting Relative to the Spawning Year of Each Chinook Salmon Race

Calendar Year

	1997												1998												1999											
Race	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fall																																				
Ocean	▲	▲	▲	▲	▲	▲							■	■	■	■	■	■							◆	◆	◆	◆	◆	◆						
In-River							▲	▲	▲	▲	▲	▲							■	■	■	■	■	■							◆	◆	◆	◆	◆	◆
Spawning										▲	▲	▲										■	■	■										◆	◆	◆
Data Available															▲												■									
Late Fall																																				
Ocean			■	■	■	■	■	■	■						◆	◆	◆	◆	◆	◆	◆						★	★	★	★	★	★	★			
In-River										■	■	■	■									◆	◆	◆	◆									★	★	★
Spawning													■	■	■	■									◆	◆	◆									
Data Available																	■											◆								
Winter																																				
Ocean								■	■	■	■	■								◆	◆	◆	◆	◆								★	★	★	★	★
Spawning																■	■	■	■									◆	◆	◆	◆					
Data Available																				■												◆				
Spring																																				
Ocean	▲	▲	▲								■	■	■	■	■								◆	◆	◆	◆	◆								★	★
In-River				▲	▲	▲	▲	▲	▲							■	■	■	■	■	■							◆	◆	◆	◆	◆	◆			
Spawning									▲	▲											■	■											◆	◆		
Data Available															▲												■									

LEGEND:

- ▲ Spawning Year 1997
- ■ Spawning Year 1998
- ◆ Spawning Year 1999
- ★ Spawning Year 2000

First Report Generation Under CAMP for all Races of Chinook Salmon - March-April 1999

Fall - Generated March 99 representing Spawning Year 98

Late Fall - Generated May 98 representing Spawning Year 98

Winter - Generated August 98 representing Spawning Year 98

Spring - Generated March 99 representing Spawning Year 98

TABDYR2.XLS
4/24/97

The availability of adult monitoring data for entry into CAMP calculations will also be constrained by the data reporting schedules of each monitoring program. Figure 4-4 shows how the data reporting schedules of each monitoring program for chinook salmon are related to the biological timing of in-river migration, spawning, and ocean migration of adult chinook salmon. Because CAMP calculations rely on a single data value for each monitoring period (e.g, a single carcass count value), the data collected during a given time period should be summarized and provided to CAMP as soon as possible following the conclusion of monitoring.

Data reporting schedules of agencies and the spawning/migration periods of each fish species and race will also influence the timing of CAMP reports. As shown in Figure 4-1, the observations associated with the 1998 spawning year for fall-run chinook salmon should include ocean harvest data from March 1997 through September 1997, and should continue through December 1998, when the in-river harvest count (generally from angler surveys) and the spawner abundance estimates (from carcass and hatchery surveys) should be completed. Therefore, the overall time frame to collect data for a single spawning year spans 22 months for chinook salmon. This lengthy time period is partially due to the fact that the total ocean harvest estimates for salmon do not differentiate the several chinook salmon races. Before an annual production estimate for each species/race on each watershed can be calculated, the ocean harvest associated with each species on each watershed should be derived from this total ocean harvest estimate and attributed to the appropriate spawning year of each race. It should be noted that if the monitoring programs are initiated in January 1997, only partial data for fall-run and spring-run chinook salmon will be available to estimate the 1997 spawning year production.

Agency reporting schedules and collection periods for steelhead trout, striped bass, American shad , and white sturgeon are shown in Figure 4-5. The collection periods and reporting schedules for each of these species are simpler than for chinook salmon because fewer monitoring methods are involved and because of the different spawning and migration periods of each chinook salmon race. The data collection and reporting schedules for each species differ and will require coordination among data collectors and CAMP data managers throughout the year to ensure that data needed for CAMP estimates are available for entry into CAMP calculations.

Juvenile Data

Similar to adult data, the availability of juvenile data to CAMP data managers will be constrained by the outmigration period of fall-, spring-, and winter-run chinook salmon on various rivers and reporting schedules of agencies. In general, outmigrant juvenile salmon monitoring should take place in the winter and spring. Daily screw trap data and trap efficiency results should be provided to CAMP data managers at the end of the outmigration period. The availability of related juvenile monitoring data should vary based upon the types of parameters being monitored and the monitoring agency's reporting schedule. For example, temperature and flow data should be summarized over the juvenile rearing period for each chinook salmon race, in general, for the period just prior to and encompassing the outmigration period. In comparison to adult monitoring data, juvenile monitoring data should be analysed quantitatively and

Figure 4-5. Collection and Availability of Data for Steelhead Trout, Striped Bass, American Shad, and White Sturgeon

Species	Monitoring Method	Collection Period	Month Data Available
Steelhead	Hatchery Counts Angler Survey	July - March July - March	April April
Striped Bass	Angler Survey Tagging	March - June Year-round	July December
American Shad	Midwater Trawl Survey	Sept. - Dec.	January (following year)
White Sturgeon	Mark-recapture	Sept.- Nov.	December

qualitatively. This analysis will increase the amount of time needed to develop regular CAMP reports on the results of the comparison of juvenile to adult data.

DATA PROCESSING

Adult and juvenile monitoring data should be processed through a series of steps to achieve CAMP objectives. To calculate annual natural production estimates for adult chinook salmon, adult data should be entered into species- and watershed-specific calculations. Adult production estimates for striped bass, American shad, white sturgeon, and green sturgeon should be provided directly to CAMP data managers by the agency collecting the data. Section 2 details the recommended monitoring program for each target species/race and Appendix A contains the accompanying calculations for adult chinook salmon and steelhead trout. To estimate juvenile production on each watershed, daily juvenile monitoring data should be entered into a series of data tables. These tables should provide information on daily, weekly, monthly, and yearly juvenile abundance estimates. Similarly, flow and temperature data should be processed to provide daily, average weekly, monthly, and yearly values. Following is a description of the data relationships and processing software that should be used to integrate data from multiple monitoring programs to meet CAMP objectives.

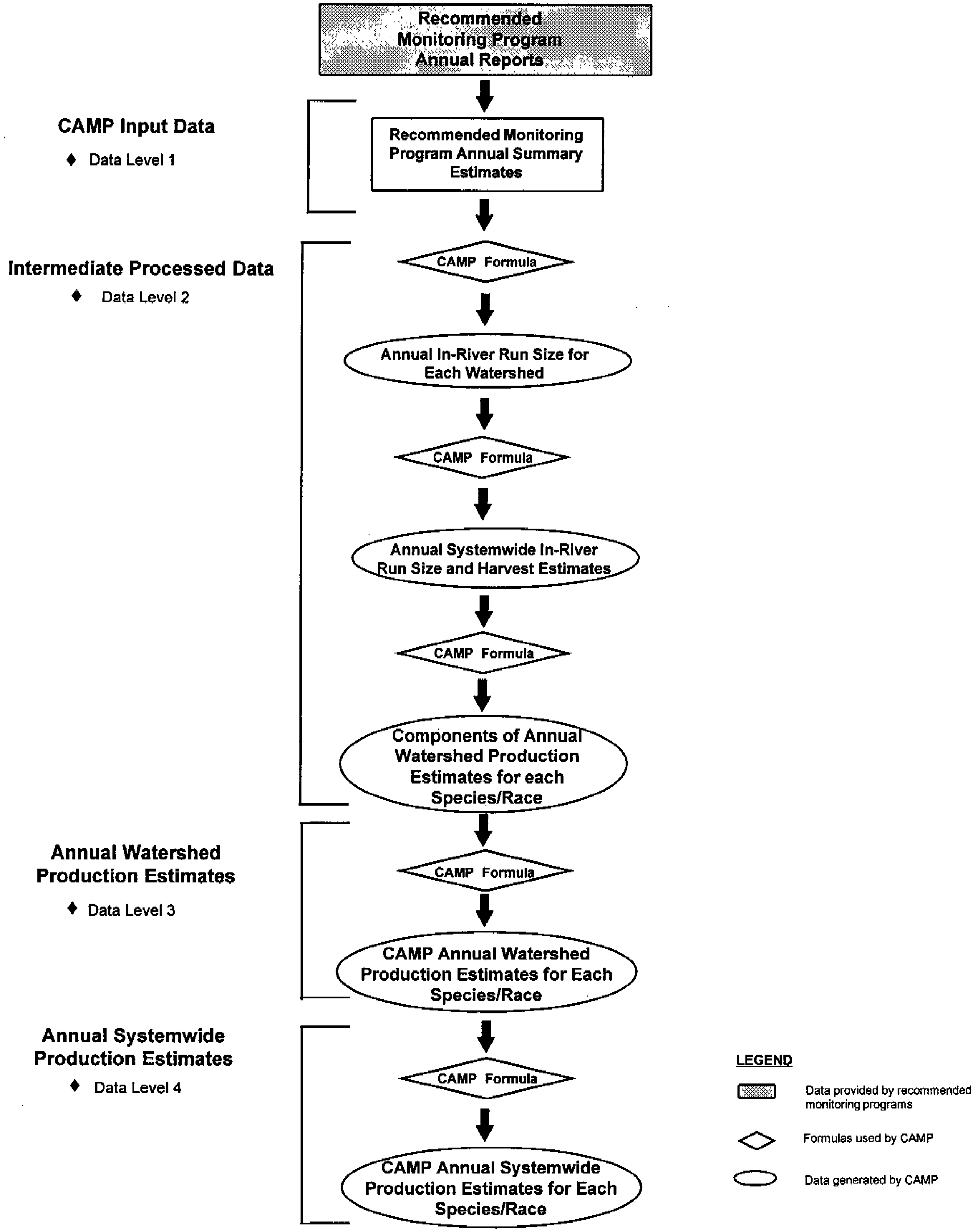
Adult Data

Data for adult chinook salmon should be processed through a series of calculations that are programmed into the database to estimate annual adult production (Figure 4-6). The relationship between the data that should be input into CAMP calculations and the resulting CAMP output data for chinook salmon and steelhead trout is shown in Figure 4-6. Following is a detailed description of the flow of data from individual monitoring programs through CAMP formulas to generate annual adult production estimates for chinook salmon.

Individual monitoring programs should calculate annual data and provide these data to CAMP data managers as "raw" input data. These data should consist of a single annual summary value for each monitoring method (e.g., a single value for each carcass survey, hatchery count, in-river harvest survey, and ocean harvest sampling). These data should be obtained from monitoring programs and entered as the first level of data. The first data level should include monitoring data for natural spawner abundance, naturally produced fish entering a hatchery (if applicable), inland harvest of natural fish in a watershed, and the total ocean harvest. Data for some of the calculations may not be available in some instances. Assumptions should be developed to fill these data gaps.

Following entry of data into the first data level, the "raw" input data should be automatically entered into a series of worksheets. These worksheets should calculate a set of intermediate values, as well as watershed-specific and system-wide production values for each species and race. The intermediate values generated by these worksheets comprise the second

Figure 4-6. Data Flow Schematic for Annual CAMP Natural Production Estimates for Chinook Salmon and Steelhead Trout



data level. This data level consists of four types of intermediate data for each race of chinook salmon:

- In-river run estimates for each watershed
- System-wide in-river run size and in-river harvest estimate
- Downstream harvest estimates for each watershed
- The portion of the ocean harvest allocated to each race in each watershed.

The equations used to calculate these values for each race of chinook salmon on each watershed are provided in Appendix A.

The third data level consists of annual estimates of natural adult production for each race in each watershed. These estimates are calculated through addition of the in-river run, the portion of the downstream harvest associated with each watershed, and the portion of the ocean harvest associated with each watershed. The estimates generated by the third data level should be used to assess the *overall* effectiveness of anadromous fish restoration actions by providing a watershed-specific adult production estimate for comparison with AFRP watershed-specific adult production targets.

The fourth data level consists of a system-wide production estimate for each race. These values are calculated through addition of all watershed production estimates for a particular race. Similar to the estimates in the third data level, the estimates generated by the fourth data level should be used to assess the *overall* effectiveness of anadromous fish restoration actions by providing system-wide adult production estimates for each chinook salmon race for comparison with AFRP system-wide production targets. Together, the system-wide production estimates in data level four and the watershed-specific production estimates in data level three should allow an analysis of the relative contribution of each watershed to the system-wide adult production of each race.

Entry, calculation, and storage of data on adult production should be accomplished through a customized worksheet process using compatible spreadsheet software. A set of linked spreadsheets should be developed, one for each watershed, that would provide complete summaries of all necessary data to review each watershed production estimate. The spreadsheet for each watershed should include locations for data entry (level one data), display of intermediate calculations (level two data), and watershed-specific calculations of production (level three data). An example of an interface for a watershed is shown in Figure 4-7. In addition to a set of sheets for each watershed, a summary sheet would be necessary to calculate and display system-wide estimates of production (data level four). An example of a system-wide calculation spreadsheet is shown in Figure 4-8.

The data for striped bass, American shad, white sturgeon and green sturgeon should not require processing through a series of formulas. Annual production estimates for these species should be provided to CAMP data managers by the agencies that collect the data on each species.

Figure 4-7. Data Sheet Showing Input Data and Calculations for Fall-Run Chinook Salmon on the American River

SPECIES/RACE: Fall-Run Chinook Salmon

WATERSHED: American River

SPAWNING YEAR:

INPUT DATA:

Data Collection Year	Monitoring Method	Value	Variable	Source of Data
	Carcass Survey		$E_{C,F,N,AM}$	
	Hatchery Count		$E_{H,F,N,AM}$	
	Instream Angler Harvest		$H_{A,F,N,AM,I}$	

CALCULATED INTERMEDIATE VALUES:

Data Type	Calculated Value	Variable	Formula
In-River Run		$I_{F,N,AM}$	$E_{C,F,N,AM} + E_{H,F,N,AM} + H_{A,F,N,AM,I}$
Downstream Angler Harvest		$H_{A,F,N,AM,D}$	$(H_{A,\alpha,N,\beta,D})(I_{F,N,AM}/I_{\alpha,N,\beta})$
Ocean Harvest		$H_{O,F,N,AM}$	$(H_{O,\alpha,N,\beta})(I_{F,N,AM} / I_{\alpha,N,\beta})$
TOTAL WATERSHED PRODUCTION ESTIMATE		$P_{F,AM}$	$I_{F,N,AM} + H_{A,F,N,AM,D} + H_{O,F,N,AM}$

ANNUAL CALCULATIONS USED FOR ALL SPECIES AND WATERSHED PRODUCTION ESTIMATES:

Data Type	Calculated Value	Variable	Formula
Systemwide In-River Run		$I_{\alpha,N,\beta}$	$I_{F,N,AM} + I_{F,N,BA} + I_{LF,N,BA} + I_{F,N,BU} + I_{S,N,BU} + I_{F,N,DE} + I_{S,N,DE} + I_{F,N,FE} + I_{F,N,ME} + I_{F,N,MI} + I_{S,N,MI} + I_{F,N,MO} + I_{F,N,SA} + I_{LF,N,SA} + I_{W,N,SA} + I_{S,N,SA} + I_{F,N,ST} + I_{F,N,TU} + I_{F,N,YU}$
Systemwide Downstream Angler Harvest		$H_{A,\alpha,N,\beta,D}$	$H_{A,\alpha,N,\beta} - (H_{A,F,N,AM,I} + H_{A,F,N,FE,I} + H_{A,F,N,SA,I} + H_{A,LF,SA,I} + H_{A,S,SA,I} + H_{A,F,N,ST,I} + H_{A,F,N,YU,I})$
Systemwide Angler Harvest		$H_{A,\alpha,N,\beta}$	$(H_{A,\alpha,T,\beta})(1-h_{A,\alpha,\beta})$

KEY:

Variables	Subscripts: Monitoring Methods	Species	Watersheds	
E = Escapement	C = Carcass Survey	F = Fall-run Chinook	AM = American River	MO = Mokelumne River
H = Harvest	H = Hatchery Count	LF = Late fall-run Chinook	BA = Battle Creek	SA = Sacramento River
I = In-River Run	A = Angler Survey	W = Winter -run Chinook	BU = Butte Creek	ST = Stanislaus River
h = fish of hatchery origin	I = Instream	S = Spring -run Chinook	DE = Deer Creek	TU = Tuolumne River
	D = Downstream	α = all chinook salmon races	FE = Feather River	YU = Yuba River
	R = Aerial Redd Count	N = fish of natural origin	ME = Merced River	β = all CAMP target watersheds
	O = Ocean Harvest	T = Natural + Hatchery fish	MI = Mill Creek	
	g = all monitoring methods			

Shaded boxes represent data to be entered from annual reports.

Figure 4-8. Input Data Values and Production Estimates for a Single Watershed Per Spawning Year

Data Type	Value	Source of Data
Carcass Survey		Program Name
Hatchery Returns		Program Name
Instream Angler Harvest		Program Name
Downstream Angler Harvest		Calculated for All CAMP Angler Harvests
Ocean Harvest		Calculated base upon PSMFC Estimate
Watershed Production Estimate		See Implementation Plan for Formula

Therefore, the data for these species should consist of a single annual production number that is stored in the CAMP database, along with any descriptive meta-data.

Juvenile Data

The complexity of monitoring data needed to determine the *relative* effectiveness of restoration actions will require an intricate processing system to relate the juvenile monitoring data to flow, temperature, and other data. To establish links between juvenile fish data from screw traps, temperature, flow and other data, a relational database system is recommended. These data links should allow a complete analysis of factors affecting juvenile abundance. The relationships between different types of data should be normalized to ensure easy access to specific types of data and to limit the size of the electronic files.

Currently, the IEP manages several different types of data, including: physical-chemical data (water quality, hydrodynamics, meteorological, etc.), biological data, and modeling data. IEP's data management system provides the IEP staff with the ability to relate and query data from all these different data sets simultaneously. The IEP is considering the use of a relational database management system to relate the information contained in its diverse data sets. Following is a series of data tables illustrating the process that should be used to establish data links and relationships between flow, temperature, and screw trap data for CAMP. This format can be easily merged into the IEP Database. The * denotes data fields linked between tables. Field size refers to the maximum number of characters allowable for a given entry.

Juvenile Outmigrant Data

Catch Table

This table should contain data on fish sampled by screw traps.

Field Name	Data Type	Field Size	Comments
*StationID	Number	8	Same as Watershed Station ID
*Date	Date/Time	8	
*OrganismCode	Text	10	Same as Species ID
*GearCode	Text	9	Same as Monitoring Method ID
LengthFreq	Number	8	
Count	Number	8	Same as Raw Number

Organism Table

This table should contain data about each captured fish such as the species, subspecies, etc.

Field Name	Data Type	Field Size	Comments
*OrganismCode	Text	8	Same as Species ID
Genus	Text	30	Genus
Species	Text	30	Species
SubSpecies	Text	30	Sub-Species
CommonName	Text	50	Same as Species Name
Comment	Text	50	

Station Table

This table should contain data on the exact location associated with the sampling station. In the future, this information could be readily input into a geographic information system (GIS) to show spatial relationships between data.

Field Name	Data Type	Field Size	Comments
*StationID	Number	8	Same as Watershed Station ID
Comment	Text	50	Location, Agency Responsible
LatD	Number	8	Latitude Degrees
LatM	Number	8	Latitude Minutes
LatS	Number	8	Latitude Seconds
LongD	Number	8	Longitude Degrees
LongM	Number	8	Longitude Minutes
LongS	Number	8	Longitude Seconds

Physical Data

Flow and Temperature Table

This table should contain the physical data (e.g., hydrology, temperature, etc.).

Field Name	Data Type	Field Size	Comments
*AgencyCode	Text	10	Same as Data Source for Flow and *Temp
* StationID	Number	10	Same as Watershed Station ID
*Date	Date/Time	8	
Flow	Number	10	
Temperature	Number	10	
SourceID	Number	8	Same as Data Source ID

Meta-Data

Meta File

Unlike the data above, data for this file should be stored in an ASCII file format, not a table. The Source ID refers to the name of the ASCII file that contains the corresponding data. In this way, the meta files provide links to the files that they describe.

Microsoft Access has the capability and the robustness that a database of this size will need and has an interactive graphical user interface. Data can be imported into the database tables described above from a variety of formats (e.g., Microsoft Excel, Lotus 123, other MS Access tables, text files, etc.) as should be available from individual agency files. The data can be browsed through the use of "Forms". The ability to edit data should be limited to the CAMP data managers. A database can be queried for any pertinent data and the reports generated along with any charts through the use of "Queries" and "Reports".

DATA STORAGE

Adult Data

All four data levels mentioned in the Data Processing discussion should be stored in the CAMP database. As a result, the "raw" input data and all subsequent calculations used to generate annual production estimates should be stored in a central location. Once the annual production estimates are calculated for each species/race for each watershed, the results should be stored in a standard format. It is recommended that data be stored initially in "flat" ASCII files, using a data storage protocol developed and currently implemented by the IEP. This protocol specifies comma-delimited data, using double quotations for character values. The protocol also describes the relationship between data files, and supporting metadata files including data descriptions, relationships to other data, and data sources. As mentioned earlier, it is possible that the IEP will convert their flat file structure to a relational database structure at some future time. At that time, the CAMP data could also be converted to a relational database format.

Initially, four types of data file formats are recommended. These four data files should be organized based upon watershed-specific and system-wide production estimates. Following are the four data file formats:

- Species/race production estimates for each year on a watershed basis
- Species/race production estimates for all years on a watershed basis
- Species/race production estimates for each year on all watersheds (system-wide)
- Species/race production estimates for all years on all watersheds (system-wide)

Exceptions to this data file format are associated with the irregular monitoring of striped bass and white sturgeon. Therefore, data for striped bass, white sturgeon, and green sturgeon will not be available for each year in this format.

<u>Species/Race Production Estimates for Each Year -- Watershed-Specific</u>

The annual watershed production files for each species/race should include watershed-production data for a single spawning year. Each file should contain the "raw" input data from each watershed, relevant calculated values, such as downstream and ocean harvests, and the annual natural production estimate for the species/race. An example of the contents of this type of data file is shown in Figure 4-8.

<u>Species/Race Production Estimates for All Years -- Watershed-Specific</u>

Time-series watershed production files for each species/race should include watershed production estimates for all years included in the monitoring program. These files should include a single entry for each year's production estimate. These data files should allow users to view trends over time in adult production for each species on each watershed.

Species/Race Production Estimates for Each Year --System-Wide

The annual system-wide production files for each species/race should include all watershed production estimates for a single year. These values should be added to calculate the system-wide production estimate for each year, which should also be stored in the file. The watershed production estimates that should be used in these files to calculate system-wide production estimates should be obtained from the set of watershed production files for each species/race for the year, described above. An example of the type of data to be stored in these files is shown in Figure 4-9.

Species/Race Production Estimates for All Years --System-Wide

The time-series system-wide production files for each species/race should include annual production estimates for all years and all watersheds. The data for each year should include the system-wide production estimates for each year discussed above.

Juvenile Data

The daily juvenile catch numbers, trap efficiencies, and temperature and flow data should be stored in a standard format. The data should be stored as "flat" ASCII files using the existing IEP storage protocol for data and "meta-data." It is also possible that the information could be stored as Microsoft ACCESS files (or other format) as part of a long-term database of both juvenile and adult monitoring data. Both annual and time-series summaries of all data should be stored in these formats.

Juvenile fish data should be stored as daily catch records of individual fish categorized by race, length, and juvenile stage (fry, parr, smolt, or yearling) and should be organized hierarchically by year, species, and watershed. Accompanying flow and temperature data should consist of daily records of average water temperature and flow from the appropriate gauging station chosen as representative for each trap location. Data should be extracted from the database in summaries appropriate to the types of analyses described in Section 3. These types of analyses may require daily, weekly, monthly and/or yearly summaries of juvenile fish data, flow data and temperature data.

DATA ACCESSIBILITY

The data compiled and entered into the CAMP database should be made available to a wide array of users through the use of an Internet home-page interface. In addition to data access, the home-page should serve as a mechanism to access a variety of information related to the overall CAMP process. It is recommended that the home-page include program descriptive information so that visitors will be able to obtain information on all aspects of CAMP. The following discussion describes the types of information that should be provided through the CAMP home-page interface.

Figure 4-9. Data Sheet for Fall-Run Chinook Salmon Systemwide Production

Spawning Year:

Watershed	Calculated Value	Variable	Formula
American River		$P_{F,N,AM}$	$I_{F,N,AM} + H_{A,F,N,AM,D} + H_{O,F,N,AM}$
Battle Creek		$P_{F,N,BA}$	$I_{F,N,BA} + H_{A,F,N,BA,D} + H_{O,F,N,BA}$
Butte Creek		$P_{F,N,BU}$	$I_{F,N,BU} + H_{A,F,N,BU,D} + H_{O,F,N,BU}$
Deer Creek		$P_{F,N,DE}$	$I_{F,N,DE} + H_{A,F,N,DE,D} + H_{O,F,N,DE}$
Feather River		$P_{F,N,FE}$	$I_{F,N,FE} + H_{A,F,N,FE,D} + H_{O,F,N,FE}$
Merced River		$P_{F,N,ME}$	$I_{F,N,ME} + H_{A,F,N,ME,D} + H_{O,F,N,ME}$
Mill Creek		$P_{F,N,MI}$	$I_{F,N,MI} + H_{A,F,N,MI,D} + H_{O,F,N,MI}$
Mokelumne River		$P_{F,N,MO}$	$I_{F,N,MO} + H_{A,F,N,MO,D} + H_{O,F,N,MO}$
Sacramento River		$P_{F,N,SA}$	$I_{F,N,SA} + H_{A,F,N,SA,D} + H_{O,F,N,SA}$
Stanislaus River		$P_{F,N,ST}$	$I_{F,N,ST} + H_{A,F,N,ST,D} + H_{O,F,N,ST}$
Tuolumne River		$P_{F,N,TU}$	$I_{F,N,TU} + H_{A,F,N,TU,D} + H_{O,F,N,TU}$
Yuba River		$P_{F,N,YU}$	$I_{F,N,YU} + H_{A,F,N,YU,D} + H_{O,F,N,YU}$
Systemwide Fall-Run Chinook Salmon Production		$P_{F,N,\beta}$	$P_{F,N,AM} + P_{F,N,BA} + P_{F,N,BU} + P_{F,N,DE} + P_{F,N,FE} + P_{F,N,ME} + P_{F,N,MI} + P_{F,N,MO} + P_{F,N,SA} + P_{F,N,ST} + P_{F,N,TU} + P_{F,N,YU}$

KEY:

Variables	Subscripts			
	Monitoring Methods	**Species**	**Watersheds**	
E = Escapement	C = Carcass Survey	F = Fall-run Chinook	AM = American River	MO = Mokelumne River
H = Harvest	H = Hatchery Count	LF = Late fall-run Chinook	BA = Battle Creek	SA = Sacramento River
I = In-River Run	A = Angler Survey	W = Winter -run Chinook	BU = Butte Creek	ST = Stanislaus River
h = fish of hatchery origin	I = Instream	S = Spring -run Chinook	DE = Deer Creek	TU = Tuolumne River
P = Production	D = Downstream	α = all chinook salmon races	FE = Feather River	YU = Yuba River
	R = Aerial Redd Count	N = fish of natural origin	ME = Merced River	β = all CAMP target watersheds
	O = Ocean Harvest	T = Natural + Hatchery fish	MI = Mill Creek	
	γ = all monitoring methods			

Home-Page

The main CAMP home-page should provide an overview of all of the types of activities associated with CAMP. It should provide linkages to CAMP data, and linkages to other related programs, such as AFRP, CVPIA, USBR, USFWS, and the IEP home-pages. The main home-page should include bullet listings of a variety of categories, such as background on CAMP, a summary of monitoring programs that provide data to CAMP, a status report of activities completed to date, a summary of the calculations used to obtain annual production estimates, and a gateway to CAMP data. Each of the bullets should lead the user to one or more pages, to provide as much detail regarding a specific topic as desired. The names of person(s) responsible for maintaining the database should also be provided so that questions may be directed to him/her.

The IEP has developed a series of home-pages to provide summary information and data access to users. It is recommended that IEP develop the CAMP home-page, and load the data to the IEP network. This process should enable IEP to utilize a set of interface tools that were developed for similar home-pages, and minimize the level of effort necessary to develop the CAMP home-page.

Data Access Pages

One of the main objectives of the home-page is to provide access to the data in the CAMP database. The data access portion of the home-page should be designed to allow the user to specify the type of data desired. This system should allow the user to specify the species/race, watershed, and year for which data are desired.

A flow chart, showing the type of selection criteria that should be available to the user accessing adult production data, is shown in Figure 4-10. The flow chart illustrates how a user should be able to select watershed-specific adult data for a single year or series of years. The interface should also provide the option to select system-wide production estimates for each species for a given year or a series of years. Figure 4-11 shows the accessibility of juvenile outmigrant data, flow data, and temperature data. The flow chart shows how a user should be able to select the watershed-specific data for a series of years, months, weeks, and/or days. This accessibility should allow a comprehensive analysis of the data at several different temporal and spatial scales.

Figure 4-10. Accessibility of Adult Production Data through the CAMP Home-page

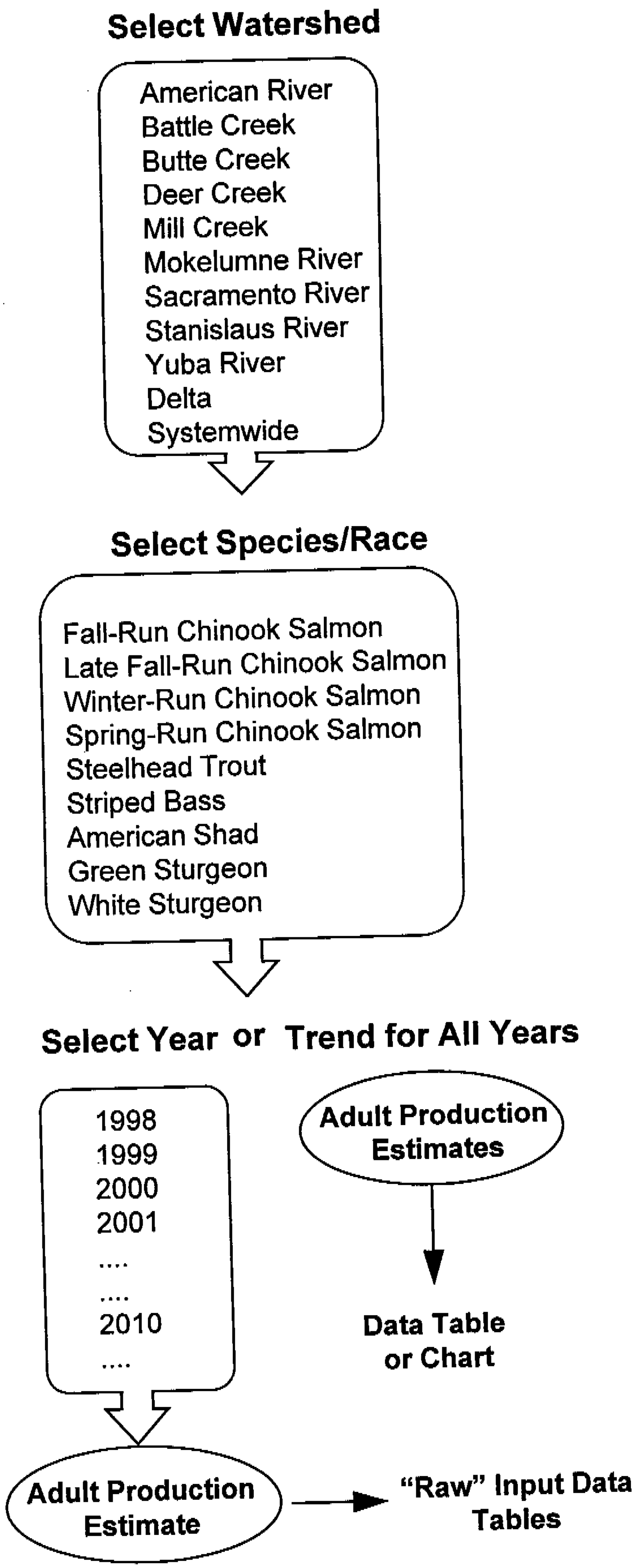
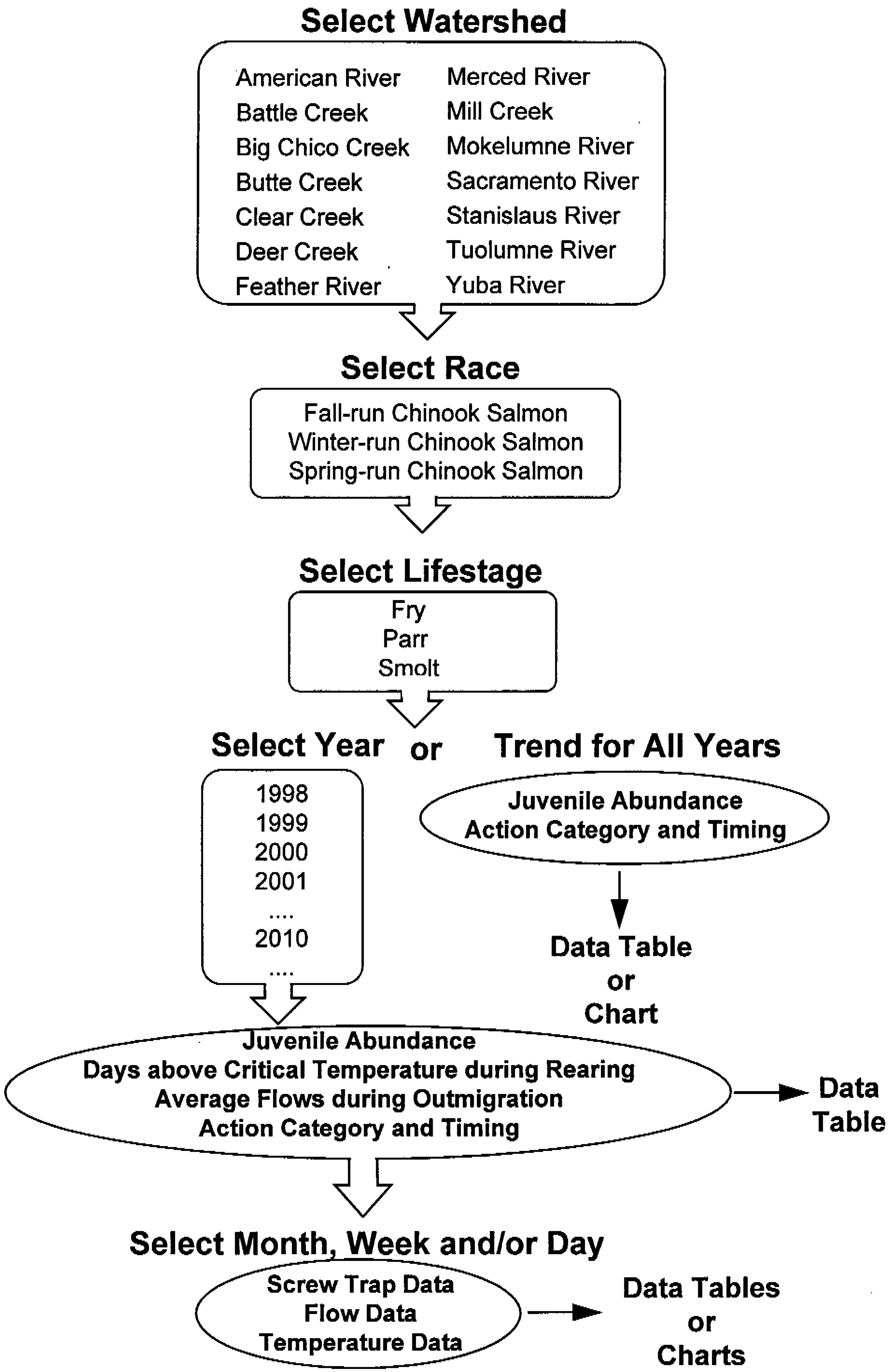


Figure 4-11. Accessibility of Juvenile Salmonid Data through the CAMP Home-page



SECTION 5. STAFFING AND BUDGET REQUIREMENTS

SECTION 5
STAFFING AND BUDGET REQUIREMENTS

INTRODUCTION

This section presents projected budgets for CAMP's recommended monitoring and data management programs. Budgets have been compiled for individual target species and for all target species combined. Also presented in this section is an estimate of CAMP's funding requirements for the first 5 years of program implementation. All costs are based on 1995 dollars.

CAMP's funding requirements are dependent on the extent to which CAMP can utilize data from existing programs that are funded from sources other than CAMP. The CAMP recommended programs were compared to existing monitoring programs to determine the extent to which existing programs might meet CAMP's needs. In some cases, CAMP monitoring needs will be completely met by existing programs. In others, CAMP will require existing programs to be expanded in scope, or CAMP will need to establish new programs. This section identifies the impact existing programs may have on CAMP's funding requirements. It is organized to present the following information:

- Summary assumptions used to estimate budget and funding requirements
- Linkages between existing and recommended programs
- Detailed monitoring program cost tables by species, watershed, and method
- Estimates of CAMP funding requirements to implement recommended monitoring programs (presented as first year start-up and 5-year operating costs)
- Budget and funding requirements for data management
- Total CAMP funding requirements

Appendix D provides detailed cost assumptions and staffing, operations, and equipment needs for recommended monitoring programs. Appendix B describes existing monitoring programs that partially or fully meet CAMP's needs.

SUMMARY ASSUMPTIONS

Summary assumptions used to calculate costs for each monitoring method are presented below. More detailed assumptions can be found in Appendix D.

Adult Programs

Carcass Surveys

- Costs include only labor hours required for monitoring chinook salmon (race specific) during spawning months and for producing a data report that summarizes carcass survey data.
- Program costs shared equally in adjacent watersheds when possible.
- Costs for each watershed scaled from an existing program with the most complete detailed cost breakdown.

Snorkel Surveys

- Vehicle costs shared between programs.
- Labor needs only costed for designated survey period.

Ladder Counts

- Primarily costs for labor during the months of upstream migration of target species.

Aerial Redd Counts

- Costs include airplane rental and fuel, and specified labor and equipment costs.

Hatchery Marking Program

- A constant fraction of hatchery released salmon will be marked.
- Staffing and budget requirements vary among hatcheries based on the species and number of fish marked.

Hatchery Counts

- No equipment costs are required in addition to ongoing hatchery management costs.
- Nimbus Hatchery costs (provided by CDFG-Mills, 1995) were extrapolated to other hatcheries.

Angler Survey

- Angling regulations determine duration of monitoring effort for each species within each watershed.
- CAMP level of effort for each species is equal to 50% of CDFG's proposed total data collection effort for multiple species within a watershed.

Mark-Recapture Method

- Boats, nets, and other equipment will be shared between the striped bass and sturgeon programs.
- Operating costs are primarily for implementing the program from boats throughout the Delta, including travel and fuel.

- Striped bass program labor costs are based on the proposed wide-spread sampling program in the Western Delta and lower Sacramento River and the annual tagging of 3,000 to 18,000 striped bass.
- White sturgeon will be sampled in fewer numbers from a more discrete area of the Delta, therefore costs will be proportionally lower for white sturgeon than striped bass.

Mid-water Trawl Survey

- The proposed CAMP program is identical to that now implemented by CDFG.
- No equipment costs are proposed because boats can be shared with other CDFG, DWR, and Service monitoring programs in the Delta.

Ocean Harvest Monitoring

- Monitoring will be conducted during relevant sport and commercial fishing seasons.
- Sampling goals are 20% of the salmon landed by ocean commercial and recreational fisheries.

Fall-, Spring-, and Winter-Run Chinook Salmon Juvenile Abundance Estimates

The basic monitoring program for measuring juvenile salmon abundance for any given race on any given stream will consist of the operation of a single screw trap deployed immediately downstream of all juvenile rearing areas. All three juvenile life stages will be assessed; fry, parr, yearlings, and smolts. Most traps will be deployed over the 6-month primary out-migration period of January through June for all target watersheds and races, as shown in Table 2-3. Exceptions are for Big Chico, Butte, Deer and Mill creeks, where monitoring will include spring-run juveniles and the Upper Sacramento River which includes winter-run juvenile salmon monitoring. The estimates for the recommended program were developed after review of monitoring costs from Mills (1995) and consultation with agency staff.

The proposed screw trap program consists of an Associate Biologist assisted by three seasonal staff over the required monitoring months. The 12-month Upper Sacramento River monitoring period is required to account for both fall- and winter-run juvenile emigration. The 10-month monitoring period for Mill, Deer, Big Chico, and Butte Creeks is needed to cover spring-run emigration in those streams.

Uniform monthly operating expenses and equipment costs were calculated for the 14 salmon monitoring watersheds based on estimates for existing programs. The proposed operating budget was set at a median to high value from the examples of existing screw trap program budgets. The recommended equipment cost, consisting of the purchase of a single screw trap per watershed, is based on the probable need for replacement at some time within the first 5 years of the program. Those equipment costs are shown here as occurring in the first year of the program.

Daily juvenile counts and trap efficiency data will be provided for each life stage and salmon race by the monitoring agency and the estimates will be provided annually to CAMP. Temperature and flow monitoring data will be acquired from existing agency data.

RECOMMENDED MONITORING PROGRAM COSTS - FIRST YEAR CAPITAL, OPERATING AND OVERHEAD

First year recommended program costs for CAMP represent the expenditure necessary to begin the recommended monitoring program, not taking into account any existing programs. CAMP recommended monitoring costs were scaled from costs associated with comparable existing monitoring programs.

Estimates of staffing and budget requirements are based on those provided by Mills (1995) for existing juvenile salmon monitoring programs, including screw trapping, on CVPIA streams. Budget information existed for most of the CAMP-recommended streams and a composite, average budget was developed to fill in currently unmonitored streams and to adjust budgets for programs that currently monitor in excess of CAMP needs. One problem with the development of a budget for the CAMP juvenile field monitoring effort is that there is much less overlap with existing agency programs (in contrast to the adult monitoring program). The following budget may need to be modified based on initial field reconnaissance or potential unforseen problems with installing new traps at the monitoring sites.

Tables 5-1 and 5-2 summarize recommended monitoring program responsibilities for all target anadromous fish species for adult and juvenile programs, respectively. Costs include field monitoring and initial data summary.

EXISTING MONITORING PROGRAMS THAT PARTIALLY OR FULLY MEET CAMP NEEDS

Adult Monitoring Programs

Existing programs are part of an ongoing effort by agencies to better understand and manage anadromous fish. Although these monitoring programs provide much important data on many aspects of fish biology, most of this information is additional to CAMP's specific needs. Existing monitoring program costs represent the annual program funding requirements reported by CDFG in December 1995. These expenditures represent capital, labor, operating, and overhead costs. Total costs of existing programs are presented by watershed (Table 5-1). CAMP recommended monitoring programs are not always met by existing agency programs. Key examples include:

Table 5-1. CAMP Recommended Adult Monitoring Programs, Existing Monitoring Programs, and CAMP Projected Funding Requirements by Species and Watershed

			CAMP Recommended Adult Programs (first year costs)					Existing Program Costs				CAMP Projected Funding Requirements: Year 1				Years 2-5	
Species	Watershed	Recommended Monitoring Method	Capital Cost	Operating Cost	Overhead Cost	Total Cost	Existing Program Number	Capital Cost	Operating Cost	Overhead Cost	Total Cost	Capital Costs [1]	Operating Cost	Overhead Cost	Total Costs	Operating Costs (Annual)	CAMP 5 Year Unmet Needs [2]
Fall-run	American River	Carcass Surveys	$13,250	$39,977	$8,875	$62,102	1	$0	$39,777	$8,831	$48,608	$13,250	$200	$44	$13,494	$244	$14,471
Fall-run	American River	Hatchery Counts	$0	$6,537	$1,451	$7,988	17	$1,000	$16,481	$3,659	$21,140	$0	$0	$0	$0	$0	$0
Fall-run	American River	Hatchery Marking Instream Angler	$10,000	$116,998	$25,974	$152,971	12	$84,700	$100,625	$22,339	$207,664	$0	$16,373	$3,635	$20,007	$20,007	$100,036
Fall-run	American River	Survey	$30,000	$28,581	$6,345	$64,926	-	$0	$0	$0	$0	$30,000	$28,581	$6,345	$64,926	$34,926	$204,632
Subtotal Fall-run chinook American River			$53,250	$192,093	$42,645	$287,988		$85,700	$156,883	$34,828	$277,412	$43,250	$45,154	$10,024	$98,428	$55,178	$319,140
Fall-run	Battle Creek	Carcass Surveys	$4,750	$14,875	$3,302	$22,927	2	$0	$54,538	$12,108	$66,646	$4,750	$0	$0	$4,750	$0	$4,750
Fall-run	Battle Creek	Hatchery Counts	$0	$6,537	$1,451	$7,988	18	$0	$9,828	$2,182	$12,010	$0	$0	$0	$0	$0	$0
Fall-run	Battle Creek	Hatchery Marking	$15,000	$118,998	$26,418	$160,415	13	$133,200	$85,436	$18,967	$237,603	$0	$33,562	$7,451	$41,012	$41,012	$205,062
Subtotal Fall-run chinook Battle Creek			$19,750	$140,409	$31,171	$191,330		$133,200	$149,802	$33,256	$316,258	$4,750	$33,562	$7,451	$45,762	$41,012	$209,812
Fall-run	Butte Creek	Carcass Surveys	$4,750	$14,875	$3,302	$22,927	3	$0	$0	$0	$0	$4,750	$14,875	$3,302	$22,927	$18,177	$95,634
Subtotal Fall-run chinook Butte Creek			$4,750	$14,875	$3,302	$22,927		$0	$0	$0	$0	$4,750	$14,875	$3,302	$22,927	$18,177	$95,634
Fall-run	Clear Creek	Carcass Surveys	$4,750	$14,875	$3,302	$22,927	-	$4,750	$14,875	$3,302	$22,927	$0	$0	$0	$0	$0	$0
Subtotal Fall-run chinook Clear Creek			$4,750	$14,875	$3,302	$22,927		$4,750	$14,875	$3,302	$22,927	$0	$0	$0	$0	$0	$0
Fall-run	Deer	Carcass Surveys	$4,750	$14,775	$3,280	$22,805	4	$0	$23,938	$5,314	$29,252	$4,750	$0	$0	$4,750	$0	$4,750
Subtotal Fall-run chinook Deer Creek			$4,750	$14,775	$3,280	$22,805		$0	$23,938	$5,314	$29,252	$4,750	$0	$0	$4,750	$0	$4,750
Fall-run	Feather River	Carcass Surveys	$6,750	$19,397	$4,306	$30,454	5	$0	$9,828	$2,182	$12,010	$6,750	$9,570	$2,124	$18,444	$11,694	$65,221
Fall-run	Feather River	Hatchery Counts	$0	$6,537	$1,451	$7,988	19	$0	$6,537	$1,451	$7,988	$0	$0	$0	$0	$0	$0
Fall-run	Feather River	Hatchery Marking Instream Angler	$15,000	$118,998	$26,418	$160,415	14	$84,700	$100,625	$22,339	$207,664	$0	$18,373	$4,079	$22,451	$22,451	$112,256
Fall-run	Feather River	Survey	$49,000	$21,557	$4,786	$75,343	-	$0	$0	$0	$0	$49,000	$21,557	$4,786	$75,343	$26,343	$180,716
Subtotal Fall-run chinook Feather River			$70,750	$166,490	$36,961	$274,200		$84,700	$116,990	$25,972	$227,662	$55,750	$49,500	$10,989	$116,239	$60,489	$358,193
Fall-run	Merced River	Carcass Surveys	$5,000	$14,215	$3,156	$22,371	6	$0	$21,970	$4,877	$26,847	$5,000	$0	$0	$5,000	$0	$5,000
Fall-run	Merced River	Hatchery Counts	$0	$6,537	$1,451	$7,988	20	$0	$9,828	$2,182	$12,010	$0	$0	$0	$0	$0	$0
Fall-run	Merced River	Hatchery Marking Instream Angler	$10,000	$116,998	$25,974	$152,971	15	$27,450	$57,545	$18,967	$103,962	$0	$59,453	$7,007	$66,459	$66,459	$332,297
Fall-run	Merced River	Survey	$0	$0	$0	$0	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Subtotal Fall-run chinook Merced River			$15,000	$137,750	$30,581	$183,330		$27,450	$89,342	$26,026	$142,818	$5,000	$59,453	$7,007	$71,459	$66,459	$337,297
Fall-run	Mill Creek	Carcass Surveys	$4,750	$14,875	$3,302	$22,927	4	$0	$23,938	$5,314	$29,252	$4,750	$0	$0	$4,750	$0	$4,750
Subtotal Fall-run chinook Mill Creek			$4,750	$14,875	$3,302	$22,927		$0	$23,938	$5,314	$29,252	$4,750	$0	$0	$4,750	$0	$4,750
Fall-run	Mokelumne River	Hatchery Counts	$0	$6,537	$1,451	$7,988	21	$0	$16,365	$3,633	$19,998	$0	$0	$0	$0	$0	$0
Fall-run	Mokelumne River	Hatchery Marking Instream Angler	$10,000	$116,998	$25,974	$152,971	16	$27,450	$57,545	$12,775	$97,770	$0	$59,453	$13,199	$72,651	$72,651	$363,256
Fall-run	Mokelumne River	Survey	$67,000	$21,584	$4,792	$93,375	-	$0	$0	$0	$0	$67,000	$21,584	$4,792	$93,375	$26,375	$198,876
Fall-run	Mokelumne River	Ladder Counts	$1,250	$8,790	$1,951	$11,991	10	$0	$16,610	$3,688	$20,298	$1,250	$0	$0	$1,250	$0	$1,250
Subtotal Fall-run chinook Mokelumne River			$78,250	$153,908	$34,168	$266,326		$27,450	$90,520	$20,095	$138,066	$68,250	$81,036	$17,990	$167,276	$99,026	$563,382

Table 5-1. CAMP Recommended Adult Monitoring Programs, Existing Monitoring Programs, and CAMP Projected Funding Requirements by Species and Watershed

			CAMP Recommended Adult Programs (first year costs)					Existing Program Costs				CAMP Projected Funding Requirements					
												Year 1				Years 2-5	
Species	Watershed	Recommended Monitoring Method	Capital Cost	Operating Cost	Overhead Cost	Total Cost	Existing Program Number	Capital Cost	Operating Cost	Overhead Cost	Total Cost	Capital Costs [1]	Operating Cost	Overhead Cost	Total Costs	Operating Costs (Annual)	CAMP 5 Year Unmet Needs [2]
Fall-run	Sacramento River	Aerial Redd Counts	$0	$21,560	$4,786	$26,347	26	$0	$106,019	$23,536	$129,555	$0	$0	$0	$0	$0	$0
Fall-run	Sacramento River	Ladder Counts	$1,250	$8,790	$1,951	$11,991	26	$0	$106,019	$23,536	$129,555	$0	$0	$0	$0	$0	$0
Fall-run	Sacramento River	Carcass Surveys	$13,250	$36,393	$8,079	$57,722	26	$0	$74,876	$16,622	$91,498	$13,250	$0	$0	$13,250	$0	$13,250
Fall-run	Sacramento River	Instream Angler Survey	$28,750	$12,037	$2,672	$43,459	-	$0	$0	$0	$0	$28,750	$12,037	$2,672	$43,459	$14,709	$102,294
Subtotal Fall-run chinook Sacramento River			$43,250	$78,780	$17,489	$139,519		$0	$286,913	$63,695	$350,608	$42,000	$12,037	$2,672	$56,709	$14,709	$115,544
Fall-run	San Joaquin River	Instream Angler Survey	$100,000	$36,099	$8,014	$144,113	-	$0	$0	$0	$0	$100,000	$36,099	$8,014	$144,113	$44,113	$320,567
Subtotal Fall-run chinook San Joaquin River			$100,000	$36,099	$8,014	$144,113		$0	$0	$0	$0	$100,000	$36,099	$8,014	$144,113	$44,113	$320,567
Fall-run	Stanislaus River	Carcass Surveys	$5,000	$14,215	$3,156	$22,371	7	$500	$21,939	$4,871	$27,310	$4,500	$0	$0	$4,500	$0	$4,500
Fall-run	Stanislaus River	Instream Angler Survey	$2,000	$28,258	$6,273	$36,532	-	$0	$0	$0	$0	$2,000	$28,258	$6,273	$36,532	$34,532	$174,658
Subtotal Fall-run chinook Stanislaus River			$7,000	$42,473	$9,429	$58,902		$500	$21,939	$4,871	$27,310	$6,500	$28,258	$6,273	$41,032	$34,532	$179,158
Fall-run	Tuolumne River	Carcass Surveys	$5,000	$14,215	$3,156	$22,371	8	$0	$27,697	$6,149	$33,846	$5,000	$0	$0	$5,000	$0	$5,000
Subtotal Fall-run chinook Tuolumne River			$5,000	$14,215	$3,156	$22,371		$0	$27,697	$6,149	$33,846	$5,000	$0	$0	$5,000	$0	$5,000
Fall-run	Yuba River	Carcass Surveys	$6,750	$19,397	$4,306	$30,454	9	$23,000	$62,115	$13,789	$98,904	$0	$0	$0	$0	$0	$0
Fall-run	Yuba River	Instream Angler Survey	$48,000	$30,759	$6,829	$85,588	-	$0	$0	$0	$0	$48,000	$30,759	$6,829	$85,588	$37,588	$235,938
Subtotal Fall-run chinook Yuba River			$54,750	$50,157	$11,135	$116,041		$23,000	$62,115	$13,789	$98,904	$48,000	$30,759	$6,829	$85,588	$37,588	$235,938
Subtotal Fall-run chinook all watersheds			$466,000	$1,071,772	$237,933	$1,775,706		$386,750	$1,064,953	$242,612	$1,694,315	$392,750	$390,733	$80,550	$864,033	$471,283	$2,749,165
Late Fall-run	Battle Creek	Carcass Surveys	$4,750	$14,875	$3,302	$22,927	-	$0	$14,692	$3,262	$17,954	$4,750	$182	$41	$4,973	$223	$5,865
Late-Fall-run	Battle Creek	Hatchery Counts	$0	$6,537	$1,451	$7,988	18	$0	$0	$0	$0	$0	$6,537	$1,451	$7,988	$7,988	$39,941
Late-Fall-run	Battle Creek	Hatchery Marking	$15,000	$52,887	$11,741	$79,628	13	$0	$0	$0	$0	$15,000	$52,887	$11,741	$79,628	$64,628	$338,140
Subtotal Late Fall-run chinook Battle Creek			$19,750	$74,299	$16,494	$110,543		$0	$14,692	$3,262	$17,954	$19,750	$59,607	$13,233	$92,589	$72,839	$383,946
Late-Fall-run	Sacramento River	Aerial Redd Counts	$0	$21,560	$4,786	$26,347	26	$0	$0	$0	$0	$0	$21,560	$4,786	$26,347	$26,347	$131,734
Late-Fall-run	Sacramento River	Instream Angler Survey	$28,750	$8,359	$1,856	$38,964	-	$0	$0	$0	$0	$28,750	$8,359	$1,856	$38,964	$10,214	$79,822
Subtotal Late Fall-run chinook Sacramento River			$28,750	$29,919	$6,642	$65,311		$0	$0	$0	$0	$28,750	$29,919	$6,642	$65,311	$36,561	$211,556
Subtotal Late Fall-run chinook all watersheds			$48,500	$104,218	$23,136	$175,854		$0	$14,692	$3,262	$17,954	$48,500	$89,526	$19,875	$157,900	$109,400	$595,502
Winter-run	Battle Creek	Hatchery Marking	$0	$26,444	$5,870	$32,314	13	$0	$0	$0	$0	$0	$26,444	$5,870	$32,314	$32,314	$161,570
Winter-run	Sacramento River	Aerial Redd Counts	$0	$21,560	$4,786	$26,347	26	$0	$0	$0	$0	$0	$21,560	$4,786	$26,347	$26,347	$131,734
Winter-run	Sacramento River	Ladder Counts	$1,250	$8,790	$1,951	$11,991	26	$0	$106,019	$23,536	$129,555	$0	$0	$0	$0	$0	$0
Winter-run	Sacramento River	Carcass Surveys	$13,250	$36,393	$8,079	$57,722	26	$0	$0	$0	$0	$13,250	$36,393	$8,079	$57,722	$44,472	$235,611
Subtotal Winter-run chinook Sacramento River			$14,500	$93,187	$20,687	$128,374		$0	$106,019	$23,536	$129,555	$13,250	$84,397	$18,736	$116,383	$103,133	$528,915
Subtotal Winter-run chinook all watersheds			$14,500	$93,187	$20,687	$128,374		$0	$106,019	$23,536	$129,555	$13,250	$84,397	$18,736	$116,383	$103,133	$528,915

Table 5-1. CAMP Recommended Adult Monitoring Programs, Existing Monitoring Programs, and CAMP Projected Funding Requirements by Species and Watershed

			CAMP Recommended Adult Programs (first year costs)					Existing Program Costs				CAMP Projected Funding Requirements					
												Year 1				Years 2-5	
Species	Watershed	Recommended Monitoring Method	Capital Cost	Operating Cost	Overhead Cost	Total Cost	Existing Program Number	Capital Cost	Operating Cost	Overhead Cost	Total Cost	Capital Costs [1]	Operating Cost	Overhead Cost	Total Costs	Operating Costs (Annual)	CAMP 5 Year Unmet Needs [2]
Spring-run	Butte Creek	Snorkel Survey	$3,850	$18,603	$4,130	$26,583	3	$0	$8,237	$1,829	$10,065	$3,850	$10,366	$2,301	$16,517	$12,667	$67,186
Subtotal Spring-run chinook Butte Creek			$3,850	$18,603	$4,130	$26,583		$0	$8,237	$1,829	$10,065	$3,850	$10,366	$2,301	$16,517	$12,667	$67,186
Spring-run	Deer Creek	Snorkel Survey	$3,850	$18,603	$4,130	$26,583	4	$4,500	$50,611	$11,236	$66,347	$0	$0	$0	$0	$0	$0
Subtotal Spring-run chinook Deer Creek			$3,850	$18,603	$4,130	$26,583		$4,500	$50,611	$11,236	$66,347	$0	$0	$0	$0	$0	$0
Spring-run	Mill Creek	Ladder Counts	$2,500	$11,188	$2,484	$16,172	4	$4,500	$41,837	$9,288	$55,624	$0	$0	$0	$0	$0	$0
Subtotal Spring-run chinook Mill Creek			$2,500	$11,188	$2,484	$16,172		$4,500	$41,837	$9,288	$55,624	$0	$0	$0	$0	$0	$0
Spring-run	Feather River	Hatchery Marking	$0	$59,499	$13,209	$72,708	14	$0	$0	$0	$0	$0	$59,499	$13,209	$72,708	$72,708	$363,538
Subtotal Spring-run chinook Feather River			$0	$59,499	$13,209	$72,708		$0	$0	$0	$0	$0	$59,499	$13,209	$72,708	$72,708	$363,538
Spring-run	Sacramento River	Instream Angler Survey	$28,750	$20,462	$4,543	$53,755	-	$0	$0	$0	$0	$28,750	$20,462	$4,543	$53,755	$25,005	$153,774
Spring-run	Sacramento River	Ladder Counts	$1,250	$8,790	$1,951	$11,991	-	$0	$0	$0	$0	$1,250	$8,790	$1,951	$11,991	$10,741	$54,955
Subtotal Spring-run chinook Sacramento River			$30,000	$29,252	$6,494	$65,746		$0	$0	$0	$0	$30,000	$29,252	$6,494	$65,746	$35,746	$208,729
Subtotal Spring-run chinook all watersheds			$40,200	$137,144	$30,446	$207,791		$9,000	$100,685	$22,352	$132,037	$33,850	$99,117	$22,004	$154,971	$121,121	$639,454
Steelhead	Battle Creek	Hatchery Counts	$0	$6,537	$1,451	$7,988	18	$0	$0	$0	$0	$0	$6,537	$1,451	$7,988	$7,988	$39,941
Steelhead	Battle Creek	Hatchery Marking	$15,000	$52,887	$11,741	$79,628	13	$0	$0	$0	$0	$15,000	$52,887	$11,741	$79,628	$64,628	$338,140
Subtotal Steelhead trout Battle Creek			$15,000	$59,424	$13,192	$87,616		$0	$0	$0	$0	$15,000	$59,424	$13,192	$87,616	$72,616	$378,081
Steelhead	Sacramento River	Instream Angler Survey	$28,750	$6,821	$1,514	$37,085	-	$0	$0	$0	$0	$28,750	$6,821	$1,514	$37,085	$8,335	$70,425
Subtotal Steelhead trout Sacramento River			$28,750	$6,821	$1,514	$37,085		$0	$0	$0	$0	$28,750	$6,821	$1,514	$37,085	$8,335	$70,425
Subtotal Steelhead trout all watersheds			$43,750	$66,245	$14,706	$124,701		$0	$0	$0	$0	$43,750	$66,245	$14,706	$124,701	$80,951	$448,506
Striped Bass	Delta	Mark-recapture	$22,500	$150,687	$33,452	$206,639	22	$22,500	$191,350	$42,480	$256,330	$0	$0	$0	$0	$0	$0
American Shad	Delta	Mid-water Trawl	$0	$102,825	$22,827	$125,652	24	$0	$96,325	$21,384	$117,709	$0	$6,500	$1,443	$7,943	$7,943	$39,716
White Sturgeon	Delta	Mark-recapture	$0	$28,029	$6,223	$34,252	23	$8,020	$41,390	$9,189	$58,599	$0	$0	$0	$0	$0	$0
Green Sturgeon			$0	$0	$0	$0	23	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Subtotal Delta Species Delta watershed			$22,500	$281,541	$62,502	$366,543		$30,520	$329,065	$73,052	$432,637	$0	$6,500	$1,443	$7,943	$7,943	$39,716
All chinook salmc	All except delta	Ocean Harvest	$0	$105,000	$429,463	$524,804	25	$0	$429,463	$95,341	$524,804	$0	$0	$334,122	$334,122	$334,122	$1,670,611
Subtotal Ocean watershed			$0	$105,000	$429,463	$524,804		$0	$429,463	$95,341	$524,804	$0	$0	$334,122	$334,122	$334,122	$1,670,611
Grand Total			**$635,450**	**$1,859,108**	**$818,874**	**$3,303,773**		**$426,270**	**$2,044,877**	**$460,154**	**$2,931,301**	**$532,100**	**$736,517**	**$491,437**	**$1,760,054**	**$1,227,954**	**$6,671,868**

[1] Annual capital costs are assumed to meet all capital needs for the first 5 years of the programs.
[2] CAMP requirements for the first 5 years reflects the capital costs for year 1 and the operating and overhead costs for years 1-5.

Table 5-2. CAMP Recommended Juvenile Programs, Existing Programs, and CAMP Unmet Needs

			CAMP Recommended Juvenile Programs				Existing Program Funding Status, 1997				Program Funding Status, 1997, 1998-2001: CAMP 1997 Unmet Needs				
Recommended Monitoring Method	Watershed	Species	Capital Cost	Operating Cost	Overhead Cost	Total Cost	Capital Cost	Operating Cost	Overhead Cost	Total Cost	Capital Cost	Operating Cost	Overhead Cost	Total Unmet Needs	CAMP 5 Year Unmet Needs [1]
Screw Trapping	Upper Sacramento River	Winter-run	$15,000	$118,885	$26,393	$160,278	$15,000	$42,750	$9,491	$67,241	$0	$76,135	$16,902	$93,037	$465,184
	Upper Sacramento River	Fall-run													
	Upper Sacramento River	Spring-run													
	Clear Creek	Fall-run	$15,000	$61,943	$13,751	$90,694	$0	$0	$0	$0	$15,000	$61,943	$13,751	$90,694	$393,470
	Battle Creek	Fall-run	$15,000	$61,943	$13,751	$90,694	$30,000	$43,701	$9,702	$83,403	$0	$18,242	$4,049	$22,291	$111,455
	Mill Creek	Fall-run													
	Mill Creek	Spring-run	$15,000	$90,708	$20,137	$125,846	$25,000	$53,831	$11,951	$90,782	$0	$36,877	$8,186	$45,064	$225,318
	Deer Creek	Fall-run													
	Deer Creek	Spring-run	$15,000	$90,708	$20,137	$125,846	$25,000	$54,680	$12,139	$91,819	$0	$36,028	$7,998	$44,027	$220,133
	Big Chico Creek	Fall-run													
	Big Chico Creek	Spring-run	$15,000	$90,708	$20,137	$125,845	$0	$0	$0	$0	$15,000	$90,708	$20,137	$125,846	$569,225
	Butte Creek	Fall-run													
	Butte Creek	Spring-run	$15,000	$90,708	$20,137	$125,846	$0	$35,018	$7,774	$42,792	$15,000	$55,690	$12,363	$83,053	$355,265
	Feather River	Fall-run	$15,000	$61,943	$13,751	$90,694	$89,000	$61,191	$13,584	$163,775	$0	$752	$167	$919	$4,595
	Yuba River	Fall-run	$15,000	$61,943	$13,751	$90,694	$0	$0	$0	$0	$15,000	$61,943	$13,751	$90,694	$393,470
	American River	Fall-run	$15,000	$61,943	$13,751	$90,694	$0	$61,017	$13,546	$74,563	$15,000	$926	$205	$16,131	$20,655
	Mokelumne River	Fall-run	$15,000	$61,943	$13,751	$90,694	$15,000	$34,026	$7,554	$56,580	$0	$27,917	$6,197	$34,114	$170,570
	Stanislaus River	Fall-run	$15,000	$61,943	$13,751	$90,694	$25,000	$86,364	$19,173	$130,537	$0	$0	$0	$0	$0
	Tuolumne River	Fall-run	$15,000	$61,943	$13,751	$90,694	$0	$78,052	$17,328	$95,380	$15,000	$0	$0	$15,000	$15,000
	Merced River	Fall-run	$15,000	$61,943	$13,751	$90,694	$0	$71,206	$15,808	$87,014	$15,000	$0	$0	$15,000	$15,000
Grand Total			$210,000	$1,039,202	$230,702	$1,479,905	$224,000	$621,836	$138,050	$983,886	$105,000	$467,160	$103,708	$675,869	$2,959,338

[1] CAMP requirements for the first 5 years reflects the capital costs for year 1 and the operating and overhead costs for years 1-5.

- The fall-run, late fall-run, and winter-run chinook salmon carcass surveys are not completely funded by existing programs.
- The Butte Creek snorkel surveys are not fully funded.
- The hatchery marking program must be modified and expanded from current programs.
- The angler survey program is currently unfunded, but is essential to CAMP.

A cross-listing of recommended and existing adult monitoring programs is provided in Table 5-3.

Juvenile Monitoring Programs Which Include Screw Trapping for Juvenile Chinook Salmon

Existing, currently funded programs that meet or partially meet CAMP needs are listed in Table 5-2. These juvenile monitoring programs usually include additional monitoring methods and/or extended monitoring periods other than those strictly required to meet CAMP objectives (i.e., see Mills, 1995). In addition, some CVP watersheds have existing juvenile salmon monitoring programs that do not include screw trapping. Those programs are not included here as they provide no overlap with CAMP needs.

Recommended CAMP program costs were subtracted from those of existing programs to yield the estimated initial funding requirements for the first year of monitoring (Table 5-2).

CAMP MONITORING PROGRAM FUNDING REQUIREMENTS

CAMP funding estimates are based on the assumption that CAMP will use relevant information from existing monitoring programs and those programs will continue to be funded from other sources. Tables 5-1 and 5-2 compare CAMP's total program costs with existing agency program costs. The difference between these costs is identified as the projected requirement for CAMP funds.

Capital costs are assumed to occur in the first year only and to be uniformly expended by all projects. Only operating and overhead costs are included for the next 4 years. No attempt has been made in this document to estimate replacement time frames for existing equipment. The most expensive capital items include vehicles and boats, which will be replaced on a greater than 5-year frequency. Rotary screw traps are assumed to be replaced on a 5-year interval. Capital, operating, and overhead fields are compared individually assuming, if an existing monitoring program cost is greater than a CAMP recommended monitoring program cost, that there will be no projected CAMP funding requirement. If the existing monitoring program cost is less than a CAMP recommended monitoring program cost, then the cost reflects the projected funding requirement minus the existing monitoring program cost. Annual operating costs for years 2

Table 5-3. CAMP Recommended Adult Programs and Corresponding Existing Monitoring Programs

Recommended Monitoring	Watershed	Species	Existing Program Number	Existing Program Name
Carcass Surveys	American River	Fall-run	1	Lower American River Chinook Salmon Abundance Survey
Carcass Surveys	Battle Creek	Fall-run	2	Battle Creek, Spawning Escapement Survey
Carcass Surveys	Battle Creek	Late Fall-run	-	-
Carcass Surveys	Butte Creek	Fall-run	3	Butte Creek Chinook Salmon Spawning Escapement and Snorkel Surveys
Carcass Surveys	Clear Creek	Fall-run	-	-
Carcass Surveys	Deer Creek	Fall-run	4	Central Valley Salmon and Steelhead Project, Spawning Escapement Survey
Carcass Surveys	Feather River	Fall-run	5	Feather River Chinook Salmon Spawning Escapement Survey
Carcass Surveys	Merced River	Fall-run	6	Merced River Escapement Survey
Carcass Surveys	Mill Creek	Fall-run	4	Central Valley Salmon and Steelhead Project, Spawning Stock Assessment
Carcass Surveys	Sacramento River	Fall-run	26	Upper Sacramento River Escapement Survey
Carcass Surveys	Sacramento River	Winter-run	26	Upper Sacramento River Escapement Survey
Carcass Surveys	Stanislaus River	Fall-run	7	Stanislaus River Escapement Survey
Carcass Surveys	Tuolumne River	Fall-run	8	Tuolumne River Escapement Survey
Carcass Surveys	Yuba River	Fall-run	9	Yuba River Chinook Salmon Spawning Escapement Survey
Snorkel Survey	Butte Creek	Spring-run	3	Butte Creek Chinook Salmon Spawning Escapement and Snorkel Surveys
Snorkel Survey	Deer Creek	Spring-run	4	Central Valley Salmon and Steelhead Project, Spawning Stock Assessment
Ladder Counts	Mill Creek	Spring-run	4	Central Valley Salmon and Steelhead Project, Spawning Stock Assessment
Ladder Counts	Mokelumne River	Fall-run	10	Mokelumne River Salmon and Steelhead Monitoring Program
Ladder Counts	Sacramento River	Spring-run	11	Central Valley Salmon and Steelhead Project
Ladder Counts	Sacramento River	Fall-run	11	Central Valley Salmon and Steelhead Project
Ladder Counts	Sacramento River	Winter-run	11	Central Valley Salmon and Steelhead Project
Aerial Redd Counts	Sacramento River	Fall-run	11	Central Valley Salmon and Steelhead Project, Spawning Stock Assessment
Aerial Redd Counts	Sacramento River	Late Fall-run	11	Central Valley Salmon and Steelhead Project, Spawning Stock Assessment
Aerial Redd Counts	Sacramento River	Winter-run	11	Central Valley Salmon and Steelhead Project, Spawning Stock Assessment
Hatchery Marking	American River	Fall-run	12	Nimbus Fish Hatchery Coded-Wire Tagging Program
Hatchery Marking	Battle Creek	Fall-run	13	Coleman National Fish Hatchery Coded-Wire Tagging Program
Hatchery Marking	Battle Creek	Late Fall-run	13	Coleman National Fish Hatchery Coded-Wire Tagging Program
Hatchery Marking	Battle Creek	Steelhead	13	Coleman National Fish Hatchery Coded-Wire Tagging Program
Hatchery Marking	Battle Creek	Winter	13	Coleman National Fish Hatchery Coded-Wire Tagging Program
Hatchery Marking	Feather River	Fall-run	14	Feather River Hatchery Coded-Wire Tagging Program
Hatchery Marking	Feather River	Spring	14	Feather River Hatchery Coded-Wire Tagging Program
Hatchery Marking	Merced River	Fall-run	15	Merced River Hatchery Coded-Wire Tagging Program
Hatchery Marking	Mokelumne River	Fall-run	16	Mokelumne River Hatchery Coded-Wire Tagging Program

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Sheet1
4/24/97

Table 5-3. CAMP Recommended Adult Programs and Corresponding Existing Monitoring Programs

Recommended Monitoring	Watershed	Species	Existing Program Number	Existing Program Name
Hatchery Counts	American River	Fall-run	17	Nimbus Salmon Hatchery, Salmon and Steelhead Program
Hatchery Counts	Battle Creek	Fall-run	18	Coleman National Fish Hatchery Salmon and Steelhead Stock Composition
Hatchery Counts	Battle Creek	Late Fall-run	18	Coleman National Fish Hatchery Salmon and Steelhead Stock Composition
Hatchery Counts	Battle Creek	Steelhead	18	Coleman National Fish Hatchery Salmon and Steelhead Stock Composition
Hatchery Counts	Feather River	Fall-run	19	Feather River Hatchery Assessment
Hatchery Counts	Merced River	Fall-run	20	Merced River Fish Facility
Hatchery Counts	Mokelumne River	Fall-run	21	Mokelumne River Hatchery Assessment
Instream Angler Survey	American River	Fall-run	-	-
Instream Angler Survey	Feather River	Fall-run	-	-
Instream Angler Survey	Merced River	Fall-run	-	-
Instream Angler Survey	Mokelumne River	Fall-run	-	-
Instream Angler Survey	Sacramento River	Fall-run	-	-
Instream Angler Survey	Sacramento River	Late Fall-run	-	-
Instream Angler Survey	Sacramento River	Spring-run	-	-
Instream Angler Survey	Sacramento River	Steelhead	-	-
Instream Angler Survey	San Joaquin River	Fall-run	-	-
Instream Angler Survey	Stanislaus River	Fall-run	-	-
Instream Angler Survey	Yuba River	Fall-run	-	-
Mark-recapture	Delta	Striped Bass	22	Estuarine Monitoring Program, Adult Striped Bass Study
Mark-recapture	Delta	White Sturgeon	23	Estuarine Monitoring Program, Sturgeon Study
Mid-water Trawl	Delta	American Shad	24	Estuarine Monitoring Program
Ocean Harvest	Pacific Coast	Chinook Salmon	25	Ocean Salmon Project

through 5 reflect the sum of projected funding requirements for operating and overhead costs. The capital and operating costs summarize the funding requirements of a 5-year monitoring program.

DATA ANALYSES AND REPORTING

To calculate annual adult production estimates, CAMP relies on annual summaries of the raw data collected by recommended monitoring programs. Annual summary data will be included in the annual reports of each monitoring agency. These summary data will need to be compiled and entered into the CAMP calculations described in Section 2 each year. Specifics regarding how the data will be managed to calculate annual production estimates are described in Section 3.

Juvenile monitoring data will be compiled as raw daily trap count data and trap efficiencies from all watersheds. The summarized juvenile salmon abundance data will be combined with flow and temperature data and information on AFRP actions and monitoring results to complete the final analysis.

Based upon the calculations in Section 2 and the data management needs described in Section 4, data management and reporting costs have been estimated for CAMP. Data management costs are based upon professional labor rates used for the monitoring programs, CDFG benefits and overhead rates, and the estimated level of effort to enter data, create the CAMP homepage, and develop the calculations and data structure needed to calculate production estimates. Data management and report preparation is expected to be a minor part of the overall CAMP program costs. Annual data management costs are presented in Table 5-4.

COMPREHENSIVE BUDGET

The comprehensive budget to implement the recommended monitoring program and data management system, including the field monitoring, data summary, analysis, and reporting, is presented in Table 5-5.

Table 5-4. Estimated First Year CAMP Costs for Data Management, Analysis, Coordination and Report Preparation for Combined Juvenile and Adult Monitoring Programs

Category	Labor	Expenses	Total	Basis of Estimate
Initial Startup Costs	$21,662	$1,000	**$22,662**	Associate Biologist: 14 weeks
Data Input into IEP	$2,944	$100	**$3,044**	Senior Biologist: 2 weeks
Collection from Agency Programs	$5,348	$1,000	**$6,348**	Associate Biologist: 4 weeks
Ongoing Input to IEP Database	$5,348	$500	**$5,848**	Associate Biologist: 4 weeks
Analysis of Data	$8,022	$1,000	**$9,022**	Associate Biologist: 6 weeks
Program Coordinator	$76,544	$2,500	**$79,044**	Senior Biologist: Full Time
Preparation of Annual Report	$5,348	$1,000	**$6,348**	Associate Biologist: 4 weeks
Total	**$125,216**	**$7,100**	**$132,316**	

Table 5-5. CAMP Monitoring Program Comprehensive Budget and Funding Estimates

	Projected Cost		
Project	**Total Budget (First Year)**	**Funding Requirements (First Year)**	**Funding Requirements (First 5 Years)**
Field Monitoring	$4,783,681	$2,435,923	$9,631,206
Data Management	$132,316	$132,316	$661,580
Total	**$4,915,997**	**$2,568,239**	**$10,292,786**

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Table 5-4
4/24/97

through 5 reflect the sum of projected funding requirements for operating and overhead costs. The capital and operating costs summarize the funding requirements of a 5-year monitoring program.

DATA ANALYSES AND REPORTING

To calculate annual adult production estimates, CAMP relies on annual summaries of the raw data collected by recommended monitoring programs. Annual summary data will be included in the annual reports of each monitoring agency. These summary data will need to be compiled and entered into the CAMP calculations described in Section 2 each year. Specifics regarding how the data will be managed to calculate annual production estimates are described in Section 3.

Juvenile monitoring data will be compiled as raw daily trap count data and trap efficiencies from all watersheds. The summarized juvenile salmon abundance data will be combined with flow and temperature data and information on AFRP actions and monitoring results to complete the final analysis.

Based upon the calculations in Section 2 and the data management needs described in Section 4, data management and reporting costs have been estimated for CAMP. Data management costs are based upon professional labor rates used for the monitoring programs, CDFG benefits and overhead rates, and the estimated level of effort to enter data, create the CAMP homepage, and develop the calculations and data structure needed to calculate production estimates. Data management and report preparation is expected to be a minor part of the overall CAMP program costs. Annual data management costs are presented in Table 5-4.

COMPREHENSIVE BUDGET

The comprehensive budget to implement the recommended monitoring program and data management system, including the field monitoring, data summary, analysis, and reporting, is presented in Table 5-5.

Table 5-4. Estimated First Year CAMP Costs for Data Management, Analysis, Coordination and Report Preparation for Combined Juvenile and Adult Monitoring Programs

Category	Labor	Expenses	Total	Basis of Estimate
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Data Input into IEP	$2,944	$100	**$3,044**	Senior Biologist: 2 weeks
Collection from Agency Programs	$5,348	$1,000	**$6,348**	Associate Biologist: 4 weeks
Ongoing Input to IEP Database	$5,348	$500	**$5,848**	Associate Biologist: 4 weeks
Analysis of Data	$8,022	$1,000	**$9,022**	Associate Biologist: 6 weeks
Program Coordinator	$76,544	$2,500	**$79,044**	Senior Biologist: Full Time
Preparation of Annual Report	$5,348	$1,000	**$6,348**	Associate Biologist: 4 weeks
Total	**$125,216**	**$7,100**	**$132,316**	

Table 5-5. CAMP Monitoring Program Comprehensive Budget and Funding Estimates

	Projected Cost		
Project	**Total Budget (First Year)**	**Funding Requirements (First Year)**	**Funding Requirements (First 5 Years)**
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Data Management	$132,316	$132,316	$661,580
Total	**$4,915,997**	**$2,568,239**	**$10,292,786**

SECTION 6. CITATIONS

SECTION 6
CITATIONS

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APPENDIX A. ADULT PRODUCTION CALCULATIONS

APPENDIX A

ADULT PRODUCTION CALCULATIONS

Calculations to estimate annual adult production for each race of chinook salmon and steelhead trout by watershed are presented in Tables A-1 through A-5. Calculations for fall-run, late fall-run, winter-run, and spring-run chinook salmon, and steelhead trout are presented in Tables A-1, A-2, A-3, A-4, and A-5, respectively. A key to calculation variables and subscripts follows Table A-5.

Table A-1. Calculations to Estimate Annual Fall-run Chinook Salmon Production

Watershed	Monitoring Method	Variable	Formula
American River	Carcass Survey	$E_{C,F,N,AM}$	$(E_{C,F,T,AM})(1 - h_{C,F,AM})$
American River	Hatchery Returns	$E_{H,F,N,AM}$	$(E_{H,F,T,AM})(1 - h_{H,F,AM})$
American River	Instream Angler Harvest	$H_{A,F,N,AM,I}$	$(H_{A,F,T,AM,I})(1 - h_{A,F,AM,I})$
American River	In-River Run[a]	$I_{F,N,AM}$	$E_{C,F,N,AM} + E_{H,F,N,AM} + H_{A,F,N,AM,I}$
American River	Downstream Angler Harvest[a]	$H_{A,F,N,AM,D}$	$(H_{A,\alpha,N,\beta,D})(I_{F,N,AM} / I_{\alpha,N,\beta})$
American River	Ocean Harvest	$H_{O,F,N,AM}$	$(H_{O,\alpha,N,\beta})(I_{F,N,AM} / I_{\alpha,N,\beta})$
American River	**Watershed Production Estimate for Fall-run**	$P_{F,N,AM}$	$I_{F,N,AM} + H_{A,F,N,AM,D} + H_{O,F,N,AM}$
Battle Creek	Carcass Survey	$E_{C,F,N,BA}$	$(E_{C,F,T,BA})(1 - h_{C,F,BA})$
Battle Creek	Hatchery Returns	$E_{H,F,N,BA}$	$(E_{H,F,T,BA})(1 - h_{H,F,BA})$
Battle Creek	In-River Run[a]	$I_{F,N,BA}$	$E_{C,F,N,BA} + E_{H,F,N,BA}$
Battle Creek	Downstream Angler Harvest[a]	$H_{A,F,N,BA,D}$	$(H_{A,\alpha,N,SA,I})(I_{F,N,BA} / (E_{Y,\alpha,N,SA} + I_{\alpha,N,BA} + I_{\alpha,N,BU} + I_{\alpha,N,CL} + I_{\alpha,N,DE} + I_{\alpha,N,MI})) + (H_{A,\alpha,N,\beta,D})(I_{F,N,BA} / I_{\alpha,N,\beta})$
Battle Creek	Ocean Harvest	$H_{O,F,N,BA}$	$(H_{O,\alpha,N,\beta})(I_{F,N,BA} / I_{\alpha,N,\beta})$
Battle Creek	**Watershed Production Estimate for Fall-run**	$P_{F,N,BA}$	$I_{F,N,BA} + H_{A,F,N,BA,D} + H_{O,F,N,BA}$
Butte Creek	Carcass Survey	$E_{C,F,N,BU}$	$(E_{C,F,T,BU})(1 - h_{C,F,BU})$
Butte Creek	In-River Run[a]	$I_{F,N,BU}$	$E_{C,F,N,BU}$

Shading indicates CAMP calculations.
No shading indicates agency calculations.

Table A-1. Calculations to Estimate Annual Fall-run Chinook Salmon Production

Watershed	Monitoring Method	Variable	Formula
Butte Creek	Downstream Angler Harvest[a]	$H_{A,F,N,BU,D}$	$(H_{A,\alpha,N,SA,I})(I_{F,N,BU} / (E_{\gamma,\alpha,N,SA} + I\alpha_{,N,BA} + I\alpha_{,N,BU} + I\alpha_{,N,CL} + I\alpha_{,N,DE} + I\alpha_{,N,MI})) + (H_{A,\alpha,N,\beta,D})(I_{F,N,BU} / I\alpha_{,N,\beta})$
Butte Creek	Ocean Harvest	$H_{O,F,N,BU}$	$(H_{O,\alpha,N,\beta})(I_{F,N,BU} / I\alpha_{,N,\beta})$
Butte Creek	**Watershed Production Estimate for Fall-run**	$P_{F,N,BU}$	$I_{F,N,BU} + H_{A,F,N,BU,D} + H_{O,F,N,BU}$
Clear Creek	Carcass Survey	$E_{C,F,N,CL}$	$(E_{C,F,T,CL})$
Clear Creek	In-River Run[a]	$I_{F,N,CL}$	$E_{C,F,N,CL}$
Clear Creek	Downstream Angler Harvest[a]	$H_{A,F,N,CL,D}$	$(H_{A,\alpha,N,SA,I})(I_{F,N,CL} / (E_{\gamma,\alpha,N,SA} + I\alpha_{,N,BA} + I\alpha_{,N,BU} + I\alpha_{,N,CL} + I\alpha_{,N,DE} + I\alpha_{,N,MI})) + (H_{A,\alpha,N,\beta,D})(I_{F,N,CL} / I\alpha_{,N,\beta})$
Clear Creek	Ocean Harvest	$H_{O,F,N,CL}$	$(H_{O,\alpha,N,\beta})(I_{F,N,CL} / I\alpha_{,N,\beta})$
Clear Creek	**Watershed Production Estimate for Fall-run**	$P_{F,N,BU}$	$I_{F,N,BU} + H_{A,F,N,BU,D} + H_{O,F,N,BU}$
Deer Creek	Carcass Survey	$E_{C,F,N,DE}$	$(E_{C,F,T,DE})(1 - h_{C,F,DE})$
Deer Creek	In-River Run[a]	$I_{F,N,DE}$	$E_{C,F,N,DE}$
Deer Creek	Downstream Angler Harvest[a]	$H_{A,F,N,DE,D}$	$(H_{A,\alpha,N,SA,I})(I_{F,N,DE} / (E_{\gamma,\alpha,N,SA} + I\alpha_{,N,BA} + I\alpha_{,N,BU} + I\alpha_{,N,CL} + I\alpha_{,N,DE} + I\alpha_{,N,MI})) + (H_{A,\alpha,N,\beta,D})(I_{F,N,DE} / I\alpha_{,N,\beta})$
Deer Creek	Ocean Harvest	$H_{O,F,N,DE}$	$(H_{O,\alpha,N,\beta})(I_{F,N,DE} / I\alpha_{,N,\beta})$
Deer Creek	**Watershed Production Estimate for Fall-run**	$P_{F,N,DE}$	$I_{F,N,DE} + H_{A,F,N,DE,D} + H_{O,F,N,DE}$
Feather River	Carcass Survey	$E_{C,F,N,FE}$	$(E_{C,F,T,FE})(1 - h_{C,F,FE})$
Feather River	Hatchery Returns	$E_{H,F,N,FE}$	$(E_{H,F,T,FE})(1 - h_{H,F,FE})$

Shading indicates CAMP calculations.
No shading indicates agency calculations.

Table A-1. Calculations to Estimate Annual Fall-run Chinook Salmon Production

Watershed	Monitoring Method	Variable	Formula
Feather River	Instream Angler Harvest	$H_{A,F,N,FE,I}$	$(H_{A,F,T,FE,I})(1 - h_{A,F,FE,I})$
Feather River	In-River Run[a]	$I_{F,N,FE}$	$E_{C,F,N,FE} + E_{H,F,N,FE} + H_{A,F,N,FE,I}$
Feather River	Downstream Angler Harvest[a]	$H_{A,F,N,FE,D}$	$(H_{A,\alpha,N,\beta,D})(I_{F,N,FE} / I_{\alpha,N,\beta})$
Feather River	Ocean Harvest	$H_{O,F,N,FE}$	$(H_{O,\alpha,N,\beta})(I_{F,N,FE} / I_{\alpha,N,\beta})$
Feather River	**Watershed Production Estimate for Fall-run**	$P_{F,N,FE}$	$I_{F,N,FE} + H_{A,F,N,FE,D} + H_{O,F,N,FE}$
Merced River	Carcass Survey	$E_{C,F,N,ME}$	$(E_{C,F,T,ME})(1 - h_{C,F,ME})$
Merced River	Hatchery Returns	$E_{H,F,N,ME}$	$(E_{H,F,T,ME})(1 - h_{H,F,ME})$
Merced River	In-River Run[a]	$I_{F,N,ME}$	$E_{C,F,N,ME} + E_{H,F,N,ME}$
Merced River	Downstream Angler Harvest[a]	$H_{A,F,N,ME,D}$	$(H_{A,\alpha,N,\beta,D})(I_{F,N,ME} / I_{\alpha,N,\beta})$
Merced River	Ocean Harvest	$H_{O,F,N,ME}$	$(H_{O,\alpha,N,\beta})(I_{F,N,ME} / I_{\alpha,N,\beta})$
Merced River	**Watershed Production Estimate for Fall-run**	$P_{F,N,ME}$	$I_{F,N,ME} + H_{A,F,N,ME,D} + H_{O,F,N,ME}$
Mill Creek	Carcass Survey	$E_{C,F,N,MI}$	$(E_{C,F,T,MI})(1 - h_{C,F,MI})$
Mill Creek	In-River Run[a]	$I_{F,N,MI}$	$E_{C,F,N,MI}$
Mill Creek	Downstream Angler Harvest[a]	$H_{A,F,N,MI,D}$	$(H_{A,\alpha,N,SA,I})(I_{F,N,MI} / (E_{\gamma,\alpha,N,SA} + I_{\alpha,N,BA} + I_{\alpha,N,BU} + I_{\alpha,N,CL} + I_{\alpha,N,DE} + I_{\alpha,N,MI})) + (H_{A,\alpha,N,\beta,D})(I_{F,N,MI} / I_{\alpha,N,\beta})$
Mill Creek	Ocean Harvest	$H_{O,F,N,MI}$	$(H_{O,\alpha,N,\beta})(I_{F,N,MI} / I_{\alpha,N,\beta})$

Shading indicates CAMP calculations.
No shading indicates agency calculations.

Table A-1. Calculations to Estimate Annual Fall-run Chinook Salmon Production

Watershed	Monitoring Method	Variable	Formula
Mill Creek	**Watershed Production Estimate for Fall-run**	$P_{F,N,MI}$	$I_{F,N,MI} + H_{A,F,N,MI,D} + H_{O,F,N,MI}$
Mokelumne River	Ladder Count	$E_{L,F,N,MO}$ [b]	$(E_{L,F,T,MO})(1 - h_{L,F,MO})$ or $E_{L,F,T,MO} - E_{H,F,T,MO}$
Mokelumne River	Hatchery Returns[c]	$E_{H,F,T,MO}$	$E_{H,F,T,MO}$
Mokelumne River	In-River Run[a]	$I_{F,N,MO}$	$E_{L,F,N,MO}$
Mokelumne River	Downstream Angler Harvest[a]	$H_{A,F,N,MO,D}$	$(H_{A,\alpha,N,\beta,D})(I_{F,N,MO} / I_{\alpha,N,\beta})$
Mokelumne River	Ocean Harvest	$H_{O,F,N,MO}$	$(H_{O,\alpha,N,\beta})(I_{F,N,MO} / I_{\alpha,N,\beta})$
Mokelumne River	**Watershed Production Estimate for Fall-run**	$P_{F,N,MO}$	$I_{F,N,MO} + H_{A,F,N,MO,D} + H_{O,F,N,MO}$
Sacramento River	Carcass Survey	$E_{C,F,N,SA}$	$(E_{C,F,T,SA})(1 - h_{C,F,SA})$
Sacramento River	Aerial Redd Count[d]	$E_{R,F,N,SA}$	$(E_{R,F,T,SA})(1 - h_{C,F,SA})$
Sacramento River	Ladder Count[d]	$E_{L,F,N,SA}$	$E_{L,F,T,SA}$
Sacramento River	Instream Angler Harvest	$H_{A,F,N,SA,I}$	$(H_{A,\alpha,N,SA,I})((E_{C,F,N,SA}) / (E_{\gamma,\alpha,N,SA} + I_{\alpha,N,BA} + I_{\alpha,N,BU} + I_{\alpha,N,CL} + I_{\alpha,N,DE} + I_{\alpha,N,MI}))$
Sacramento River	In-River Run[a]	$I_{F,N,SA}$	$E_{C,F,N,SA}$ [e] $+ H_{A,F,N,SA,I}$
Sacramento River	Downstream Angler Harvest[a]	$H_{A,F,N,SA,D}$	$(H_{A,\alpha,N,\beta,D})(I_{F,N,SA} / I_{\alpha,N,\beta})$
Sacramento River	Ocean Harvest	$H_{O,F,N,SA}$	$(H_{O,\alpha,N,\beta})(I_{F,N,SA} / I_{\alpha,N,\beta})$
Sacramento River	**Watershed Production Estimate for Fall-run**	$P_{F,N,SA}$	$I_{F,N,SA} + H_{A,F,N,SA,D} + H_{O,F,N,SA}$

Shading indicates CAMP calculations.
No shading indicates agency calculations.

Table A-1. Calculations to Estimate Annual Fall-run Chinook Salmon Production

Watershed	Monitoring Method	Variable	Formula
Stanislaus River	Carcass Survey	$E_{C,F,N,ST}$	$(E_{C,F,T,ST})(1 - h_{C,F,ST})$
Stanislaus River	Instream Angler Harvest	$H_{A,F,N,ST,I}$	$(H_{A,F,T,ST,I})(1 - h_{A,F,ST,I})$
Stanislaus River	In-River Run[a]	$I_{F,N,ST}$	$E_{C,F,N,ST} + H_{A,F,N,ST,I}$
Stanislaus River	Downstream Angler Harvest[a]	$H_{A,F,N,ST,D}$	$(H_{A,\alpha,N,\beta,D})(I_{F,N,ST} / I_{\alpha,N,\beta})$
Stanislaus River	Ocean Harvest	$H_{O,F,N,ST}$	$(H_{O,\alpha,N,\beta})(I_{F,N,ST} / I_{\alpha,N,\beta})$
Stanislaus River	**Watershed Production Estimate for Fall-run**	$P_{F,N,SA}$	$I_{F,N,ST} + H_{A,F,N,ST,D} + H_{O,F,N,ST}$
Tuolumne River	Carcass Survey	$E_{C,F,N,TU}$	$(E_{C,F,T,TU})(1 - h_{C,F,TU})$
Tuolumne River	In-River Run[a]	$I_{F,N,TU}$	$E_{C,F,N,TU}$
Tuolumne River	Downstream Angler Harvest[a]	$H_{A,F,N,TU,D}$	$(H_{A,\alpha,N,\beta,D})(I_{F,N,TU} / I_{\alpha,N,\beta})$
Tuolumne River	Ocean Harvest	$H_{O,F,N,TU}$	$(H_{O,\alpha,N,\beta})(I_{F,N,TU} / I_{\alpha,N,\beta})$
Tuolumne River	**Watershed Production Estimate for Fall-run**	$P_{F,N,TU}$	$I_{F,N,TU} + H_{A,F,N,TU,D} + H_{O,F,N,TU}$
Yuba River	Carcass Survey	$E_{C,F,N,YU}$	$(E_{C,F,T,YU})(1 - h_{C,F,YU})$
Yuba River	Instream Angler Harvest	$H_{A,F,N,YU,I}$	$(H_{A,F,T,YU,I})(1 - h_{A,F,YU,I})$
Yuba River	In-River Run[a]	$I_{F,N,YU}$	$E_{C,F,N,YU} + H_{A,F,N,YU,I}$
Yuba River	Downstream Angler Harvest[a]	$H_{A,F,N,YU,D}$	$(H_{A,\alpha,N,\beta,D})(I_{F,N,YU} / I_{\alpha,N,\beta})$
Yuba River	Ocean Harvest	$H_{O,F,N,YU}$	$(H_{O,\alpha,N,\beta})(I_{F,N,YU} / I_{\alpha,N,\beta})$

Shading indicates CAMP calculations.
No shading indicates agency calculations.

Table A-1. Calculations to Estimate Annual Fall-run Chinook Salmon Production

Watershed	Monitoring Method	Variable	Formula
Yuba River	Watershed Production Estimate for Fall-run	$P_{F,N,YU}$	$I_{F,N,YU} + H_{A,F,N,YU,D} + H_{O,F,N,YU}$
All Watersheds	Systemwide Fall-run Production Estimate	$P_{F,N,\beta}$	$P_{F,N,AM} + P_{F,N,BA} + P_{F,N,BU} + P_{F,N,DE} + P_{F,N,FE} + P_{F,N,ME} + P_{F,N,MI} + P_{F,N,MO} + P_{F,N,SA} + P_{F,N,ST} + P_{F,N,TU} + P_{F,N,YU}$

[a] Data derived directly from calculations, not field monitoring.

[b] Use alternate equation if tag recovery data cannot be obtained at Woodbridge Dam, assumes hatchery returns are composed of only hatchery fish.

[c] Hatchery returns are only composed of hatchery fish, no naturally produced fish enter hatchery.

[d] These data are used as supportive data for carcass surveys.

[e] Adjusted based on aerial redd counts.

Notes:

$I_{\alpha,N,\beta} = I_{F,N,AM} + I_{F,N,BA} + I_{LF,N,BA} + I_{F,N,BU} + I_{S,N,BU} + I_{F,N,DE} + I_{S,N,DE} + I_{F,N,FE} + I_{F,N,ME} + I_{F,N,MI} + I_{S,N,MI} + I_{F,N,MO} + I_{F,N,SA} + I_{LF,N,SA} + I_{W,N,SA} + I_{S,N,SA} + I_{F,N,ST} + I_{F,N,TU} + I_{F,N,YU}$

$H_{A,\alpha,N,\beta,D} = H_{A,\alpha,N,\beta} - (H_{A,F,N,AM,I} + H_{A,F,N,FE,I} + H_{A,F,N,SA,I} + H_{A,LF,N,SA,I} + H_{A,S,N,SA,I} + H_{A,F,N,ST,I} + H_{A,F,N,YU,I})$

$H_{A,\alpha,N,\beta} = (H_{A,\alpha,T,\beta})(1-h_{A,\alpha,\beta})$

$H_{O,\alpha,N,\beta} = (H_{O,\alpha,T,\beta})(1-h_{O,\alpha,\beta})$

Shading indicates CAMP calculations.
No shading indicates agency calculations.

Table A-2. Calculations to Estimate Annual Late Fall-run Chinook Salmon Production

Watershed	Monitoring Method	Variable	Formula
Battle Creek	Carcass Survey	$E_{C,LF,N,BA}$	$(E_{C,LF,T,BA})(1 - h_{C,LF,BA})$
Battle Creek	Hatchery Returns	$E_{H,LF,N,BA}$	$(E_{H,LF,T,BA})(1 - h_{H,LF,BA})$
Battle Creek	In-River Run[a]	$I_{LF,N,BA}$	$E_{C,LF,N,BA} + E_{H,LF,N,BA}$
Battle Creek	Downstream Angler Harvest[a]	$H_{A,LF,N,BA,D}$	$(H_{A},\alpha_{,N,SA,I})(I_{LF,N,BA} / (E_{\gamma},\alpha_{,N,SA} + I\alpha_{,N,BA} + I\alpha_{,N,BU} + I\alpha_{,N,CL} + I\alpha_{,N,DE} + I\alpha_{,N,MI})) + (H_{A},\alpha_{,N,\beta,D})(I_{LF,N,BA} / I\alpha_{,N,\beta})$
Battle Creek	Ocean Harvest	$H_{O,LF,N,BA}$	$(H_{O},\alpha_{,N,\beta})(I_{LF,N,BA} / I\alpha_{,N,\beta})$
Battle Creek	**Watershed Production Estimate for Late Fall-run**	$\mathbf{P_{LF,N,BA}}$	$\mathbf{I_{LF,N,BA} + H_{A,LF,N,BA,D} + H_{O,LF,N,BA}}$
Sacramento River	Aerial Redd Surveys	$E_{R,LF,N,SA}$	$(E_{R,LF,T,SA})(1 - h_{A,LF,SA,I})$
Sacramento River	Instream Angler Harvest	$H_{A,LF,N,SA,I}$	$(H_{A},\alpha_{,N,SA,I})((E_{R,LF,N,SA}) / (E_{\gamma},\alpha_{,N,SA} + I\alpha_{,N,BA} + I\alpha_{,N,BU} + I\alpha_{,N,CL} + I\alpha_{,N,DE} + I\alpha_{,N,MI}))$
Sacramento River	In-River Run[a]	$I_{LF,N,SA}$	$E_{R,LF,N,SA} + H_{A,LF,N,SA,I}$
Sacramento River	Downstream Angler Harvest[a]	$H_{A,LF,N,SA,D}$	$(H_{A},\alpha_{,N,\beta,D})(I_{LF,N,SA} / I\alpha_{,N,\beta})$

Shading indicates CAMP calculations.
No shading indicates agency calculations.

Table A-2. Calculations to Estimate Annual Late Fall-run Chinook Salmon Production

Watershed	Monitoring Method	Variable	Formula
Sacramento River	Ocean Harvest	$H_{O,LF,N,SA}$	$(H_{O,\alpha,N,\beta})(I_{LF,N,SA} / I_{\alpha,N,\beta})$
Sacramento River	**Watershed Production Estimate for Late Fall-run**	$P_{LF,N,SA}$	$I_{LF,N,SA} + H_{A,LF,N,SA,D} + H_{O,LF,N,SA}$
All Watersheds	**Systemwide Production Estimate for Late Fall-run**	$P_{LF,\beta}$	$P_{LF,N,BA} + P_{LF,N,SA}$

[a] Data derived directly from calculations, not field monitoring.

Notes:

$I_{\alpha,N,\beta} = I_{F,N,AM} + I_{F,N,BA} + I_{LF,N,BA} + I_{F,N,BU} + I_{S,N,BU} + I_{F,N,DE} + I_{S,N,DE} + I_{F,N,FE} + I_{F,N,ME} + I_{F,N,MI} + I_{S,N,MI} + I_{F,N,MO} +$
$I_{F,N,SA} + I_{LF,N,SA} + I_{W,N,SA} + I_{S,N,SA} + I_{F,N,ST} + I_{F,N,TU} + I_{F,N,YU}$

$H_{A,\alpha,N,\beta,D} = H_{A,\alpha,N,\beta} - (H_{A,F,N,AM,I} + H_{A,F,N,FE,I} + H_{A,F,N,SA,I} + H_{A,LF,N,SA,I} + H_{A,S,N,SA,I} + H_{A,F,N,ST,I} + H_{A,F,N,YU,I})$

$H_{A,\alpha,N,\beta} = (H_{A,\alpha,T,\beta})(1-h_{A,\alpha,\beta})$

$H_{O,\alpha,N,\beta} = (H_{O,\alpha,T,\beta})(1-h_{O,\alpha,\beta})$

Shading indicates CAMP calculations.
No shading indicates agency calculations.

Table A-3. Calculations to Estimate Annual Winter-run Chinook Salmon Production

Watershed	Monitoring Method	Variable	Formula
Sacramento River	Carcass Survey	$E_{C,W,N,SA}$	$(E_{C,W,T,SA})(1 - h_{C,W,SA})$
Sacramento River	Aerial Redd Survey[b]	$E_{R,W,N,SA}$	$(E_{R,W,T,SA})(1 - h_{C,W,SA})$
Sacramento River	Ladder Count[b]	$E_{L,F,N,SA}$	$E_{L,F,T,SA}$
Sacramento River	In-River Run[a]	$I_{W,N,SA}$	$E_{C,W,N,SA}$
Sacramento River	Ocean Harvest	$H_{O,W,N,SA}$	$(H_{O,\alpha,N,\beta})(I_{W,N,SA} / I_{\alpha,N,\beta})$
Sacramento River	**Watershed Production Estimate for Winter-run**	$P_{W,N,SA}$	$I_{W,N,SA} + H_{O,W,N,SA}$
All Watersheds	**Systemwide Production Estimate for Winter-run**	$P_{W,N,\beta}$	$P_{W,N,SA}$

[a] Data derived directly from calculations, not field monitoring.

[b] These data are used as supportive data for carcass surveys.

Notes:

$I_{\alpha,N,\beta} = I_{F,N,AM} + I_{F,N,BA} + I_{LF,N,BA} + I_{F,N,BU} + I_{S,N,BU} + I_{F,N,DE} + I_{S,N,DE} + I_{F,N,FE} + I_{F,N,ME} + I_{F,N,MI} + I_{S,N,MI} + I_{F,N,MO} + I_{F,N,SA} + I_{LF,N,SA} + I_{W,N,SA} + I_{S,N,SA} + I_{F,N,ST} + I_{F,N,TU} + I_{F,N,YU}$

$H_{A,\alpha,N,\beta,D} = H_{A,\alpha,N,\beta} - (H_{A,F,N,AM,I} + H_{A,F,N,FE,I} + H_{A,F,N,SA,I} + H_{A,LF,N,SA,I} + H_{A,S,N,SA,I} + H_{A,F,N,ST,I} + H_{A,F,N,YU,I})$

$H_{A,\alpha,N,\beta} = (H_{A,\alpha,T,\beta})(1-h_{A,\alpha,\beta})$

$H_{O,\alpha,N,\beta} = (H_{O,\alpha,T,\beta})(1-h_{O,\alpha,\beta})$

Shading indicates CAMP calculations.
No shading indicates agency calculations.

Table A-4. Calculations to Estimate Annual Spring-run Chinook Salmon Production

Watershed	Monitoring Method	Variable	Formula
Butte Creek	Snorkel Survey	$E_{S,S,N,BU}$	$(E_{S,S,T,BU})(1 - h_{?,S,BU})$[b]
Butte Creek	In-River Run[a]	$I_{S,N,BU}$	$E_{S,S,N,BU}$
Butte Creek	Downstream Angler Harvest	$H_{A,S,N,BU,D}$	$(H_{A,\alpha,N,SA,I})(I_{S,N,BU}/(E_{\gamma,\alpha,N,SA} + I_{\alpha,N,BA} + I_{\alpha,N,BU} + I_{\alpha,N,CL} + I_{\alpha,N,DE} + I_{\alpha,N,MI})) + (H_{A,\alpha,N,\beta,D})(I_{S,N,BU}/I_{\alpha,N,\beta})$
Butte Creek	Ocean Harvest	$H_{O,S,N,BU}$	$(H_{O,\alpha,N,\beta})(I_{S,N,BU}/ I_{\alpha,N,\beta})$
Butte Creek	**Watershed Production Estimate for Spring-run**	$P_{S,N,BU}$	$I_{S,N,BU} + H_{A,S,N,BU,D} + H_{O,S,N,BU}$
Deer Creek	Snorkel Survey	$E_{S,S,N,DE}$	$(E_{S,S,T,DE})(1 - h_{?,L,S,DE})$[c]
Deer Creek	In-River Run[a]	$I_{S,N,DE}$	$E_{S,S,N,DE}$
Deer Creek	Downstream Angler Harvest	$H_{A,S,N,DE,D}$	$(H_{A,\alpha,N,SA,I})(I_{S,N,DE} / (E_{\gamma,\alpha,N,SA} + I_{\alpha,N,BA} + I_{\alpha,N,BU} + I_{\alpha,N,CL} + I_{\alpha,N,DE} + I_{\alpha,N,MI})) + (H_{A,\alpha,N,\beta,D})(I_{S,N,DE} / I_{\alpha,N,\beta})$
Deer Creek	Ocean Harvest	$H_{O,S,N,DE}$	$(H_{O,\alpha,N,\beta})(I_{S,N,DE} / I_{\alpha,N,\beta})$
Deer Creek	**Watershed Production Estimate for Spring-run**	$P_{S,N,DE}$	$I_{S,N,DE} + H_{A,S,N,DE,D} + H_{O,S,N,DE}$

Shading indicates CAMP calculations.
No shading indicates agency calculations.

Table A-4. Calculations to Estimate Annual Spring-run Chinook Salmon Production

Watershed	Monitoring Method	Variable	Formula
Mill Creek	Ladder Counts	$E_{L,S,N,MI}$	$(E_{L,S,T,MI})(1 - h_{L,S,MI})$
Mill Creek	In-River Run[a]	$I_{S,N,MI}$	$E_{L,S,N,MI}$
Mill Creek	Downstream Angler Harvest	$H_{A,S,N,MI,D}$	$(H_{A},\alpha_{,N,SA,I})(I_{S,N,MI} / (E_{\gamma,}\alpha_{,N,SA} + I\alpha_{,N,BA} + I\alpha_{,N,BU} + I\alpha_{,N,CL} + I\alpha_{,N,DE} + I\alpha_{,N,MI})) + (H_{A},\alpha_{,N,\beta,D})(I_{S,N,MI} / I\alpha_{,N,\beta})$
Mill Creek	Ocean Harvest	$H_{O,S,N,MI}$	$(H_{O},\alpha_{,N,\beta})(I_{S,N,MI} / I\alpha_{,N,\beta})$
Mill Creek	**Watershed Production Estimate for Spring-run**	$P_{S,N,MI}$	$I_{S,N,MI} + H_{A,S,N,MI,D} + H_{O,S,N,MI}$
Sacramento River	Ladder Counts	$E_{L,S,N,SA}$	$(E_{L,S,T,SA})(1 - h_{L,S,SA,I})$
Sacramento River	Instream Angler Harvest	$H_{A,S,N,SA,I}$	$(H_{A},\alpha_{,N,SA,I})((E_{L,S,N,SA}) / (E_{\gamma,}\alpha_{,N,SA} + I\alpha_{,N,BA} + I\alpha_{,N,BU} + I\alpha_{,N,CL} + I\alpha_{,N,DE} + I\alpha_{,N,MI}))$
Sacramento River	In-River Run[a]	$I_{S,N,SA}$	$E_{L,S,N,SA} + H_{A,SN,SA,I}$
Sacramento River	Downstream Angler Harvest	$H_{A,S,N,SA,D}$	$(H_{A},\alpha_{,N,\beta,D})(I_{S,N,SA} / I\alpha_{,N,\beta})$

Shading indicates CAMP calculations.
No shading indicates agency calculations.

Table A-4. Calculations to Estimate Annual Spring-run Chinook Salmon Production

Watershed	Monitoring Method	Variable	Formula
Sacramento River	Ocean Harvest	$H_{O,S,N,SA}$	$(H_{O,\alpha,N,\beta})(I_{S,N,SA} / I_{\alpha,N,\beta})$
Sacramento River	Watershed Production Estimate for Spring-run	$P_{S,N,SA}$	$I_{S,N,SA} + H_{A,S,N,SA,D} + H_{O,S,N,SA}$
All Watersheds	Systemwide Production Estimate for Spring-run	$P_{S,N,\beta}$	$P_{S,N,BU} + P_{S,N,DE} + P_{S,N,MI} + P_{S,N,SA}$

a Data derived directly from calculations, not field monitoring.

b Hatchery fraction cannot be estimated from snorkel surveys; carcass surveys or video recordings of chinook salmon passing Parrott-Phelan sources of hatchery fraction.

c Observations of chinook salmon passing Stanford-Vina Dam are potential sources of hatchery fraction.

Notes:

$I_{\alpha,N,\beta} = I_{F,N,AM} + I_{F,N,BA} + I_{LF,N,BA} + I_{F,N,BU} + I_{S,N,BU} + I_{F,N,DE} + I_{S,N,DE} + I_{F,N,FE} + I_{F,N,ME} + I_{F,N,MI} + I_{S,N,MI} + I_{F,N,MO} + I_{F,N,SA} + I_{LF,N,SA} + I_{W,N,SA} + I_{S,N,SA} + I_{F,N,ST} + I_{F,N,TU} + I_{F,N,YU}$

$H_{A,\alpha,N,\beta,D} = H_{A,\alpha,N,\beta} - (H_{A,F,N,AM,I} + H_{A,F,N,FE,I} + H_{A,F,N,SA,I} + H_{A,LF,N,SA,I} + H_{A,S,N,SA,I} + H_{A,F,N,ST,I} + H_{A,F,N,YU,I})$

$H_{A,\alpha,N,\beta} = (H_{A,\alpha,T,\beta})(1-h_{A,\alpha,\beta})$

$H_{O,\alpha,N,\beta} = (H_{O,\alpha,T,\beta})(1-h_{O,\alpha,\beta})$

Shading indicates CAMP calculations.
No shading indicates agency calculations.

Table A-5. Calculations to Estimate Annual Steelhead Trout Production

Watershed	Monitoring Method	Variable	Formula
Battle Creek	Hatchery Returns	$E_{H,ST,N,BA}$	$(E_{H,ST,T,BA})(1 - h_{H,ST,BA})$
Sacramento River	Instream Angler Harvest	$H_{A,ST,N,SA,I}$	$(H_{A,ST,T,SA,I})(1 - h_{A,ST,SA,I})$
Sacramento River	In-River Run[a]	$I_{ST,N,SA}$	$H_{A,ST,N,SA,I}$[b]

[a] Data derived directly from calculations, not field monitoring.
[b] Regression equation used to estimate in-river run size based upon instream angler harvest.

Shading indicates CAMP calculations.
No shading indicates agency calculations.

Key to Calculation Variables and Subscripts

Variables	Subscripts		
	Monitoring Method	**Species/Race**	**Watersheds**
E = spawner abundance (escapement)			
H = harvest	C = Carcass Survey	F = Fall-run Chinook Salmon	AM = American River
P = production	R = Aerial Redd Count	LF = Late Fall-run Chinook Salmon	BA = Battle Creek
I = in-river run	L = Ladder Count	W = Winter-run Chinook Salmon	BU = Butte Creek
h = fish of hatchery origin	S = Snorkel Survey	S = Spring-run Chinook Salmon	CL = Clear Creek
	H = Hatchery Count	α = all chinook salmon races	DE = Deer Creek
	A = Angler Survey	ST = Steelhead Trout	FE = Feather River
	I = Instream	N = fish of natural origin	ME = Merced River
	D = Downstream	T = natural + hatchery fish	MI = Mill Creek
	O = Ocean Harvest		MO = Mokelumne River
	γ = all monitoring methods		SA = Sacramento River
	? = unknown monitoring method		ST = Stanislaus River
			TU = Tuolumne River
			YU = Yuba River
			β = all CAMP target watersheds

APPENDIX B. EXISTING ADULT AND JUVENILE MONITORING PROGRAMS

APPENDIX B

EXISTING ADULT AND JUVENILE MONITORING PROGRAMS

Following is a series of worksheets that details existing adult and juvenile monitoring programs that will provide useful data to CAMP. The first set of worksheets pertains to adult monitoring programs, while the second set of worksheets pertains to juvenile monitoring programs.

EXISTING ADULT PROGRAM 1
Lower American River Salmon Escapement Survey

Species: Fall-run Chinook Salmon
Watershed: American River

BACKGROUND INFORMATION

Monitoring Methods: Spawning escapement survey

Target Species: Fall-run chinook salmon

Target Life Stages: Adult spawners

Program Name: Lower American River Chinook Salmon Escapement Survey

Lead Agency: California Department of Fish and Game

Program Manager: Nick Villa

Address: California Department of Fish and Game, Region 2
1701 Nimbus Road
Rancho Cordova, CA 95670

Phone: (916) 358-2943

Key Supporting Agencies: County of Sacramento, East Bay Municipal Utilities District, Alameda County Superior Court

Key Supporting Staff: Maury Fjelstad

Program Goals:

1) Estimate lower American River fall-run chinook salmon spawning populations, including confidence limits.
2) Evaluate the Jolly-Seber and the Schaefer population estimation procedures and recommend future escapement estimation procedures.
3) Augment redd surveys to provide baseline information on spawning distribution, spawning habitat availability, instream flow requirements, and status of chinook salmon in the Lower American River.

Program Duration: 1954 to present

Geographic Area Covered: Uppermost 14 miles of lower American River (RM 9-23)

Parameters Measured:

Biological: Population estimates, spatial and temporal spawning distribution, length frequency, sex ratio, egg retention, coded-wire tagged fish
Physical: Water clarity, temperature
Chemical: None

How Were Hatchery Fish Distinguished from Wild Fish?: Presence of adipose fin clip, coded-wire tag or other mark indicating hatchery fish, otherwise indistinguishable; otoliths currently being evaluated for utility in separating hatchery- and naturally-produced fish.

Data Storage:

Location: California Department of Fish and Game, Sacramento
Contact for Data Retrieval: Bill Snider, CDFG
Available to Public: For review
Cost of data: None for agencies, photocopy charge for private parties
Storage Format(electronic/hardcopy): Hardcopy and electronic
Hardware: PC
Software: dBASE IV, QuattroPro, Lotus 123
Quality Assurance (for data entry as opposed to analytical): Yes

Products (Delivery Dates):

Data: Usually by March of each year
Progress Reports: Annual reports
Final Reports: Ongoing program, no final reports

Comparable Data Available during 1967-1991 Period: Mills, T. J. And F. Fisher. 1994. Central Valley anadromous sport fish annual run size, harvest, and population estimates, 1967 through 1991. Inland Fisheries Technical Report, June 1993. Revised August 1994. California Department of Fish and Game. Sacramento, CA.

Note: Before 1974, expanded direct counts were used. After 1974, the Schaefer method was used primarily, but expanded direct counts and Jolly-Seber method were also used.

Reliance on other Monitoring Programs: Water clarity, flow, and temperature obtained from concurrent study.

Funding Source: County of Sacramento, CDFG (through 1994)

Quantity of Funds: $15,000 from Sacramento County (1993); No CDFG funds were officially allocated, but program manager estimates the total cost exceeded above funds about threefold.

Security of Funds: Not secure, program in jeopardy

References (any reprints or reports used in compiling entry): Snider, W.M., N. Keenan and M. Munos. 1993. Lower American River chinook salmon escapement survey: September 1992-January 1993. California Department of Fish and Game, Stream Evaluation Program, Environmental Services Division. Sacramento, CA.

Specific Monitoring Methods: Schaefer and Jolly-Seber mark-recovery methods based on salmon carcasses.

Sampling Reaches:

1) Sailor Bar to Rossmoor (RM 23-18)
2) Rossmoor to Goethe Park Footbridge (RM 18-14.5)
3) Goethe Park Footbridge to Watt Avenue (RM 14.5-9)

Sampling Frequency: Weekly; reaches surveyed on three consecutive days.

Sampling Period: October 15 to January 31 (15 weeks)

Sampling Equipment: Drift boat or skiff, outboard motor, life jackets, waders, long- and short-handled gaffs, hog rings, colored surveying tape, hog ring pliers, machetes, data recording slates, tape measures, thermometer, knife, plastic bags, recovery tags for adipose-clipped fish, first-aid kit.

Sampling Methods:

1) Survey reaches on three consecutive days per week in a downstream direction.
2) Tag all fresh carcasses (clear-eye and/or pink gills) with color-coded hog ring in upper jaw.
3) Determine sex and measure standard length and fork length (if possible) of fresh carcasses.
4) Determine egg retention (completely spawned, partially spawned, unspawned females).
5) Return fresh carcasses to flowing water just upstream from where they were collected.
6) Count non-fresh carcasses and cut through backbone with machete to remove from future surveys.

7) Tag recaptured tagged carcasses with a second hog ring, record week of initial tagging, and replace carcass in river as described above.
8) Continue surveys 2-4 weeks beyond the last tagging date to recover tagged carcasses.

Data Analysis: Estimate total escapement (numbers of fish) of adults and grilse by reach using Schaefer and Jolly-Seber methods.

Staffing:

Field Work: 10 personnel months
Data Analysis/Management/Report: 4.6 personnel months

Report Prepared by: California Department of Fish and Game

Report Contents Include:

1) Estimated total escapement of adults and grilse based on Schaefer and Jolly-Seber methods.
2) Fresh and nonfresh carcass counts by reach and week.
3) Proportions of adults and grilse among fresh carcasses.
4) Length frequency distribution and sex composition of fresh carcasses.
5) Proportions of completely, partially, and unspawned females.
6) Flows, water temperatures, and water visibility during survey period.
7) Number of coded-wire tagged salmon by recovery week and hatchery of origin.

EXISTING ADULT PROGRAM 2
Battle Creek Escapement Survey

Species: Chinook Salmon
Watershed: Battle Creek

BACKGROUND INFORMATION

Monitoring Methods: Spawning escapement surveys

Target Species: Fall-, late fall-, and winter-run chinook salmon

Target Life Stages: Adults

Program Name: Battle Creek Escapement Survey

Lead Agency: California Department of Fish and Game

Program Manager: Frank Fisher

Address: California Department of Fish and Game
P.O. Box 578
Red Bluff, CA 96080

Phone: (916) 527-8892

Key Supporting Agencies: U.S. Fish and Wildlife Service

Key Support Staff: Colleen Harvey, CDFG

Program Goals: Estimate annual fall-, late fall-, and winter-run chinook salmon spawning populations in Battle Creek.

Program Duration: 1952-present

Geographic Area Covered: Battle Creek from mouth to CNFH barrier dam.

Parameters Measured:
Biological: Spawner abundance estimates
Physical: None
Chemical: None

How Were Hatchery Fish Distinguished From Wild Fish?: Presence of adipose fin clip (coded-wire tag) or other fin clip, otherwise not distinguishable.

Data Storage:

Location: CDFG, Red Bluff
Contact for Data Retrieval: Frank Fisher, Colleen Harvey (CDFG)
Address: Red Bluff
Phone: (916) 527-8892
Available to Public: Yes
Cost of data: None
Storage Format(electronic/hardcopy): Electronic storage and hardcopy reports
Hardware: PC
Software: Lotus 123
Quality Assurance (for data entry as opposed to analytical):

Products (Delivery Dates):

Data: N/A
Progress Reports: Annual
Final Reports: Ongoing program, no final reports

Comparable Data Available during 1967-1991 Period: Mills, T. J. And F. Fisher. 1994. Central Valley anadromous sport fish annual run size, harvest, and population estimates, 1967 through 1991. Inland Fisheries Technical Report, June 1993. Revised August 1994. California Department of Fish and Game. Sacramento, CA.

Reliance on Other Monitoring Programs: None

Funding Source: 75% Federal Sportfish Restoration Funds (Wallop-Breaux), 25% State Preservation Funds.

Quantity of Funds:

Security of Funds:

References (any reprints or reports used in compiling entry):

Specific Monitoring Methods:

Ladder counts (fall-, late fall-, spring-, and winter-run chinook salmon)
Snorkel surveys (spring-run chinook salmon)
Carcass surveys (fall- and late fall-run chinook salmon)

Sampling Reaches:

Ladder counts: Fish barrier dam at Coleman National Fish Hatchery.
Snorkel counts: Above fish barrier dam.
Carcass surveys:

Sampling Frequency:

Ladder counts: Daily (continuous) during fall-, late fall-, spring-, and winter-run immigration periods.
Snorkel counts:
Carcass surveys: Weekly during fall- and late fall-run spawning periods.

Sampling Period:

Ladder counts: July 1-June 30, depending on flows
Snorkel counts: July 1-August 31
Carcass surveys: October 1-March 1

Sampling Equipment:

Ladder Counts: Video recording system.
Snorkel Surveys: Mask, snorkel, wetsuit, thermometer, underwater slate.
Carcass Surveys: Gaffs, hog rings and pliers, colored surveying tape, machetes, data recording slates, tape measures, knife, plastic bags, recovery labels for adipose-clipped fish.

Sampling Methods:

Ladder Counts:
1) Count fish directly or from video recordings of fish passing counting facilities.
2) Record species, race, sex, sampling date, and time.
3) Estimate fish lengths visually or from video recordings.
4) Record adipose fin clips and other marks (e.g., non-adipose fin clips).

Snorkel Surveys:
1) Thoroughly inspect potential or known holding areas for presence of adult salmon.
2) Count and record numbers of adult salmon observed.
3) Measure water temperatures and extent of thermal stratification.

Carcass Surveys:
1) Tag all fresh carcasses (clear-eye) with color-coded hog ring in lower jaw.
2) Record sex and age class (adult or grilse) of fresh carcasses.

3) Return fresh carcasses to flowing water just upstream from where they were collected.
4) Record nonfresh carcasses and age class (adult or grilse) and cut through backbone with machete to remove from future surveys.
5) Record recovered tagged carcasses, age class (adult or grilse), week of tagging, and cut through backbone to remove from future surveys.
6) Collect otoliths/scales, measure standard and fork lengths from representative sample of carcasses (30 carcasses per survey).
7) Remove snout from adipose-clipped carcasses and retain in individually labeled plastic bags for later detection, removal, and decoding of coded-wire tags.

Data Analysis:

Ladder Counts:
1) Summarize daily ladder counts of chinook salmon by race.
2) Estimate total run size above fish barrier dam by race.

Snorkel Surveys:
1) Summarize counts and distribution of spring-run adults in summer holding areas.

Carcass Surveys:
1) Estimate escapement (numbers of fish) of fall- and late fall-run adults and grilse using Schaefer method.
2) Describe spatial and temporal spawning distributions.
3) Summarize length frequency and sex composition data.
4) Summarize flow, water temperature, and water visibility data.
5) Summarize counts of tagged/marked fish and coded-wire tagged salmon.

Staffing:

Field Work:
Ladder counts: 12.0 personnel months
Snorkel Surveys: 0.6 personnel months
Carcass Surveys: 8.0 personnel months

Data Analysis/Management/Report:
Ladder Counts: 1.0 personnel months per stream
Snorkel Surveys: 0.3 personnel month per stream
Carcass Surveys: 2.0 personnel month per stream

Report Prepared by: California Department of Fish and Game

Report Contents Include:

1) Ladder counts of fall-, late fall-, winter-, and spring-run chinook salmon by week.
2) Snorkeling counts of spring-run chinook salmon.
3) Estimated escapement of adult and grilse fall- and late fall-run chinook salmon by reach.
4) Periods for which counts or estimates could not be obtained or were generated by other means (e.g., interpolation).

EXISTING ADULT PROGRAM 3
Butte Creek Escapement and Snorkel Survey

Species: Chinook Salmon
Watershed: Butte Creek

BACKGROUND INFORMATION

Monitoring Methods: Carcass surveys and snorkel surveys

Target Species: Fall- and spring-run chinook salmon

Target Life Stages: Adults

Program Name: Butte Creek Escapement and Snorkel Survey

Lead Agency: California Department of Fish and Game

Program Managers: Nick Villa

Address: California Department of Fish and Game, Region 2
1701 Nimbus Road
Rancho Cordova, CA 95670

Phone: (916) 358-2939

Key Supporting Agencies:

Key Support Staff: John Nelson, Kathy Hill, CDFG

Program Goals: Estimate annual spring- and fall-run chinook salmon spawning populations in Butte Creek

Program Duration: 1967-1995 (spring-run); 1995 (fall-run)

Geographic Area Covered: Centerville Dam downstream to approx. Parrott-Phelan Dam (spring-run); Parrott-Phelan Dam to Gorill Dam (fall-run).

Parameters Measured:

Biological: Snorkeling counts, spawner abundance estimates
Physical: Water temperature
Chemical: None

How Were Hatchery Fish Distinguished From Wild Fish?: Presence of adipose fin clip (coded-wire tag) or other fin clip, otherwise not distinguishable.

Data Storage:

Location: CDFG, Rancho Cordova
Contact for Data Retrieval: Kathy Hill, CDFG
Address: Rancho Cordova, CA
Phone: (916) 358-2929
Available to Public: Yes
Cost of data: None
Storage Format(electronic/hardcopy): Hardcopy and electronic
Hardware: PC
Software: N/A
Quality Assurance (for data entry as opposed to analytical):

Products (Delivery Dates):

Data:
Progress Reports: Annual
Final Reports: Ongoing program

Comparable Data Available during 1967-1991 Period: Mills, T. J. And F. Fisher. 1994. Central Valley anadromous sport fish annual run size, harvest, and population estimates, 1967 through 1991. Inland Fisheries Technical Report, June 1993. Revised August 1994. California Department of Fish and Game. Sacramento, CA.

Reliance on Other Monitoring Programs: None

Funding Source: CDFG

Quantity of Funds: No funding specifically allocated for this program.

Security of Funds: None

References (any reprints or reports used in compiling entry): Annual DFG file memoranda - Butte Creek chinook salmon spawning stock estimates 1967 to present. DFG Region 2, Rancho Cordova, CA.

Specific Monitoring Methods:

Snorkel surveys (spring-run chinook salmon)
Carcass surveys using Schaefer mark-recovery method (fall-run chinook salmon)

Sampling Reaches:

Snorkel surveys: Centerville Head Dam to Durham-Mutual Dam
Carcass surveys: Parrott-Phelan Dam to Goodspeed-Watt Road

Sampling Frequency:

Snorkel surveys: Twice per year (early and late summer)
Carcass surveys: weekly

Sampling Period:

Snorkel surveys: July or August
Carcass surveys: October 1-December 31

Sampling Equipment:

Snorkel surveys: Mask, snorkel, wetsuit, thermometer, underwater slate
Carcass Surveys: Gaffs, hog rings and pliers, colored surveying tape, machetes, data recording slates, tape measures, knife, plastic bags, recovery labels for adipose-clipped fish.

Sampling Methods:

Snorkel Surveys:
1) Thoroughly inspect potential or known holding areas for presence of adult salmon.
2) Count adult salmon and record number observed.
3) Measure water temperatures and presence of thermal stratification.

Carcass Surveys:
1) Tag all fresh carcasses (clear-eye) with color-coded hog ring in lower jaw.
2) Record sex and age class (adult or grilse) of fresh carcasses.
3) Return fresh carcasses to flowing water just upstream from where they were collected.

4) Count nonfresh carcasses, record age class (adult or grilse), and cut through backbone with machete to remove from future surveys.
5) Record recovered tagged carcasses, age class (adult or grilse), and week of tagging, and cut through backbone to remove from future surveys.
6) Collect otoliths/scales, measure standard and fork lengths from representative sample of carcasses (30 carcasses per week).
7) Remove snout from adipose-clipped carcasses and retain in individually labelled plastic bags for later detection, removal, and decoding of coded-wire tags.

Data Analysis:

Snorkel Surveys:

1) Summarize counts and distribution of spring-run adults.
2) Estimate total abundance of spring-run adults.

Carcass Surveys:

1) Estimate escapement (numbers of fish) of fall-run adults and grilse by reach using Schaefer method.
2) Describe spatial and temporal spawning distributions.
3) Summarize length frequency and sex composition data.
4) Summarize flow, water temperature, and water visibility data.
5) Summarize counts of tagged/marked fish and coded-wire tag recovery data.

Staffing:

Field Work:

Snorkel Surveys: 2.5 personnel months [4 persons per crew, 9 days per year, 12 hours per day]

Carcass Surveys: 4 personnel months [3 persons per crew, 27 days per year, 8 hours per day]

Data Analysis/Management/Report:

Snorkel Surveys: 0.7 personnel months
Carcass Surveys: 1.2 personnel months

Report Prepared by: California Department of Fish and Game

Report Contents Include:

1) Snorkeling counts of spring-run chinook salmon.
2) Estimated escapement of adult and grilse fall-run chinook salmon.
3) Periods for which counts or estimates could not be obtained or were developed by other means (e.g., interpolation).

EXISTING ADULT PROGRAM 4
Central Valley Salmon and Steelhead Project-Spawning Escapement Survey

Species: Chinook Salmon
Watershed: Deer Creek, Mill Creek

<u>BACKGROUND INFORMATION</u>

Monitoring Methods: Ladder counts, snorkel surveys

Target Species: Spring-run chinook salmon

Target Life Stages: Adults

Program Name: Central Valley Salmon and Steelhead Project, Spawning Escapement Survey

Lead Agency: California Department of Fish and Game

Program Managers: Frank Fisher, Ralph Carpenter

Address: California Department of Fish and Game
P.O. Box 578
Red Bluff, CA 96080

Phone: (916) 527-8892

Key Supporting Agencies:

Key Support Staff: Colleen Harvey

Program Goals: Estimate annual spring- and fall-run chinook salmon spawning populations in Deer and Mill Creek.

Program Duration:

Geographic Area Covered: Deer Creek (upper Deer Creek falls downstream to Stanford-Vina Dam) and Mill Creek (Morgan Hot Springs downstream to Clough Dam).

Parameters Measured:

Biological: Ladder counts of adult salmon passing Stanford-Vina Dam (Deer Creek) and Clough Dam (Mill Creek); redd counts (Deer Creek); number of adults in summer holding areas (Deer Creek).
Physical: None
Chemical: None

How Were Hatchery Fish Distinguished From Wild Fish?: Presence of adipose fin clip (coded-wire tag) or other fin clip, otherwise not distinguishable.

Data Storage:

Location: CDFG, Red Bluff
Contact for Data Retrieval: Frank Fisher, Collen Harvey (CDFG)
Address: Red Bluff
Phone: (916) 527-8892
Available to Public: Yes
Cost of data: None
Storage Format(electronic/hardcopy): Electronic storage and hardcopy reports
Hardware: PC
Software: dBase IV, Lotus 123
Quality Assurance (for data entry as opposed to analytical):

Products (Delivery Dates):

Data: N/A
Progress Reports: Annual
Final Reports: Ongoing program, no final reports

Comparable Data Available during 1967-1991 Period: Mills, T. J. And F. Fisher. 1994. Central Valley anadromous sport fish annual run size, harvest, and population estimates, 1967 through 1991. Inland Fisheries Technical Report, June 1993. Revised August 1994. California Department of Fish and Game. Sacramento, CA.

Reliance on Other Monitoring Programs: None

Funding Source:

Quantity of Funds:

Security of Funds:

References (any reprints or reports used in compiling entry):

Specific Monitoring Methods: Ladder counts and snorkel surveys (spring-run chinook salmon), Schaefer mark-recovery estimate (fall-run chinook salmon).

Sampling Reaches:

Deer Creek: Stanford-Vina Dam (ladder counts)

Mill Creek: Clough Dam (ladder counts)

Sampling Frequency: Daily ladder counts during spring-run immigration period; one snorkel survey (1-2 days) in summer; weekly carcass surveys during fall-run spawning period.

Sampling Period: Ladder counts (begin March 1, ending date dependent on flows, run timing); snorkel survey (mid- to late August); carcass surveys (October 1-December 31).

Sampling Equipment:

Ladder Counts: Electronic fish counter
Snorkel Surveys: Mask, snorkel, wetsuit, thermometer, underwater slate
Carcass Surveys: Gaffs, hog rings and pliers, colored surveying tape, machetes, data recording slates, tape measures, knife, plastic bags, recovery labels for adipose-clipped fish.

Sampling Methods:

Ladder Counts:
1) Inspect, maintain, and ensure adequate operation of fish counter throughout immigration period.
2) Determine reliability of ladder counts by visually counting salmon during three 24-hour periods during immigration period.

Snorkel Surveys:
1) Conduct survey in upstream direction during daylight hours.
2) Thoroughly inspect potential or known holding areas for presence of adult salmon.
3) Count adult salmon and record total number in each holding area.
4) Measure water temperatures and extent of thermal stratification.

Carcass Surveys:
1) Tag all fresh carcasses (clear-eye and/or pink gills) with color-coded hog ring in lower jaw.
2) Record sex and measure standard and fork length (if possible) of fresh carcasses.

3) Record egg retention in females (completely spawned, partially spawned, unspawned).
4) Return fresh carcasses to flowing water just upstream from where they were collected.
5) Record non-fresh carcasses and cut through backbone with machete to remove from future surveys.
6) Record recovered tagged carcasses, age class (adult or grilse), week of tagging, and cut through backbone to remove from future surveys.
7) Collect otoliths/scales, measure standard and fork lengths from representative sample of carcasses (30 carcasses per survey).
8) Remove snout from adipose-clipped carcasses and retain in individually labelled plastic bags for later detection, removal, and decoding of coded-wire tags.

Data Analysis:

Ladder Counts:
1) Summarize daily ladder counts of spring-run adults.
2) Estimate total run size.

Snorkel Surveys:
1) Summarize counts and distribution of spring-run adults.

Carcass Surveys:
1) Estimate escapement (numbers of fish) of fall-run adults and grilse by reach using Schaefer method.
2) Describe spatial and temporal spawning distributions.
3) Summarize fresh and nonfresh carcass counts by reach and week.
4) Summarize length frequency, sex composition, and egg retention data for fresh carcasses.
5) Summarize flow, water temperature, and water visibility data for survey period.
6) Present number of coded-wire tagged salmon by recovery week and hatchery of origin.

Staffing:

Field Work:

Ladder Counts: 8 personnel months per stream
Snorkel Surveys: 2 personnel x 16 hours = 32 personnel hours per stream (0.2 personnel months per stream)
Carcass Surveys: 8 personnel months per stream

Data Analysis/Management/Report:

Ladder Counts: 3 personnel months per stream

Snorkel Surveys: 0.2 personnel month per stream
Carcass Surveys: 1 personnel month per stream

Report Prepared by: California Department of Fish and Game

Report Contents Include:

1) Ladder counts of spring-run chinook salmon by week.
2) Snorkeling counts of spring-run chinook salmon.
3) Estimated escapement of adult and grilse fall-run chinook salmon.
4) Periods for which counts or estimates could not be obtained or were interpolated, including interpolation method.

EXISTING ADULT PROGRAM 5
Feather River Chinook Salmon Escapement Survey

Species: Fall-run Chinook Salmon
Watershed: Feather River

BACKGROUND INFORMATION

Monitoring Methods: Spawning escapement survey

Target Species: Fall-run chinook salmon

Target Life Stages: Adult spawners

Program Name: Feather River Chinook Salmon Escapement Survey

Lead Agency: California Department of Fish and Game

Program Manager: Fred Meyer

Address: California Department of Fish and Game, Region 2
1701 Nimbus Road
Rancho Cordova, CA 95670

Phone: (916) 358-2938

Key Supporting Agencies: None

Key Supporting Staff:

Program Goals: Estimate Feather River fall-run chinook salmon spawning escapement.

Program Duration: 1979 to present (excluding 1991)

Geographic Area Covered: Feather River from Oroville fish barrier dam to Gridley boat ramp

Parameters Measured:
Biological: Population estimates, spatial and temporal spawning distribution, length frequency, sex ratio, coded-wire tagged fish.
Physical: Water clarity, temperature
Chemical: None

How Were Hatchery Fish Distinguished from Wild Fish?: Presence of adipose fin clip (coded-wire tag) or other mark indicate hatchery fish, otherwise indistinguishable.

Data Storage:

Location: California Department of Fish and Game, Rancho Cordova
Contact for Data Retrieval: Fred Meyer
Available to Public: Yes
Cost of data: None
Storage Format(electronic/hardcopy): Hardcopy
Hardware:
Software:
Quality Assurance (for data entry as opposed to analytical):

Products (Delivery Dates):

Data: Usually by February of each year
Progress Reports: Annual reports
Final Reports: Ongoing program, no final reports

Comparable Data Available during 1967-1991 Period: Mills, T. J. and F. Fisher. 1994. Central Valley anadromous sport fish annual run size, harvest, and population estimates, 1967 through 1991. Inland Fisheries Technical Report, June 1993. Revised August 1994. California Department of Fish and Game. Sacramento, CA.

Reliance on other Monitoring Programs: None

Funding Source: CDFG, DWR

Quantity of Funds: $12,000 per year

Security of Funds: year-to-year

References (any reprints or reports used in compiling entry):

Specific Monitoring Methods: Schaefer mark-recovery methods based on salmon carcasses.

Sampling Reaches:

1) Oroville fish barrier dam to Thermalito Afterbay outlet.
2) Thermalito Afterbay outlet to Gridley boat ramp.

Sampling Frequency: Weekly; reaches surveyed on two consecutive days

Sampling Period: October 1 to December 15 (11 weeks)

Sampling Equipment: Drift boat or skiff, gaffs, hog rings and pliers, colored surveying tape, machetes, data recording slates, tape measures, knife, plastic bags, recovery labels for adipose-clipped fish.

Sampling Methods:

1) Count and tag all fresh carcasses (clear-eye) with color-coded hog ring in lower jaw.
2) Record sex and age class (adult or grilse) of fresh carcasses.
3) Return fresh carcasses to flowing water just upstream from where they were collected.
4) Count and record age class (adult or grilse) of nonfresh carcasses and cut through backbone with machete to remove from future surveys.
5) Record recovered tagged carcasses, age class (adult or grilse), week of tagging, and cut through backbone to remove from future surveys.
6) Collect otoliths/scales, measure standard lengths from representative sample of fresh carcasses (30 carcasses per week).
7) Remove snout from adipose-clipped carcasses and retain in individually labeled plastic bags for later detection, removal, and decoding of coded-wire tags.
8) Count carcasses with other marks/tags and record type of mark/tag.

Data Analysis:

1) Total escapement (numbers of fish) of adults and grilse by reach based on Schaefer method.
2) Spatial and temporal spawning distribution.
3) Length frequency and sex composition of fresh carcasses.
4) Flow, water temperature, and water visibility data during survey period.

Staffing:

Field Work: 4 field personnel x 20 hours/week x 11 weeks = 880 personnel hours (5.5 personnel months)

Data Analysis/Management/Report: 1 personnel x 60 hours = 60 personnel hours (0.3 personnel months)

Report Prepared by: California Department of Fish and Game

Report Contents Include:

1) Estimated total escapement of adults and grilse by reach.
2) Length frequency distribution and sex composition of fresh carcasses.
3) Flows, water temperatures, and water visibility during survey period.
4) Periods for which estimates could not be obtained or were generated by other means (e.g., interpolation).
5) Coded-wire tag data from recovered salmon, including CWT#, number of adults/grilse recovered, brood year, number of juveniles planted, release date, release site, and hatchery of origin.
6) Number of recovered adults and grilse with other marks/tags.

EXISTING ADULT PROGRAM 6
Merced River Salmon Escapement Survey

Species: Fall-run Chinook Salmon
Watershed: Merced River

BACKGROUND INFORMATION

Monitoring Methods: Spawning escapement survey

Target Species: Fall-run chinook salmon

Target Life Stages: Adult spawners

Program Name: Merced River Salmon Escapement Survey

Lead Agency: California Department of Fish and Game

Program Manager: Bill Loudermilk

Address: California Department of Fish and Game
1234 East Shaw Avenue
Fresno, CA 93710

Phone: (209) 222-3761

Key Supporting Agencies: Merced Irrigation District

Key Supporting Staff:

Program Goals: Estimate annual Merced River fall-run chinook salmon spawning escapement.

Program Duration: 1953-present

Geographic Area Covered: Merced River from Crocker-Huffman Dam to Cressy

Parameters Measured:

Biological: Population estimates, spatial and temporal spawning distribution, length frequency, sex ratio, coded-wire tagged fish.
Physical: Water clarity, temperature
Chemical: None

How Were Hatchery Fish Distinguished from Wild Fish?: Presence of adipose fin clip (coded-wire tag) or other mark indicate hatchery fish, otherwise indistinguishable.

Data Storage:

Location: California Department of Fish and Game, Fresno
Contact for Data Retrieval: Bill Loudermilk
Available to Public: Yes
Cost of data: None
Storage Format(electronic/hardcopy): Hardcopy
Hardware:
Software:
Quality Assurance (for data entry as opposed to analytical):

Products (Delivery Dates):

Data: June 30
Progress Reports: June 30
Final Reports: Ongoing program, no final reports

Comparable Data Available during 1967-1991 Period: Mills, T. J. and F. Fisher. 1994. Central Valley anadromous sport fish annual run size, harvest, and population estimates, 1967 through 1991. Inland Fisheries Technical Report, June 1993. Revised August 1994. California Department of Fish and Game. Sacramento, CA.

Reliance on other Monitoring Programs: None

Funding Source: MID rate payers, CDFG

Quantity of Funds:

Security of Funds:

References (any reprints or reports used in compiling entry):

Specific Monitoring Methods: Schaefer mark-recovery methods based on salmon carcasses.

Sampling Reaches:

1) Crocker-Huffman Dam to Highway 59 bridge
2) Highway 59 bridge to Bettencourt Ranch

Sampling Frequency: Weekly; reaches surveyed on two consecutive days

Sampling Period: October 15 to December 31 (11 weeks)

Sampling Equipment: Drift boat or skiff, gaffs, hog rings and pliers, colored surveying tape, machetes, data recording slates, tape measures, knife, plastic bags, recovery labels for adipose-clipped fish.

Sampling Methods:

1) Count and tag all fresh carcasses (clear-eye) with color-coded hog ring in lower jaw.
2) Record sex and age class (adult or grilse) of fresh carcasses.
3) Return fresh carcasses to flowing water just upstream from where they were collected.
4) Count and record age class (adult or grilse) of nonfresh carcasses and cut through backbone with machete to remove from future surveys.
5) Record recovered tagged carcasses, age class (adult or grilse), week of tagging, and cut through backbone to remove from future surveys.
6) Collect otoliths/scales, measure standard lengths from representative sample of fresh carcasses (30 carcasses per week).
7) Remove snout from adipose-clipped carcasses and retain in individually labeled plastic bags for later detection, removal, and decoding of coded-wire tags.
8) Count carcasses with other marks/tags and record type of mark/tag.

Data Analysis:

1) Estimate total escapement (numbers of fish) of adults and grilse by reach using Schaefer method.
2) Describe spatial and temporal spawning distribution.
3) Summarize length frequency and sex composition data.
4) Summarize flow, water temperature, and water visibility data.

Staffing:

Field Work:

Data Analysis/Management/Report:

Report Prepared by: California Department of Fish and Game

Report Contents Include:

1) Estimated total escapement of adults and grilse by reach.
2) Length frequency distribution and sex composition of fresh carcasses.
3) Flows, water temperatures, and water visibility during survey period.
4) Periods for which estimates could not be obtained or were generated by other means (e.g., interpolation).
5) Coded-wire tag data from recovered salmon, including CWT#, number of adults/grilse recovered, brood year, number of juveniles planted, release date, release site, and hatchery of origin.
6) Number of recovered adults and grilse with other marks/tags.

EXISTING ADULT PROGRAM 7
Stanislaus Salmon Escapement Survey

Species: Fall-run Chinook Salmon
Watershed: Stanislaus River

BACKGROUND INFORMATION

Monitoring Study Type: Spawning escapement survey

Target Species: Fall-run chinook salmon

Target Life Stages: Adult spawners

Program Name: Stanislaus Salmon Escapement Survey

Lead Agency: California Department of Fish and Game

Program Manager: Bill Loudermilk

Address: California Department of Fish and Game
1234 East Shaw Avenue
Fresno, CA 93710

Phone: (209) 222-3761

Key Supporting Agencies: U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service

Key Supporting Staff:

Program Goals: Estimate annual Stanislaus River fall-run chinook salmon spawning escapement.

Program Duration: 1953-present

Geographic Area Covered: Stanislaus River from Goodwin Dam to Riverbank bridge

Parameters Measured:

Biological: Population estimates, spatial and temporal spawning distribution, length frequency, sex ratio, coded-wire tagged fish.
Physical: Water clarity, temperature
Chemical: None

How Were Hatchery Fish Distinguished from Wild Fish?: Presence of adipose fin clip (coded-wire tag) or other mark indicate hatchery fish, otherwise indistinguishable

Data Storage:

Location: California Department of Fish and Game, Fresno
Contact for Data Retrieval: Bill Loudermilk, CDFG
Available to Public: Yes
Cost of data: None
Storage Format(electronic/hardcopy): Hardcopy and electronic
Hardware: PC
Software: Lotus 123, dBase IV
Quality Assurance (for data entry as opposed to analytical):

Products (Delivery Dates):

Data: June 30
Progress Reports: June 30 (annual report)
Final Reports: Ongoing program, no final reports

Comparable Data Available during 1967-1991 Period: Mills, T. J. and F. Fisher. 1994. Central Valley anadromous sport fish annual run size, harvest, and population estimates, 1967 through 1991. Inland Fisheries Technical Report, June 1993. Revised August 1994. California Department of Fish and Game. Sacramento, CA.

Reliance on other Monitoring Programs:

Funding Source: CDFG, USBR

Quantity of Funds: $150,000 annually

Security of Funds:

References (any reprints or reports used in compiling entry):

Specific Monitoring Methods: Schaefer mark-recovery methods based on salmon carcasses.

Sampling Reaches:

1) Goodwin Dam to Orange Blossom
2) Orange Blossom to Oakdale bridge
3) Oakdale bridge to Riverbank bridge

Sampling Frequency: Weekly; reaches surveyed on three consecutive days

Sampling Period: October 15 to December 31 (11 weeks)

Sampling Equipment: Drift boat, gaffs, hog rings and pliers, colored surveying tape, machetes, data recording slates, tape measures, knife, plastic bags, recovery labels for adipose-clipped fish.

Sampling Methods:

1) Count and tag all fresh carcasses (clear-eye) with color-coded hog ring in lower jaw.
2) Record sex and age class (adult or grilse) of fresh carcasses.
3) Return fresh carcasses to flowing water just upstream from where they were collected.
4) Count and record age class (adult or grilse) of nonfresh carcasses and cut through backbone with machete to remove from future surveys.
5) Record recovered tagged carcasses, age class (adult or grilse), week of tagging, and cut through backbone to remove from future surveys.
6) Collect otoliths/scales, measure standard lengths from representative sample of fresh carcasses (30 carcasses per week).
7) Remove snout from adipose-clipped carcasses and retain in individually labeled plastic bags for later detection, removal, and decoding of coded-wire tags.
8) Count carcasses with other marks/tags and record type of mark/tag.

Data Analysis:

1) Estimate total escapement (numbers of fish) of adults and grilse by reach using Schaefer method.
2) Describe spatial and temporal spawning distribution.
3) Summarize length frequency and sex composition data.
4) Summarize flow, water temperature, and water visibility data.

Staffing:

Field Work:

Data Analysis/Management/Report:

Report Prepared by: California Department of Fish and Game

Report Contents Include:

1) Estimated total escapement of adults and grilse by reach.
2) Length frequency distribution and sex composition of fresh carcasses.
3) Flows, water temperatures, and water visibility during survey period.
4) Periods for which estimates could not be obtained or were generated by other means (e.g., interpolation).
5) Coded-wire tag data from recovered salmon, including CWT#, number of adults/grilse recovered, brood year, number of juveniles planted, release date, release site, and hatchery of origin.
6) Number of recovered adults and grilse with other marks/tags.

EXISTING ADULT PROGRAM 8
Tuolumne Salmon Escapement Survey

Species: Fall-run Chinook Salmon
Watershed: Tuolumne River

BACKGROUND INFORMATION

Monitoring Study Type: Spawning escapement survey

Target Species: Fall-run chinook salmon

Target Life Stages: Adult spawners

Program Name: Tuolumne Salmon Escapement Survey

Lead Agency: California Department of Fish and Game

Program Manager: Bill Loudermilk

Address: California Department of Fish and Game
1234 East Shaw Avenue
Fresno, CA 93710

Phone: (209) 222-3761

Key Supporting Agencies:

Key Supporting Staff:

Program Goals: Estimate annual Tuolumne River fall-run chinook salmon spawning escapement.

Program Duration: 1953-present

Geographic Area Covered: Tuolumne River from old La Grange bridge to Reed Rock Plant near Waterford.

Parameters Measured:

Biological: Population estimates, spatial and temporal spawning distribution, length frequency, sex ratio, coded-wire tagged fish.

Physical: Water clarity, temperature
Chemical: None

How Were Hatchery Fish Distinguished from Wild Fish?: Presence of adipose fin clip (coded-wire tag) or other mark indicate hatchery fish, otherwise indistinguishable.

Data Storage:

Location: California Department of Fish and Game, Fresno
Contact for Data Retrieval: Bill Loudermilk, CDFG
Available to Public: Yes
Cost of data: None
Storage Format(electronic/hardcopy): Hardcopy and electronic
Hardware: PC
Software: Lotus 123, dBase IV
Quality Assurance (for data entry as opposed to analytical):

Products (Delivery Dates):

Data: June 30
Progress Reports: June 30 (annual report)
Final Reports: Ongoing program, no final reports

Comparable Data Available during 1967-1991 Period: Mills, T. J. and F. Fisher. 1994. Central Valley anadromous sport fish annual run size, harvest, and population estimates, 1967 through 1991. Inland Fisheries Technical Report, June 1993. Revised August 1994. California Department of Fish and Game. Sacramento, CA.

Reliance on other Monitoring Programs: Modesto Irrigation District, Turlock Irrigation District

Funding Source: CDFG, MID, TID

Quantity of Funds:

Security of Funds:

References (any reprints or reports used in compiling entry):

Specific Monitoring Methods: Schaefer mark-recovery methods based on salmon carcasses.

Sampling Reaches:

1) La Grange Dam to Basso bridge
2) Basso bridge to Turlock Lake State Recreation Area
3) Turlock Lake State Recreation Area to Reed Rock Plant near Waterford

Sampling Frequency: Weekly; reaches surveyed on three consecutive days

Sampling Period: October 15 to December 31 (11 weeks)

Sampling Equipment: Drift boat, gaffs, hog rings and pliers, colored surveying tape, machetes, data recording slates, tape measures, knife, plastic bags, recovery labels for adipose-clipped fish.

Sampling Methods:

1) Count and tag all fresh carcasses (clear-eye) with color-coded hog ring in lower jaw.
2) Record sex and age class (adult or grilse) of fresh carcasses.
3) Return fresh carcasses to flowing water just upstream from where they were collected.
4) Count and record age class (adult or grilse) of nonfresh carcasses and cut through backbone with machete to remove from future surveys.
5) Record recovered tagged carcasses, age class (adult or grilse), week of tagging, and cut through backbone to remove from future surveys.
6) Collect otoliths/scales, measure standard lengths from representative sample of fresh carcasses (30 carcasses per week).
7) Remove snout from adipose-clipped carcasses and retain in individually labeled plastic bags for later detection, removal, and decoding of coded-wire tags.
8) Count carcasses with other marks/tags and record type of mark/tag.

Data Analysis:

1) Estimate total escapement (numbers of fish) of adults and grilse by reach using Schaefer method.
2) Describe spatial and temporal spawning distribution.
3) Summarize length frequency and sex composition data.
4) Summarize flow, water temperature, and water visibility data.

Staffing:

Field Work:

Data Analysis/Management/Report:

Report Prepared by: California Department of Fish and Game

Report Contents Include:

1) Estimated total escapement of adults and grilse by reach.
2) Length frequency distribution and sex composition of fresh carcasses.
3) Flows, water temperatures, and water visibility during survey period.
4) Periods for which estimates could not be obtained or were generated by other means (e.g., interpolation).
5) Coded-wire tag data from recovered salmon, including CWT#, number of adults/grilse recovered, brood year, number of juveniles planted, release date, release site, and hatchery of origin.
6) Number of recovered adults and grilse with other marks/tags.

EXISTING ADULT PROGRAM 9
Yuba River Chinook Salmon Spawning Escapement Survey

Species: Fall-Run Chinook Salmon
Watershed: Yuba River

BACKGROUND INFORMATION

Monitoring Study Type: Spawning escapement survey
Target Species: Fall-run chinook salmon
Target Life Stages: Spawning adults

Program Name: Yuba River chinook salmon spawning escapement survey

Lead Agency: California Department of Fish and Game

Program Manager: John Nelson

Address: California Department of Fish and Game, Region 2
1701 Nimbus Road
Rancho Cordova, CA 95670

Phone: (916)358-2939

Key Supporting Agencies: Yuba County Water Agency

Key Supporting Staff: Fred Meyer

Program Goals: Estimate annual fall-run chinook salmon spawning population.

Program Duration: 1953-present

Geographic Area Covered: Highway 20 bridge approximately to E Street bridge in Marysville; Infrequent surveys of Narrows to Highway 20 bridge reach.

Parameters Measured:

Biological: Population estimates, spatial and temporal spawning distribution, sex ratio, proportion of adults and grilse, coded-wire-tagged fish.
Physical: Water clarity, temperature
Chemical: None

How Were Hatchery Fish Distinguished From Wild Fish?: Presence of adipose fin clip (coded-wire tag) or other mark indicate hatchery fish, otherwise indistinguishable.

Data Storage:

Location: California Department of Fish and Game, Region 2
Contact for Data Retrieval: John Nelson
California Department of Fish and Game, Region 2
1701 Nimbus Road
Rancho Cordova, CA 95670
(916) 358-2939
Available to Public: For review
Cost of data: None for agencies, photocopy charge for private individuals.
Storage Format(electronic/hardcopy): hardcopy
Hardware: N/A
Software: N/A
Quality Assurance (for data entry as opposed to analytical): N/A

Products (Delivery Dates):

Data: N/A
Progress Reports: Annual reports
Final Reports: Ongoing program, no final reports

Comparable Data Available during 1967-1991 Period: Mills, T. J. and F. Fisher. 1994. Central Valley anadromous sport fish annual run size, harvest, and population estimates, 1967 through 1991. Inland Fisheries Technical Report, June 1993. Revised August 1994. California Department of Fish and Game. Sacramento, CA.

Reliance on Other Monitoring Programs: None

Funding Source: CDFG/Yuba County Water Agency

Quantity of Funds: No funding specifically allocated for this program.

Security of Funds: None

References (any reprints or reports used in compiling entry): Annual DFG file memoranda regarding Yuba River chinook salmon spawning stock estimates, 1979 to present (incomplete series). California Department of Fish and Game, Region 2. Rancho Cordova, CA.

Specific Monitoring Methods: Schaefer mark-recovery method based on salmon carcasses.

Sampling Reaches:

1) Narrows to Highway 20 bridge
2) Highway 20 bridge to Daguerre Point Dam
3) Daguerre Point Dam to E Street

Sampling Frequency: Weekly; reaches surveyed on three consecutive days

Sampling Period: October 15 to December 15 (9 weeks)

Sampling Equipment: Drift boat or skiff, gaffs, hog rings and pliers, colored surveying tape, machetes, data recording slates, tape measures, thermometer, knife, plastic bags, recovery labels for adipose-clipped fish.

Sampling Methods:

1) Tag all fresh carcasses (clear-eye) with color-coded hog ring in lower jaw.
2) Record sex and age class (adult or grilse) of fresh carcasses.
3) Return fresh carcasses to flowing water just upstream from where they were collected.
4) Record nonfresh carcasses, record age class (adults or grilse), and cut through backbone with machete to remove from future surveys.
5) Record recovered tagged carcasses, age class (adult or grilse), week of tagging, and cut through backbone to remove from future surveys.
6) Collect otoliths/scales, measure standard and fork lengths from representative sample of fresh carcasses (30 carcasses per survey).
7) Remove snout from adipose-clipped carcasses and retain in individually labeled plastic bags for later detection, removal, and decoding of coded-wire tags.

Data Analysis:

1) Estimate spawning escapement (numbers of fish) of fall-run adults and grilse by reach using Schaefer method.
2) Describe spatial and temporal spawning distributions.
3) Summarize length frequency and sex composition data.
4) Summarize flow, water temperature, and water visibility data.
5) Summarize counts of tagged/marked fish and coded-wire tag recovery.

Staffing:

Field Work: 3 personnel for 5 weeks, 4 personnel for 4 weeks (during spawning peak) = 930 personnel hours (5.8 personnel months)

Data Analysis/Management/Report: 60 personnel hours (0.3 personnel months)

Report Prepared by: California Department of Fish and Game

Report Contents to Include:

1) Estimated spawning escapement (numbers of fish) of adults and grilse by reach.
2) Spatial and temporal spawning distribution.
3) Length frequency distribution and sex composition.
4) Flows, water temperatures, and water visibility during survey period.
5) Periods for which estimates could not be obtained or were generated by other means (e.g., interpolation).
6) Counts of tagged/marked salmon and coded-wire tag data.

EXISTING ADULT PROGRAM 10
Mokelumne River Salmon and Steelhead Monitoring

Species: Chinook Salmon, Steelhead Trout
Watershed: Mokelumne River

BACKGROUND INFORMATION

Monitoring methods: Ladder counts

Target Species: Fall-run chinook salmon, steelhead trout

Target Life Stages: Adult spawners

Program Name: Mokelumne River Salmon and Steelhead Monitoring Program

Lead Agency: East Bay Municipal Utility District

Program Manager: Joe Miyamoto

Address: East Bay Municipal Utility District
500 San Pablo Dam Road
Orinda, CA 94563

Phone: (510) 254-3778

Key Supporting Agencies: East Bay Municipal Utility District

Key Supporting Staff: David Vogel, Natural Resource Sciences, Inc.

Program Goals: Monitor daily abundance of migrating salmon and steelhead at Woodbridge Dam.

Program Duration: 1992-1996

Geographic Area Covered: Lower Mokelumne River at Woodbridge Dam

Parameters Measured:

Biological: Numbers, sex, and lengths of adult salmon and steelhead

Physical: Water temperature, visibility
Chemical: None

How Were Hatchery Fish Distinguished from Wild Fish?: Presence of adipose fin clip (coded-wire tag) or other mark, otherwise indistinguishable.

Data Storage:

Location: NRS, Inc.
Contact for Data Retrieval: Joe Miyamoto, EBMUD
Available to Public: Subject to EBMUD approval
Cost of data:
Storage Format(electronic/hardcopy): Hardcopy and electronic format
Hardware: PC
Software:
Quality Assurance (for data entry as opposed to analytical):

Products (Delivery Dates):

Data:
Progress Reports:
Final Reports:

Comparable Data Available during 1967-1991 Period: Mills, T. J. and F. Fisher. 1994. Central Valley anadromous sport fish annual run size, harvest, and population estimates, 1967 through 1991. Inland Fisheries Technical Report, June 1993. Revised August 1994. California Department of Fish and Game. Sacramento, CA.

Reliance on other Monitoring Programs: No

Funding Source: EBMUD

Quantity of Funds:

Security of Funds:

References (any reprints or reports used in compiling entry):

Specific Monitoring Methods: Ladder counts

Sampling Reaches: Woodbridge Dam

Sampling Frequency: Daily (continuous)

Sampling Period: September 15-March 31

Sampling Equipment: Trapping chamber in fishway, underwater video recording system, electronic fish counter.

Sampling Methods:

1) Count fish visually or from video recordings as they pass counting facilities.
2) Record species, sex, sampling date, and time.
3) Estimate fish lengths visually or from video recordings.
4) Record adipose fin clips and other marks.

Data Analysis:

1) Sum daily counts of salmon and steelhead.
2) Summarize length frequency and sex composition data by species.
3) Summarize counts of tag/marked fish.

Staffing:

Field Work:
Data Analysis/Management/Report:

Report Prepared by:

Report Contents Include:

1) Annual ladder counts of fall-run chinook salmon and steelhead trout.
2) Periods for which counts could not be obtained or were generated by other means (e.g., interpolation).
3) Length frequency and sex composition of adult migrants.
4) Counts of tagged/marked fish.

EXISTING ADULT PROGRAM 11
Central Valley Salmon and Steelhead Program

Species: Chinook Salmon, Steelhead Trout
Watershed: Upper Sacramento River

BACKGROUND INFORMATION

Monitoring Methods: Run size and spawning stock assessment/monitoring

Target Species: Fall-, winter-, and spring-run chinook salmon; steelhead trout (ladder counts); fall-, late fall-, winter-, and spring-run chinook salmon (aerial redd surveys).

Target Life Stages: Adults

Program Name: Central Valley Salmon and Steelhead Program

Lead Agency: California Department of Fish and Game

Program Managers: Frank Fisher, Ralph Carpenter

Address: California Department of Fish and Game
P.O. Box 578
Red Bluff, CA 96080

Phone: (916) 527-8892

Key Supporting Agencies: U.S. Fish and Wildlife Service

Key Support Staff:

Program Goals: Estimate annual run size and spawner abundance in upper Sacramento River.

Program Duration: 1967 to present; currently supported by 5-year grant, renewable in 1997

Geographic Area Covered: Upper Sacramento River from Keswick Dam to Princeton

Parameters Measured:

Biological: Partial ladder counts of adult salmon and steelhead at Red Bluff Diversion Dam, salmon redd counts.

Physical: None
Chemical: None

How Were Hatchery Fish Distinguished From Wild Fish?: Presence of adipose or other fin clip, otherwise not distinguishable.

Data Storage:

Location: CDFG, Red Bluff; Pacific States Marine Fisheries Commission, Portland, OR
Contact for Data Retrieval: Frank Fisher (CDFG), Duanne Anderson (PSMFC)
Address: California Department of Fish and Game
P.O. Box 578
Red Bluff, CA 96080
Phone: (916) 527-8892
Available to Public: Yes
Cost of data: None
Storage Format(electronic/hardcopy): Electronic storage and hardcopy reports
Hardware: PC
Software: Lotus 123
Quality Assurance (for data entry as opposed to analytical):

Products (Delivery Dates):

Data: N/A
Progress Reports: N/A
Final Reports: 1982 last run year published (CDFG spawning stock reports); February (PSMFC review of ocean salmon fisheries of previous year)

Comparable Data Available during 1967-1991 Period: Mills, T. J. And F. Fisher. 1994. Central Valley anadromous sport fish annual run size, harvest, and population estimates, 1967 through 1991. Inland Fisheries Technical Report, June 1993. Revised August 1994. California Department of Fish and Game. Sacramento, CA.

Reliance on Other Monitoring Programs: U.S. Fish and Wildlife Service fisheries monitoring at RBDD

Funding Source: Wallop-Baeux Sport Fish Restoration Act, NMFS, CDFG

Quantity of Funds: $200,000 per year

Security of Funds: None

References (any reprints or reports used in compiling entry):

Specific Monitoring Methods: Ladder Counts

Sampling Reaches: Red Bluff Diversion Dam fish ladders and counting facilities

Sampling Frequency: Daily (continuous during daylight hours)

Sampling Period: Year-round, subject to dam and ladder operation, water visibility

Sampling Equipment: Electronic logger

Sampling Methods:

1) Visually count individuals as they pass counting facilities and record species, race, sampling date and time.
2) Visually estimate and record salmon and steelhead lengths.
3) Record adipose fin clips and other marks .

Data Analysis:

1) Sum daily counts of fish species and race by week and month.
2) Sum daily counts of salmon and steelhead by length class.
3) Develop counts for periods of no observation through interpolation.
4) Sum daily counts to generate annual run sizes by species and race.

Staffing:

Field Work:

Data Analysis/Management/Report: 12.2 personnel months

Report Prepared by: California Department of Fish and Game

Report Contents Include:

1) Ladder counts of fish species and race by week and month.
2) Length distribution of salmon and steelhead by month and race.
3) Number of adult and grilse salmon by race.
4) Periods for which counts were interpolated, and reason.

Specific Monitoring Methods: Aerial Redd Counts

Sampling Reaches:

1) Princeton to Red Bluff Diversion Dam (fall-run only).
2) Red Bluff Diversion Dam to Keswick Dam (fall- and winter-run).

Sampling Frequency: Weekly (daylight hours)

Sampling Period: May 1-July 15 (winter-run); October 1-December 15 (fall-run)

Sampling Equipment: Fixed-wing aircraft or helicopter, survey forms

Sampling Methods:

1) Visually count and photograph redds at all spawning areas.
2) Standardize flight paths, effort, and observer qualifications/experience.

Data Analysis:

1) Verify redd counts based on photographs.
2) Tabulate counts of fall- and winter-run redds by reach and week.

Staffing:

Field Work:

Data Analysis/Management/Report: 12.2 personnel months

Report Prepared by: California Department of Fish and Game

Report Contents Include:

1) Aerial counts of fall- and winter-run redds by reach and week.
2) Periods for which counts could not be made, and reason.
3) Total number of fall- and winter-run redds by reach.

EXISTING ADULT PROGRAM 12
Nimbus Salmon Hatchery Coded-Wire Tagging

Species: Fall-run Chinook Salmon
Watershed: American River

BACKGROUND INFORMATION

Monitoring Methods: Hatchery coded-wire tagging

Target Species: Fall-run chinook salmon

Target Life Stages: Juveniles

Program Name:

Lead Agency: California Department of Fish and Game

Program Manager: Frank Fisher

Address: California Department of Fish and Game
P.O. Box 578
Red Bluff, CA 96080

Phone: (916)527-8892

Key Supporting Agencies:

Key Supporting Staff:

Program Goals:

Program Duration:

Geographic Area Covered: Lower American River at Nimbus Dam

Parameters Measured:

Biological:
Physical:
Chemical:

How Were Hatchery Fish Distinguished from Wild Fish?: N/A

Data Storage:

Location:
Contact for Data Retrieval:
Available to Public:
Cost of data:
Storage Format(electronic/hardcopy):
Hardware:
Software:
Quality Assurance (for data entry as opposed to analytical):

Products (Delivery Dates):

Data:
Progress Reports:
Final Reports:

Comparable Data Available during 1967-1991 Period:

Reliance on other Monitoring Programs: No

Funding Source:

Quantity of Funds:

Security of Funds:

References (any reprints or reports used in compiling entry):

Specific Monitoring Methods: Hatchery Marking and Coded-Wire Tagging

Sampling Reaches: Nimbus Salmon and Steelhead Hatchery

Sampling Frequency: Annual

Sampling Period:

Sampling Equipment: Rearing facilities

Sampling Methods:

Data Analysis:

Staffing:

Field Work:

Data Analysis/Management/Report:

Report Prepared by: California Department of Fish and Game

Report Contents Include:

EXISTING ADULT PROGRAM 13
Coleman National Fish Hatchery Coded-Wire Tagging

Species: Chinook Salmon, Steelhead Trout
Watershed: Battle Creek

BACKGROUND INFORMATION

Monitoring Methods: Hatchery coded-wire tagging

Target Species: Chinook salmon (fall-, late fall-, and winter-run), steelhead trout

Target Life Stages: Juveniles

Program Name:

Lead Agency: U.S. Fish and Wildlife Service

Program Manager:

Address:

Phone:

Key Supporting Agencies:

Key Supporting Staff:

Program Goals:

Program Duration:

Geographic Area Covered: Battle Creek

Parameters Measured:

Biological:
Physical:
Chemical:

How Were Hatchery Fish Distinguished from Wild Fish?: N/A

Data Storage:

Location:
Contact for Data Retrieval:
Available to Public:
Cost of data:
Storage Format(electronic/hardcopy):
Hardware:
Software:
Quality Assurance (for data entry as opposed to analytical):

Products (Delivery Dates):

Data:
Progress Reports:
Final Reports:

Comparable Data Available during 1967-1991 Period:

Reliance on other Monitoring Programs: No

Funding Source:

Quantity of Funds:

Security of Funds:

References (any reprints or reports used in compiling entry):

Specific Monitoring Methods:

Sampling Reaches:

Sampling Frequency:

Sampling Period:

Sampling Equipment:

Sampling Methods:

Data Analysis:

Staffing:

Hatchery:

Data Analysis/Management/Report:

Report Prepared by:

Report Contents Include:

EXISTING ADULT PROGRAM 14
Feather River Hatchery Coded-Wire Tagging

Species: Chinook Salmon
Watershed: Feather River

<u>BACKGROUND INFORMATION</u>

Monitoring Methods: Hatchery coded-wire tagging

Target Species: Fall-run and spring-run chinook salmon, steelhead trout

Target Life Stages: Juveniles

Program Name:

Lead Agency: California Department of Fish and Game

Program Manager: Frank Fisher

Address: California Department of Fish and Game
P.O. Box 578
Red Bluff, CA 96080

Phone: (916)527-8892

Key Supporting Agencies:

Key Supporting Staff:

Program Goals:

Program Duration:

Geographic Area Covered: Feather River Hatchery and Annex

Parameters Measured:

Biological:
Physical:
Chemical:

How Were Hatchery Fish Distinguished from Wild Fish?: N/A

Data Storage:

Location:
Contact for Data Retrieval:
Available to Public:
Cost of data:
Storage Format(electronic/hardcopy):
Hardware:
Software:
Quality Assurance (for data entry as opposed to analytical):

Products (Delivery Dates):

Data:
Progress Reports:
Final Reports:

Comparable Data Available during 1967-1991 Period:

Reliance on other Monitoring Programs: No

Funding Source:

Quantity of Funds:

Security of Funds:

References (any reprints or reports used in compiling entry):

Specific Monitoring Methods:

Sampling Reaches:

Sampling Frequency:

Sampling Period:

Sampling Equipment:

Sampling Methods:

Data Analysis:

Staffing:

Hatchery:

Data Analysis/Management/Report:

Report Prepared by:

Report Contents Include:

EXISTING ADULT PROGRAM 15
Merced River Fish Facility Coded-Wire Tagging

Species: Fall-Run Chinook Salmon
Watershed: Merced River

BACKGROUND INFORMATION

Monitoring Methods: Hatchery coded-wire tagging

Target Species: Fall-run chinook salmon

Target Life Stages: Juveniles

Program Name:

Lead Agency: California Department of Fish and Game

Program Manager: Frank Fisher

Address: California Department of Fish and Game
P.O. Box 578
Red Bluff, CA 96080

Phone: (916)527-8892

Key Supporting Agencies:

Key Supporting Staff:

Program Goals:

Program Duration:

Geographic Area Covered: Merced River at Crocker-Huffman Dam

Parameters Measured:

Biological:
Physical:
Chemical:

How Were Hatchery Fish Distinguished from Wild Fish?: N/A

Data Storage:

Location:
Contact for Data Retrieval:
Available to Public:
Cost of data:
Storage Format(electronic/hardcopy):
Hardware:
Software:
Quality Assurance (for data entry as opposed to analytical):

Products (Delivery Dates):

Data:
Progress Reports:
Final Reports:

Comparable Data Available during 1967-1991 Period:

Reliance on other Monitoring Programs: No

Funding Source:

Quantity of Funds:

Security of Funds:

References (any reprints or reports used in compiling entry):

Specific Monitoring Methods:

Sampling Reaches:

Sampling Frequency:

Sampling Period:

Sampling Equipment:

Sampling Methods:

Data Analysis:

Staffing:

Hatchery:

Data Analysis/Management/Report:

Report Prepared by:

Report Contents Include:

EXISTING ADULT PROGRAM 16
Mokelumne River Hatchery Coded-Wire Tagging

Species: Chinook Salmon, Steelhead Trout
Watershed: Mokelumne River

BACKGROUND INFORMATION

Monitoring Methods: Hatchery coded-wire tagging

Target Species: Fall-run chinook salmon

Target Life Stages: Juveniles

Program Name:

Lead Agency: California Department of Fish and Game

Program Manager: Frank Fisher

Address: California Department of Fish and Game
P.O. Box 578
Red Bluff, CA 96080

Phone: (916)527-8892

Key Supporting Agencies:

Key Supporting Staff:

Program Goals:

Program Duration:

Geographic Area Covered: Mokelumne River at Comanche Dam

Parameters Measured:

Biological:
Physical:
Chemical:

How Were Hatchery Fish Distinguished from Wild Fish?: N/A

Data Storage:

Location:
Contact for Data Retrieval:
Available to Public:
Cost of data:
Storage Format(electronic/hardcopy):
Hardware:
Software:
Quality Assurance (for data entry as opposed to analytical):

Products (Delivery Dates):

Data:
Progress Reports:
Final Reports:

Comparable Data Available during 1967-1991 Period:

Reliance on other Monitoring Programs:

Funding Source:

Quantity of Funds:

Security of Funds:

References (any reprints or reports used in compiling entry):

Specific Monitoring Methods:

Sampling Reaches:

Sampling Frequency:

Sampling Period:

Sampling Equipment:

Sampling Methods:

Data Analysis:

Staffing:

Hatchery:

Data Analysis/Management/Report:

Report Prepared by:

Report Contents to Include:

EXISTING ADULT PROGRAM 17
Nimbus Salmon Hatchery-Salmon and Steelhead Program

Species: Fall-run Chinook Salmon, Steelhead Trout
Watershed: American River

BACKGROUND INFORMATION

Monitoring Methods: Hatchery Counts

Target Species: Fall-run chinook salmon, steelhead trout

Target Life Stages: Adult spawners

Program Name: Nimbus Salmon and Steelhead Hatchery

Lead Agency: California Department of Fish and Game

Program Manager: Bruce Barngrover

Address: California Department of Fish and Game, Region 2
Nimbus Salmon and Steelhead Hatchery
1701 Nimbus Road
Rancho Cordova, CA 95670

Phone: (916)358-2820

Key Supporting Agencies: U.S. Bureau of Reclamation

Key Supporting Staff: Ranse Reynolds

Program Goals: Mitigate loss of salmon and steelhead production due to installation of Folsom and Nimbus dams; current annual production goal is 4 million fingerling (50/lb) fall-run chinook salmon and 0.5 million yearling (3-4/lb) steelhead.

Program Duration: 1955 to present

Geographic Area Covered: Lower American River at Nimbus Dam

Parameters Measured:

Biological: Number of fish returning to hatchery, timing of fish returns, number of eggs produced, percent fertility of eggs, number of juvenile produced/released, hatchery of origin of coded-wire tagged.
Physical: Water temperature, turbidity
Chemical: Regular monitoring of hatchery inflow/ouflow chemicals, including dissolved oxygen, copper, and other trace metals.

How Were Hatchery Fish Distinguished from Wild Fish?: Presence of adipose fin clip (coded-wire tag) or other mark, otherwise indistinguishable.

Data Storage:

Location: Nimbus Salmon and Steelhead Hatchery
Contact for Data Retrieval: Ronald D. Ducey, CDFG
Available to Public: Yes
Cost of data: None
Storage Format(electronic/hardcopy): Hardcopy for 1955-91 (currently being entered into computer); hardcopy and electronic for 1992-94.
Hardware: PC
Software: Hatchery automation system
Quality Assurance (for data entry as opposed to analytical):

Products (Delivery Dates):

Data: Usually available by October 31
Progress Reports: Annual reports
Final Reports: Ongoing program, no final report

Comparable Data Available during 1967-1991 Period: Mills, T. J. and F. Fisher. 1994. Central Valley anadromous sport fish annual run size, harvest, and population estimates, 1967 through 1991. Inland Fisheries Technical Report, June 1993. Revised August 1994. California Department of Fish and Game. Sacramento, CA.

Reliance on other Monitoring Programs: No

Funding Source: Mitigation fish production funded by USBR.

Quantity of Funds: $963,350 (1994-95); $1,014,000 projected (1995-96)

Security of Funds: Secure; USBR mandated to provide funds to meet mitigation goals.

References (any reprints or reports used in compiling entry): Ducey, R.D. 1994. Annual Report: Nimbus salmon and steelhead hatchery, 1992-93. California Department of Fish and Game, Inland Fisheries Division, Administrative Report No. 94-97, Sacramento, CA.
Reynolds, F.L., T.J. Mills, R. Benthin, and A. Low. 1993. Restoring Central Valley streams: a plan for action. California Department of Fish and Game, Inland Fisheries Division, Sacramento, CA.

Specific Monitoring Methods: Hatchery counts

Sampling Reaches: Nimbus Salmon and Steelhead Hatchery

Sampling Frequency: Annual

Sampling Period: Fish ladder opened approximately November 1 through March 31, subject to water temperature, run timing and magnitude.

Sampling Equipment: Fish racks; ladder; spawning, incubation, and rearing facilities.

Sampling Methods:

1) Count adult and grilse chinook salmon and steelhead trout arriving daily.
2) Determine sex, measure standard length and fork length, and remove scales/otoliths from salmon and steelhead.
3) Record and count adipose-clipped (coded-wire tagged) fish and fish marked otherwise.
4) Remove snout of adipose-clipped fish for detection, removal, and decoding of coded-wire tag.

Data Analysis:

1) Daily counts of chinook salmon (adults and grilse) and steelhead trout.
2) Daily hatchery water temperatures.
3) Length frequency distribution and sex composition by species.
4) Counts of tagged/marked fish and coded-wire tag recovery data.

Staffing:

Field Work: 1 month Fish Culturist; 1 month Fish and Wildlife Assistant I

Data Analysis/Management/Report: 1 day Hatchery Manager

Report Prepared by: California Department of Fish and Game

Report Contents Include:

1) Annual hatchery counts of chinook salmon (adults and grilse) and steelhead trout.
2) Counts of tagged/marked fish and coded-wire tag recovery data, including species, race, brood year, hatchery of origin, release size, release date, and release location.

EXISTING ADULT PROGRAM 18
Coleman National Fish Hatchery-Salmon and Steelhead Stock Composition

Species: Chinook Salmon, Steelhead Trout
Watershed: Battle Creek

BACKGROUND INFORMATION

Monitoring Methods: Hatchery counts

Target Species: Chinook salmon (fall-, late fall-, and winter-run), steelhead trout

Target Life Stages: Adult spawners

Program Name: Coleman National Fish Hatchery

Lead Agency: U.S. Fish and Wildlife Service

Program Manager: Jim Smith

Address: U.S. Fish and Wildlife Service
Northern Central Valley Fishery Resource Office
10950 Tyler Road
Red Bluff, CA 96080

Phone: (916) 527-3043

Key Supporting Agencies: U.S. Bureau of Reclamation, California Department of Fish and Game

Key Supporting Staff: Scott Hamelberg, Steve Croci, USFWS

Program Goals: Mitigate loss of salmon and steelhead production due to installation of Shasta and Keswick dams.

Program Duration: 1943 to present

Geographic Area Covered: Battle Creek

Parameters Measured:

Biological: Number of fish returning to hatchery by race, timing of fish returns, hatchery of origin of coded-wire tagged adults.
Physical: Water temperature, turbidity
Chemical: Dissolved oxygen, pH

How Were Hatchery Fish Distinguished from Wild Fish?: Presence of adipose fin clip (coded-wire tag) or other mark, otherwise indistinguishable.

Data Storage:

Location: U.S. Fish and Wildlife Service, NCVFRO, Red Bluff, CA
Contact for Data Retrieval: Scott Hamelberg, USFWS
Available to Public: Yes
Cost of data: None
Storage Format(electronic/hardcopy): Electronic storage and hardcopy reports
Hardware: PC
Software: dBase 5 for Windows, Lotus 123
Quality Assurance (for data entry as opposed to analytical):

Products (Delivery Dates):

Data: N/A
Progress Reports: Annual
Final Reports: Ongoing program, no final report

Comparable Data Available during 1967-1991 Period: Mills, T. J. and F. Fisher. 1994. Central Valley anadromous sport fish annual run size, harvest, and population estimates, 1967 through 1991. Inland Fisheries Technical Report, June 1993. Revised August 1994. California Department of Fish and Game. Sacramento, CA.

Reliance on other Monitoring Programs: No

Funding Source: USBR

Quantity of Funds:

Security of Funds:

References (any reprints or reports used in compiling entry):

Specific Monitoring Methods: Hatchery counts

Sampling Reaches: Coleman National Fish Hatchery

Sampling Frequency: Annual

Sampling Period: Fish ladder opened approximately July 1 through March 31.

Sampling Equipment: Hatchery weir; ladder; spawning, incubation, and rearing facilities

Sampling Methods:

1) Count adult and grilse chinook salmon and steelhead trout entering hatchery daily.
2) Measure standard lengths and fork lengths, remove scales/otoliths from representative sample of salmon (all races) and steelhead.
3) Count and record adipose-clipped (coded-wire tagged) fish and fish marked otherwise.
4) Remove snout of adipose-clipped fish for later detection, removal, and decoding of coded-wire tag.

Data Analysis:

1) Daily counts of chinook salmon (adults and grilse) and steelhead trout.
2) Daily hatchery water temperatures.
3) Length frequency distribution and sex composition by species and race.
4) Coded-wire tag recovery data and counts of tagged/marked fish.

Staffing:

Hatchery:

Data Analysis/Management/Report:

Report Prepared by: California Department of Fish and Game

Report Contents Include:

1) Annual hatchery counts of fall- and late fall-run chinook salmon (adults and grilse) and steelhead trout.
2) Counts of tagged/marked fish and coded-wire tag recovery data, including species, race, brood year, hatchery of origin, release size, release date, and release location.

EXISTING ADULT PROGRAM 19
Feather River Hatchery Assessment

Species: Chinook Salmon, Steelhead Trout
Watershed: Feather River

BACKGROUND INFORMATION

Monitoring Methods: Hatchery counts

Target Species: Fall-run and spring-run chinook salmon, steelhead trout

Target Life Stages: Adult spawners

Program Name: Feather River Hatchery

Lead Agency: California Department of Fish and Game

Program Manager: Bruce Barngrover

Address: Feather River Salmon and Steelhead Hatchery
5 Table Mountain Blvd.
Oroville, CA 95965

Phone: (916) 538-2222

Key Supporting Agencies: California Department of Water Resources

Key Supporting Staff: Pat Overton, CDFG

Program Goals: Mitigate loss of salmon and steelhead production due to installation of Oroville Dam; current annual production goals are 8 million fingerling (60/lb) fall-run chinook salmon, 5 million fingerling (60/lb) spring-run chinook salmon, and 4 million fingerling (60/lb) and yearling (4/lb) steelhead.

Program Duration: 1967 to present

Geographic Area Covered: Feather River Hatchery and Annex

Parameters Measured:

Biological: Number of fish returning to hatchery, timing of fish returns, number of eggs produced at hatchery and received from other sources, percent fertility of eggs, number of juveniles produced/released, hatchery of origin of coded-wire tagged adults.
Physical: Water temperature, turbidity
Chemical: Dissolved oxygen, pH, copper, and other trace metals

How Were Hatchery Fish Distinguished from Wild Fish?: Presence of adipose fin clip (coded-wire tag) or other mark, otherwise indistinguishable.

Data Storage:

Location: Feather River Hatchery
Contact for Data Retrieval: Pat Overton, CDFG
Available to Public: Yes
Cost of data: None
Storage Format(electronic/hardcopy): Hardcopy; some years in electronic format
Hardware: PC
Software:
Quality Assurance (for data entry as opposed to analytical):

Products (Delivery Dates):

Data: Hardcopies of data available immediately after data collection.
Progress Reports: September 30
Final Reports: Ongoing program, no final report

Comparable Data Available during 1967-1991 Period: Mills, T. J. and F. Fisher. 1994. Central Valley anadromous sport fish annual run size, harvest, and population estimates, 1967 through 1991. Inland Fisheries Technical Report, June 1993. Revised August 1994. California Department of Fish and Game. Sacramento, CA.

Reliance on other Monitoring Programs: No

Funding Source: DWR (Feather River Hatchery); Annex (5/6 DFG, 1/6 DWR)

Quantity of Funds: Feather River Hatchery (projected for 1995-96): $1,014,321
Annex (projected for 1995-96): $300,000

Security of Funds: Feather River Hatchery: secure
Annex: secure

References (any reprints or reports used in compiling entry): Schlicting, D. L. 1993. Feather River Hatchery, annual report, 1991-92. California Department of Fish and Game, Inland Fisheries Administrative Report. No. 93-7. Sacramento, CA.

Reynolds, F. L., T. J. Mills, R. Benthin, and A. Low. 1993. Restoring Central Valley streams: A plan for action. California Department of Fish and Game. Sacramento, CA.

Specific Monitoring Methods: Hatchery counts

Sampling Reaches: Feather River Hatchery

Sampling Frequency: Annual

Sampling Period: Fish ladder opened approximately September 1 through March 31; chinook salmon entering between September 1 and October 1 considered spring-run, thereafter fall-run.

Sampling Equipment: Fish racks; ladder; spawning, incubation, and rearing facilities

Sampling Methods:

1) Count adult and grilse chinook salmon and steelhead trout arriving daily.
2) Measure standard lengths and fork lengths, remove scales/otoliths from representative sample of salmon and steelhead.
3) Count and record adipose-clipped (coded-wire tagged) fish and fish marked otherwise.
4) Remove snout of adipose-clipped fish for detection, removal, and decoding of coded-wire tag.

Data Analysis:

1) Daily counts of chinook salmon (adults and grilse) and steelhead trout.
2) Daily hatchery water temperatures.
3) Length frequency distribution and sex composition by species and race.
4) Coded-wire tag recovery data and counts of tagged/marked fish.

Staffing:

Hatchery: 1 month Fish Culturist, 1 month Fish and Wildlife Assistant I

Data Analysis/Management/Report: I month Fish Hatchery Manager II

Report Prepared by: California Department of Fish and Game

Report Contents to Include:

1) Annual hatchery counts of spring- and fall-run chinook salmon (adults and grilse) and steelhead trout.
2) Counts of tagged/marked fish and coded-wire tag recovery data, including species, race, brood year, hatchery of origin, release size, release date, and release location.

EXISTING ADULT PROGRAM 20
Merced River Fish Facility Assessment

Species: Fall-Run Chinook Salmon
Watershed: Merced River

BACKGROUND INFORMATION

Monitoring Methods: Hatchery counts

Target Species: Fall-run chinook salmon

Target Life Stages: Adult spawners

Program Name: Merced River Fish Facility

Lead Agency: California Department of Fish and Game

Program Manager: Michael D. Cozart

Address: California Department of Fish and Game

Phone:

Key Supporting Agencies: Merced Irrigation District

Key Supporting Staff:

Program Goals: Mitigate loss of salmon and steelhead production due to installation of Crocker-Huffman Dam.

Program Duration: 1970 to present

Geographic Area Covered: Merced River at Crocker-Huffman Dam

Parameters Measured:

Biological: Number of fish returning to hatchery by race, timing of fish returns, hatchery of origin of coded-wire tagged adults.
Physical: Water temperature, turbidity
Chemical: Dissolved oxygen, pH

How Were Hatchery Fish Distinguished from Wild Fish?: Presence of adipose fin clip (coded-wire tag) or other mark, otherwise indistinguishable.

Data Storage:

Location: California Department of Fish and Game, Fresno
Contact for Data Retrieval:
Available to Public:
Cost of data:
Storage Format(electronic/hardcopy): Hardcopy and electronic format
Hardware: PC
Software:
Quality Assurance (for data entry as opposed to analytical):

Products (Delivery Dates):

Data:
Progress Reports: March
Final Reports: Ongoing program, no final report

Comparable Data Available during 1967-1991 Period: Mills, T. J. and F. Fisher. 1994. Central Valley anadromous sport fish annual run size, harvest, and population estimates, 1967 through 1991. Inland Fisheries Technical Report, June 1993. Revised August 1994. California Department of Fish and Game. Sacramento, CA.

Reliance on other Monitoring Programs: No

Funding Source: CDFG, MID
Quantity of Funds:
Security of Funds:

References (any reprints or reports used in compiling entry):

Specific Monitoring Methods: Hatchery counts

Sampling Reaches: Merced River Fish Installation

Sampling Frequency: Annual

Sampling Period: Fish ladder opened approximately October 1 through December 31.

Sampling Equipment: Hatchery ladder; spawning, incubation, and rearing facilities

Sampling Methods:

1) Count adult and grilse chinook salmon trapped daily at hatchery.
2) Measure standard lengths and fork lengths, remove scales/otoliths from representative sample of salmon.
3) Count and record adipose-clipped (coded-wire tagged) fish and fish marked otherwise.
4) Remove snout of adipose-clipped fish for later detection, removal, and decoding of coded-wire tag.

Data Analysis:

1) Summarize daily counts of chinook salmon (adults and grilse).
2) Summarize daily hatchery water temperatures.
3) Summarize length frequency distribution and sex composition data.
4) Summarize coded-wire tag recovery data and counts of tagged/marked fish.

Staffing:

Hatchery:

Data Analysis/Management/Report:

Report Prepared by: California Department of Fish and Game

Report Contents to Include:

1) Annual hatchery counts of fall-run chinook salmon (adults and grilse).
2) Counts of tagged/marked fish and coded-wire tag recovery data, including species, race, brood year, hatchery of origin, release size, release date, and release location.

EXISTING ADULT PROGRAM 21
Mokelumne River Hatchery Assessment

Species: Chinook Salmon, Steelhead Trout
Watershed: Mokelumne River

BACKGROUND INFORMATION

Monitoring Methods: Hatchery counts

Target Species: Fall-run chinook salmon, steelhead trout

Target Life Stages: Adult spawners

Program Name: Mokelumne River Hatchery

Lead Agency: California Department of Fish and Game

Program Manager: Mike Cochran

Address: Mokelumne River Hatchery
P.O. Box 158
Clements, CA 95227

Phone: (209) 759-3383

Key Supporting Agencies: East Bay Municipal Utility District

Key Supporting Staff:

Program Goals: Mitigate loss of salmon and steelhead production due to installation of Camanche Dam; current annual production goals are 3.5 million fingerling (60/lb) and yearling (10/lb) fall-run chinook salmon and 0.1 million fingerling and yearling (4/lb) steelhead.

Program Duration: 1964 to present

Geographic Area Covered: Mokelumne River at Comanche Dam

Parameters Measured:

Biological: Number of fish returning to hatchery, timing of fish returns, number of eggs

and juveniles produced, number of eggs and juveniles received from other sources, percent fertility of eggs, hatchery of origin of coded-wire tagged adults.
Physical: Water temperature, turbidity
Chemical: Dissolved oxygen, pH

How Were Hatchery Fish Distinguished from Wild Fish?: Presence of adipose fin clip (coded-wire tag) or other mark, otherwise indistinguishable.

Data Storage:

Location: Mokelumne River Hatchery
Contact for Data Retrieval:
Available to Public: Yes
Cost of data: None
Storage Format(electronic/hardcopy): Hardcopy; some years in electronic format
Hardware: PC
Software:
Quality Assurance (for data entry as opposed to analytical):

Products (Delivery Dates):

Data:
Progress Reports: September 30
Final Reports: Ongoing program, no final report

Comparable Data Available during 1967-1991 Period: Mills, T. J. and F. Fisher. 1994. Central Valley anadromous sport fish annual run size, harvest, and population estimates, 1967 through 1991. Inland Fisheries Technical Report, June 1993. Revised August 1994. California Department of Fish and Game. Sacramento, CA.

Reliance on other Monitoring Programs: No

Funding Source: EBMUD, Commercial Salmon Trollers Stamp Fund

Quantity of Funds:

Security of Funds: secure

References (any reprints or reports used in compiling entry): Estey, D. F. 1994. Annual Report: Mokelumne River Hatchery, 1992-93. California Department of Fish and Game, Inland Fisheries Administrative Report. No. 94-6. Sacramento, CA.

Specific Monitoring Methods: Hatchery counts

Sampling Reaches: Mokelumne River Hatchery

Sampling Frequency: Annual

Sampling Period: Fish ladder opened approximately November 1 through March 31.

Sampling Equipment: Fish racks; ladder; spawning, incubation, and rearing facilities

Sampling Methods:

1) Count adult and grilse chinook salmon and steelhead trout arriving daily.
2) Measure standard lengths and fork lengths, remove scales/otoliths from representative sample of salmon and steelhead.
3) Count and record adipose-clipped (coded-wire tagged) fish and fish marked otherwise.
4) Remove snout of adipose-clipped fish for detection, removal, and decoding of coded-wire tag.

Data Analysis:

1) Summarize daily counts of chinook salmon (adults and grilse) and steelhead trout.
2) Summarize daily hatchery water temperatures.
3) Summarize length frequency and sex composition data by species.
4) Summarize coded-wire tag recovery data and counts of tagged/marked fish.

Staffing:

Hatchery: 1 month Fish Culturist

Data Analysis/Management/Report: 1 Month Fish Hatchery Manager II

Report Prepared by: California Department of Fish and Game

Report Contents to Include:

1) Annual counts of fall-run chinook salmon (adults and grilse) and steelhead trout entering hatchery.
2) Counts of tagged/marked fish and coded-wire tag recovery data, including species, race, brood year, hatchery of origin, release size, release date, and release location.

EXISTING ADULT PROGRAM 22
Estuarine Monitoring Program-Adult Striped Bass Study

Species: Striped Bass
Watershed: Sacramento-San Joaquin Delta

BACKGROUND INFORMATION

Monitoring Methods: Mark-recapture program

Target Species: Striped Bass

Target Life Stages: Adults

Program Name: Estuarine Monitoring Program: Adult Striped Bass Study

Lead Agency: California Department of Fish and Game

Program Manager: David Kohlhorst

Address: California Department of Fish and Game
4001 North Wilson Way
Stockton, CA 95205

Phone: (209)948-7800

Key Supporting Agencies: IEP, CDFG

Key Supporting Staff: Raymond Schaffter, Kenneth Miller

Program Goals:

1) Determine long-term trends in abundance and mortality rates of adult striped bass.
2) Determine dependence of adult abundance on abundance of earlier life stages.
3) Determine factors affecting adult striped bass abundance and mortality with emphasis on water development and sport fishing.

Program Duration: 1969 to present

Geographic Area Covered: Tagging: Broad Slough to Colusa on the Sacramento River and Broad Slough to Venice Island on the San Joaquin River. Creel Survey: Nearshore Pacific Ocean to Colusa on Sacramento River and to Mossdale on San Joaquin River.

Parameters Measured:

Biological: Abundance estimates, distribution, mortality rates, harvest rates, length and age composition.
Physical: Water temperature
Chemical: None

How Were Hatchery Fish Distinguished from Wild Fish?: Presence of coded-wire tag

Data Storage:

Location: CDFG Bay-Delta Division, Stockton
Contact for Data Retrieval: David Kohlhorst, CDFG
Available to Public: Yes
Cost of data:
Storage Format(electronic/hardcopy): Electronic
Hardware: PC
Software: dBASE IV
Quality Assurance (for data entry as opposed to analytical): KLP verification; error-checking software

Products (Delivery Dates):

Data: June 30
Progress Reports: June 30 (IEP annual report)
Final Reports: Ongoing program, no final reports

Comparable Data Available during 1967-1991 Period: Mills, T. J. and F. Fisher. 1994. Central Valley anadromous sport fish annual run size, harvest, and population estimates, 1967 through 1991. Inland Fisheries Technical Report, June 1993. Revised August 1994. California Department of Fish and Game. Sacramento, CA.

Reliance on other Monitoring Programs: DFG's Striped Bass Hatchery Evaluation Project (angler survey)

Funding Source: DFG (Federal Sport Fish Restoration Fund, Fish and Game Preservation Fund)

Quantity of Funds: $210,000

Security of Funds: Funded 1995-1996 fiscal year; future availability of funds uncertain

References (any reprints or reports used in compiling entry): IEP. 1995. Preliminary recommendations for the proposed revision of the monitoring, special study and research activities of the Interagency Ecological Program (IEP) for the Sacramento-San Joaquin estuary. Attachment 1: Input from project work teams including revised program element fact sheets and associated issues and ideas. August 18, 1995.

Specific Monitoring Methods: Mark-recapture program

Sampling Reaches:

Gill Nets: Sacramento River from Decker Island to Broad Slough, Broad Slough, San Joaquin River at Jersey Island, Santa Clara Shoals, Prisoner's Point.

Fyke Traps: Sacramento River at Knight's Landing.

Angler Survey: Pacific Ocean beaches to Colusa on the Sacramento River and Mossdale on the San Joaquin River.

Sampling Frequency: Every other year

Sampling Period: Gill nets: 5 days per week during 1 April - 31 May; fyke traps: continuously from 1 April - 15 June); angler survey: year-round.

Sampling Equipment: Fyke traps, drift gill nets

Sampling Method:

1) Determine sex, measure lengths, and collect scales from striped bass captured by gill net or fyke trap.
2) Tag striped bass with individually numbered disk-dangler tags (a minimum of 10% are reward tags) below the spinous dorsal fin and release at capture site.
3) During angler surveys, collect scales and record numbers, lengths, tag number, and sex of tagged and untagged striped bass caught by anglers.
4) Record tag numbers of tagged and untagged striped bass captured during subsequent spring tagging periods.

Data Analysis:

1) Use age-length key developed from known-aged fish to apportion unaged fish into appropriate age classes .

2) Use modified Peterson estimator to generate age- and sex-stratified striped bass abundance estimates (with confidence intervals) based on recaptures of tagged fish during tagging in subsequent years and from angler surveys.
3) Estimate harvest rate from ratio of tags returned by anglers (corrected for proportion of recovered tagged fish not reported) and total numbers of tagged fish.
4) Estimate annual mortality rates based on tag recoveries reported by anglers and from angler surveys.
5) Describe movement patterns based on month and location of tag recoveries reported by anglers.

Staffing:

Field Work:

Tagging: 6 persons for gill nets (3/boat), 8-10 hr/day, 44 days/yr 3 persons for fyke traps, 8-10 hr/day, 50 days/yr.

Other times: 2 temporary personnel for 40 days to prepare for tagging and repair and store equipment after tagging.
1 biologist for 10 days to prepare for tagging
2 lab assistants 8 hr/day for 20 days to prepare for tagging

Data Analysis/Management/Report: Senior biologist, biologist, 2 senior lab assistants

Report Prepared by: California Department of Fish and Game

Report Contents Include: Estimated abundance of adult striped bass (with confidence intervals) stratified by sex and age.

EXISTING ADULT PROGRAM 23
Estuarine Monitoring Program-Sturgeon Study

Species: White Sturgeon, Green Sturgeon
Watershed: Sacramento-San Joaquin Delta

BACKGROUND INFORMATION

Monitoring Study Type: Mark-recapture program

Target Species: White sturgeon

Target Life Stages: Adults

Program Name: Estuarine Monitoring Program: Sturgeon Study

Lead Agency: California Department of Fish and Game

Program Manager: David Kohlhorst

Address: California Department of Fish and Game
4001 North Wilson Way
Stockton, CA 95205

Phone: (209) 948-7800

Key Supporting Agencies: IEP, USBR, DWR

Key Supporting Staff: Lee Miller, CDFG

Program Goals:

1) Determine trends in legal-sized white sturgeon abundance and mortality rates.
2) Determine dependence of adult abundance on production of earlier life stages.
3) Determine factors affecting legal-sized sturgeon abundance with emphasis on water development, spawning habitat quality and quantity, and sport fishing.

Program Duration: 1954 to present (intermittent)

Geographic Area Covered: San Pablo Bay and Suisun Bay

Parameters Measured:

Biological: Abundance estimates, distribution, mortality rates, harvest rates, length and age composition.
Physical: Water temperature
Chemical: None

How Were Hatchery Fish Distinguished from Wild Fish?: N/A

Data Storage:

Location: CDFG Bay-Delta Division, Stockton
Contact for Data Retrieval: David Kohlhorst, CDFG
Available to Public: Yes
Cost of data:
Storage Format(electronic/hardcopy): Electronic
Hardware: PC
Software: dBASE IV
Quality Assurance (for data entry as opposed to analytical): Error checking by looking for outliers.

Products (Delivery Dates):

Data: June 30
Progress Reports: June 30 (IEP annual report)
Final Reports: Ongoing program, no final reports

Comparable Data Available during 1967-1991 Period: Mills, T. J. and F. Fisher. 1994. Central Valley anadromous sport fish annual run size, harvest, and population estimates, 1967 through 1991. Inland Fisheries Technical Report, June 1993. Revised August 1994. California Department of Fish and Game. Sacramento, CA.

Reliance on other Monitoring Programs:

Funding Source: DFG (Federal Sport Fish Restoration Fund, Fish and Game Preservation Fund)

Quantity of Funds: $26,700

Security of Funds: Funded 1995-1996 fiscal year; future availability of funds uncertain

References (any reprints or reports used in compiling entry): IEP. 1995. Preliminary recommendations for the proposed revision of the monitoring, special study and research activities of the Interagency Ecological Program (IEP) for the Sacramento-San Joaquin estuary. Attachment

1: Input from project work teams including revised program element fact sheets and associated issues and ideas. August 18, 1995.

Specific Monitoring Methods: Mark-recapture program

Sampling Reaches: San Pablo Bay and Suisun Bay

Sampling Frequency: Alternating years when striped bass are not tagged

Sampling Period: September-early November

Sampling Equipment: Boat, trammel net, fish cradles, disc-dangler tags

Sampling Method:

1) Tag legal-sized white sturgeon with individually-numbered reward disk-dangler tags placed below the anterior end of the dorsal fin and release near the site where they were captured.
2) Tag legal-sized green sturgeon with reward tag that is distinctive from those used to tag white sturgeon.
2) Measure total lengths of white sturgeon and green sturgeon to the nearest centimeter.
3) Record recaptures of all tagged fish from previous tagging periods.

Data Analysis:

1) Estimate white sturgeon abundance and confidence intervals based on recaptures of tagged fish during tagging [use Bailey's modified Petersen method (recapture sample available from later year) or multiple census method of Schumacher and Eschmeyer (recaptures available during tagging only)].
2) Estimate harvest rate from tags returned by anglers.
3) Estimate mortality rate from tags returned by anglers [use Brownie et al. (1978) maximum-likelihood equation (tagging conducted in two consecutive years) or from catch curve method based on age frequencies of tagged sturgeon (tagging not conducted in consecutive years)].
4) Describe movement patterns based on month and location of tags returned by anglers.
5) Summarize length and age composition data.
6) Estimate green sturgeon abundance based on estimated white sturgeon abundance and the ratio of green sturgeon to white sturgeon observed during tagging.

Staffing:

Field Work:
Data Analysis/Management/Report:

Report Prepared by: California Department of Fish and Game

Report Contents Include:

1) Estimated annual white sturgeon abundance and confidence intervals.
2) Estimated green sturgeon abundance.

EXISTING ADULT PROGRAM 24
Estuarine Monitoring Program

Species: American Shad
Watershed: Sacramento-San Joaquin Delta

BACKGROUND INFORMATION

Monitoring Study Type: Midwater Trawl Survey

Target Species: American shad

Target Life Stages: Juveniles (young-of-the-year)

Program Name: Estuarine Monitoring Program

Lead Agency: California Department of Fish and Game

Program Manager: Donald E. Stevens

Address: California Department of Fish and Game
4001 North Wilson Way
Stockton, CA 95205

Phone: (209) 948-7800

Key Supporting Agencies: IEP, DWR, USFWS, USBR

Key Supporting Staff: Lee Miller, Dale Sweetnam

Program Goals: Monitor abundance and distribution of striped bass and other species that inhabit the estuary during fall.

Program Duration: 1967 to present except 1974 and 1979 when no sampling was conducted.

Geographic Area Covered: San Pablo Bay, Suisun Bay, Sacramento-San Joaquin Delta

Parameters Measured:
Biological: Catch by species, striped bass lengths
Physical: Secchi, water temperature, specific conductance, water velocities
Chemical: None

How Were Hatchery Fish Distinguished from Wild Fish?: N/A

Data Storage:

Location: CDFG (IEP server)
Contact for Data Retrieval: Olaf Hansen, IEP, or Lee Miller, CDFG
Available to Public: Yes
Cost of data:
Storage Format(electronic/hardcopy): Electronic
Hardware: PC
Software: ASCII files (IEP server)
Quality Assurance (for data entry as opposed to analytical): Raw data edited, data files edited, error rate checked by random sampling.

Products (Delivery Dates):

Data: June 30
Progress Reports: June 30 (IEP annual report)
Final Reports: Ongoing program, no final reports

Comparable Data Available during 1967-1991 Period: Mills, T. J. and F. Fisher. 1994. Central Valley anadromous sport fish annual run size, harvest, and population estimates, 1967 through 1991. Inland Fisheries Technical Report, June 1993. Revised August 1994. California Department of Fish and Game. Sacramento, CA.

Reliance on other Monitoring Programs:

Funding Source: IEP, CVPIA

Quantity of Funds: $265,000

Security of Funds: Funded 1995-1996 fiscal year

References (any reprints or reports used in compiling entry): Program activities of the Interagency Ecological Program for the Sacramento-San Joaquin Estuary. May 1, 1995.

Specific Monitoring Methods: Fall Midwater Trawl Survey

Sampling Reaches: Approximately 90 sites in San Pablo Bay, Suisun Bay, and the Sacramento-San Joaquin Delta.

Sampling Frequency: 6-day period per month

Sampling Period: September-December

Sampling Equipment: Boat, midwater trawl

Sampling and Laboratory Methods:

1) Conduct 10-minute diagonal tow at each sampling site from bottom (if possible) to surface.
2) All fish and shrimp catches are identified and enumerated in the field. All striped bass are measured and up to 50 individuals of each other species are measured. Water clarity, temperature, and electrical conductivity are measured at each site. Water flow is measured during towing using a General Oceanics flowmeter. The speed of the boat as well as site depth is measured.

Data Analysis:

1) Count or estimate (by subsampling) number of American shad juveniles per trawl and measure length.
2) Calculate American shad abundance indices based on trawl catches and the water volume sampled by area and month.
3) Sum monthly abundance indices to generate annual abundance indices.

Staffing:

Field Work: 3 persons, 10 hr/day, 6 days/month
Laboratory Work: 1 technician
Data Analysis/Management/Report: Senior biologist, biologist

Report Prepared by: California Department of Fish and Game

Report Contents Include:

1) Annual fall midwater trawl abundance index for American shad.
2) Monthly spatial and temporal distribution of American shad based on trawl catches.

EXISTING ADULT PROGRAM 25
Ocean Salmon Project

Species: Chinook Salmon
Watershed: Pacific Ocean

BACKGROUND INFORMATION

Monitoring Study Type: Ocean Harvest Monitoring

Target Species: Chinook salmon

Target Life Stages: Adult

Program Name: Ocean Salmon Project

Lead Agency: California Department of Fish and Game

Program Manager: Alan Baracco

Address: California Department of Fish and Game, Region 2
Ocean Salmon Project
1701 Nimbus Road
Rancho Cordova, CA 95670

Phone: (916) 358-2841

Key Supporting Agencies: National Marine Fisheries Service (commercial and recreational fishery management); U.S. Coast Guard (enforcement); Pacific States Marine Fisheries Commission (CWT data); federal, state, tribal entities.

Key Supporting Staff: Rod McInnis, NMFS, SW Region, Long Beach, CA
Ken Johnson, PSMFC, Gladstone, OR

Program Goals:

1) Monitor and regulate ocean commercial and recreational harvest.
2) Sample a minimum of 20% of the commercial and sport harvest within all port areas and fishing seasons.

Program Duration: 1952 to present (commercial harvest monitoring); 1962 to present (recreational); 1975 to present (CWT monitoring program)

Geographic Area Covered: Five port areas from the southern Oregon coast to central California coast (Crescent City, Eureka, Fort Bragg, San Francisco, Monterey).

Parameters Measured:

Fishery: Number of deliveries, days fished, number of anglers, economic value
Biological: Species, weight, and number of fish in landings
Physical: None
Chemical: None

How Were Hatchery Fish Distinguished From Wild Fish?: Presence of adipose fin clip or other fin clip, otherwise not distinguishable.

Data Storage:

Location: California Department of Fish and Game, Sacramento; CWT data compiled by PSMFC
Contact for Data Retrieval: Alan Baracco
Address: See above
Phone: See above
Available to Public: Yes
Cost of data: None
Storage Format: Electronic ASCII flat file
Hardware: PC
Software: SAS
Quality Assurance (for data entry as opposed to analytical): High

Products (Delivery Dates):

Data: Summary reports available on request
Progress Reports: Annual summaries of harvest statistics
Final Reports: CWT data reported by PSMFC

Comparable Data Available during 1967-1991 Period: Yes

Reliance on other Monitoring Programs: Coordination with Oregon and Washington Ocean monitoring programs.

Funding Source: State, NMFS, DWR, USFWS (Sport Fish Restoration Act funds)

Quantity of Funds: Approximately $350,000 per year (ocean harvest monitoring)

Security of Funds: Secure as long as commercial and recreational fisheries exist.

References (any reprints or reports used in compiling entry): Dixon, R. 1994. Summary of methods used to estimate the California ocean salmon catch and coded-wire tag contribution for 1993. CDFG report, Sacramento, CA.

Mills, T.J., and F. Fisher. 1994. Central Valley anadromous sport fish annual run-size, harvest, and population estimates. California Department of Fish and Game, Inland Fisheries Technical Report. Sacramento, CA.

Pacific Fishery Management Council. 1996. Review of 1995 ocean salmon fisheries. Portland, OR.

___________. 1993. Historical ocean salmon fishery data for Washington, Oregon and California. Portland, OR

Specific Monitoring Methods: Ocean Harvest Monitoring

Sampling Reaches:

Port Areas: Crescent City, Eureka, Fort Bragg, San Francisco, Monterey

Sampling Frequency: Sampling of commercial troll fishery stratified into semi-monthly periods (1st to 15th, 16th to end of month) at a minimum rate of 20% throughout the commercial season; sampling of recreational skiff and charterboat fisheries stratified by weekend day/holiday and weekday at a minimum rate of 20% throughout the recreational season.

Sampling Period: May 1-September 30 (commercial season subject to later openings, mid-season closures, and earlier closures); February 15-November 15 (recreational season).

Sampling Equipment: Field log book, recovery tags for snouts of adipose-clipped fish, measuring tape.

Sampling Methods:

Commercial Fishery:

1) Random sampling procedure stratified by port area and time period.
2) Record species, weight, and numbers of salmon from sampled landings from single- and multiple-day boats.
3) Record total weight of landings from commercial salmon buyer records by species, port and time periods.

4) Record species, fork length, and sampling date of adipose-clipped salmon; retain snout for later removal and decoding of coded-wire tag.
5) Record species, fork length, and sampling date of marked salmon (other than adipose-clipped).

Recreational Skiff and Charterboat Fishery:

1) Random sampling procedure stratified by port areas, sub-ports, and time period.
2) Interview all recreational skiff and charterboat anglers and record species, number of salmon landed, number of anglers.
3) Tally number of boats not sampled.
4) Record species, fork length, and sampling date of adipose-clipped salmon; retain snout for later removal and decoding of coded-wire tag.
5) Record species, fork length, and sampling date of marked salmon (other than adipose-clipped).

Data Analysis:

1) Estimate total landings (number and weight) of chinook salmon by port area and month.
2) Estimate percentage of total landings sampled by port area and month.
3) Estimate total fishing effort in number of deliveries (commercial fishery), days fished (commercial and recreational fishery), and angler-days (recreational fishery) by port area and month.
4) Estimate economic value (exvessel) in commercial fishery.
5) CWT observations and expansions for sample level in PSMFC format.

Staffing:

Field Work:

Data Analysis/Management/Report:

Report Prepared by: California Department of Fish and Game

Report Contents Include:

1) Estimated landings (number and weight) of chinook salmon by port area and month.
2) Estimated percentage of total landings sampled by port area and month.
3) Estimated total fishing effort in number of deliveries (commercial fishery), days fished (commercial and recreational fishery), and angler-days (recreational fishery) by port area and month.

EXISTING ADULT PROGRAM 26
Upper Sacramento River Escapement Survey

Species: ***Chinook Salmon***
Watershed: ***Upper Sacramento River***

BACKGROUND INFORMATION

Monitoring Methods: Escapement survey

Target Species: Fall-run chinook salmon

Target Life Stages: Adult

Program Name: Stream Flow and Habitat Evaluation Program

Lead Agency: California Department of Fish and Game

Program Manager: Bill Snider

Address: Environmental Services Division
1416 Ninth St., Room 1314
Sacramento, CA 95814

Phone: (916) 653-2185

Key Supporting Agencies:

Key Supporting Staff: Larry Hanson, Bob Reavis (DFG)

Program Goals:

1) To estimate the 1995, in-river, fall-run chinook salmon spawning population for the upper Sacramento River.
2) To examine the Jolly-Seber and Schaefer population models and recommend future escapement estimating procedures.
3) To augment redd surveys to provide baseline information on spawning distribution, spawning habitat availability, instream flow requirements, and the status of chinook salmon in the upper Sacramento River.

Program Duration:

Geographic Area Covered: Upper Sacramento River between ACID dam to Cottonwood Creek

Parameters Measured

Biological: Number of salmon carcasses, fork length, egg retention for females
Physical: Water flow
Chemical: Water temperature

How Were Hatchery Fish Distinguished from Wild Fish?:

Data Storage:

Location: California Department of Fish and Game, Rancho Cordova
Contact for Data Retrieval: Bill Snider
Available to Public: Yes
Cost of data:
Storage Format (electronic/hardcopy):
Hardware: PC
Software:
Quality Assurance (for data entry as opposed to analytical):

Products (Delivery Dates):

Data:
Progress Reports:
Final Reports:

Comparable Data Available during 1967-1991 Period:

Mills, T. J., and F. Fisher. 1994. Central Valley anadromous sport fish annual run size, harvest, and population estimates, 1967 through 1991. Inland Fisheries Technical Report, June 1993. Revised August 1994. California Department of Fish and Game. Sacramento, CA.

Reliance on other Monitoring Programs:
Funding Source: U.S. Fish and Wildlife Service

Quantity of Funds:

Security of Funds:

Specific Monitoring Methods: Carcass survey

Sampling Reaches: 25.5-mile long stream segment from ACID dam (river mile 298.5) downstream to the mouth of Cottonwood Creek (river mile 273).

Sampling Frequency: Weekly (broken up into four days)

Sampling Period: October 1 through December 23, 1995

Sampling Equipment: Machete, hog rings with flagging, hog pliers, gaffs

Sampling Methods:

Carcasses with the head in tact were normally tagged. The following groups of carcasses were chopped and not tagged: 1) those on shore in a "leathery conditions"; 2) those in Reach 4 (the most downstream reach) that would likely wash out of the survey area and never be recovered; and 3) carcasses in excess of the number crews could tag during a day. "Fresh" and "decayed" carcasses were combined to calculate population estimates

Data Analysis: Schaefer and Jolly-Seber models

Staffing:

Field work:
Data Analysis/Management/Report:

Report Prepared by: Bill Snider, Larry Hanson, Bob Reavis

Report Contents Include:

Weekly counts of carcasses, along with flows and temperatures; carcass distribution by reach; size and sex ratio of subsample of carcasses; age composition of carcasses by week; spawning completion (egg retention) summary; summary of historical escapement estimates for the Upper Sacramento River; population estimate based on the Schaefer model.

EXISTING JUVENILE PROGRAM 1
Lower American River Emigration Survey

Species: ***Fall-Run Chinook Salmon***
Watershed: ***American River***

BACKGROUND INFORMATION

Monitoring Methods: Juvenile Outmigration Monitoring

Target Species: Chinook salmon, steelhead trout, American shad

Target Life Stages: Fry, parr, silvery parr, smolts

Program Name: Lower American River Emigration Survey

Lead Agency: California Department of Fish and Game

Program Manager: Bill Snider

Address: Environmental Services Division
1416 Ninth St., Room 1314
Sacramento CA 95814

Phone: (916) 653-2185
(916) 653-2588 fax

Key Supporting Agencies: County of Sacramento, East Bay Municipal Utility District, Alameda County Superior Court

Key Supporting Staff: Robert Titus

Program Goals:

1) To identify the general attributes of emigration in the Lower American River, including timing, abundance, fish size (life stage) composition and fish condition.
2) To relate the above attributes primarily to flow dependent, environmental conditions.
3) To develop an empirically based model to link emigration with flow.
4) To develop procedures to quantify or index the size of the emigrating population.

5) Ultimately, to associate production and survival with environmental conditions by combining emigration data with information being collected on spawner population size, numbers and distribution of redds, and the magnitude and dynamics of the rearing phase of chinook salmon precedent to emigration.

Program Duration: 1992-1995

Geographic Area Covered: Lower American River below Nimbus dam.

Parameters Measured

Biological: Species captured, timing of salmon emigration, length and weight of captured fish, Fultons condition factor of measured emigrants, life stage of emigrants (fry, parr, silvery parr or smolts), age of emigrants
Physical: Water temp, trap efficiency, stream flow, turbidity.
Chemical: None

How Were Hatchery Fish Distinguished from Wild Fish?: No hatchery fish have been released in the American River since 1991.

Data Storage:

Location: DFG, Sacramento
Contact for Data Retrieval: Bill Snider, CDFG
Available to Public: For review
Cost of data: None for agencies, photocopy charge for private parties.
Storage Format(electronic/hardcopy): Hardcopy and electronic.
Hardware: PC
Software: dBASE, QuattroPro
Quality Assurance (for data entry as opposed to analytical): Yes

Products (Delivery Dates):

Data: N/A
Progress Reports: Annual reports
Final Reports: Pending

Comparable Data Available during 1967-1991 Period: Beak Consultants, Inc. 1988. Smolt emigration assessment, lower American River fisheries investigation-progress report. Prepared for McDonough, Holland and Allen.

Reliance on other Monitoring Programs: Water temperature data provided by Beak Consultants, Inc; flow data provided by USBR records for Nimbus Dam.

Funding Source: EBMUD, County of Sacramento, DFG

Quantity of Funds: $24,750 from EBMUD in 1992, and $22,000 in 1993; $25,725 from the County of Sacramento (1992); No DFG funds were officially allocated, but the program manager estimates the total cost exceeded above funds about threefold.

Security of Funds: Not Secure, program in jeopardy.

Specific Monitoring Methods:

Sampling Reaches: Two sites downstream of the Watt Avenue Bridge (RM 9)

Sampling Frequency: 24 hr operation of traps (excluding some weekends) during trapping season.

Sampling Period: Annually, mid-November to mid-July

Sampling Equipment: Two pontoon mounted rotary screw traps, fyke nets, seines,

Sampling Methods:

1) Screw traps placed in separate channels in water >4 ft deep and >1 ft/s velocity.
2) Each trap fished 4-7% of their respective channel widths.
3) Traps fished weekdays, were serviced each morning.
4) Trap efficiency measured via mark-recapture methods.

Data Analysis: Mark-Recapture; Fulton's Condition Factor (K) statistics by life stage for chinook salmon

Staffing:

Field work:
Data Analysis/Management/Report:

Report Prepared by: California Department of Fish and Game

Report Contents Include:

1) Length frequency distribution of chinook salmon.
2) Fulton's condition factor statistics for chinook salmon.
3) Trap efficiencies.
4) Flow, water temperature, and turbidity of the American River.
5) Catch distribution over time of chinook salmon, steelhead trout, pacific lamprey, and American shad.

EXISTING JUVENILE PROGRAM 2
Butte Creek Spring-Run Chinook Salmon Juvenile Life History and Emigration Study

Species: Spring- and Fall-Run Chinook Salmon, Steelhead Trout
Watershed: Butte Creek

BACKGROUND INFORMATION

Monitoring Methods: Juvenile Emigration Study

Target Species: Spring- and fall-run chinook salmon, steelhead trout

Target Life Stages: Fry, juvenile

Program Name: Butte Creek Spring-Run Chinook Salmon Juvenile Life History and Emigration Study

Lead Agency: California Department of Fish and Game

Program Manager: Nick Villa

Address: California Department of Fish and Game, Region 2
1701 Nimbus Road
Rancho Cordova, CA 95670

Phone: (916) 358-2943

Key Supporting Agencies: DWR

Key Supporting Staff: 1 project biologist, 1 biological technician, and 1 seasonal staff member.

Program Goals: Determine presence, outmigration timing, and relative abundance of juvenile salmon and steelhead

Program Duration: Every year beginning in 1994

Geographic Area Covered: Butte Creek from Centerville Head Dam to Chico; Chico to Sutter Bypass (Sutter National Wildlife Refuge)

Parameters Measured

Biological: Number, fork length, weight (subsample), condition factor
Physical: Daily flow records, Secchi disk readings
Chemical: Water temperature

How Were Hatchery Fish Distinguished from Wild Fish?:

Data Storage:

Location: GCID; CDFG Region 2 office
Contact for Data Retrieval: Kathy Hill (CDFG)
Available to Public: Yes (not in electronic form)
Cost of data: N/A
Storage Format (electronic/hardcopy): electronic
Hardware: PC
Software: Lotus 3.0
Quality Assurance (for data entry as opposed to analytical):

Products (Delivery Dates):

Data:
Progress Reports: Annual
Final Reports: NA

Comparable Data Available during 1967-1991 Period: Sampling of outmigrants not conducted on a continuous basis, rather only short-duration trapping

Reliance on other Monitoring Programs: Data supports other programs, including Delta fisheries monitoring

Funding Source: CDFG

Quantity of Funds: Approximately $30,000 per year

Security of Funds: Insecure funding at present

Sampling Methods: Mark-recapture techniques used at all sites; however, ineffective for accurate population estimate

Sampling Reaches: Parrott-Phelan Dam, Weir #1; Sutter Bypass (Sutter National Wildlife Refuge)

Sampling Frequency: Continuous (24 hrs/day; 7 days/week)

Sampling Period: November through June

Sampling Equipment: 8 foot diameter rotary screw traps

Data Analysis:

Staffing:

Field work:
Data Analysis/Management/Report:

Report Prepared by: CDFG

Report Contents Include:

EXISTING JUVENILE PROGRAM 3
Deer Creek Salmon Rearing/Emigration Monitoring

Species: Spring-Run Chinook Salmon
Watershed: Deer Creek

BACKGROUND INFORMATION

Monitoring Methods: Juvenile rearing/emigration monitoring

Target Species: Spring-run chinook salmon

Target Life Stages: Fry, juvenile

Program Name: Sacramento River Salmon and Steelhead Assessment Program

Lead Agency: California Department of Fish and Game

Program Manager: Colleen Harvey

Address: California Department of Fish and Game
2440 Main Street
Red Bluff, CA 96080

Phone: (916) 527-8892

Key Supporting Agencies: N/A

Key Supporting Staff: 2 biologists, 2 technicians, 1 office assistant

Program Goals: Determine emergence timing, relative growth rates, emigration timing, and size of juvenile spring-run chinook salmon; coded-wire tagging of all spring-run yearlings

Program Duration: Every year since 1994

Geographic Area Covered: Deer Creek upstream of Upper Dam area

Parameters Measured
Biological: Abundance and growth of rearing juveniles; counts of juvenile outmigrants at selected locations (i.e., diversions dams)
Physical: Flow, water temperature, turbidity
Chemical:

How Were Hatchery Fish Distinguished from Wild Fish?:

Data Storage:

Location: California Department of Fish and Game, Red Bluff
Contact for Data Retrieval: Colleen Harvey
Available to Public: Yes
Cost of data: N/A
Storage Format (electronic/hardcopy): electronic
Hardware: PC
Software: Lotus
Quality Assurance (for data entry as opposed to analytical):

Products (Delivery Dates):

Data: Irregular
Progress Reports: Summary memoranda
Final Reports: Annual progress report for Sport Fish Restoration Act

Comparable Data Available during 1967-1991 Period:

Reliance on other Monitoring Programs:

Funding Source: Sport Fish Restoration Act

Quantity of Funds:

Security of Funds: Included in 5-year workplan

Specific Monitoring Methods: Seining, electrofishing, rotary screw trapping

Sampling Reaches: Upper dam area (emigration); Potato Patch, Highway 32, A-Line, Gaither Camp, Ponderosa Way (rearing)

Sampling Frequency: daily (emigration); weekly (seining, electrofishing)

Sampling Period: December through September (seining, electrofishing); September through June (screw trapping)

Sampling Equipment: 8'-diameter rotary screw trap

Sampling Methods: Seining, electrofishing, rotary screw trapping

Data Analysis:

Staffing:

Field work: Associate Biologist - 1 month; Two fish and Wildlife Assistants - 5 months each (10 months total)

Data Analysis/Management/Report: Associate Biologist - 5 months

Report Prepared by: California Department of Fish and Game

Report Contents Include: Daily catch, length, and weight sample

EXISTING JUVENILE PROGRAM 4
Feather River Salmon Emigration Survey

Species: Fall- and Spring-Run Chinook Salmon
Watershed: Feather River

BACKGROUND INFORMATION

Monitoring Methods: Juvenile outmigration

Target Species: Fall-chinook salmon

Target Life Stages: fry, juvenile

Program Name: Feather River Studies: Juvenile Outmigration Survey

Lead Agency: Department of Water Resources

Program Manager: Ted Sommer, Debbie McEwan

Address: Environmental Services Department
3251 S Street
Sacramento, CA 95816

Phone: (916) 227-7537

Key Supporting Agencies: CDFG

Key Supporting Staff: Fred Meyer, Nick Villa, Bill Snider, and Terry Mills - CDFG

Program Goals:

1) Determine the timing and magnitude of outmigration of Feather River fish species relative to different physical conditions.
2) Examine species composition of outmigrants.
3) Develop an annual juvenile salmon production index by associating information on spawning intensity with emigration data.
4) Coded-wire tagging (CWT) of in-channel produced Feather River fish for comparison with the distribution and survival of hatchery fish.
5) Integrate emigration data into "real time" monitoring program in the Delta for fisheries management.

Program Duration: 1996-1999

Geographic Area Covered: Low flow channel (Oroville Dam to Thermalito outlet), and Thermalito Outlet to Live Oak

Parameters Measured

Biological: Species, length, count, timing and rate of juvenile outmigration
Physical: Water temperature, water clarity, flow
Chemical: None

How Were Hatchery Fish Distinguished from Wild Fish?: CWT

Data Storage:

Location: worldwide web: www.iep under "Real Time Data"
Contact for Data Retrieval: Ted Sommer/Debbie McEwan, DWR
Available to Public: Yes
Cost of data: none
Storage Format (electronic/hardcopy): electronic
Hardware: PC
Software: dBASE or ASCII format
Quality Assurance (for data entry as opposed to analytical):

Products (Delivery Dates):

Data: Annually through 1999
Progress Reports: Annually, probably around September
Final Reports: Around December 1999

Comparable Data Available during 1967-1991 Period: None

Reliance on other Monitoring Programs: DWR stream gages on Lower Feather River for temperature and flow

Funding Source: Water Project

Quantity of Funds: $48,000/year for 4 years

Security of Funds: Secure through year 2000

Specific Monitoring Methods:

Sampling Reaches: Traps are in effect from the downstream end of the low flow channel, just above Thermalito Outlet, to the downstream end of the lower reach at RM 42.

Sampling Frequency: Daily

Sampling Period: Water year 1996: March - June; Water year 1997: October - June; Water years 1998-1999: December - June

Sampling Equipment: Rotary Screw Traps, Secchi disc, pontoon boat

Sampling Methods:

Two eight-foot rotary screw fish traps are deployed - at the downstream end of the low flow channel, just above Thermalito Outlet, and at RM 42. Traps are in operation daily from December through June each year. Traps are serviced at least once a day in the morning (more if fish capture and debris warrant it). Trapped fish are sorted by species, counted and fork-lengths measured to the nearest 0.5 millimeter for up to 50 of each species. Trap efficiencies are evaluated using mark-recapture (fin clips and dye-mark) methods of fish caught in the traps.

Data Analysis:

1) Species composition comparisons between reaches, similar systems in the Central Valley, and available life history data.
2) Comparisons between study years by developing a series of parameters that could be used to evaluate differences in salmon spawning timing and success, juvenile survival and production between different years.
3) Evaluation of flow, secchi depth, weather and temperature.
4) Population size estimated based on catch data and trap efficiency results, and would include confidence intervals. Standardizing the number of fry and juveniles using published survival data into a single measurement such as "juvenile equivalents" or "yearling equivalents" will be considered.
5) Emigration Indices:
   a) develop an escapement-corrected emigration index:
      Index = Emigration/Escapement; where escapement value is from DFG Region 2
   b) develop an emigration index corrected for spawning intensity:
      Index = Emigration/Spawning area; where spawning are is developed from aerial photography during the spawning surveys

Staffing:

Field work: Environmental Specialist IV - 0.5 month; Env. Spec. II - 3 months; Scientific Aides - 27 months (note that 9 months of this is for spawning surveys)

Data Analysis/Management/Report: Env. Spec. IV - 1 month; Env. Spec. II - 1 month

Report Prepared by: Department of Water Resources

Report Contents Include: Species catch by day and reach; trap efficiency estimates; relative abundance indices by reach; daily average size; time series analysis of factors affecting outmigration.

EXISTING JUVENILE PROGRAM 5
Mill Creek Salmon Rearing/Emigration Monitoring

Species: Spring-Run Chinook Salmon
Watershed: Mill Creek

BACKGROUND INFORMATION

Monitoring Methods: Juvenile rearing/outmigration sampling

Target Species: Spring-run chinook salmon

Target Life Stages: Fry, juvenile

Program Name: Sacramento River Salmon and Steelhead Assessment Program

Lead Agency: California Department of Fish and Game

Program Manager: Colleen Harvey

Address: California Department of Fish and Game
2440 Main Street
Red Bluff, CA 96080

Phone: (916) 527-8892

Key Supporting Agencies: N/A

Key Supporting Staff: 2 biologists, 2 technicians, 1 office assistant

Program Goals: Determine emergence timing, relative growth rates, emigration timing, and size of juvenile spring-run chinook salmon; coded-wire tagging of spring-run juveniles

Program Duration: Since December 1995

Geographic Area Covered: Mill Creek upstream of Upper Dam

Parameters Measured

Biological: Abundance of rearing juveniles; daily counts of juvenile outmigrants at trap locations (i.e., diversion dams); fork lengths and weights

Physical: Flow, water temperature, turbidity
Chemical:

How Were Hatchery Fish Distinguished from Wild Fish?:

Data Storage:

Location: California Department of Fish and Game, Red Bluff
Contact for Data Retrieval: Colleen Harvey
Available to Public: Yes
Cost of data: None
Storage Format (electronic/hardcopy): electronic storage and hardcopy reports
Hardware: PC
Software: Lotus
Quality Assurance (for data entry as opposed to analytical):

Products (Delivery Dates):

Data: Irregular
Progress Reports: Summary memoranda
Final Reports: Annual progress report for Sport Fish Restoration Act

Comparable Data Available during 1967-1991 Period: Yes

Reliance on other Monitoring Programs:

Funding Source: Sport Fish Restoration Act

Quantity of Funds:

Security of Funds: Included in 5-year work plan

Specific Monitoring Methods:

Sampling Reaches: Upper Dam (emigration); Highway 32, Little Hole-in-the-Ground, Hole-in-the-Ground, Black Rock (rearing)

Sampling Frequency: daily (emigration); weekly (seining, electrofishing)

Sampling Period: December through September (seining, electrofishing); September through June (screw trapping)

Sampling Equipment: 5 foot diameter rotary screw trap

Sampling Methods: Seining, electrofishing, rotary screw trapping

Data Analysis:

Staffing:

Field work: Associate Biologist - 1 month; Two fish and Wildlife Assistants - 5 months each (10 months total)
Data Analysis/Management/Report: Associate Biologist - 5 months

Report Prepared by: California Department of Fish and Game

Report Contents Include: Daily catch, length, and weight sample

EXISTING JUVENILE PROGRAM 6
Stanislaus River Juvenile Salmon Survey

Species: Chinook Salmon
Watershed: Stanislaus River

BACKGROUND INFORMATION

Monitoring Methods: Juvenile Outmigrant Trapping

Target Species: Chinook salmon

Target Life Stages: Fry, juvenile

Program Name: Stanislaus River Emigration Study

Lead Agency: U.S. Fish and Wildlife Service

Program Manager: Patricia Brandes (USFWS)

Address: U.S. Fish and Wildlife Service
40001 North Wilson Way
Stockton, CA 95205

Phone: (209)946-6400

Key Supporting Agencies: California Department of Fish and Game

Key Supporting Staff: Bill Loudermilk, CDFG

Program Goals: Estimate number, size and timing of juvenile chinook salmon migrating out of the Stanislaus River.

Program Duration: Project expected to continue annually

Geographic Area Covered: Stanislaus River upstream of Caswell State Park

Parameters Measured:

Biological: species captured, size and smolt status, timing of emigration, number of marked and unmarked fish, scale samples for age determination, CWT recovery

Physical: Discharge, water temperature, turbidity
Chemical:

How Were Hatchery Fish Distinguished from Wild Fish?:

Data Storage:

Location: USFWS, Stockton
Contact for Data Retrieval: Patricia Brandes
Available to Public: yes
Cost of data: N/A
Storage Format(electronic/hardcopy): Both
Hardware: PC
Software: Lotus spreadsheet, dBASE IV
Quality Assurance (for data entry as opposed to analytical):

Products (Delivery Dates):

Data: Descriptive statistics
Progress Reports: Monthly summaries
Final Reports: Annual reports

Comparable Data Available during 1967-1991 Period: None

Reliance on other Monitoring Programs: Individual programs by basin irrigation districts

Funding Source: USFWS

Quantity of Funds: $85,000 annually

Security of Funds: N/A

Specific Monitoring Methods: Rotary screw trapping

Sampling Reaches: Caswell State Park

Sampling Frequency: Continuous sampling, daytime and nighttime stratification

Sampling Period: February through June

Sampling Equipment: Rotary screw trap

Sampling Methods: Record daily catches (day and night samples); conduct efficiency tests with marked fish (natural and hatchery) to evaluate relationship between flow and capture rates

Data Analysis: Analyze relationship between trap efficiency and flow

Staffing:

Field work:
Data Analysis/Management/Report:

Report Prepared by: S.P. Cramer and Associates (report in progress)

Report Contents Include:

EXISTING JUVENILE PROGRAM 7
Red Bluff Research Pumping Plant Studies

Species: Chinook Salmon, Steelhead Trout
Watershed: Upper Sacramento River

BACKGROUND INFORMATION

Monitoring Methods: Juvenile Outmigrant Sampling

Target Species: Chinook salmon and steelhead trout

Target Life Stages: Fry, juvenile

Program Name: Abundance and seasonal, spatial and diel distribution patterns of juvenile salmonids passing the Red Bluff Diversion Dam, Sacramento River California

Lead Agency: U. S. Fish and Wildlife Service

Program Manager: Rich Johnson

Address: Northern Central Valley Fish and Wildlife Office
10950 Tyler Road
Red Bluff, CA 96080

Phone: (916) 527-3043

Key Supporting Agencies:

Key Supporting Staff:

Program Goals:

1) Estimate abundance of each of the four runs of juvenile salmon and steelhead trout passing RBDD,
2) Estimate the seasonal and spatial distribution of juvenile salmon and steelhead trout passing RBDD
3) Estimate diel patterns of abundance of juvenile salmon and steelhead trout passing RBDD.

Program Duration: 1994, multi-year effort to provide adequate replications in all strata

Geographic Area Covered: Upper Sacramento River, Red Bluff Diversion Dam (RBDD), and the Tehama-Colusa Canal (TCC), Red Bluff, California

Parameters Measured

Biological: Captured fish identification, enumeration, and length measurements (fork length) and weight of subsample, survival and mortality
Physical: Length of time trap was fished, water velocity immediately in front of the cont at depth two feet, debris type and amount
Chemical: Water temperature, turbidity

How Were Hatchery Fish Distinguished from Wild Fish?: Coded Wire Tagging

Data Storage:

Location: Red Bluff
Contact for Data Retrieval: Rich Johnson
Available to Public: Yes
Cost of data: N/A
Storage Format (electronic/hardcopy): electronic
Hardware: PC
Software: dBASE IV
Quality Assurance (for data entry as opposed to analytical): Proofread weekly

Products (Delivery Dates):

Data:
Progress Reports: Quarterly reports beginning on March 31, 1994
Final Reports: Annual reports

Comparable Data Available during 1967-1991 Period: N/A

Reliance on other Monitoring Programs: USBR, CDFG

Funding Source: USFWS, USBR

Quantity of Funds:

Security of Funds:

Specific Monitoring Methods:

Sampling Reaches: Behind RBDD in a transect to represent three spatial zones within the stream channel: west river channel, mid-channel, and east river channel.

Sampling Frequency: Sampled under two different regimes: Labor intensive in which traps are checked every three hours over a 24-hour period while fishing four traps simultaneously; and labor non-intensive in which one, two, three or four traps are fished over a 24-hour period over four to five days per week.

Sampling Period: Year-round

Sampling Equipment: Four 8' diameter rotary screw traps on aluminum pontoons, fyke nets, beach seines, Oceanic Model 2030 flow meter, Model 2100A Hach Turbidimeter

Sampling Methods: Continuous sampling stratified into day and night periods; trap efficiency estimated using mark-recapture techniques

Data Analysis: Calculated: Absolute abundance index, relative abundance, trap efficiency, and length selectivity and trap bias

Staffing:

Field work:
Data Analysis/Management/Report:

Report Prepared by:

Report Contents Include: Seasonal, spatial, and diel distribution patterns

EXISTING JUVENILE PROGRAM 8
Glenn-Colusa Irrigation District Studies

Species: Chinook Salmon, Steelhead Trout
Watershed: Upper Sacramento River

<u>**BACKGROUND INFORMATION**</u>

Monitoring Methods: Juvenile Outmigrant Sampling

Target Species: Chinook salmon (all races) and steelhead trout

Target Life Stages: Fry, juvenile

Program Name: Glenn-Colusa Irrigation District Studies

Lead Agency: California Department of Fish and Game

Program Manager: Nick Villa

Address: Region II Headquarters
1701 Nimbus Road
Rancho Cordova, CA 95670

Phone: (916) 358-2943

Key Supporting Agencies: DWR, GCID

Key Supporting Staff: Julie Brown, CDFG

Program Goals: Monitor timing, relative abundance, relative survival, and diversion rates of downstream migrants; evaluate fish screen performance

Program Duration: 1991; work done on as needed basis as far back as 1920s

Geographic Area Covered: Upper Sacramento River

Parameters Measured

Biological: Number of juveniles, fork length, weight (subsample)
Physical:
Chemical:

How Were Hatchery Fish Distinguished from Wild Fish?: Adipose fin-clip/coded-wire tag

Data Storage:

Location: GCID at fish screen
Contact for Data Retrieval: Julie Brown
Available to Public: No
Cost of data: N/A
Storage Format (electronic/hardcopy): electronic
Hardware: PC
Software: Lotus 123
Quality Assurance (for data entry as opposed to analytical):

Products (Delivery Dates):

Data: Monthly reports; occasionally annual report
Progress Reports: N/A
Final Reports: N/A

Comparable Data Available during 1967-1991 Period: N/A

Reliance on other Monitoring Programs:

Funding Source: DWR, GCID

Quantity of Funds:

Security of Funds: Uncertain

Specific Monitoring Methods: Downstream migrant sampling

Sampling Reaches: Upper Sacramento River above GCID diversion facility

Sampling Frequency: Continuous since 1991, weather/funding permitting

Sampling Period: Year-round.

Sampling Equipment: One 8' diameter rotary screw trap located in diversion channel

Sampling Methods: Continuous sampling stratified into day and night periods; trap efficiency tests.

Data Analysis: Length frequency analysis, identification of chinook salmon races, relative abundance by race and time; trap efficiency estimated using mark-recapture techniques

Staffing:

Field work:
Data Analysis/Management/Report:

Report Prepared by: CDFG

Report Contents Include: Length frequency and relative abundance by race and time

APPENDIX C. LIMITING FACTORS ASSOCIATED WITH TARGET WATERSHEDS

APPENDIX C

LIMITING FACTORS ASSOCIATED WITH TARGET WATERSHEDS

This section discusses the biotic and abiotic factors limiting juvenile salmonid abundance in the Central Valley. For each watershed in the program, limiting factors specific to that watershed are identified. The availability of data on limiting factors and consideration of limiting factors in the analysis of juvenile abundance data also are discussed.

Factors Limiting Juvenile Salmonid Abundance in the Central Valley

The following general information on factors limiting abundance of juvenile chinook salmon was compiled from USFWS (1995a, 1995b) and Reynolds et al. (1993). Biotic factors affecting abundance include number of spawners, predation, disease, competition, and food supply. Abiotic factors include streamflow, water temperature, physical habitat quality (including riparian habitat), entrainment in water diversions, barriers to upstream migration, and harvest (legal and illegal).

In many watersheds, streamflow has been identified as a major limiting factor. Reservoir operations in the Central Valley have altered the natural flow regime of streams by changing the frequency, magnitude, and timing of flow. These changes may affect all chinook salmon lifestages. Extremely low or high flows can block or delay upstream migration by reducing depth over shallow riffle areas or by creating high water velocities. Flows are often lower than that needed to provide adequate physical habitat for salmon spawning. Declining flows during the chinook salmon incubation period can result in mortality of eggs and alevins by dewatering redds, reducing flow rates through redds, and increasing water temperatures. Rapid flow fluctuations can result in stranding and subsequent mortality of juvenile chinook salmon resulting from elevated water temperatures, low dissolved oxygen levels, and predation. Similarly, reduced flows during the juvenile outmigration period may result in high mortality rates.

Related to flow modification, elevated water temperature also has been identified as a major limiting factor. Water temperature affects the timing of chinook salmon spawning migrations, fry emergence, and juvenile outmigration. Elevated temperature limits the geographic range of chinook salmon spawning and can result in mortality or decreased fecundity. Elevated temperatures affect egg and juvenile survival directly through acute (lethal) effects and indirectly through chronic (sublethal) effects, which include physiological stress, reduced growth rates, and increased vulnerability to disease and predation.

Reduced quantity and quality of physical habitat for salmon spawning and rearing limits abundance in many watersheds. Available spawning gravel has been limited by reduced gravel recruitment from areas upstream from dams, in-channel gravel mining, and the accumulation of fine sediments because of a lack of flushing flows. Channel modifications resulting from low flows or in-channel gravel mining create poor hydraulic conditions for juvenile salmon rearing and outmigration and improve opportunities for predators.

Entrainment losses of juvenile fish at water diversions also limit salmon abundance. Numerous small and large diversions are in operation throughout the Central Valley and most are inadequately screened to prevent entrainment losses. Delayed passage, increased stress, and increased vulnerability to predation also are factors contributing to mortality at water diversions. Diversion impacts on chinook salmon depend on diversion timing and magnitude, streamflow, race, life stage, and other factors.

Substantial reductions in stream side riparian vegetation adversely affect chinook salmon throughout the Central Valley. Riparian vegetation maintains bank stability, provides instream and overhead cover, moderates stream temperatures, contributes nutrients and energy, and provides habitat diversity. The quality of near-shore juvenile salmon habitat is enhanced by the presence of riparian vegetation along natural stream banks. Overhanging and submerged branches and root systems provide good hydraulic conditions for resting and feeding, food inputs, and cover. Naturally eroding stream banks are a valuable source of large woody material in a stream. Riparian habitat along most Central Valley streams has been significantly reduced because of flood control projects, and agricultural and urban development.

Dams and water diversions also have created barriers to upstream salmon migration on many Central Valley streams. Some structures completely block migration and access to upstream spawning and rearing areas, others impede passage.

Predation on juvenile salmon is probably of minor significance in unobstructed portions of streams. However, predator efficiency increases at artificial structures and impoundments where fish are concentrated, stressed, or delayed in their downstream migration (USBR 1983). Predation also is increased in areas where channel modifications resulting from in-channel gravel mining have created good predator habitat and cause delays in outmigration. Several non-native predator species have been introduced into Central Valley streams.

One of the most important factors influencing number of juvenile salmon produced in a watershed is the number of spawners returning (escapement). Spawner/recruit relationships have been developed for several watersheds. The number of returning spawners is significantly influenced by harvest. Illegal harvest has been identified as a limiting factor on many watersheds, although it is not considered a primary limiting factor in any of the watersheds.

Several biotic factors, such as disease, competition, and food supply have not been identified as major factors affecting salmon abundance in Central Valley streams.

Limiting Factors of Target Watersheds

USFWS (1995a) identifies specific limiting factors on each watershed in the Central Valley and recommends actions to address each factor. The following summarizes limiting factors identified for each watershed included in the CAMP juvenile monitoring program. Factors are listed in approximate order of priority (most to least limiting).

American River

1. Inadequate instream flows
2. Elevated water temperatures
3. Degraded spawning habitat
4. Entrainment of juveniles in water diversions (Fairbairn Water Treatment Plant, etc.)
5. Habitat damage due to bank and in-channel modifications
6. Over-harvest of adults (legal and illegal harvest)
7. Genetic changes due to poor hatchery practices

Battle Creek

1. Inadequate flows for spawning and rearing
2. Inadequate fish passage (CNFH weir, Eagle Canyon barrier, PG&E fish ladders)
3. Entrainment losses at water diversions
4. Straying of adults
5. Potential disease problems (Coleman National Fish Hatchery)

Big Chico Creek

1. Water diversions decrease flows for upstream migration, entrain juvenile fish. Flow splits due to flood control project can strand adults and downstream migrants
2. Upstream passage of adults impaired due to water diversions, damage of Iron Canyon fish ladder, Five-Mile Recreation Area flood control project
3. Elevated water temperatures during summer holding period
4. Degraded spawning habitat in lower creek
5. Degraded rearing habitat in Mud and Rock Creeks

Butte Creek

1. Inadequate instream flows
2. Upstream passage of adults impeded at Centerville Diversion Dam, natural barrier below Centerville Diversion Dam, Durham Mutual Dam, Western Canal Dam, Adams, Gorrill, McGowan, and McPherrin dams, Sanborn Slough bifurcation, White Mallard Dam, White Mallard Duck Club outflow, Drumheller Slough outfall, Butte Slough outfall, East-West Diversion Weir, Sutter Bypass Weir #2, Nelson Slough, Sutter Bypass Weirs #1, #3, #5

3. Entrainment of juvenile fish at Durham Mutual Dam, Western Canal Dam, Adams, Gorrill, McGowan, and McPherrin dams, Little Dry Creek pumps, Sanborn Slough bifurcation, White Mallard Dam, Butte Slough outfall gates, Sutter Bypass - Butte Slough to Sacramento River
4. Illegal harvest of adults
5. Poor land use practices

Clear Creek

1. Inadequate flows for spawning and rearing
2. Elevated water temperatures
3. In-channel gravel mining
4. Inadequate fish passage (McCormick-Saeltzer Dam)
5. Poor land use practices (erosion)
6. Lack of gravel recruitment

Deer Creek

1. Inadequate flows for up and downstream passage
2. Potential land use impacts in the upper watershed
3. Armored spawning gravel
4. Elevated water temperatures due to riparian vegetation removal
5. Spawning habitat damaged by flood control maintenance activities

Feather River

1. Inadequate instream flows for spawning and rearing
2. Degraded spawning habitat
3. Elevated water temperatures for spring-run salmon
4. Potential for excessive sport fish harvest
5. Genetic mixing of spring- and fall-run stocks; hatchery-produced fish stray into other basins in the Sacramento system
6. Potential habitat damage due to bank and streambed modification

Merced River

1. Inadequate instream flows for all life stages
2. Elevated water temperatures (fall and spring)
3. Flow fluctuations result in egg mortality, redd dewatering, and juvenile stranding
4. Degraded spawning and rearing habitat due to past and ongoing alteration of stream, riparian, and floodplain habitat
5. Degraded spawning gravel due to sedimentation
6. Lack of spawning gravel recruitment
7. Reduction in quantity of accessible spawning and rearing habitat due to dam construction
8. Entrainment of juveniles at water diversions
9. Predation on rearing and outmigrating juveniles

10. Poor water quality due to point and non-point discharge of pollutants and toxic compounds
11. Straying of adults into the mainstem San Joaquin River upstream of the Merced River confluence
12. Illegal harvest of adults

Mill Creek

1. Inadequate flows for up and downstream passage on valley floor
2. Inadequate fish passage (Clough Dam)
3. Land use impacts in upper watershed
4. Siltation of spawning and nursery areas
5. Loss of riparian vegetation on valley floor

Mokelumne River

1. Inadequate instream flows for all life stages
2. Degraded spawning habitat
3. Redd de-watering and juvenile stranding due to flow fluctuations
4. Predation losses of outmigrating juveniles at Woodbridge Dam
5. Entrainment or delay of juveniles outmigrating past Woodbridge Dam
6. Delay of adult upstream migration past Woodbridge Dam
7. Entrainment of juveniles at riparian diversions and at NSJCD diversion
8. Elevated water temperatures
9. Loss of riparian habitat
10. Poor water quality of Camanche Reservoir releases
11. Illegal harvest of adults
12. Lack of suitable rearing habitat

Stanislaus River

1. Inadequate instream flow for all life stages
2. Elevated water temperatures (fall and spring)
3. Degraded instream, riparian, and floodplain habitat
4. Degraded spawning gravel due to sedimentation
5. Lack of spawning gravel recruitment
6. Reduction in quantity of accessible spawning and rearing habitat due to dam construction
7. Entrainment of juveniles at water diversions
8. Predation on rearing and outmigrating juveniles
9. Poor water quality due to point and nonpoint discharge of pollutants and toxic compounds
10. Illegal harvest of adults

Tuolumne River

1. Inadequate instream flow for all life stages
2. Elevated water temperatures (fall and spring)

3. Flow fluctuations result in egg mortality, redd dewatering, and juvenile stranding
4. Degraded spawning and rearing habitat due to alteration of stream, riparian, and floodplain habitat
5. Degraded spawning gravel due to sedimentation
6. Lack of spawning gravel recruitment
7. Reduction in quantity of accessible spawning and rearing habitat due to dam construction
8. Entrainment of juveniles at water diversions
9. Predation on rearing and outmigrating juveniles
10. Poor water quality due to point and nonpoint discharge of pollutants and toxic compounds
11. Illegal harvest of adults

Upper Sacramento River

1. Inadequate instream flows for spawning and rearing
2. Elevated water temperatures
3. Inadequate passage at artificial impoundments (RBDD, ACID, Keswick Dam stilling basin)
4. Entrainment losses at water diversions (GCID, etc.)
5. Contaminants (toxic discharge from Iron Mountain Mine, etc.)
6. Effects of hatchery stocks on natural spawning stocks
7. Loss of riparian forests

Yuba River

1. Inadequate instream flows for migration, spawning, egg incubation, rearing, and outmigration
2. Elevated water temperatures
3. Entrainment of juvenile fish at water diversions
4. Barriers to upstream migration (Simpson Lane, Daguerre Point Dam)
5. Habitat damage due to bank and in-channel modifications
6. Over harvest of adult fish
7. Loss of juveniles due to predation and competition (Daguerre Dam)

APPENDIX D. DETAILED BUDGET ASSUMPTIONS BY MONITORING METHOD

APPENDIX D

DETAILED BUDGET ASSUMPTIONS BY MONITORING METHOD

CARCASS SURVEYS

Carcass surveys provide the most consistent, reliable spawner abundance estimates for chinook salmon. These surveys will be an essential component of CAMP monitoring of returning fall-, late fall- and winter-run chinook salmon (Tables 2-3, 2-5, 2-6). Primary CAMP needs include labor during spawning months for each race of salmon and for the production of a data report. For costing purposes in this report, program costs are assumed to be shared in adjacent watersheds when possible. Summary costs for all monitoring methods, species and watershed are shown in Table 5-1. The costs for each watershed are scaled from an existing program that includes the most complete detailed cost breakdown available. Operating and equipment costs are calculated for the duration of each carcass survey program. Watersheds with shared costs include Butte and Clear creeks, Feather and Yuba rivers; Mill and Deer creeks; Stanislaus, Tuolumne and Merced rivers. Only the American River, Sacramento River and Battle Creek have costs unshared with an adjacent watershed. For each group of watersheds, both the operating (labor) and equipment (vehicle and computer) costs are assumed to be shared equally.

SNORKEL SURVEYS

CAMP snorkel surveys are limited to assessing spawner abundance of spring-run chinook salmon in Butte and Deer creeks (Table 2-8). Vehicle costs will be shared with other programs but extensive labor hours will be needed during the limited survey period (Appendix B).

LADDER COUNTS

Ladder counts are needed to meet CAMP needs to assess returning fall-, winter- and spring-run chinook salmon in three streams, Mill Creek, Mokelumne River and Sacramento River (Table 2-13). Costs for this program primarily are for labor during the months of the species upstream migration (Appendix B).

AERIAL REDD COUNTS

Aerial redd counts are needed to meet CAMP needs for fall-, late fall-, and winter-run salmon in the upper Sacramento River (Table 2-13). This is an ongoing annual survey that will meet CAMP needs. Costs for this program include airplane rental and fuel, and limited labor and equipment costs.

HATCHERY MARKING PROGRAM

The proposed CAMP hatchery marking program is substantially different from proposed CWT programs or existing hatchery marking programs. As described, the proposed CAMP program entails fin clipping of a constant fraction of hatchery-released salmon. Staffing and budget requirements are assumed variable among hatcheries based on the species and number of fish marked. The basic program for fall-run chinook salmon at any given hatchery is assumed to require a seasonal, full-time fin clipping effort conducted by seasonal aides with Assistant Biologist II help and part-time management by senior and associate biologists. Equipment and operating costs are assumed to be minimal. A trailer is proposed to provide a mobile clipping facility.

Hatchery marking at Coleman National Hatchery will require clipping efforts for steelhead trout in addition to both fall- and late fall-run chinook salmon. Labor and equipment cost estimates have been adjusted based on sharing of equipment and reduced labor for the fewer numbers of late fall-run salmon and steelhead marked in comparison to the number of fall-run chinook salmon.

HATCHERY COUNTS

Uniform staffing and budget requirements are proposed for any given hatchery to count spawners abundance of steelhead or late fall- or fall-run salmon. Labor costs will be at the Biology Assistant I or II level and expenses will be minimal (Table 5-1). No equipment costs are proposed over normal, ongoing hatchery management costs (which are not addressed as CAMP programs). Costs were extrapolated to other hatcheries from those provided by CDFG for the Nimbus Hatchery on the American River (i.e., Mills 1995).

ANGLER SURVEY

Angler surveys are essential for the CAMP estimation of angler-caught fraction of spawner abundance for salmon and steelhead (Table 2-1). The costs are used to develop the Instream Angler Survey program for CAMP were derived from the California Department of Fish and Game's (CDFG's) Draft Proposal: *Central Valley Anadromous Sport Fish Harvest Monitoring Program* submitted to the U.S. Fish and Wildlife Service dated April 15, 1996 (Mills, 1996). CDFG's proposed program is comprehensive in both geographic coverage and species coverage. However, the CDFG harvest monitoring program would obtain harvest and other biological information for both CAMP identified species and other anadromous species which are not required for to meet adult monitoring needs under CAMP. For that reason, the CDFG proposed harvest monitoring program was reviewed to develop an instream angler survey program that specifically meets CAMP goals for monitoring adult anadromous fish populations (Table 5-1). The method and assumptions used to develop costs for CAMP angler surveys from CDFG's proposed program are provided below.

American River

Angler harvest surveys for fall-run chinook salmon are recommended for the American River (Table 2-13). Geographically, harvest estimates cover the entire lower American River from Nimbus Dam to the mouth are required for CAMP. CDFG's program specifies 3 sections throughout the American River with harvest surveys conducted with kayaks. The CDFG program also proposes to monitor four species: fall-run chinook salmon, steelhead trout, striped bass, and American shad. Furthermore, CDFG proposes to obtain additional data beyond angler harvest information: tissue samples and snouts from fin clipped salmon, gut contents, scales, and sex of striped bass, and CDFG will produce shad abundance estimates. These elements are beyond those needed for CAMP and are not included in cost estimates here. Finally, CDFG's proposed program would be a year round monitoring program. The assumptions used to develop a CAMP angler survey program from CDFG's more comprehensive program are summarized below.
Assumptions:

- Fall-run chinook: July 1 through December 31 monitoring period,
- Survey in all 3 sections of lower American River,
- Level of effort during survey for fall-run chinook is equal to 80% of CDFG's effort for data collection of multiple species. (e.g. the time and effort incurred collecting fall-run chinook angler harvest information is approximately 80% of the entire time spent during the survey, the other 20% is collection of other species information, other non-CAMP data needs etc.).

Fall-run Chinook Calculation of Effort

- If CDFG's monitoring for 12 months and,
- CAMP needs for monitoring fall-run chinook = 6 months;
- Then monitoring = 6 months/12 months = 50% of the year and,
- If 80% (estimate of CAMP/CDFG's effort) multiplied by 50% (0.8 X 0.50) = 40% of CDFG's effort for all species monitoring on American River;
- Then assume 100 % of equipment costs of CDFG's program.

Summary: CAMP needs for American River Angler Surveys

- 40% of CDFG's labor, benefits, and operations expenses and,
- 100% of CDFG's equipment expenses

Feather River

Angler harvest surveys for fall-run chinook salmon are required for the Feather River (Table 2-13). Geographically, harvest estimates for the entire lower Feather River from the Fish Dam (Oroville Fish Hatchery) to the mouth (Verona) are required for CAMP. CDFG's program specifies that harvest surveys be conducted with kayaks. The CDFG program also proposes to monitor 7 species: spring

(hatchery stock) and fall-run chinook salmon, steelhead, striped bass, American shad, and white sturgeon and green sturgeon. These elements are beyond those needed for CAMP adult production estimates. Finally, CDFG's proposed program would be a year round monitoring program. The assumptions used to develop a CAMP angler survey program from CDFG's more comprehensive program are summarized below.
Assumptions:

- Fall-run chinook: July 1 through December 31 monitoring period,
- Survey the entire lower Feather River,
- Level of effort during survey for fall-run chinook is equal to 60% of CDFG's effort for data collection of multiple species. (e.g. the time and effort incurred to collect fall-run chinook angler harvest information is approximately 60 % of the entire time spent during the survey, the other 40 % is collection of other species harvest information and other non-CAMP data needs etc.).

<u>Fall-run Chinook Calculation of Effort</u>

- If CDFG's monitoring for 12 months and,
- CAMP needs for monitoring fall-run chinook = 6 months;
- Then monitoring = 6 months/12 months = 50% of the year and,
- If 60% (estimate of CAMP/CDFG's effort) multiplied by 50% (0.60 X 0.50) = 30% of CDFG's effort for all species monitoring on Feather River;
- Then assume 100% of equipment costs of CDFG's program.

<u>Summary: CAMP needs for Feather River Angler Surveys</u>

- 30% of CDFG's labor, benefits, and operations expenses and,
- 100% of CDFG's equipment expenses

Mokelumne River

Angler harvest surveys for fall-run chinook salmon are required for the Mokelumne River (Table 2-13). Geographically, harvest estimates for the lower Mokelumne River from downstream of Commanche Dam to the San Joaquin River (including both North and South Branches are required for CAMP. This program is assumed to be a portion of CDFG's Sacramento-San Joaquin Delta program which specifies that harvest surveys be conducted with boats within the Delta. The CDFG program also proposes to monitor 2 species: fall-run chinook salmon and steelhead trout. These elements are beyond those needed for CAMP and are not included in cost estimates here. Finally, CDFG's proposed program would be a year round monitoring program. The assumptions used to develop a CAMP angler survey program from CDFG's more comprehensive program for the Delta are summarized below.

Assumptions:

- Fall-run chinook: July 1 through December 31 monitoring period,

- Survey the entire lower Mokelumne River below Woodbridge Dam (North and South Branches),
- Assumes that the Mokelumne River area equals approximately 50% of the geographic area proposed for harvest monitoring in their Delta Program,
- Level of effort during survey for fall-run chinook is equal to 90% of CDFG's effort for data collection of multiple species. (e.g. the time and effort incurred to collect fall-run chinook angler harvest information is approximately 90 % of the entire time spent during the survey, the other 10 % is collection of steelhead harvest information and other non-CAMP data needs etc.).

Fall-run Chinook Calculation of Effort

- If CDFG's monitoring for 12 months and,
- CAMP needs for monitoring fall-run chinook = 6 months;
- Then monitoring = 6 months/12 months = 50% of the year and,
- If 90% (estimate of CAMP/CDFG's effort) multiplied by 50% (months), then again by 50% (area of CDFG's proposed area) (0.80 X 0.50 X 50%) = 23% of CDFG's effort for all species monitoring on lower Mokelumne River;
- Then assume the following equipment costs (modified CDFG program):
- $19,000 for boat (verses 38,000 for 2 boats),
- $18,000 for 2 vehicles (versus $36,000 in CDFG's Delta Proposal), and
- $5,000 for 1 computers (versus $10,000 in CDFG's Delta Proposal).

Summary: CAMP needs for Mokelumne River Angler Surveys

- 20% of CDFG's labor, benefits, and operations expenses and,
- 50% of CDFG's equipment expenses

Sacramento River

Angler harvest surveys for fall-, late fall-, and spring-run chinook salmon and steelhead trout are required for the Sacramento River (Table 2-13). Geographically, harvest estimates for the entire Sacramento River from Carquinez Bridge to Keswick Dam are required for chinook salmon, and above the Red Bluff Diversion Dam for steelhead to meet CAMP needs. CDFG's program specifies eight sections throughout the Sacramento River with harvest surveys roughly divided into three reaches covered by one large all-weather boat, and two river jet boats. The CDFG program also proposes to monitor nine species: four runs of chinook salmon, steelhead, striped bass, American shad, white sturgeon and green sturgeon. Furthermore, CDFG proposes to obtain additional data beyond angler harvest information: tissue samples and snouts from fin clipped salmon, gut contents, scales, and sex of striped bass, and CDFG will produce shad abundance estimates. These elements are beyond those needed for CAMP and are not included in cost estimates here. Finally, CDFG's proposed program would be a year round monitoring program. The assumptions used to develop a CAMP angler survey program from CDFG's more comprehensive program are summarized below.

Chinook and steelhead assumptions:

- Fall-run chinook: July 15 through December 31 monitoring period
- Late fall-run chinook: October 1 through January 15 monitoring period
- Spring-run chinook: July 15 through October 1 monitoring period
- Steelhead trout: July 15 through March 15 monitoring period
- Chinook salmon survey in a total of eight sections (3 reaches: upper, middle, lower Sacramento River)
- Steelhead survey limited to sections 7 and 8 (1 reach: upper Sacramento River)
- Level of effort for CAMP needs during a survey for each species is equal to 50% of CDFG's proposed total effort for data collection of multiple species. (e.g. the time and effort incurred to collect fall-run chinook angler harvest information is approximately 50 % of the entire time spent during the survey, the other 50 % is collection of other species information, other non-CAMP data needs etc.).
- Additionally, the assignment of the monthly level of effort for monitoring multiple CAMP species simultaneously is identified in Table D-1:

Table D-1. Assignment of Months for Calculation of Angler Survey Level of Effort

	Month												
Species/Race	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Sum
Fall-run chinook							0.3	0.3	0.3	0.3	0.3	0.3	2.0
Late fall-run chinook	0.5									0.3	0.3	0.3	1.5
Spring-run chinook							0.3	0.3	0.3				1.0
Steelhead Trout	0.5	1					0.3	0.3	0.3	0.3	0.3	0.3	4.5
Total	1	1					1	1	1	1	1	1	9.0

Fall-run Chinook Calculation of Effort

- If CDFG's level of effort = 9 species x 3 reaches x 12 months = 324 effort equivalents (labor, benefits, and operation costs) and,
- CAMP needs = (assume 1 species, fall-run chinook, = 50% of CDFG's effort for 9 species or 4.5 species) and survey lasts 6 months;
- Then 4.5 species (50 % effort) x 3 reaches x 2.0 months = 27 effort equivalents and,
- If 27 equivalents / 324 possible equivalents = 8.3 % of CDFG's effort for all species in Sacramento River;
- Then assume 25 % of equipment costs of CDFG's program assigned to fall chinook (the other 75% to the 3 other Sacramento River CAMP species.

Summary: CAMP needs for Fall-run Chinook Angler Surveys

- 8.3% of CDFG's labor, benefits, and operations expenses and,
- 25% of CDFG's equipment expenses

Late Fall-run Chinook Calculation of Effort

- If 4.5 species (50% effort) x 3 reaches x 1.5 months = 20.3 effort equivalents and,
- The 20.25 equivalents / 324 possible equivalents = 6.25 % of CDFG's effort for all species in Sacramento River;
- Then assume 25 % of equipment costs of CDFG's program assigned to late fall-run chinook (the other 75% to the 3 other Sacramento River CAMP species.

Summary: CAMP needs for Late fall-run Chinook Angler Surveys

- 6.25 % of CDFG's labor, benefits, and operations expenses and,
- 25% of CDFG's equipment expenses

Spring-run Chinook Calculation of Effort

- If 4.5 species (50% effort) x 3 reaches x 1.0 months = 13.5 effort equivalents and,
- The 13.5 equivalents / 324 possible equivalents = 4.2 % of CDFG's effort for all species in Sacramento River;
- Then assume 25 % of equipment costs of CDFG's program assigned to spring chinook the other 75% to the 3 other Sacramento River CAMP species.

Summary: CAMP needs for Spring Chinook Angler Surveys

- 4.2 % of CDFG's labor, benefits, and operations expenses and,
- 25% of CDFG's equipment expenses

Steelhead Trout Calculation of Effort

- If 4.5 species (50% effort) x 1 reaches x 4.5 months = 20.25 effort equivalents and,
- The 20.25 equivalents / 324 possible equivalents = 6.3 % of CDFG's effort for all species in Sacramento River;
- Then assume 25 % of equipment costs of CDFG's program assigned to steelhead trout (the other 75% to the 3 other Sacramento River CAMP species.

Summary: CAMP needs for Steelhead Angler Surveys

- 6.3 % of CDFG's labor, benefits, and operations expenses and,
- 25% of CDFG's equipment expenses

Summary for all Species for CAMP needs for the Sacramento River

- 25.1 % of CDFG's labor, benefits, and operational costs and,
- 100 % of CDFG's equipment costs.

San Joaquin River

Angler harvest surveys for fall-run chinook salmon are required for the San Joaquin River (Table 2-13). Geographically, harvest estimates for the lower San Joaquin River from Vernalis to Pittsburg are required for CAMP. CDFG's program specifies that harvest surveys be conducted with boats. The CDFG program also proposes to monitor two species: fall-run chinook salmon and steelhead trout. Surveys for steelhead trout are beyond those needed for CAMP. Finally, CDFG's proposed program would be a year round monitoring program. The assumptions used to develop a CAMP angler survey program from CDFG's more comprehensive program are summarized below. Assumptions:

- Fall-run chinook: July 1 through December 31 monitoring period,
- Survey the entire lower San Joaquin River,
- Level of effort during survey for fall-run chinook is equal to 80% of CDFG's effort for data collection of multiple species. (e.g. the time and effort incurred to collect fall-run chinook angler harvest information is approximately 80 % of the entire time spent during the survey, the other 20 % is collection of steelhead harvest information and other non-CAMP data needs etc.).

Fall-run Chinook Calculation of Effort

- If CDFG's monitoring for 12 months and,
- CAMP needs for monitoring fall-run chinook = 6 months;
- Then monitoring = 6 months/12 months = 50% of the year and,
- If 80 % (estimate of CAMP/CDFG's effort) multiplied by 50% (0.80 X 0.50) = 40 % of CDFG's effort for all species monitoring on lower San Joaquin River;
- Then assume 100 % of equipment costs of CDFG's program.

Summary: CAMP needs for San Joaquin River Angler Surveys

- 40% of CDFG's labor, benefits, and operations expenses and,
- 100% of CDFG's equipment expenses

Stanislaus River

Angler harvest surveys for fall-run chinook salmon are required for the Stanislaus River (Table 2-13). Geographically, harvest estimates for the entire lower Stanislaus River from Goodwin Dam to the mouth are required for CAMP. CDFG's program specifies that harvest surveys be conducted with kayaks. The CDFG program also proposes to monitor two species: fall-run chinook salmon, and steelhead trout. These elements are beyond those needed for CAMP and are not included in cost estimates here. Finally, CDFG's proposed program would be a year round monitoring program. For the purpose of estimating CAMP efforts we assumed CDFG's monitoring would only be 8 months August through March. The assumptions used to develop a CAMP angler survey program from CDFG's more comprehensive program are summarized below.

Assumptions

- Fall-run Chinook: July 1 through December 31 monitoring period,
- Survey the entire lower Stanislaus River,
- Level of effort during survey for fall-run chinook is equal to 95% of CDFG's effort for data collection of multiple species. (e.g., the time and effort incurred to collect fall-run chinook angler harvest information is approximately 95 % of the entire time spent during the survey, the

other 5 % is collection of steelhead harvest information and other non-CAMP data needs etc.).

Fall-run Chinook Calculation of Effort

- CDFG's monitoring for 9 months and,
- CAMP needs for monitoring fall-run chinook= 6 months;
- Then monitoring = 6 months/9 months = 66.7% of the year and,
- If 95% (estimate of CAMP/CDFG's effort) multiplied by 66.7% (0.95 X 0.667) = 63.4 % of CDFG's effort for 2 species monitoring on Stanislaus River;
- Then assume 100 % of equipment costs of CDFG's program.

Summary: CAMP needs for Stanislaus River Angler Surveys

- 63.4% of CDFG's labor, benefits, and operations expenses and,
- 100% of CDFG's equipment expenses

Yuba River

Angler harvest surveys for fall-run chinook salmon are required for the Yuba River (Table 2-13). Geographically, harvest estimates for the lower Yuba River from 1 mile upstream of Highway 20 bridge (8 miles above Daguerre Point Dam) to Marysville are required for CAMP. CDFG's program specifies that harvest surveys be conducted with kayaks. The CDFG program also proposes to monitor 3 species: fall-run chinook salmon, steelhead, and American shad. Surveys for the last two species are beyond those needed for CAMP. Finally, CDFG's proposed program would be a year-round monitoring program. The assumptions used to develop a CAMP angler survey program from CDFG's more comprehensive program are summarized below.
Assumptions:

- Fall-run chinook: July 1 through December 31 monitoring period,
- Survey the entire lower Yuba River,
- Level of effort during survey for fall-run chinook is equal to 90% of CDFG's effort for data collection of multiple species. (e.g. the time and effort incurred to collect fall-run chinook angler harvest information is approximately 90% of the entire time spent during the survey, the other 10% is collection of steelhead and American shad harvest information and other non-CAMP data needs etc.).

Fall-run Chinook Calculation of Effort

- If CDFG's monitoring for 12 months and,
- CAMP needs for monitoring fall-run chinook = 6 months;
- Then monitoring = 6 months/12 months = 50% of the year and,
- If 90 % (estimate of CAMP/CDFG's effort) multiplied by 50% (0.90 X 0.50) = 45% of CDFG's effort for all species monitoring on Yuba River;
- Then assume 100% of equipment costs of CDFG's program.

Summary: CAMP needs for Yuba River Angler Surveys

- 45% of CDFG's labor, benefits, and operations expenses and,
- 100% of CDFG's equipment expenses

MARK-RECAPTURE METHOD

The mark-recapture method is proposed for monitoring adult populations of striped bass and white sturgeon (Table 2-13). Boats, nets, and other equipment will be shared between the striped bass and sturgeon programs. Operating costs are mostly associated with implementing the program from boats throughout the delta, including travel and fuel. Higher labor costs for the striped bass program are based on the proposed wide-spread sampling program in the western delta and lower Sacramento River and the annual tagging of 3,000 to 18,000 striped bass. In contrast, sturgeon are sampled in fewer numbers from a more discrete area of the Delta. Costs are proportionally lower for sturgeon than striped bass (Appendix B).

MID-WATER TRAWL SURVEY

The Midwater Trawl (MWT) monitoring for American Shad is essential for the adult fish monitoring effort (Table 2-13). The proposed CAMP program is identical to that now implemented by CDFG. No additional equipment costs are proposed because boats can be shared with other CAMP monitoring programs in the delta. CAMP-recommended operating costs were estimated on the basis of being comparable to those of the existing striped bass program. Relatively high labor costs are associated with the large number of sampling sites (90) sampled for four months of the year (September through December) (Appendix B).

OCEAN HARVEST MONITORING

The Ocean Harvest Monitoring Program of PSMFC and CDFG is recommended and necessary for adult fish monitoring (Table 2-1). As detailed above, the program is needed to provide the ocean harvest component of annual production for all races of chinook salmon. The monitoring effort is planned for all year with most labor costs at Assistant II level and below with the goal of sampling 20% of the salmon landed by ocean commercial and recreational fisheries (Appendix B).

APPENDIX E. IEP DATA FILE SPECIFICATIONS

APPENDIX E

IEP DATA FILE SPECIFICATIONS

The following describes the data file format for data in the IEP database. It is recommended that a similar approach be used for data stored in the CAMP database.

- The data files are in ASCII format, and must not contain special characters such as non-printable, binary, or software specific codes.

- The delimiter between data fields in the ASCII file is the comma (,).

- The placeholder for missing data is a double quote (""). The following example shows
- a record with no time and depth stored:
  "RSAC087","704",19880724,"","",59,7,13,4,805,2,etc.

- All non-numeric data such as characters or numeric codes are put in double quotes. The following example shows both RKI and station ID in quotes:
  "RSAC087","704",19880724,"","",59,7,13,4,805,2,etc.

- The maximum file size of an individual file is not larger than 1 Megabyte. While 1 MB is the upper size limit, it is recommended that small files should be combined when possible. The maximum record length of files should be recorded in format file.

- The maximum record length (width of file) is 540 characters after converting it to IEP format. (This is the maximum number of characters of an ASCII file read into Lotus 1-2-3, Release 4 running in Windows).

- The data files contain no header.

- The maximum file length (number of rows) is 8000 lines. (This is the maximum number of lines of an ASCII file read into Lotus 1-2-3, Release 4 running in Windows).

- All files start with the same 5 data fields: RKI, [station identifier], sample date, [sample time], and [depth of sample]. Data items in [ ] brackets are optional, however should be included if available. If data are missing in these first fields, commas and placeholders ("") still need to be in the file.

***RKI*:** All sites are identified by RKI (River Kilometer Index) of the sampling station. If the RKI is currently not available, it must be provided one year after first submittal of ASCII data files.

Station ID: If the study uses one internal station ID system, that ID will follow immediately after the RKI field. Other additional site ID aliases may be listed in the file after the first 5 data fields. Latitude and longitude of monitoring sites are mandatory, and must be supplied with the data, either directly in the ASCII file or in a cross-reference table. The format for lat/long needs to be explained in the REF table, or FMT file.

Date: The sample date is in the format of YYYYMMDD (e.g., April 11, 1994 would be 19940411).

Time: Sample time is recorded in 2400 hour format, and identified as local or standard time [Pacific Standard Time (PST) or Pacific Daylight-savings Time (PDT)].

Depth: Depth of sample is stored either in feet or metric units, but units must be identified. All other remaining data fields collected at that location, date, time, and depth stay exactly the same as in the original data base. This may include gear type, sample ID, organism counts, taxonomic code, ID for field staff, chemical parameter, meteorological data, etc. The following is an example of one possible record in a file for a station in the Sacramento River North side across from Sherman Lake visited by the DFG townet survey:
"RSAC087","704",19590614,1230,0,59,6,14,1,704,1,"",5