State of California
The Resources Agency

DEPARTMENT OF WATER RESOURCES and
DEPARTMENT OF FISH AND GAME

Hatchery and Genetic Management Plan for Feather River Fish Hatchery Spring-run Chinook Salmon

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HATCHERY AND GENETIC MANAGEMENT PLAN

Feather River Fish Hatchery
Spring-run Chinook Salmon Program

Hatchery Program:	Feather River Spring-run Chinook salmon
Species or Hatchery Stock:	Spring-run Chinook salmon (*Oncorhynchus tshawytscha)*
Agency/Operator:	California Department Fish and Game (Operator)/ California Department Water Resources (Contractor)
Watershed and Region:	Feather River, Sacramento River drainage
Date Submitted:	December 2011
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APPENDIXES

LIST OF ABBREVIATIONS

AFRP	Anadromous Fish Restoration Plan
BO	Biological Opinion
BY	Brood Year
CALFED	California (Water Policy Council) and Federal (Ecosystem Directorate)
CEQA California	Environmental Quality Act
CNFH	Coleman National Fish Hatchery
Commission	California Fish and Game Commission
CV	Central Valley
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CWA	Clean Water Act
D-893	Decision 893
DFG	California Department of Fish and Game
Division	American River Division (of CVP)
DPC	Delta Protection Commission
DPS	Distinct Population Segment
DWR	California Department of Water Resources
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionary Significant Unit
FHL	Fish Health Laboratory (California Department of Fish)
FMS	Flow Management Standard
FRFH	Feather River Hatchery
IEP	Interagency Ecological Program
NFH	Nimbus Fish Hatchery
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
OCAP	Operations, Criteria, and Plan
Reclamation	United States Department of the Interior, Bureau of Reclamation
RMG	River Management Group
ROD	Record of Decision
SEPWT	Salmonid Escapement Project Work Team
State	State of California
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
USRFRHMP	Upper Sacramento River Fisheries and Riparian Habitat Management Plan
WCB	Wildlife Conservation Board
WQCB	Water Quality Control Board
WRA-EIR	Water Forum Agreement Environmental Impact Review

INTRODUCTION

Section 7 of the Endangered Species Act (ESA) provides that agencies are obligated to consult with National Marine Fisheries Service (NMFS) on any activities that may affect a listed anadromous fish species, including hatchery programs (16 USC 1531. 2002). Hatchery and Genetic Management Plans (HGMPs) are described in the final salmon and steelhead 4(d) rule (NOAA 2005a) as a mechanism for addressing the take of certain listed species that may occur as a result of artificial propagation activities. The NMFS uses the information provided by HGMPs to evaluate impacts on anadromous salmon and steelhead listed under the ESA, and in certain situations, the HGMPs will apply to the evaluation and issuance of Section 10 take permits. Completed HGMPs may also be used for regional fish production and management planning by federal, state, and tribal resource managers. The primary goal of the HGMP is to devise biologically-based artificial propagation management strategies that ensure the conservation and recovery of listed Evolutionarily Significant Units (ESUs).

The California Department of Water Resources (DWR) constructed the Feather River Hatchery (FRFH) in the mid 1960s to mitigate for Chinook salmon *Oncorhynchus tshawytscha* and steelhead *O. mykiss* spawning habitat made inaccessible due to construction of Oroville Dam on the Feather River near the City of Oroville. The Oroville Dam and reservoir are key features of the State Water Project (SWP) and provide flood protection, water storage, hydropower production, recreation, and other benefits. Contracts between the DWR and the California Department of Fish and Game (DFG) are negotiated every three to five years to support operation and maintenance of FRFH. On 22 October 2004, DWR received a Biological Opinion (BO) following formal consultation with the NMFS pursuant to Section 7 of the ESA on the effects of the proposed long-term operations, criteria, and plan (OCAP) for the SWP on threatened and endangered fish species. The OCAP BO issued by NMFS did not address the effects of hatchery operations, but it did highlight the requirement for DWR to enter into consultations on the effects of the hatchery operations on potentially affected listed species. A primary prerequisite to completing the required consultation is a description of fish production management practices used by DFG and directed by DWR in order to meet conservation requirements.

This HGMP for the FRFH spring-run Chinook salmon program describes hatchery operations and addresses impacts on anadromous salmonids listed under the ESA that are related to the production of fish required by DWR to meet conservation goals.

1. PROJECT DESCRIPTION

1.1 Name of Hatchery or Program

Feather River Hatchery spring-run Chinook salmon program

1.2 Species and Populations (or Stock) in Propagation and ESA Status

Hatchery and natural-origin Feather River spring-run Chinook salmon are listed as "threatened" as part of the Central Valley spring-run Chinook salmon ESU, which includes spring-run Chinook salmon from Deer, Mill and Butte creeks (NOAA 2005a).

1.3 Responsible Organization and Individual

The FRFH is operated by the DFG under contract with the DWR. The following individuals are key personnel for FRFH operations.

DWR Contract Manager:
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Although there are no other agencies, tribes or co-operators directly involved in operating FRFH, one advisory group provides guidance. The Feather River Technical Team, a multi-agency steering group, advises DWR and DFG personnel to help integrate hatchery operations into management of the Feather River below Oroville Dam, the upstream limit of anadromous fish migration.

1.4 Funding, Staff Level, and Annual FRFH Program Operational Costs

The FRFH staff currently includes 13 full-time, permanent employees (Table 1-1). The annual operating budget is approximately $1.9 million and includes $125,000 for temporary help personnel. In addition, FRFH receives approximately $350,000 for personal services and operation/equipment from the DWR Oroville Field Division.

Table 1-1. FRFH staff by classification title.

Position	Personnel Years
Hatchery Manager II	1
Hatchery Manager I	1
Personnel Services Spec 1	1
Fish and Wildlife Technician A/B	9
Office Technician –Typing	1

The annual FRFH budget includes operations at the Thermalito Annex facility and production of fall-run Chinook salmon, steelhead, and coldwater fisheries enhancement stocking for Lake Oroville. Costs of fish tagging, marking, and other monitoring programs are not included.

1.5 Location(s) of Hatchery and Associated Facilities

The FRFH main facility is located at river kilometer 107 on the Feather River in the town of Oroville, California (Figure 1-1). Additionally, a separate facility, the FRFH Annex, is located downstream adjacent to the Thermalito Afterbay and Highway 99. The Feather River enters the Sacramento River at river kilometer 129. The Sacramento River flows through the Sacramento-San Joaquin Delta and into San Francisco Bay.

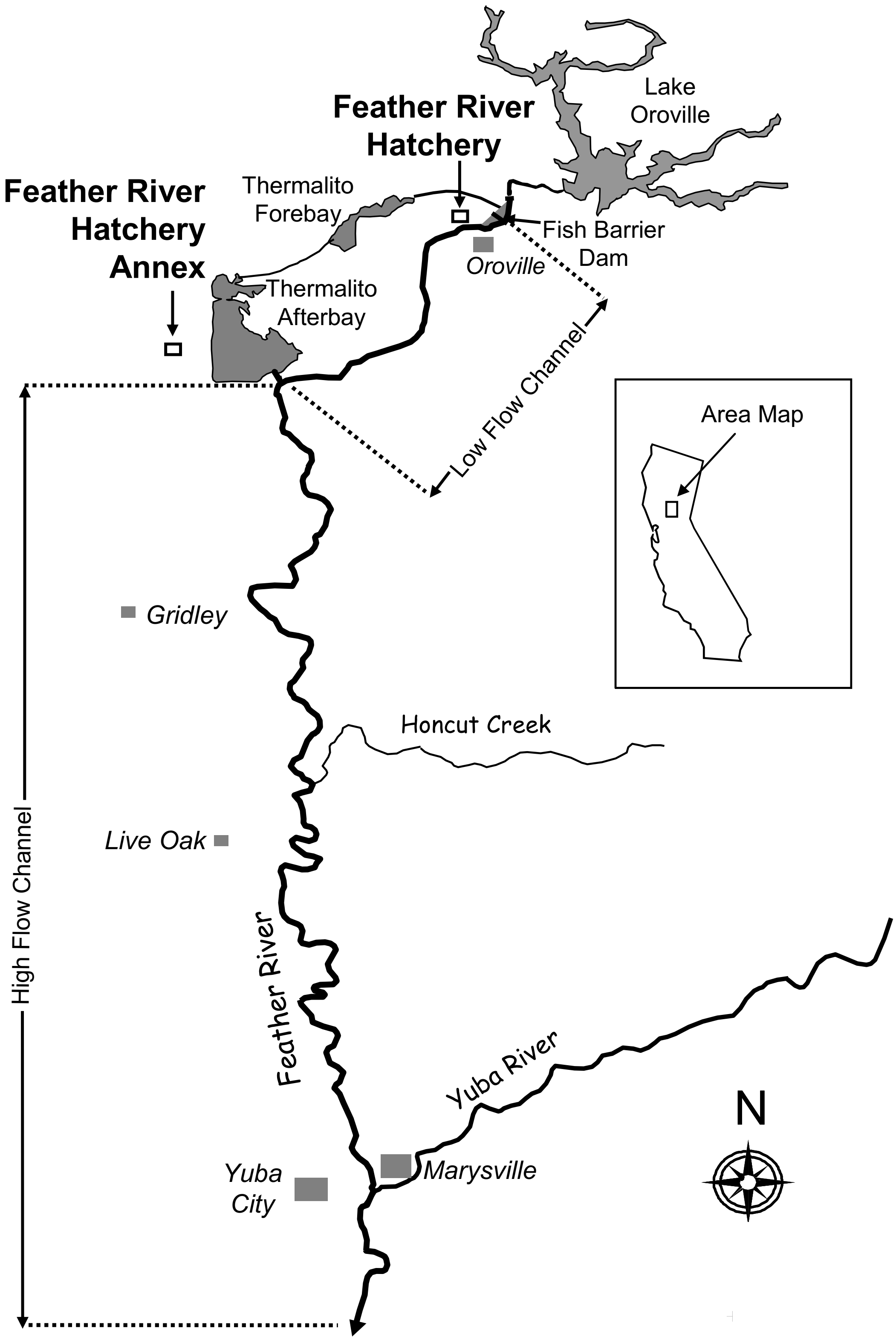

Figure 1-1. Feather River Hatchery and vicinity.

The latitude and longitude of the FRFH is:

39°31'4.44"N 121°33'13.47"W

The latitude and longitude of the FRFH annex is:

39°28'39.88"N 121°41'17.44"W

The Pacific States Marine Fisheries Commission's (PSMFC) Regional Mark Information System code for the FRFH is: 6FCSAFEA FRFH

1.6 Type of Program

The spring-run Chinook salmon program at FRFH is an Integrated Recovery Program which seeks to aid in the recovery and conservation of Central Valley spring-run Chinook. Fish produced are intended to spawn in the wild or be genetically integrated with the targeted natural population as FRFH broodstock (adapted from NPCC 2003).

1.7 Purpose (Goal) of Program

The primary purpose of the program is the conservation of phenotypic and genotypic characteristics of Feather River spring-run Chinook salmon while minimizing impacts to other listed fishes.

A secondary purpose of the program is to mitigate for spawning and rearing habitat eliminated due to construction of Oroville Dam in the early 1960s.

1.8 Justification for the Program

In 1960, California voters authorized construction and operation of the SWP. Oroville Dam and reservoir on the Feather River were essential project components providing water storage, hydroelectric power, flood control, and recreational benefits. In the years immediately prior to construction of Oroville Dam, DFG estimated from a few hundred to about two thousand spring-run Chinook salmon made their way past the dam site to spawning and rearing habitat in the upper watershed (Fry and Petrovich 1970, Painter et al. 1977). Although the dam blocked access to historic spawning grounds, access to hypolimnetic coldwater in Oroville Reservoir provided suitable holding, spawning and rearing habitat below the dam and artificial propagation of spring-run Chinook salmon was included in the original Oroville Dam mitigation plan.

The spring-run Chinook salmon mitigation program commenced with initial operation of the FRFH in 1967; thus this program has been in operation for more than four decades. Subsequently, DWR documented there had been considerable mixing of fall- and spring-run Chinook salmon stocks in the hatchery (DWR 2004a). At about the same time, the ladder to the FRFH was opened during the spring months to determine when steelhead and spring-run Chinook salmon might be holding in the Feather River. Investigators found substantial numbers of Chinook salmon ascended the fish ladder in May and June (DWR 2004a). Documentation of a phenotypic spring-run in the Feather River resulted in a new hatchery approach to collecting broodstock and minimizing introgression between early running (“spring-run”) and later running (“fall run”) Chinook. The Feather River spring-run Chinook salmon population is among the largest of the remaining spring-run Chinook salmon populations in the Central Valley, with the other major runs being to Deer, Mill and Butte creeks, all Sacramento River tributaries.

The new spring-run Chinook salmon hatchery operations went into effect with the 2004 brood year, and are designed to protect this important component of the Sacramento Valley spring-run Chinook salmon ESU as defined by National Oceanic and Atmospheric Administration (NOAA) Fisheries.

1.9 Species and Population (or Stock) in Propagation, and ESA Status

Spring-run Chinook salmon reared at FRFH are a component of the threatened Central Valley spring-run ESU (NOAA 2005a).

Adult spring-run Chinook salmon are defined as Chinook salmon that have spent at least one winter in the ocean and express a migration behavior of entering the Feather River during the months of April, May, and June while sexually immature. Hatchery origin spring-run Chinook salmon are additionally identified by adipose fin clip, coded wire tag, Hallprint tag, genetic based tag or other marker indicating stock/hatchery of origin. Hatchery origin Chinook not meeting the above criteria cannot be used for spring-run broodstock at Feather River Hatchery.

1.10 Program “Performance Standards”

The goals of the FRFH spring-run Chinook salmon program are accomplished through carefully planned trapping, artificial spawning, rearing, and release of spring-run Chinook salmon while conserving the phenotypic and genotypic characteristics of the population and minimizing impacts to other listed stocks.

Conservation will be accomplished by implementing new operational protocols for the FRFH. These protocols will include, but are not limited to, rigorous selection of broodstock to manage run timing, genetics, percent natural origin, refinement of smolt release strategies, and monitoring of harvest and escapement.

Standard 1: Program will attempt to meet production goal but not exceed greater than 10% of the goal.

> ***Indicator 1.1**:* Up to 1500 adults are collected annually according to Broodstock Collection Protocols in 7.2 and 7.3.
>
> ***Indicator 1.2**:* A goal of 2.25 million, but no more than 2.5 million spring-run Chinook salmon smolts are released annually.

Standard 2: All (100%) hatchery-produced juvenile spring-run Chinook salmon are marked. Mark types include coded wire tag with adipose fin clip, otolith thermal mark, genetic tag or any other tag deemed acceptable by DWR, NOAA Fisheries and DFG.

Indicator 2.1: Consistency between hatchery annual reports and tagged fish release reports indicating that 100% of spring-run Chinook juveniles have been marked with an acceptable tag as defined above.

Standard 3: Minimize straying and related genetic introgression of hatchery origin spring-run Chinook salmon with Yuba River and other out-of-basin natural origin spring-run Chinook. When possible, releases will occur at a time when the potential impacts of water pumping from state and federal facilities are reduced or absent.

Indicator 3.1: All (100%) FRFH spring-run juvenile Chinook salmon will be released into the Feather River between the Fish Barrier Dam and the Sacramento River confluence.

Indicator 3.2: FRFH spring-run Chinook salmon compose less than 5% of the natural origin spawning population in each creek or river evaluated (outside of the Feather River).

Standard 4: Survival of FRFH spring-run Chinook salmon releases are maximized while minimizing adverse interactions with natural-origin salmonids. When possible, releases will occur at a time when the potential impacts of water pumping from state and federal facilities are reduced or absent.

Indicator 4.1: Report locations, dates, and size distributions of juvenile FRFH spring-run Chinook salmon releases and rationale for how these releases are expected to maximize survival while minimizing adverse interactions.

Indicator 4.2: Evaluate the effectiveness of in-river release strategies to increase survival and promote rapid emigration including but not limited to transport methods, release methods, release locations, release times, and effects of stream flows and water quality.

Standard 5: Spring-run Chinook salmon broodstock are collected in a manner that minimizes introgression with fall-run Chinook salmon, and also approximates the distribution in age and size of natural-origin fish.

Indicator 5.1: Only early running, spring-run Chinook identified with an external tag will be used as broodstock according to broodstock marking and collection protocols described in Chapter 7.2.

Indicator 5.2: Collect data on age and size of hatchery broodstock and natural in-river spawning phenotypic spring run.

Standard 6: The percentage of first generation hatchery fish used for broodstock will be identified, where possible. Although a proportion of <15% hatchery origin fish is desirable (Lindley 2007), the current stock composition is unknown but presumed to be predominately composed of hatchery-origin fish.

Indicator 6.1: Collect data on the proportion of natural origin and hatchery origin known fish among FRFH spring-run broodstock and among fish spawning in the Feather River.

Indicator 6.2: DWR, in consultation with DFG and NOAA Fisheries will develop and implement a plan for increasing proportion of natural origin spring-run Chinook in the FRFH and naturally spawning broodstock.

Indicator 6.3: Annual reports indicate the proportion of known natural-origin fish among the FRFH broodstock and naturally spawning spring-run Chinook salmon.

Standard 7: The FRFH adult spring-run Chinook salmon broodstock will be spawned to more closely mimic natural size assortative mating: each spawner will be paired with a similar-sized mate (Hankin et al. 2009). Jacks will make up no more than 2% of males spawned unless necessary to meet conservation goals.

Indicator 7.1: Report data indicating sex and fork length for mating pairs consistent with Standard 7.

Indicator 7.2: Collect data on number of males, females and jacks spawned consistent with Standard 7.

Standard 8: Genetic composition of Feather River Chinook salmon will be consistent with HGMP goals.

Indicator 8.1: Collection of genetic samples of Feather River spring-run and fall-run Chinook salmon is conducted annually.

Indicator 8.2: Reports describing genetic analyses indicate natural and hatchery-origin fish are genetically similar and shows increasing divergence between FRFH spring- and fall-run Chinook salmon.

Standard 9: All Chinook entering the FRFH fish ladder after September 1 are processed in a manner that minimizes pre-spawning mortality.

Indicator 9.1: Date, fork length, sex, adipose clip status, presence of other tags or marks are reported for each pre-spawning mortality.

Indicator 9.2: Dates of ladder operations, dates of FRFH fish processing, and related number of fish spawned, culled, or returned to round tanks (for holding) is reported.

Standard 10: FRFH spring-run Chinook salmon eggs, fry, or juvenile fish in excess of conservation needs (as defined in Standard 1) are disposed of in a manner that 1) increases the separation of spring and fall run broodstock and 2) is consistent with DFG policies on egg culling and fish disposal.

Indicator 10.1: Spawn date (lot #), number, and method of disposal of excess FRFH spring-run juvenile Chinook salmon eggs, fry, or juvenile fish.

Indicator 10.2: Excess eggs, fry or juvenile salmon are not released, placed, or planted into any anadromous waters, with the exception of eggs, fry or juveniles provided to the San Joaquin River Restoration program.

Standard 11: FRFH spring-run Chinook salmon program is operated in compliance with DFG fish health policies and guidelines.

Indicator 11.1: Number of broodstock sampled for pathogens, types and frequencies of observed infections, treatments prescribed are reported in FRFH annual reports.

Indicator 11.2: Survival rates for: 1) egg to fry and, 2) fry to juvenile fish released reported in FRFH annual reports.

Indicator 11.3: Results of fish health examinations.

Indicator 11.4: Number of juveniles sampled and pathogens observed immediately prior to release reported in FRFH annual reports.

Standard 12: FRFH effluent complies with the conditions and water quality limitations identified in the current National Pollutant Discharge Elimination System (NPDES) permit.

Indicator 12.1: Dates, locations and number of water samples collected.

Indicator 12.2: Samples analyzed and results reported.

Indicator 12.3: Sampling and results consistent with NDPES permit.

Standard 13: FRFH spring-run Chinook salmon carcasses are disposed of in a manner identified in the HGMP, and comply with DFG and NMFS criteria.

Indicator 13.1: Carcass disposal is consistent with DFG policy and numbers of fish and disposition methods are reported in FRFH annual reports.

Standard 14: Information on FRFH operations will be collected, reviewed and reported in a consistent and scientifically-rigorous manner, and available for public distribution at a time determined by the Feather River Technical Team.

Indicator 14.1: Annual reports are prepared following DFG administrative report format (Appendix C) and made available for public distribution at a time determined by the Feather River Technical Team.

2. EFFECTS ON ESA-LISTED SALMONID POPULATIONS

2.1 ESA Permits or Authorizations in Hand for the Hatchery Program

Operation of the SWP, including the Oroville Dam and related structures is covered by the October 2004 NOAA Fisheries BO on the Operation of Long-Term CVP and SWP Operations Criteria and Plan.

DWR also has a 4-d permit from NOAA Fisheries that allows the FRFH fish ladder to remain open through the end of July, to provide for the counting, capture, and tagging of phenotypic spring-run Chinook salmon for use as broodstock.

2.2 Provide Descriptions, Status, and Projected Take Actions and Levels

There are two listed salmonids in the target area: Central Valley spring-run Chinook salmon and steelhead rainbow trout. Both species are listed as threatened under the federal ESA (NOAA 2005a). Both hatchery and naturally spawning populations of spring-run Chinook salmon are considered part of the Central Valley ESU. The Sacramento Valley also includes the winter-run Chinook salmon, a state and federal endangered species. Green sturgeon are listed as threatened under the federal ESA (NOAA 2005b) and are known to occur in the Feather River.

Table 2-1. Estimated annual take of Central Valley spring-run Chinook salmon as a result actions associated with implementation of the FRFH spring-run Chinook salmon program. There is no anticipated take of winter-run Chinook or green sturgeon.

	Spring-run Chinook salmon program activity							
	Springtime capture and tagging		Artificial spawning		Smolts for survival experiments		Smolts for pathology	
Species	Expected take	Indirect Mortality	Lethal take	Indirect Mortality	Expected take	Indirect Mortality	Lethal Take	Indirect Mortality
Central Valley spring-run Chinook	20,000	200	1,500	0	1,000	100	100	0
Central Valley steelhead	25	0	0	0	0	0	0	0

2.2.1 Description of NMFS ESA-listed Salmonid Population(s) Affected by the Program

Chinook salmon - Sacramento River Winter-run *Oncorhynchus tshawytscha*
The Sacramento River winter-run Chinook salmon ESU is represented by a single extant population. Construction of the Shasta and Keswick dams completely displaced this ESU from its historical spawning habitat. Cold-water releases from the reservoir behind Shasta Dam artificially maintain the remaining spawning habitat in the mainstem Sacramento River.The productivity and abundance of the naturally spawning component of this ESU have exhibited improvement in recent years, compared to years of relatively low abundance in the 1980s and early 1990s. Construction of Shasta Dam merged at least four independent populations into a single population, resulting in a substantial loss of genetic diversity, life-history variability, and local adaptation. Critically low salmon abundance (particularly in the early 1990s) imposed "bottlenecks" for the single remaining population, which further reduced genetic diversity.

Chinook salmon - Sacramento River spring-run *Oncorhynchus tshawytscha*
Spring-run Chinook salmon in the Sacramento-San Joaquin River system was once among the largest runs on the Pacific Coast (Yoshiyama et al. 1998). The Sacramento River drainage alone was estimated to support spring-run Chinook salmon exceeding 100,000 fish in many years between the late 1800s and 1940s (Moyle 2002). Historic runs were reported in the McCloud River, Pit River, Little Sacramento River, Feather River (including above Oroville Dam), Yuba River (including above Englebright Dam), and American River (including above Folsom Dam) (Moyle 2002).

In the Central Valley, spring-run Chinook salmon historically migrated upstream as far as they could in the larger tributaries to the Sacramento and San Joaquin Rivers, where they held for several months in deep cold pools (Moyle 2002). Today, Central Valley spring-run Chinook salmon persist in a few systems in the Sacramento River watershed. Currently, the largest naturally occurring populations of the principal habitats available to Central Valley spring-run Chinook salmon can be found in Deer, Mill, and Butte creeks (Campbell and Moyle 1991; Yoshiyama et al. 2001; Moyle 2002). Considerably smaller spawning populations of spring-run Chinook salmon have been reported in several small tributaries of the Sacramento River (Moyle 2002) and in the lower Yuba River (DFG 1998).

Spring-run Chinook salmon populations in Mill, Deer and Butte creeks are genetically distinguishable from other Central Valley salmonids (Banks et al. 2000). Spring-run Chinook salmon are propagated at FRFH and a segment of this run also spawns naturally in the Feather River. However, Feather River spring-run Chinook salmon more closely resemble fall-run Chinook salmon, and to date cannot be completely separated from fall run by genetic techniques. CWT returns also indicate that fish identified as spring-run Chinook salmon are intermixed at the hatchery with those identified as fall-run Chinook salmon (Hedgecock et al. 2001); and FRFH and in-river spring run Chinook salmon cannot be separated with current information (Hedgecock 2002).

Most spring-run Chinook salmon are thought to exhibit a classic "stream-type" life history pattern (Moyle 2002). Stream-type Chinook salmon spend one or more years in freshwater before migrating downstream toward the ocean. As a result, stream-type juveniles are more dependent on freshwater streams. At the time of saltwater entry, stream-type (yearling) smolts are much larger than their ocean-type (subyearling) counterparts and are therefore able to move offshore relatively quickly, making extensive offshore oceanic migrations. This life history pattern tends to separate spring-run Chinook salmon from other salmon runs. Spring-run Chinook salmon historically migrated further upstream than other Chinook salmon runs, taking advantage of higher elevation habitats that were inaccessible during summer and fall months as a result of high temperatures and low flows in lower reaches (Moyle 2002). This geographic separation also helped preserve their genetic integrity (Moyle 2002).

Spring-run Chinook salmon begin their upstream migration in late January to early February (DFG 1998) and enter the Feather River as immature adults from March to September (Painter et al. 1977; DFG 1993; DFG 1998; Yoshiyama et al. 1998; Sommer et al. 2001). However, recent protocols put in place at FRFH to select predominantly early arriving spring run for broodstock use June 30 as the end date for spring run migration into the FRFH. Because spring-run Chinook salmon enter freshwater as sexually immature adult fish, the holding period can last for several months before individuals are ready to spawn (Moyle 2002; DFG 1998). Deep, cool, and oxygenated pools are important for salmon energy conservation (Berman and Quinn 1991; USBR and DWR 2000).

Sommer et al. (2001) reported that spring-run Chinook salmon in the Feather River spawn in the autumn (September and October), following their upstream migration. The inter-gravel egg and fry incubation life stage for spring-run Chinook salmon generally extends through March (Yoshiyama et al. 1998), but in the Feather River most spring-run Chinook salmon fry emerge from the gravel before February (Seesholtz et al 2004). The inter-gravel residence period of incubating eggs and alevins (yolk-sac fry), and egg incubation survival rates, are highly dependent on water temperature. Newly emerged fry remain in shallow, lower velocity edgewaters, particularly where debris aggregates, making fish less visible to predators (DFG 1998). Fry then gradually move into deeper and faster water as they increase in size (Moyle 2002). Rearing juveniles require adequate space, cover, and food, and cool water temperatures. Suitable habitat includes areas with instream and overhead cover in the form of undercut banks, downed trees, and large, overhanging tree branches. The organic materials forming fish cover also help provide sources of food (i.e., aquatic and terrestrial insects). Juvenile spring-run Chinook salmon are opportunistic drift feeders and feed on terrestrial and aquatic insect larvae and crustaceans.

Juveniles may rear in streams for one to 15 months. Some authors (Yoshiyama et al. 1998; Moyle 2002) suggest that a shorter period of rearing may be a response to altered flow regimes (caused by dams and diversions) and required use of lower elevation sections of streams. Rearing occurs in natal streams, the mainstem of the Sacramento River, non-natal streams, the floodplain of the Yolo and Sutter bypass and the Delta. The overwhelming majority of spring-run Chinook salmon in the Feather River emigrate the system as YOY (Seesholtz et al. 2004).

Out-migrants may spend some time in the Sacramento River or in the estuary and gain additional size prior to smolting and migrating out to sea. Juveniles that migrate as yearlings move downstream with the onset of the stormy season, beginning in October of the year following spawning and continuing through March (DFG 1998). Based on 1998 to 2007 rotary screw trap data, emigration of spring-run sized Chinook salmon from the Feather River peaks in December, and is followed by another pulse of juvenile YOY emigrants at Live Oak in April and May (Seesholtz et al. 2004, DWR 2007b, DWR 2009).

The co-occurrence of spring- and fall-run Chinook salmon on the remaining spawning grounds below Oroville Dam, along with poor run segregation practices at FRFH, has led to considerable intermixing and confusion between Feather River fall- and spring-run. Beginning in 2004, DWR and DFG began opening the FRFH fish ladder from April to June. Salmon entering FRFH during this time are externally tagged and released back into the Feather River. Much of the information we have regarding FRFH spring-run Chinook salmon results from spring FRFH ladder operations and resulting recoveries of tagged salmon. However, these data represent only those fish which entered FRFH, and may not be representative for in-river spawning hatchery origin fish or for natural origin salmon.

Steelhead - California Central Valley *Oncorhynchus mykiss*

Central Valley Steelhead are the anadromous form of rainbow trout. At one time, steelhead and resident rainbow trout were considered separate subspecies or different species altogether. However, most researchers have found little or no morphologic or genetic differentiation between the two forms inhabiting the same stream system (McEwan and Jackson 1996). Genetic analysis indicates that steelhead stocks from the FRFH, CNFH, Deer and Mill creeks, and the Stanislaus River are genetically similar but distinct from coastal steelhead stocks (Busby et al. 1996; NOAA 1998

On 19 March 1998, naturally spawned Central Valley steelhead was listed as threatened by NOAA Fisheries (NOAA 1998). The Central Valley ESU includes all naturally spawned populations of steelhead (and their progeny) in the Sacramento and San Joaquin rivers and their tributaries, including the naturally spawned steelhead in the Feather River (NOAA 1998). The listing was further clarified in January 2006, redefining the protected fish as the Central Valley steelhead (NOAA 2006). The final designation for Central Valley steelhead critical habitat was published on 2 September 2005, and took effect on 2 January 2006 (NOAA 2005a).

The new critical habitat for Central Valley steelhead has redefined the boundaries of critical habitat to more specific areas in which the fish are found, or to include habitats that are specifically essential to their conservation. Designated critical habitat for Central Valley steelhead includes: the lower Feather River; Battle, Cottonwood, Antelope, Mill, Deer, Big Chico, and Butte creeks; Sacramento, Yuba, American, Cosumnes, Mokelumne, Calaveras, San Joaquin, Merced, Tuolumne, and Stanislaus rivers; and, the Delta (NOAA 2005a).

Central Valley steelhead ranged throughout many of the tributaries and headwaters of the Sacramento and San Joaquin rivers, including tributaries above Shasta Dam such as the Little Sacramento, McCloud, Fall, and Pit rivers, and many tributaries on the west side of the Sacramento Valley (McEwan and Jackson 1996; Yoshiyama et al. 1996, 1998).

Steelhead distribution in Central Valley drainages has been greatly reduced because of construction of dams and other barriers, water development, and other human activities/ or manipulations (McEwan and Jackson 1996). NOAA (2003) estimated the Central Valley steelhead population at less than 3,000 adults. Steelhead are now primarily restricted to a few remaining free-flowing tributaries and to stream reaches below large dams. Naturally spawning steelhead populations have been found in: the upper Sacramento River and tributaries below Keswick Dam; Mill, Deer, and Butte creeks; and, the Feather, Yuba, American, and Mokelumne rivers. It is possible that naturally spawning populations exist in many other streams, but are undetected because of the lack of monitoring or research programs.

Steelhead may be distinguished from rainbow trout by their strong behavioral differences, which relate directly to their anadromous nature. Steelhead life history, however, can be quite variable with some populations reverting to residency when flow conditions block access to the ocean (McEwan and Jackson 1996).

Only winter steelhead are found in Central Valley rivers (Moyle 2002). “Winter” refers to run timing, but in the Sacramento River watershed, steelhead might be better termed “fall” steelhead, as the adult steelhead migration begins in July to August, peaks at the end of September to October, and continues through February or March (Bailey 1954; Hallock et al. 1961; McEwan and Jackson 1996; Moyle 2002). Counts made on the Feather River generally follow a similar pattern, although some fish have been counted as late as April and May (Painter et al. 1977; USBR 2004).

In the Feather River, steelhead spawn from December to March, with the peak in spawning occurring in late January (DWR 2003). Steelhead are iteroparous, potentially spawning more than once during their lives. Some may return to the ocean and repeat the spawning cycle for two or three years (McEwan and Jackson 1996). The percentage of adults surviving for multiple spawning is generally low for Central Valley steelhead, but varies annually and between stocks (McEwan and Jackson 1996). The intergravel egg and alevin incubation life stage for Feather River steelhead extends from December through May, with a peak from January through April. Newly hatched steelhead alevins remain in the gravel from two to six weeks (USBR and DWR 2000; Moyle 2002). Upon emergence from the gravel, steelhead fry move to shallow, protected areas along stream banks, live in small schools, and exhibit little aggressive behavior (McEwan and Jackson 1996; Cavallo and Kurth In prep). As the juvenile steelhead grow, the schools break up and establish individual feeding territories. Steelhead juveniles are opportunistic feeders, consuming small aquatic invertebrates and terrestrial insects (Moyle 2002).

Most steelhead rear along the margins of riffles and glides, and with increasing age and size, are found in increasingly swifter waters (McEwan and Jackson 1996, Cavallo and Kurth In prep). Juvenile steelhead will rear in freshwater for one to three years, with most naturally produced Central Valley steelhead rearing for two years prior to emigrating (McEwan 2001). It is unknown when most steelhead smolts emigrate from the Feather River; however YOY and juveniles have been caught in Feather River screw traps between December and August, with a peak occurring in the spring (Seesholtz et al. 2004, DWR 2007b, DWR 2009). Once in the ocean, steelhead remain there for one to four growing seasons before returning to spawn in their natal streams (McEwan and Jackson 1996).

2.2.2 Status of NMFS ESA-listed Salmonid Population(s) Affected by the Program

The following ESA-listed salmonid populations could be affected by the operation of FRFH:

Chinook salmon – Sacramento River Winter-run *Oncorhynchus tshawytscha*

Date Listed: November 5, 1990; reclassified January 4, 1994; classification reaffirmed June 25, 2005
Legal Status: Endangered (reclassified from original listing as threatened)

Description: The Evolutionarily Significant Unit (ESU) for this species includes all naturally spawned populations of winter-run Chinook salmon in the Sacramento River and its tributaries, as well as two now terminated artificial propagation programs: 1) winter-run Chinook salmon from the Livingston Stone National Fish Hatchery (NFH), and 2) winter-run Chinook salmon in captive broodstock programs maintained at Livingston Stone NFH and the University of California Bodega Marine Laboratory.

ESU viability is assessed on the basis of four Viable Salmon Population (VSP) criteria: abundance, productivity, spatial structure, and diversity. For this ESU, the Biological Recovery Team (BRT) found extremely high risk for each of the four VSP categories, with the highest concern for spatial structure and diversity, and significant concern for abundance and productivity. While encouraged by somewhat recent increases in abundance of the single population, the majority opinion of the BRT was that the naturally-spawned component of the Sacramento River winter-run ESU is still “likely to become extinct within the foreseeable future.”

A second naturally spawning population is considered critical to the long-term viability of this ESU, and plans are under way (but not yet implemented) to attempt establishment of a second population in the upper Battle Creek watershed, using the artificial propagation program as a source for fish. The artificial propagation program has contributed to maintaining diversity of the ESU through careful use of spawning protocols to maximize genetic diversity of propagated fish and minimize impacts on the naturally spawning population. In addition, the artificial propagation and captive broodstock programs have contributed to preserving the genome of this ESU.

Recovery Plan Status: A draft recovery plan for the Sacramento winter-run Chinook salmon ESU was issued in October 2009. Available at:
http://swr.nmfs.noaa.gov/recovery/cent_val/Public_Draft_Recovery_Plan.pdf

Chinook salmon - Sacramento River spring-run *Oncorhynchus tshawytscha*

Date Listed: September 16, 1999 and reaffirmed June 25, 2005
Legal Status: Threatened

Description: Extant natural populations of spring-run Chinook salmon are primarily found in Butte, Deer, and Mill creeks. Additional populations of spring run exist in the Sacramento River, the Feather River, and the Yuba River. Spring-run Chinook salmon enter the Sacramento River between February and June. They move upstream and enter tributary streams from February through July, peaking in May-June. These fish migrate into the headwaters, hold in pools until they spawn, starting as early as mid-August and ending in mid-October, peaking in September. The juvenile life history is more variable. Some fish emerge starting in early November and continuing through the following April. These juveniles emigrate from the tributaries as fry from mid-November through June. Some fish remain in the stream until the following October and emigrate as "yearlings", usually with the onset of storms starting in October through the following March, peaking in November-December.

Species Status: The DFG's Status Review Report was submitted to the California FGC in June 1998 with a recommendation that the species warranted a threatened status. In August 1998 the FGC found that the species warranted listing as a threatened species. The Sacramento River spring-run Chinook salmon was formally listed by the state as a threatened species on February 5, 1999.

NMFS published a final rule on September 16, 1999, listing Central Valley spring-run Chinook salmon as federally threatened. The effective date of the regulation is November 15, 1999. The Status in 1998 and 1999 of the Sacramento River spring-run Chinook salmon: Stable to Declining.

Recovery Plan Status: A draft recovery plan for the Sacramento spring-run Chinook salmon ESU was issued in October 2009. Available at:
http://swr.nmfs.noaa.gov/recovery/cent_val/Public_Draft_Recovery_Plan.pdf

Steelhead - California Central Valley *Oncorhynchus mykiss*

Date Listed: March 19, 1998

Legal Status: Threatened; classification reaffirmed January 5, 2006

Description: Includes all naturally spawned populations of steelhead (and their progeny) in the Sacramento and San Joaquin rivers and their tributaries.
Excluded are steelhead from San Francisco and San Pablo bays and their tributaries.

Species: The Central Valley (CV) steelhead DPS is thought to have occurred historically from the McCloud River and other northern tributaries to Tulare Lake and the Kings River in the southern San Joaquin Valley. It is estimated that more than 95% of historical spawning habitat is now inaccessible to this DPS, and little information is available regarding the viability of the naturally spawning component of the CV DPS. The Biological Review Team (BRT) reported that recent spawner surveys of small Sacramento River tributaries (Mill, Deer, Antelope, Clear, and Beegum Creeks) and incidental captures of juvenile steelhead via monitoring on the Calaveras, Cosumnes, Stanislaus, Tuolumne, and Merced rivers confirmed that steelhead are distributed throughout accessible streams and rivers.

Artificial propagation programs at Coleman National Fish hatchery and Feather River Fish hatchery are considered to be part of the CV steelhead DPS; both are located in the Sacramento River Basin, consisting of large-scale mitigation facilities intended to support recreational fisheries for steelhead, and not to supplement naturally spawning populations. All production is marked and the hatchery fish are integrated with the natural-origin fish. Informed by the BRT's findings, and NMFS' assessment of the effects of artificial propagation programs on the viability of the DPS, the Artificial Propagation Evaluation Workshop concluded that the California CV steelhead DPS altogether is "in danger of extinction."

Recovery Plan Status: A draft recovery plan for the Central Valley steelhead ESU was issued in October 2009. Available at:
http://swr.nmfs.noaa.gov/recovery/cent_val/Public_Draft_Recovery_Plan.pdf

2.2.3 Hatchery Activities Associated Monitoring, and Evaluation and Research Programs, that may Lead to the Take of NMFS-listed Fish in the Target Area, and Estimated Annual Levels of Take

Program operation of the FRFH fish ladder to monitor or evaluate phenotypic spring-run Chinook salmon and implement program activities will result in take of listed salmonids. These numbers are estimated in Table 10-1. In addition to those fish taken as part of adult broodstock collection, 100 juvenile spring-run Chinook salmon (smolts) may be sacrificed for fish health monitoring and up to 1,500 may be used as part of acoustic tagging survival and outmigration experiments. Large releases of coded wire tagged FRFH spring Chinook smolts as part of a mark recapture program to investigate survival could result in the capture of Yuba River spring Chinook if rotary screw fish traps or other devices are operated below the mouth of the Yuba

River.   Only FRFH smolts would be detectable in traps due to the 100% mark and adipose clip applied to all FRFH spring run smolts. Therefore, naturally produced juveniles or smolts from the Yuba River would be indistinguishable from naturally produced fish from the Feather River so levels of take would be difficult to estimate. However, it is expected that these experiments would only occur for two months and would result in the take of less than 10,000 Yuba River juveniles or smolts. Lethal take would be expected to be less than 1%. No other activities associated with monitoring, evaluation and research of this program should result in take of listed salmonids.

3. RELATIONSHIP OF PROGRAM TO OTHER MANAGEMENT OBJECTIVES

3.1 Describe alignment of the hatchery program with any ESU-wide hatchery plan (e.g. *Hood Canal Summer Chum Conservation Initiative*) or other regionally accepted policies (e.g. the NPPC *Annual Production Review* Report and Recommendations - NPPC document 99-15). Explain any proposed deviations from the plan or policies.

Other than policies found in the California Fish and Game Code and operating procedures listed in the DFG Operations Manual for anadromous fish hatcheries, there is currently no Central Valley-wide hatchery plan in place. Overall coordination of hatcheries is provided by DFG, but to date operations of Central Valley anadromous salmonid hatcheries have not been coordinated with regard to operational or ecological guidelines or concerns.

The DFG Operations Manual contains sections that provide direction and guidance to the Department for anadromous fish management, and fish production and distribution, including fish health policies and procedures (Appendix B).

3.2 Existing Cooperative Agreements, Memoranda of Understanding, Memoranda of Agreement, or other Management Plans or Court Orders under which the Hatchery Operates

Operations Contract between Department of Water Resources and Department of Fish and Game

Enhancement Program Contract between Salmon Trollers Association and Department of Fish and Game

FERC project 2100 Settlement Agreement – Feather River Fish Hatchery Improvement Program

California Department of Fish and Game Operations Manual

NOAA Fisheries Formal and Early Section 7 ESA Consultation on the Coordinated Operations of the CVP and SWP and Operational Criteria and Plan (OCAP 2004)

3.3 Relationship to Harvest Objectives

Harvest of FRFH spring run is not a specific goal of the program, however frequent harvest does occur. Fish may be harvested in the ocean commercial and recreational fisheries and in the inland recreational fisheries. It is important to understand the fisheries and their harvest because: 1) harvest provides significant socio-economic benefits, 2) harvest of abundant hatchery fish may lead to incidental harvest of naturally spawning stocks and 3) trends in harvest, including effort, should be considered when setting or adjusting hatchery production goals. The Pacific Fishery Management Council and the California Fish and Game Commission set regulations allocating harvest and monitor catch in a manner that protects the overall fisheries resources and, in particular, stocks and species at risk. Data collected from hatchery programs, coded-wire-tag recoveries, harvest, and adult escapement surveys provide essential information needed to set annual fishery regulations.

Pacific Fishery Management Council (PFMC). The PFMC is one of eight regional fishery management councils established by the Magnuson Fishery Conservation and Management Act of 1976 for the purpose of managing fisheries three to 200 miles offshore of the U.S. coastline. The PFMC is responsible for salmon and other fisheries off the coasts of California, Oregon, and Washington.

The PFMC's Salmon Fishery Management Plan describes the goals and methods for salmon management. Management tools such as season length, quotas, and bag limits vary depending on how many salmon are present. There are two central parts of the Plan: 1) an annual goal for the number of spawners of the major salmon stocks (i.e., spawner escapement goals of 122,000 – 180,000 fall-run Chinook salmon returning to the Central Valley) and 2) allocation of the harvest among different groups of fishers (commercial, recreational, tribal, various ports, ocean, and inland). The PFMC must also comply with laws such as the ESA. In recent years the PFMC has adjusted the ocean fisheries to help ensure that Klamath River and Central Valley escapement goals are met. The ESA and fishery season, gear and location-related adjustments to protect specific stocks have affected the numbers of salmon that escape to the Feather River and other Central Valley streams.

California Fish and Game Commission. The Commission has the general regulatory function to set seasons, bag limits, and methods of take for game animals and sport fish. In adopting hunting (biennially, even-numbered years) and sport fishing regulations (biennially, odd-numbered years), the Commission, in each case, holds a series of open public meetings (three for hunting and four for sport fishing) located in various parts of the state. Individual and group input can be received and considered prior to adoption of new or changed regulations. The Commission can decide to increase the catch of salmon by increasing the bag limit for example in the Feather River sport fishery, and to limit the take of listed species, such as early returning spring-run Chinook salmon on the Feather River. Estimated numbers of Central Valley spring-run Chinook salmon harvested in ocean fisheries have varied since 1995 (Table 2-2). FRFH spring-run Chinook salmon are undoubtedly a component of this harvest, but specific harvest rates are currently unknown. Ocean commercial, ocean sport, and inland sport fisheries benefit from spring-run Chinook salmon reared and released by FRFH.

Table 3-2. Estimated ocean landings (harvest) of Central Valley spring-run Chinook salmon by brood year and age (calculated from Cramer et al. 2005).

Brood	Ocean Landings				
Year	**Age 2**	**Age 3**	**Age 4**	**Age 5**	**Total**
1995		1,571	6,785	196	8,552
1996		816	3,599	258	4,674
1997		1,318	5,796	378	7,491
1998		1,379	4,998	445	6,822
1999		769	3,456	562	4,786
2000		802	3,559	321	4,681
2001		486	2,236	756	3,478
2002		718	3,271	710	4,700
2003		610	2,782	633	4,025
2004		1,021	4,490	292	5,803
2005		3,624	4,751	323	8,698
2006		3,914	5,131	349	9,393
Totals		17,028	50,854	5223	73,103
Means		1,419	4,238	435	6,092

3.4 Relationship to Habitat Protection and Recovery Strategies

There are many factors that may affect the success of natural and FRFH origin spring-run Chinook salmon. The effects of these factors are not completely understood. The following are some of the more important protection and restoration measures.

Water Temperature – June through mid-October is the primary period during which water temperature could potentially limit natural production. Temperatures above 68°F are likely detrimental to spring-run Chinook salmon holding in the Feather River (see review, DWR 2007a). Water temperature in the Feather River for the first 12 km below the fish barrier dam can be controlled to a large degree by releasing water from various levels in Oroville Reservoir. Below the Thermalito outlet (Figure 2-1), discharge of warmed water from the Thermalito Afterbay can increase ambient river temperatures.

Flow – Although flow must be adequate to provide sufficient depth so that deposited eggs do not become stranded as flows recede, Healey (1991) found that Chinook salmon do well in a variety of flows and depths. In the Feather River, flow in the first 12 km below the fish barrier dam is typically held near 625 cfs except during very high flow years when Oroville Reservoir spills or when additional flows are necessary to meet water temperature objectives. A 1983 agreement between DFG and DWR limits flow fluctuations to minimize redd dewatering and juvenile stranding. The FERC Project 2100 settlement agreement specifies a new base flow of 800 cfs during the Chinook salmon spawning season (i.e., September 9 through March 31), and 700 cfs during the remainder of the year and additional flow as necessary to meet new temperature requirements. The new September and October flows are expected to improve conditions for spawning.

Gravel Quality – Chinook salmon production is dependent in part on the presence of gravel of the optimal size distribution. The presence of dams and regulated flows tends to reduce gravel quality, both in terms of size distribution and interstitial flow and this pattern is also apparent for the Feather River (DWR 2004b). Problems with Feather River gravel quality will be addressed as a condition of the FERC Project 2100 settlement agreement which requires gravel supplementation designed and conducted in coordination with the EC and fishery resource agencies. Planned additions of gravel will provide significant amounts of quality spawning habitat for spring Chinook.

Competition for Spawning Territory – In the Feather River, during the September through mid-October period, spring- and fall-run Chinook salmon may seek spawning sites in the river below the fish barrier dam. For much of the spawning season, fall-run Chinook salmon may re-dig spring-run Chinook salmon redds, destroying incubating eggs or exposing the developing embryos to predation and other mortality sources (super-imposition, Sommer et al. 2001). In addition, the presence of spring-run and fall-run Chinook salmon on the spawning grounds simultaneously probably results in some hybridization between the two races. A segregation weir planned as part of the FERC Settlement Agreement will keep spring and fall run Chinook isolated during spawning. The exact time frame for implementation will not be known until the new FERC Oroville license is issued.

Emigration Corridor - The Sacramento-San Joaquin Delta (Figure 2-2) is most often mentioned as the area in the emigration route having the greatest impact on naturally emigrating Central Valley Chinook salmon (OCAP BO 2004). However, juvenile spring-run Chinook salmon must migrate through 112 river kilometers of the lower Feather River, and additional distance in the Sacramento River before reaching the Delta. Little is known about pre-Delta habitat suitability or predation losses, but when flows are low and waters clear, predation losses in the Feather and Sacramento rivers are likely significant (Williams 2006). Facilities such as Sunset Pumps on the Feather River near Live Oak also present significant challenges for emigrating juveniles or smolts due to large cascading drops over large rip-rap associated with the rock weir structure. The SWP and CVP operate large pumping and fish protection facilities in the southern Delta with a combined capacity of more than 8,000 cfs. The CVP also operates a controllable set of gates on the Sacramento River near Walnut Grove (the Delta Cross Channel) that is used to move Sacramento River through the interior Delta towards the project pumps.

Recovery and Restoration Activities – In recent years there have been many programs and actions designed to help protect and restore Central Valley listed and candidate salmonid populations. Specific to the Feather River spring-run, the recent FERC settlement agreement (DWR 2006) proposes a suite of actions designed to improve and expand salmonid habitat in the

Feather River. Although these actions will not be formally adopted until FERC issues the new license, improvements will likely begin during the five year life of this HGMP and must be considered as DWR and DFG adaptively manage the naturally spawning and hatchery stocks of the threatened Feather River spring-run Chinook salmon.

At this time there is no clear understanding of what controls spring-run Chinook salmon abundance on the Feather River, or the impact of proposed restoration and recovery actions on that abundance. The presence of several thousand phenotypic spring-run Chinook salmon during the past four decades (post-Oroville Dam) indicates that whatever the conditions are, they have been adequate to support one of the largest spring Chinook salmon runs in the Sacramento Valley. However, it is clear that FRFH production has a profound influence on patterns of Feather River spring-run Chinook salmon abundance. Recent and future changes in FRFH production levels, broodstock selection and release strategies will undoubtedly play a role in recovery.

3.5 Ecological Interactions

Ecological interactions may include competition, predation, parasitism and disease transfers, and behavioral influences, while genetic interactions may occur from interbreeding between hatchery and wild fish. Interbreeding may affect the fitness of wild fish and result in the loss of genetic diversity. Adverse impacts are not necessarily inherent to hatchery programs, but poorly understood management objectives can exacerbate impacts, or perceived impacts (Campton 1995; Brannon et al. 2004). Though less often emphasized, properly managed hatcheries have many positive effects: supplementing natural populations, protecting genetic resources and provide for stream nutrient enrichment (Steward and Bjornn 1990; Cuenco et al. 1993)

3.5.1 Competition

Investigations have shown that most of the spring-run (as well as fall-run) Chinook salmon naturally-produced in the lower Feather River emerge in large numbers in January and continue to emerge through April, and initiate migration from the river shortly after emerging, with emigration peaking in February (Seesholtz et al 2003, DWR 2007b, DWR 2009). FRFH-produced spring Chinook salmon will all (100%) be released directly into the Feather River, thereby increasing the potential for competition with naturally produced salmon and other fishes. Furthermore, competition from juvenile FRFH spring-run Chinook salmon may be more intense because of their large size relative to natural origin conspecifics. However, releases will occur near river kilometer 40, below the confluence with the Yuba River. In this reach of the river flows will be greater and the duration of interaction should be limited due to the close proximity to the Sacramento River. Furthermore, spring-run Chinook salmon release generally occurs during April, when most natural-origin Chinook salmon have already emigrated. Thus, competition with naturally-produced Chinook salmon would primarily occur during migration and rearing in the lower Feather River, the Sacramento River, the Delta, San Francisco Bay, and the Pacific Ocean.

Competition between naturally-produced and hatchery-produced salmon is not restricted to freshwater rearing. Indeed, mounting evidence shows that carrying capacity for ocean salmonids is finite, and density dependent impacts may occur with the addition of large numbers of hatchery salmon (Beamish et al. 1997; Ruggerone and Nielsen 2004).

Competition for spawning and rearing habitat for anadromous salmonids below the Fish Barrier Dam has been affected by changes to the geomorphic processes caused by several factors, including hydraulic mining, land use practices, construction of flood management levees, regulated flow regimes, and operation of Oroville Dam and other upstream dams. Continued FRFH production of spring-run Chinook salmon contributes to competition for spawning and rearing habitat relative to existing conditions.

The increased intensity of competition for habitat likely contributes to adult pre-spawning mortality as well as redd superimposition. Pre-spawn mortality estimates in the lower Feather River from 2000 through 2003 were high when compared to reported estimates from some other systems (DWR 2004c). From 2000 through 2003, the pre-spawn mortality estimate ranged between 42.5% and 39.7%. The average pre-spawn mortality rate combining all study years and both reaches was approximately 41.1%. However, escapement in those years was very high, (over 100,000 Chinook in each year) and no distinction could be made between early running "spring run" and later running "fall run." From 2004 through 2006, prespawn mortality measured on naturally spawned Hallprint tagged Chinook (early running) was roughly 20%, significantly less than the non-Hallprint tagged population (DWR, unpublished data). This could be an artifact of smaller spawning populations witnessed in those years or due to the fact that the spring run spawn earlier than the fall run and thus suffer from less competition for space on the spawning grounds. It is not possible at this time to estimate the proportion of pre-spawn mortality accounted for by natural origin spring-run Chinook salmon in the lower Feather River as opposed to FRFH produced fish.

Spring-run Chinook salmon in the lower Feather River are particularly susceptible to superimposition of later arriving fall-run Chinook salmon redds, leading to reduced egg survival of spring-run Chinook salmon (Fukushima et al. 1998). Superimposition may lead to reduced egg-to-fry survival rates (Litchfield and Willete 2002). Redd disruption can also result in increased egg and alevin mortality leading to lower overall production. Redd surveys show that spawning occurred in twice as much area below the Thermalito Afterbay Outlet as compared to the LFC (Sommer et al. 2001). Yet, based on recent escapement data, a very high and increasing percentage of Chinook salmon adults spawn in the LFC, as much as 95% in 2009 (DWR 2004c and DWR unpublished data). Redd superimposition rates may decline if suitable spawning habitat in the LFC is expanded through gravel supplementation efforts.

3.5.2 Predation

Predation by FRFH juvenile salmon on natural-origin salmonids may occur, but is unlikely to be significant because juvenile Chinook salmon feed primarily on invertebrates, and are not highly piscivorous. However, hatchery releases can also have significant indirect effects (negative or positive) on natural-origin fish by either attracting predators, worsening predation (Brown and Mate 1983; Collis et al. 2001), or by swamping predators thereby reducing predation on natural-origin salmon (Marnell 1986; White et al 1995). Predator attraction or swamping effects can be compounded when hatchery salmon induce natural-origin juveniles to leave their normal habitat and join the school of hatchery fish migrating downstream (Hansen and Jonsson 1985; Hillman and Mullan 1989).

3.5.3 Parasitism and Disease Transfers

The primary disease concern at the FRFH has been infectious hematopoietic necrosis virus (IHNV), and the concern has been primarily focused on transfer of disease between hatchery fish released above the hatchery to fish in the hatchery. During serious outbreaks, mortalities of juvenile salmon can reach 70 – 80% in infected raceways.

For several years before 1998, IHNV had not been a significant problem at FRFH. Epizootics in juvenile hatchery Chinook salmon then occurred in 1998, 2000 and 2001, and 2002 with significant fish losses. However, these outbreaks occurred when large numbers of fall Chinook were being planted in lake Oroville for a sport fishery. That practice has been halted and only IHNV resistant species are now being planted in Lake Oroville(Coho salmon). In 2002, steelhead mortality due to IHNV occurred at the FRFH (personal communication, Bill Wingfield, retired DFG and W. T. Cox, Program Manager, Fish Production and Distribution, DFG; DWR 2004a).

Although data are limited, there is substantial documentation of pathogen transfers from wild to hatchery fish, but virtually none for pathogen transfer from hatchery fish to wild fish (personal communication, W. T. Cox, Program Manager, Fish Production and Distribution, DFG). Thus, it appears that IHNV is not readily transmitted from hatchery fish to salmon and other fish in streams, estuary or the ocean. However, this concern may be increased if more hatchery production is released on-site. The IHNV is ubiquitous in the Central Valley watershed and there is no indication that FRFH production has resulted in distributing the Feather River strain of the virus to other streams. Additionally, hatchery management practices at FRFH minimize the release of fish infected with pathogens, and transfer of fish to saltwater is also a control measure for any freshwater parasites that may remain when the fish are released.

3.5.4 Behavioral Differences and Influences

Spring run production released into the Feather River may influence natural origin Chinook salmon. The extent to which hatchery fish may influence natural origin Chinook salmon behavior is unknown.

3.5.5 Interbreeding

An important question for Feather River populations involves the genetic integrity of the present spring-run Chinook salmon. Unfortunately, pre-Oroville Dam genetic information is not available for comparison. However, since 1995, studies have been conducted that include samples from Feather River spring- and fall-run Chinook salmon sources including fish captured in river by anglers and early arriving fish from FRFH (Banks et al. 2000, Hedgecock et al. 2002, O'Malley et al. 2007). Based on these studies hybridization between Feather River spring- and fall-run Chinook salmon has clearly occurred. However, studies do not demonstrate hybridization between FRFH fish and winter, spring and late-fall-runs in other streams has occurred.

These findings may be consistent with the generally low straying rates estimated by recovery of CWTs (Palmer-Zwahlen et al. 2004; DWR, unpublished data). If FRFH-origin fish have been straying extensively, the effect is not apparent in the genetic structure described by microsatellite markers for Central Valley spring Chinook salmon runs in Mill, Deer and Butte creeks, or on winter and late-fall-runs that spawn in the mainstem Sacramento River. However, recent CWT data recovered from escapement surveys throughout the Central Valley indicate that spring run smolts released into the Bay are recovered at a much higher rate than spring run released in-river, and ostensibly pose greater genetic risk to other Central Valley salmon populations. Additional information on the incidence of FRFH spring run Chinook salmon straying is desirable to more accurately estimate straying rates and potential hybridization issues.

3.5.6 Strategies to Reduce Ecological and Genetic Interactions

All FRFH produced spring run Chinook production will be released into the lower Feather River. This measure alone should significantly reduce the probability of FRFH spring run straying into other systems (Butte, Mill, Deer, Big Chico Creeks). All FRFH spring Chinook are 100% marked as defined in Standard 2 so it is possible to track FRFH strays in other systems.

Rigorous selection procedures will allow the FRFH to better separate spring and fall Chinook broodstock, further improving the genetic distinction between the two races. Genetic analysis will be conducted annually to better inform future broodstock selection with regard to both origin (hatchery vs. natural) and relatedness.

Egg culling procedures will further the separation of spring and fall run broodstock by eliminating the "tails" of each run at the hatchery.

The use of size assortative mating procedures, where feasible, should provide more "natural" mate pairings, thereby reducing unforeseen selection effects from standard hatchery practices.

4. WATER SOURCE

4.1 Water Source, Water Quality Profile, and Natural Limitations to Production Attributable to the Water Source

FRFH receives raw water from the Feather River at the Thermalito Diversion Dam and distributes it to the hatchery buildings and fish rearing areas. Overall raw water intake approximates 110 cfs. The raw water is gravity fed to an aeration tower where it is aerated and piped through the entire facility. Currently, more water is being gravity fed to the aeration tower than can be used. This is necessary to maintain sufficient water pressure. Thus, when the minimum discharge through the facility is estimated to be 40 cfs, approximately 69 cfs of aerated water is discharged directly back into the Feather River through the aeration overflow pipe. An estimated minimum 40 cfs and up to a maximum of 74 cfs is used. The Thermalito Annex, near the Thermalito Afterbay, uses about 12-17cfs of well water that has percolated through Thermalito Afterbay soils.

The FRFH has requested that DWR supply daily mean water temperatures during specific time periods (Table 4-1). However, as described previously temperatures provided to FRFH are expected to change with implementation of the FERC licensing requirements for the Oroville Facilities.

Table 4-1. Current range of suitable water temperatures required for fish production at FRFH.

Time Period	Daily Mean (Range ±4°F)
September	52 (48-56)
October - November	51 (47-55)
December – March	55 (51-59)
April – May 15	51 (47-55)
May 16 – May 31	55 (51-59)
June 1 – June 15	56 (52-60)
June 16 – August 15	60 (56-64)
August 16 – August 31	60 (54-62)

Studies indicate that average quality of the water entering the FRFH has been quite good, with no constituents that are likely to adversely impact cold water fish culture or human health (DWR 2004d).

The discharge of FRFH effluent is by percolation back to the Feather River from a large settling pond. Currently, much of this water re-enters the Feather River through a river side channel adjacent to FRFH called “Hatchery Ditch”. Quality of the discharge water is regulated by NPDES permit number CA0004570 issued by the California Regional Water Quality Control Board. The permit regulates the discharge of constituents identified in Table 4-2. Discharged water has consistently met these requirements. The Thermalito Annex is regulated under a separate permit (NPDES CA0082350).

Table 4-2. FRFH discharge effluent limitations.

Parameter	Units	Effluent Limitations: Average Monthly	Maximum Daily	Instantaneous Minimum	Instantaneous Maximum
Flow[1]	mgd	--	47.3	--	--
pH	standard units	--	--	6.0	9.0
Total Suspended Solids[2]	mg/L	5	15	--	--
	lbs/day[3]	1,972	5,917	--	--
Settleable Solids[2,4]	ml/L	0.1	0.2	--	--
Copper (Total Recoverable)	µg/L	1.99	4.0	--	--
Formaldehyde	mg/L	0.1	--	--	--
Chloride	mg/L	106	--	--	--

[1]*Total of PND-001, PND-002 and EFF-003.*
[2]*Effluent limitations are net values (increase over source water).*
[3]*Based on a design flow of 47.3 mgd.*
[4]*Applicable to D001, D002 and D003 only.*

4.2 Measures to Minimize the Likelihood for the Take of Listed Natural Fish as a Result of Hatchery Water Withdrawal, Screening, or Effluent Discharge

Water used at FRFH and FRFH annex comes from sources that do not involve ESA issues. The Thermalito Diversion Pool and the Thermalito Afterbay are above fish barriers and no listed species are affected by water intake. As previously described, the effluent discharge is located within critical habitat of Central Valley steelhead and Central Valley spring-run Chinook salmon. However, under current operation FRFH meets federal and state discharge requirements and water quality standards. Since there are no plans to increase the level of operations at FRFH, or alter current hatchery water withdrawal and discharge methods, it is anticipated that current operations will continue to minimize the take or result in no take of listed natural fish.

4.3 Water Withdrawal and Screening

The Thermalito Diversion Dam Powerplant is a hydroelectric power plant located below the left abutment of the Thermalito Diversion Dam. Water flows through the power plant (or spills over the diversion dam) into the Feather River to maintain fish habitat between the Fish Barrier Dam and the Thermalito Afterbay Outlet. The FRFH water comes from a subsurface intake pipe located in the Thermalito Diversion Dam. No fish screening is present on this intake, but due to its location no special status species are impacted.

4.4 Effluent Discharge

An estimated minimum 40 cfs and up to a maximum of 74 cfs of flow-through wastewater discharges to two settling basins (approximately 300 feet long by 30 feet wide and 15 feet deep) located near an embankment on the Feather River. The two settling basins are constructed with overflow pipes, which are capable of discharging directly to the Feather River (Figure 4-1) (discharge locations D001 and D002). However, no direct discharges have occurred from D001 or D002 since completion of the settling basins in 1984 because the basins are constructed in permeable gravels resulting in the percolation of wastewater through the settling basins into the Feather River via seepage. A main sump collects water from a majority of the facility, including eight of the ten rearing raceways, the rearing channel, and the hatchery buildings. Wastewater collected in the main sump is pumped (from the hatchery building) or gravity fed (from the raceways and rearing channel) into the two settling basins. If the main sump pumps are overwhelmed or fail, this wastewater will directly discharge to the Feather River via the sump overflow pipe (Figure 4-1, D003). Wastewater from the holding tanks adjacent to the Main Hatchery Building also discharges directly to the sump over flow pipe. Wastewater from the two newer raceways located on the western portion of the facility discharges directly to Settling Basin 002.

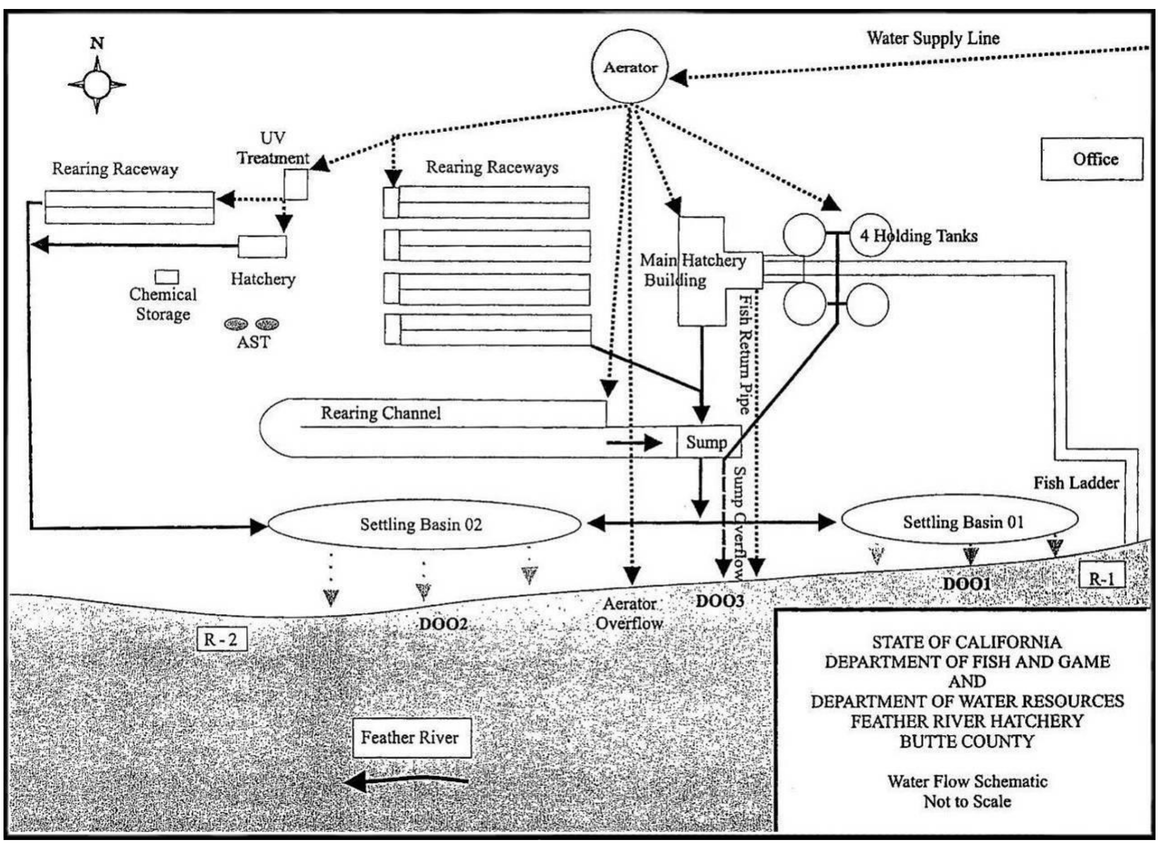

Figure 4-1. FRFH water distribution and discharge

FRFH has several raw water discharge points: the aerator overflow pipe; the fish ladder and gathering tank; the four holding tanks adjacent to the Main Hatchery Building; and, a fish return pipe located in the floor of the spawning room in the Main Hatchery Building. In order to pipe water to the two newer rearing raceways constructed on the western portion of the facility property, overall raw water intake flow to FRFH increased to approximately 110 cfs. The raw water is gravity fed to an aeration tower where it is aerated and piped through the entire facility. Currently, more water is being gravity fed to the aeration tower than can be used. When the minimum discharge through FRFH is estimated to be 40 cfs, approximately 69 cfs of aerated water is discharged directly back into the Feather River through the aeration overflow pipe. This discharge consists strictly of aerated water and contains no chemicals or hatchery wastes. When the fish ladder is in use during the migration and spawning season, raw water from the fish ladder, a gathering tank and four holding tanks located adjacent to the Main Hatchery Building, discharges directly to the Feather River. These direct discharges contain minimal quantities of fish fecal material, but no chemicals or unconsumed fish food is present, as the fish are not fed or treated in these locations.

5. DESCRIPTION OF THE FACILITY

5.1 Broodstock Collection Facilities and Methods

All upstream migrating Chinook salmon and steelhead are stopped at the Fish Barrier Dam (Figure 5-1). A 1/3-mile long gated fish ladder at the base of the dam allows fish to move up to the hatchery. The ladder gates are generally open from about September 15 through the following June to ensure that spring- and fall-run Chinook salmon and steelhead have an opportunity to enter the hatchery.

5.1.1 Fish Barrier Dam

The Feather River Fish Barrier Dam is downstream of the Thermalito Diversion Dam and immediately upstream of the FRFH. Flow over the dam maintains fish habitat in the low-flow channel of the Feather River between the Fish Barrier Dam and the Thermalito Afterbay Outlet. The dam diverts fish into a fish ladder that leads to the FRFH. The Fish Barrier Dam is constructed of concrete, 600 feet wide, with a maximum height of 91 feet (from base of dam to tallest abutment).

Figure 5-1. Fish Barrier Dam, fish ladder entrance is located to the bottom left, off picture.

The Fish Barrier Dam diverts fish into a ladder (Figure 5-2) that leads to the hatchery. The fish ladder is approximately 1/3-mile long and consists of a series of "steps" and pools. Pool length ranges from 8 – 1,000 feet, with a minimum width of six feet and a minimum water depth of two feet. Velocity of flow in the ladder ranges from two to five feet per second (fps), and the maximum drop between pools is one foot. Underwater passage of fish can be observed through 42-inch square viewing panels installed in the fish ladder wall.

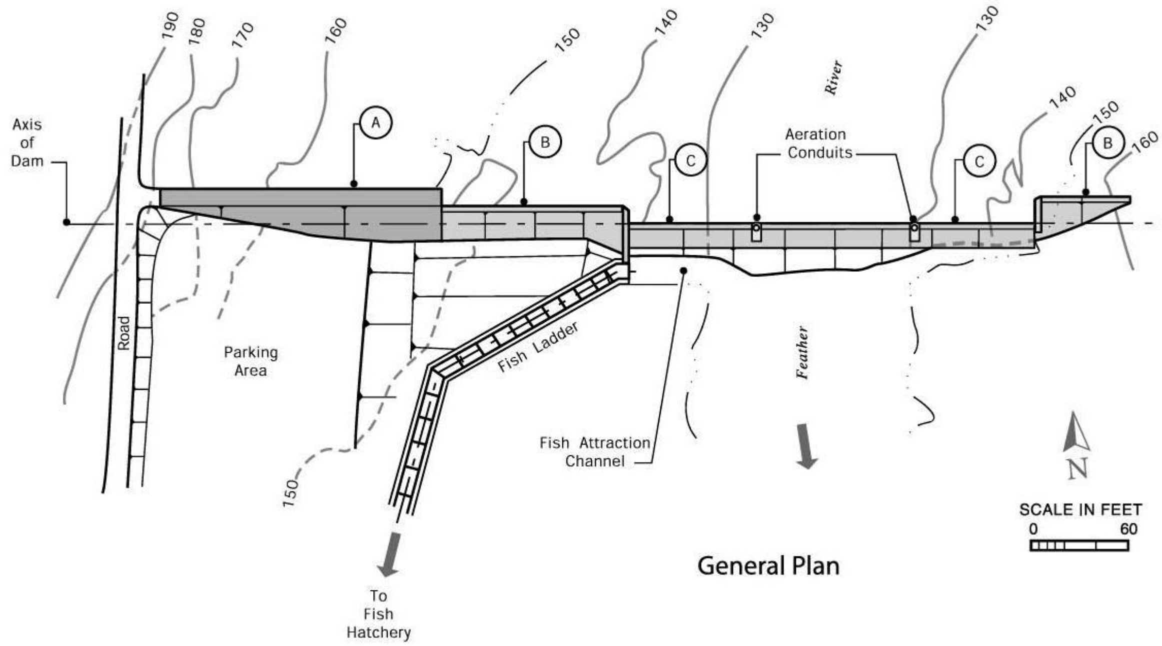

Figure 5-2. Schematic view of Fish Barrier Dam in relation to the fish ladder.

An enlarged section of the fish ladder at its upstream terminus functions as a gathering tank, entrapping fish ascending the ladder. A mechanical sweep gathers the fish and deposits them into the abutting spawning building. Four concrete circular tanks hold the fish until they are ready to spawn.5.1.2 FRFH Main Facility

The FRFH Main Facility consists of an office and maintenance building, two hatchery buildings, ten concrete raceways, one concrete rearing channel, a gathering tank, four holding tanks, an aeration tower, an ultraviolet treatment building, several storage sheds, and the fish ladder (Figures 5-3 and 5-4).

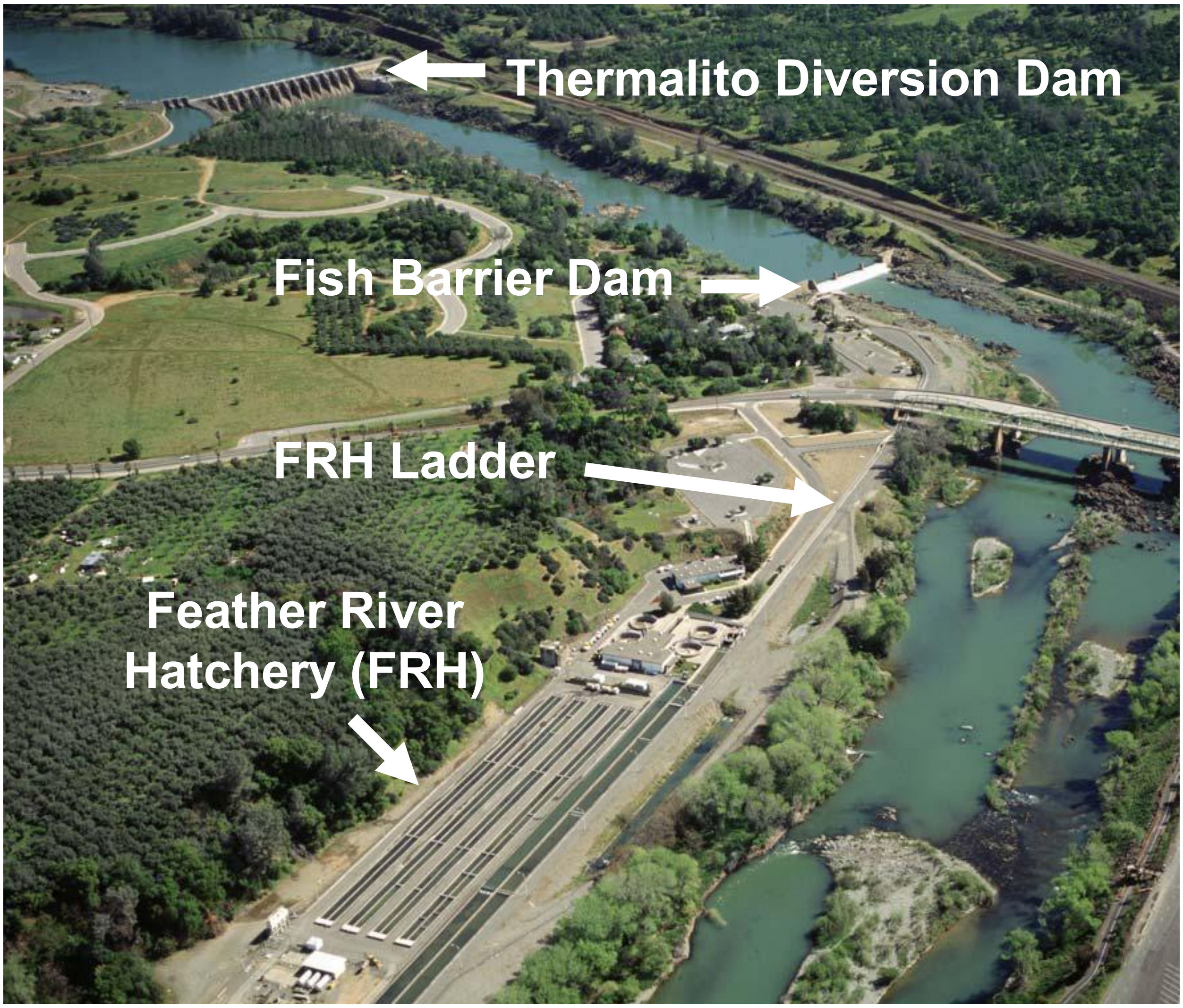

Figure 5-3. Aerial photograph of FRFH main facility and related features.

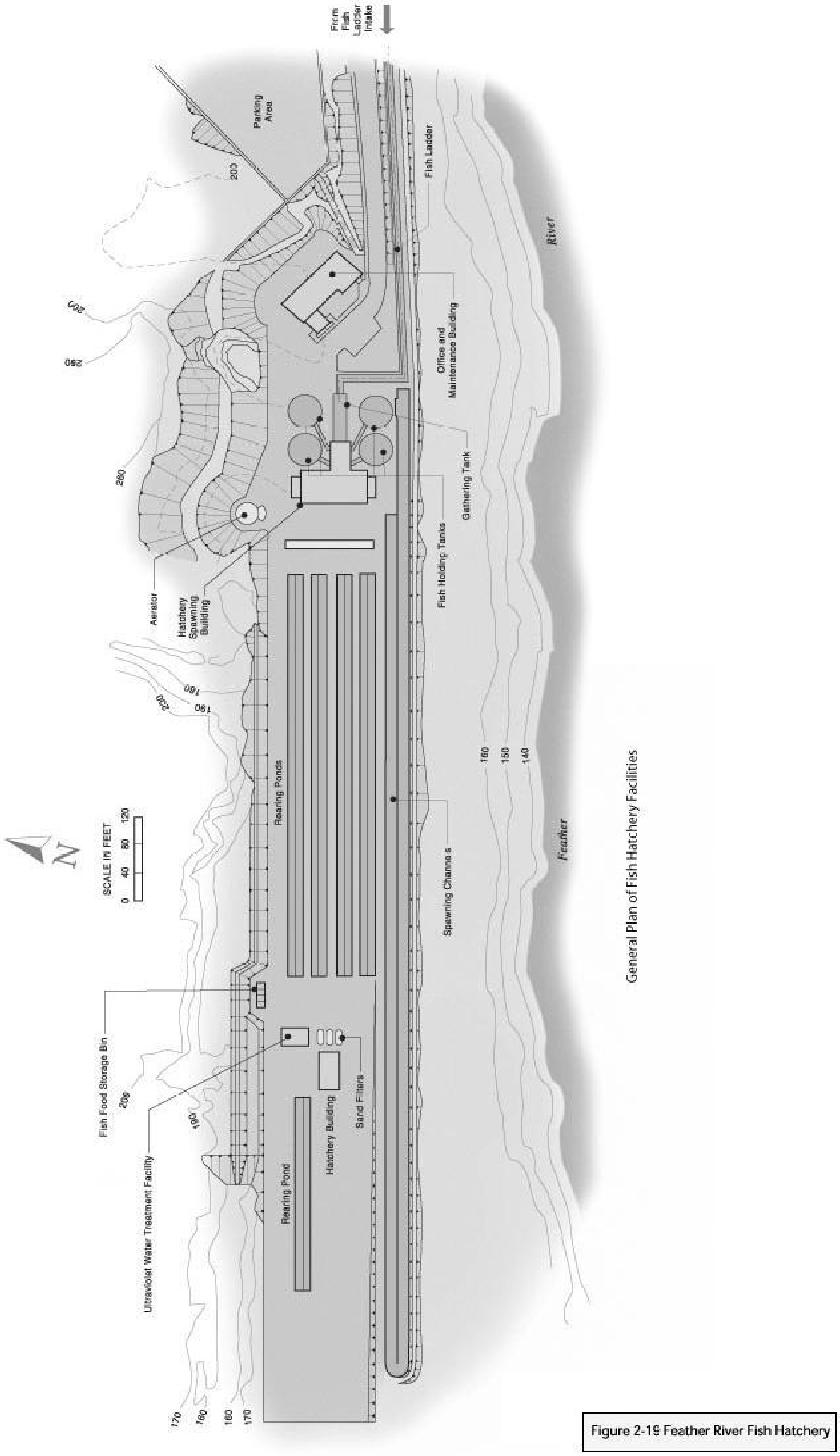

Figure 5-4. Schematic of main FRFH facility.

5.1.3 FRFH Thermalito Annex

The FRFH Thermalito Annex (Annex) is located outside of the Feather River downstream from the FRFH on the west side of the Thermalito Afterbay (Figure 1-1 and 5-5). The Annex provides additional rearing capacity for 2.5 million fingerling salmon and warmer rearing water temperatures has allowed fish to be transferred to the Annex for faster growth, or to control diseases (IHNV in particular). After growth had been achieved, or disease problems eliminated, the fish may be returned to FRFH. As of 1993, the practice of moving fish back and forth had been mostly discontinued and the Annex is being used almost exclusively for rearing mitigation and enhancement fall-run Chinook salmon and inland fish for Lake Oroville, CA (Kastner, DFG, personal communication).

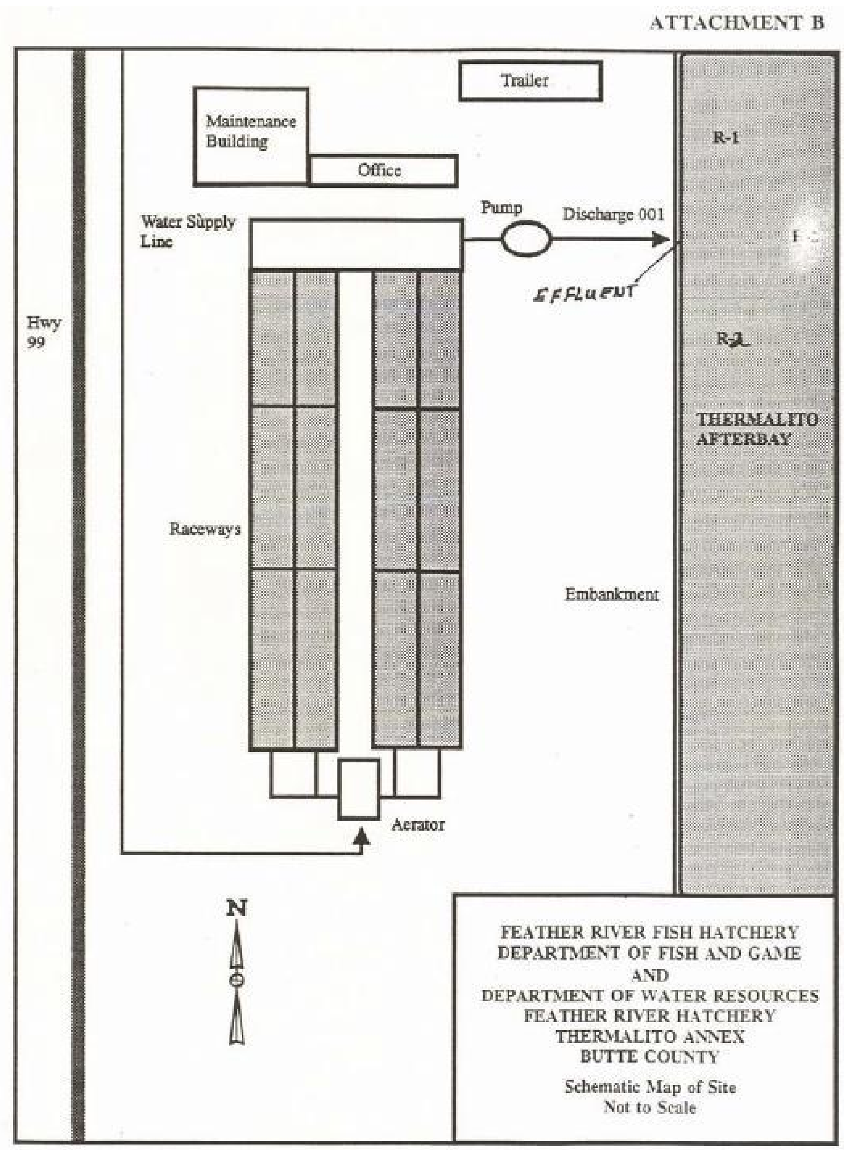

Figure 5-5. Schematic of the Thermalito Annex to FRFH.

6. BROODSTOCK ORIGIN AND IDENTITY

6.1 Hatchery Broodstock Source

The spring- run Chinook salmon broodstock for the FRFH is adult phenotypic spring-run Chinook salmon trapped and externally tagged at FRFH during the period April through June, and released and recovered at the hatchery during the fall spawning period.

6.2 Supporting Information

Historic information on spring-run Chinook salmon is lacking. Yoshiyama et al. (2001) described the historic and present distribution of Chinook salmon in the Feather River while more recent information can be found in a variety of published papers, DWR reports and FRFH annual reports (described below).

6.2.1 History

Spring-run Chinook salmon broodstock for FRFH originated from fish trapped from the Feather River. From 1967 to 2003, spring-run Chinook salmon were identified by the date adult fish entered the hatchery and were artificially spawned at the hatchery. For example, fish entering the hatchery by September 15th and spawned before October 7th would be identified as spring-run Chinook salmon while fish spawned on or after October 7th were identified as fall-run Chinook salmon. Since 2004, spring-run Chinook salmon have been identified as phenotypic spring-run Chinook salmon trapped and tagged at the FRFH between May 1 and June 30 with the exception of 2008, when trapping and tagging was extended to July 15.

6.2.2 Annual Run Size

Records of the historical size of the spring-run Chinook salmon run in the Feather River are lacking, although anecdotal information reported by Yoshiyama et al (2001) suggests the run may have numbered in the many thousands. Fry (1961) reported run-size estimates for the spring-run Chinook salmon during the period 1940–1959 to be about 1,000 to 4,000 fish. During the first fifteen years of FRFH operation, less than 750 spring-run Chinook salmon were annually trapped. During the period 1982 through 2008, an average of 3,500 (range 1,058 – 8,762) spring-run Chinook salmon were annually trapped (Figure 6-1).

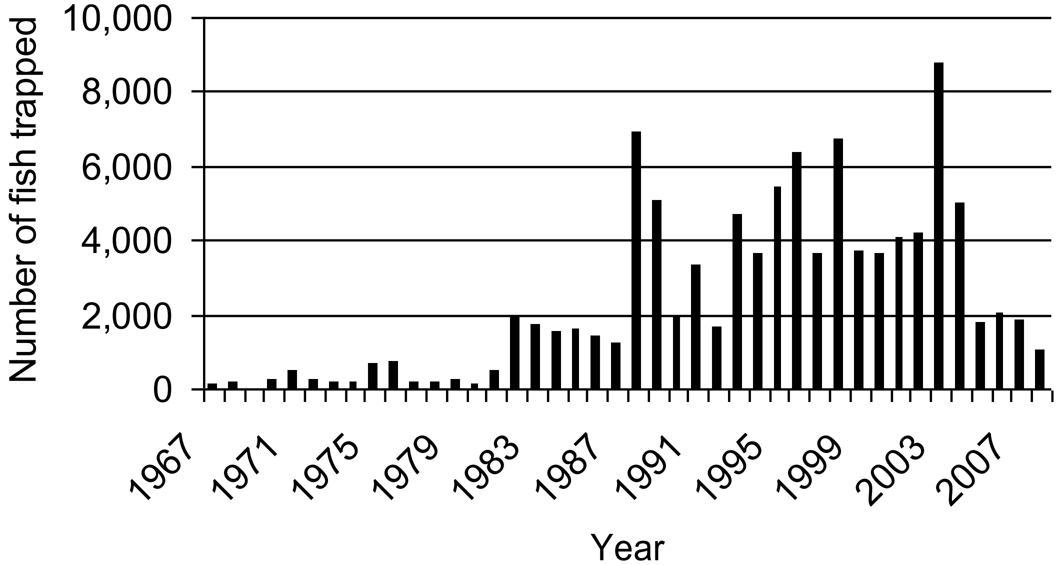

Figure 6-1. Number of adult Chinook salmon reported trapped at Feather River Hatchery, 1967 through 2008 (DFG FRFH annual reports).

6.2.3 Past and Proposed Level of Natural Fish in Broodstock.

The composition of wild origin fish in the FRFH spring-run broodstock is unknown. However, beginning in 2002, FRFH has attempted to adipose fin clip and CWT all spring-run Chinook salmon smolts produced and released. As such, starting in 2005 any unmarked spring run Chinook salmon trapped during the spring should be of natural origin. However, since a large portion (75%) of hatchery-produced fall-run Chinook salmon are not marked and an unknown number of the unmarked fish trapped in the spring may be early arriving fall-run fish, the percentage of natural origin spring-run Chinook salmon remains unknown (Figure 6-4).

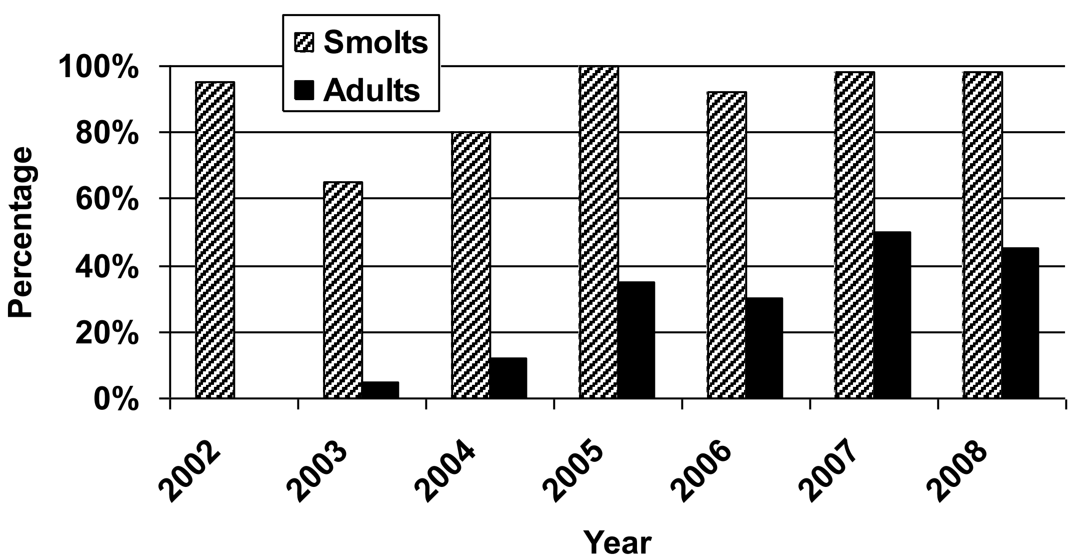

Figure 6-4. Percentage of FRFH produced spring-run Chinook salmon marked and percentage of adult spring-run Chinook salmon with adipose fin clip.

Recent data collected at FRFH suggests the majority of FRFH broodstock (>75%) are of hatchery origin (DWR, unpublished data).

6.2.4 Genetic or Ecological Differences

Limited information is available describing or documenting genetic or ecological differences between hatchery and natural origin spring-run Chinook salmon in the Feather River. Feather River spring-run Chinook salmon have been described as being genetically most similar to Central Valley fall-run (Banks et al 2000). More recently, O'Malley et al. (2007) reported significant evidence for two genetically distinct migratory runs in the Feather River using the circadian rhythm gene, and also reported the fall and threatened spring-runs were genetically homogenous based on neutral microsatellite data.

6.2.5 Reasons for Choosing Broodstock

The spring-run Chinook salmon broodstock originated from Feather River stock and is presumed to be representative of remaining Feather River spring-run Chinook salmon populations.

6.3 Measures to Minimize the Likelihood for Adverse Genetic or Ecological Effects to Listed Natural Fish that May Occur as a Result of Broodstock Selection Practices

In addition to maintaining best hatchery practices (as defined by HSRG),two measures will be implemented to minimize adverse genetic or ecological effect to listed fish as a result of broodstock selection. First, only early running, phenotypic spring-run Chinook salmon trapped and externally tagged at FRFH during the spring will be used as spring-run Chinook salmon broodstock. Second, genetic samples will be taken from phenotypic spring-run Chinook salmon tagged and tested for evidence of introgression from other runs.

7. BROODSTOCK COLLECTION

7.1 Life History Stage to be Collected (Adults, Eggs, or Juveniles)

Adult spring-run Chinook salmon collected from the Feather River will be used as broodstock.

7.2 Collection or Sampling Design and Identity

During the past ten years, FRFH has artificially spawned 7,835 female spring-run Chinook salmon and collected 42,053,422 eggs (Table 7-1). Based on historical numbers, approximately 750 pairs of spring-run Chinook salmon are required to meet egg take goals.

Table 7-1. Number of female spring-run Chinook salmon and eggs taken at Feather River Hatchery, 1998 through 2008 broodyears (data from FRFH annual reports).

Broodyear	Females	Number of Eggs [1]
1998	942	4,208,151 (4,467)
1999	891	4,920,286 (5,522)
2000	403	2,159,017 (5,357)
2001	971	5,826,002 (6,000)
2002	401	2,270,770 (5,663)
2003	534	3,044,529 (5,701)
2004	1,209	7,118,383 (5,888)
2005	803	4,010,060 (4,994)
2006	590	2,710,077 (4,593)
2007	701	3,485,040 (4,972)
2008	390	2,301,107 (5,900)
	7,835	42,053,422 (5,369)

[1] Number in parenthesis is mean number of eggs per female.

Adult spring-run Chinook salmon will be trapped from the Feather River for broodstock as follows:

1. The FRFH fish ladder will be open during the months of May and June to collect phenotypic spring-run Chinook salmon for broodstock.
2. All phenotypic spring-run Chinook salmon trapped during the May and June period will be examined for marks and tags, and other pertinent information will be recorded.
3. Each fish trapped will be tagged with two (2) sequentially numbered colored external Hallprint dart tags placed under dorsal fin (or other tag deemed appropriate by DWR and DFG). The same color will be used annually for each trapping period.
4. The number of recaptured fish and tag numbers for any mortalities will be recorded.
5. All tagged spring-run Chinook will be immediately released back to the Feather River in the vicinity of the FRFH.
6. The fish ladder will remain open until June 30 and on that date or immediately after a barrier will be installed at the bottom of the fish ladder to prevent additional fish from entering the ladder. The remaining fish in the ladder will be allowed two weeks to ascend the ladder for tagging. Fish that do not move up the ladder into the hatchery will be crowded back into the river and released or crowded up to the spawning building for processing. At that time the ladder will be dewatered and cleaned.
7. The ladder will re-opened on or near September 15 of each year to allow fish enter to the hatchery for sorting and artificial spawning. Consistent with hatchery physical constraints and water quality, all returning fish will be allowed free access to the hatchery after that date.

In the event conditions develop creating potential for unacceptable fish loss, free access may be temporarily curtailed.

8. Spring-run salmon will be paired 1 male: 1 female with individuals paired with similar-sized mates per Standard 8.
9. Up to 2% of the broodstock will be comprised of grilse. A higher percentage of grilse may be included as broodstock if adult male fish are not available during spawning.
10. If the FRFH manager determines that the number of male spring-run Chinook salmon is inadequate during artificial spawning, one male may be used to fertilize more than one female.

7.3 Numbers Collected

Conservation goals as described above are for an annual take of up to 1500 adults leading to the production and release of no more than 2.5 million smolts. Since 1999, FRFH has annually spawned an average of 784 females (Figure 7-1). Typically more males are reported spawned than females. An estimated 750 female spring-run Chinook salmon are required to meet FRFH spring-run Chinook salmon conservation goals (data from FRFH annual reports).

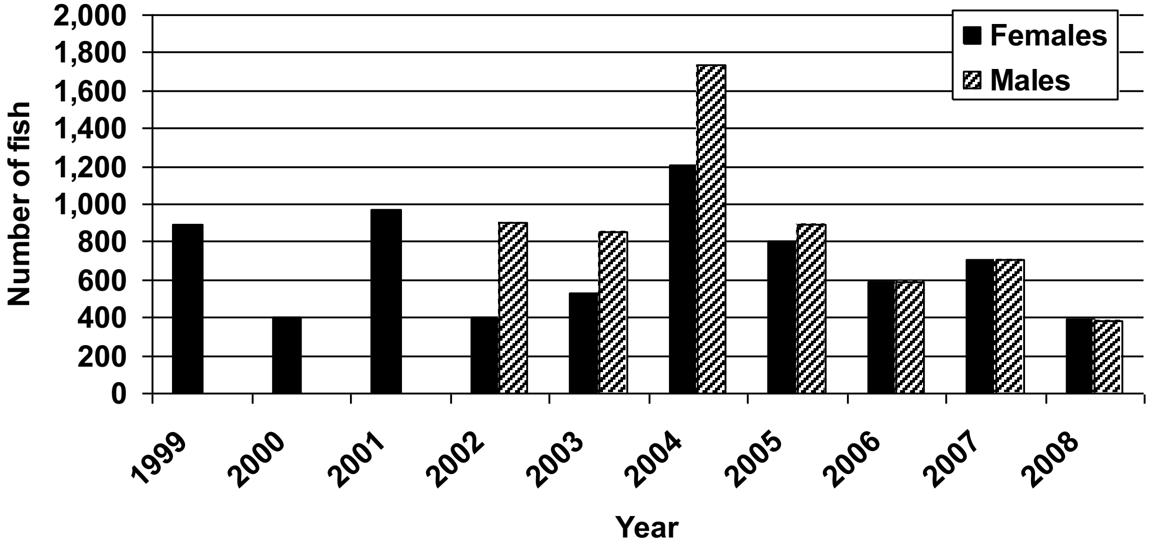

Figure 7-1. Number of male and females spring-run Chinook salmon used as broodstock at FRFH, 1999 through 2008, number of males not available 1999 - 2001 (data from FRFH annual reports).

7.4 Disposition of Hatchery-origin Fish Collected in Surplus of Broodstock Needs

All spring-run Chinook salmon trapped at FRFH after re-opening the ladder in September for broodstock collection are spawned or not spawned as described in Standard 1. During the fall spawning period, spring-run with an intact adipose fin can be returned to the Feather River to spawn naturally if crowding (within the hatchery) is a problem or if broodstock collection needs have been met (Standard 1). Adipose clipped Chinook salmon are not returned to the river and fish that are not sexually mature are retained in the adult holding ponds. All adipose clipped adult and grilse Chinook salmon in excess of those needed for conservation purposes/broodstock collection (including for San Joaquin River restoration) are euthanized and processed as described in Section 7.7 (below).

7.5 Adult Fish Transportation and Holding Methods

No adult Chinook salmon are transported to or from FRFH. All adult Chinook salmon held at the FRFH are retained in one of the adult holding ponds.

7.6 Fish Health Maintenance and Sanitation Procedures

No chemicals or therapeutics are used during the spawning process. All equipment used during spawning activities is routinely washed with clean, fresh water. Once the eggs have been fertilized, eggs are immersed for 1 hour in a 100 ppm PVP-Iodine (10% Povidone-Iodine Complex Solution) to treat for pathogens. PVP-Iodine is effective against a broad spectrum of disease-causing microorganisms, and is used to kill on contact a wide variety of bacteria, viruses, fungi, protozoa, and yeasts.

7.7 Disposition of Carcasses

All Chinook salmon carcasses and eggs collected by FRFH personnel are processed in one of two ways. Carcasses suitable for human consumption are turned over in approximately equal proportions to the California Emergency Food Link who contracts with a fish processing company that processes the carcasses into food, or the Oroville-area Native American tribe. Carcasses and eggs not suitable for human consumption are disposed of through contract with a processing/rendering company.

7.8 Measures Applied to Minimize the Likelihood for Adverse Genetic or Ecological Effects to Listed Natural Fish Resulting from the Broodstock Collection Program

Actions to reduce ecological or genetic effects on natural listed fish from the broodstock collection program include:

1. Spring-run Chinook salmon broodstock trapping and tagging is conducted at a time when phenotypic spring-run Chinook salmon are present in the Feather River and when other listed fish presence is minimal.
2. No out of basin spring-run Chinook salmon are transferred to FRFH.
3. Only phenotypic spring-run Chinook salmon that enter the FRFH fish ladder or lower Feather River in the spring are trapped and tagged for broodstock to minimize contact with other listed fish.
4. All spring-run Chinook salmon trapped for broodstock during the spring are tagged with an external tag for later identification.
5. Tissue samples will be collected and analyzed to genetically identify the composition of Feather River spring-run Chinook broodstock.
6. After the springtime period of spring-run Chinook salmon broodstock collection, the FRFH fish ladder is closed for cleaning and to minimize contact with other listed fish.
7. The FRFH fish ladder is not reopened until September 15 to minimize contact with other listed fish.

8. MATING

8.1 Selection Method

Only fish trapped and externally tagged at FRFH between April and June will be used for spring-run Chinook salmon broodstock. Only fish that are sexually mature and demonstrate free flowing eggs are spawned. Mating is accomplished using one female and one male, although one male may fertilize multiple females when numbers of male fish are insufficient to meet conservation goals. Grilse do not comprise more than 2% of the male fish artificially spawned unless additional grilse are needed when numbers of male fish are insufficient to help meet production needs for conservation goals.

8.2 Males

Only male fish with free flowing milt are used for artificial spawning.

8.3 Egg Collection and Fertilization

Spring run are transferred from a holding tank to a separate tank where they are anesthetized using CO_2 gas released into the water. After anesthetization, the fish are placed on a sorting table and examined by hatchery personnel for the degree of sexual maturation. Sexually immature fish are returned to the holding tank and Chinook salmon that expel free flowing eggs or milt are euthanized with a pneumatic knife inserted into the spinal cord posterior to the head or a single forceful blow to the cranium. Eggs are collected with the incision method described by Leitritz and Lewis (1976). The ventral wall of the abdominal cavity of each female Chinook salmon is slit open with a Wyoming style knife and eggs allowed to freely flow into a metal spawning pan. The eggs from a single female Chinook salmon are fertilized by combining the sperm expressed from a single male by stroking the male fish's vent area. Flaccid eggs are measured and directly placed into an incubator tray containing approximately 30 ppm iodine for about 30 minutes. Two ounces of eggs are taken from each female (up to 100 oz) and water hardened, this provides an expansion factor that is applied to females spawned that day. Once placed in incubator trays eggs are left alone for 30 days, but receive daily iodine treatments of 23ml iodine per vertical incubator stack.

8.4 Cryopreserved Gametes

No Chinook salmon eggs or sperm are preserved at FRFH.

8.5 Measures Applied to Minimize the Likelihood for Adverse Genetic or Ecological Effects to Listed Natural Fish Resulting from the Mating Scheme

Actions to minimize any adverse genetic or ecologic effects to listed natural fish include:

1. Only phenotypic spring-run Chinook salmon tagged during the springtime are mated together.
2. Hatchery personnel will select fish for mating based on size assortative mating to ensure similar sized males and females are mated together.
3. Only one male and one female are mated together unless enough male fish are not available during spawning to ensure 1:1 mating.
4. No more than 2% of the male fish used for mating are grilse unless adequate numbers of adult male fish are not available.

9. INCUBATION AND REARING

9.1 Incubation

Green eggs develop into eyed eggs after an average of 513 Daily Temperatures Units (range of 490-550 DTU). In approximately 30 days, hatchery personnel examine the eggs. If two eyes are present and the DTUs are near 513, the eggs are addled. After 24 hours, dead eggs are removed, the eggs re-measured, and 100 ounces of eggs are placed in each incubator tray. At this point eggs are checked daily, dead eggs removed, and the iodine treatment stopped. All eggs taken and fertilized on a single day are identified as an egg lot and assigned a lot number, starting with the number 1.

9.1.1 Number of Eggs Taken and Survival Rates to Eye-up and/or Ponding

Total number of eggs taken is summarized in FRFH annual reports and in previous sections of this HGMP (Table 7.1). From available data, survival to hatching at FRFH averages 72%, but survival rates have been as high as 85% in recent years.

9.1.2 Cause For, and Disposition of, Surplus Egg Takes

Surplus eggs are not intentionally taken at FRFH. However, egg lots subsequently determined not necessary to help meet conservation requirements (Standard 1) are disposed of under the following protocol:

- **Spring run Chinook identified by a Hallprint tag.** Eggs collected in excess of egg take goals will be culled in reverse chronological order (latest to earliest). For example, eggs collected in mid-October will be culled before eggs collected in early October.

All culled eggs are disposed of through a rendering company.

9.1.3 Loading Densities Applied During Incubation

All eggs are held in vertical stacked incubator trays. The maximum loading density for each vertical tray is 150 ounces, but typically each tray is loaded with only 100 flaccid ounces (with 1.2 to 1.5 expansion factor). All eggs incubated in trays remain until nearly all alevins have absorbed their yolk sack. Fry are transferred directly to rearing ponds (raceways).

9.1.4 Incubation Conditions

Fresh water is circulated through incubation trays at water temperatures averaging 55°F (±4) during the incubation period. Iodine is flushed through incubators on a daily basis to reduce disease and egg mortality.

9.1.5 Ponding (Tanks)

Chinook salmon fry are placed directly from the incubators into raceways where they remain until ready for release.

9.1.6 Fish Health Maintenance and Monitoring

Health inspection data for infectious hematopoietic necrosis virus (IHNV) and the bacteria *Renibacterium salmoninarum* is collected from ovarian fluid of returning adult females annually during artificial spawning.

Fish health is monitored by the DFG Fish Health Laboratory personnel during times of increased fish mortality. Diagnostic procedures for pathogen detection follow American Fisheries Society professional standards as described in Thoesen (1994). Treatments are recommended or prescribed by a DFG Fish Pathologist/Veterinarian as appropriate, and follow-up examinations are performed as needed.

9.1.7 Indicate Measures Applied to Minimize the Likelihood for Adverse Genetic and Ecological Effects to Listed Fish during Incubation

Actions taken to minimize adverse genetic and ecological effects to listed fish during incubation include:

1. Hatchery personnel routinely monitor egg incubators to ensure equipment is operating properly and egg mortality is minimized.
2. Water quality and quantity are routinely monitored by hatchery personnel to ensure egg mortality is minimized.
3. Iodine treatments are conducted daily to reduce or eliminate infection and pathogens during incubation.
4. Eggs are not moved during incubation to ensure high survival rates and eliminate any change or mixing of eggs.
5. Fish pathologists are maintained on DFG staff and are available for fish health inspections and treatments.

9.2 Rearing

9.2.1 Survival Rate Data (Average Program Performance) by Hatchery Life Stage (Fry to Fingerling; Fingerling to Smolt) for the Most Recent 10 Years, or for Years Dependable Data are Available

The sampling method for estimating the number of eggs collected, the number of eyed eggs, and the number of smolts planted is accurate; however there is error in determining the number of fingerlings ponded. This leads to inaccurate survival estimates from eyed eggs to fingerling and fingerling to smolt. Survival estimates for theses life stages are not reported, because many of the estimates were greater than 100%. In order to monitor survival in the future, it is essential to improve the methods for enumerating fry.

The estimates of survival between different life stages of FRFH spring-run Chinook is listed in Table 9.1. The mean survival from egg collection to planted smolt for brood years 2002 through 2009 is 69%. In the last four years total survival has improved and if that trend continues collecting 3 million eggs would yield approximately 2.5 million smolts.

Table 9.1. Survival rates by hatchery life stage from 2002 to 2009.

Brood Year	Collected to Eyed Egg	Total Survival
2002	73%	64%
2003	69%	62%
2004	59%	54%
2005	66%	45%
2006	83%	77%
2007	85%	77%
2008	n/a	n/a
2009	85%	78%

9.2.2 Density and Loading Criteria (Goals and Actual Levels)

The conservation goal is to annually release up to 2.25 million spring-run Chinook salmon smolts (no more than 2.5 million). To reach this goal raceways can be filled to a maximum capacity of 1.25 million fish per raceway, although densities may be reduced to encourage growth and reduce crowding.

9.2.3 Fish Rearing Conditions

Spring-run Chinook salmon are reared in concrete lined raised raceways described in section 4. The volume and flow rate of raceways can be varied by adjusting the flow rate and dam boards and the end of each raceway section.

9.2.4 Biweekly or Monthly Fish Growth Information (Average Program Performance), Including Length, Weight, and Condition Factor Data Collected During Rearing, if Available

Fish growth information is not available but is collected by hatchery personnel to help adjust feed size and amount during rearing.

9.2.5 Monthly Fish Growth Rate and Energy Reserve Data (Average Program Performance), if Available

Juvenile spring-run Chinook salmon growth varies but juvenile fish typically reach a size of 60 to 90 per pound by mid-May (Figure 9-2).

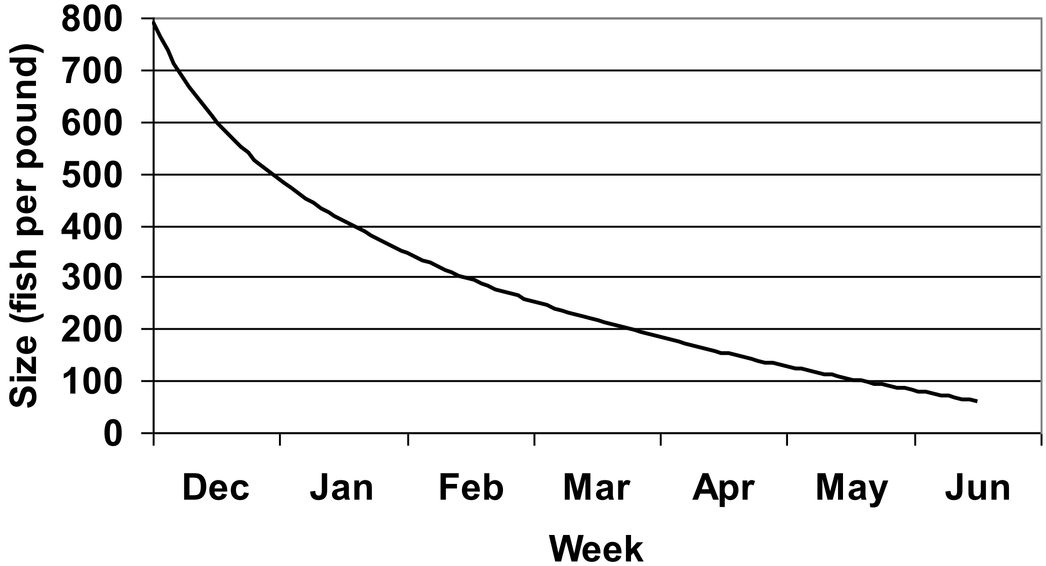

Figure 9-2. Projected growth rate of spring-run Chinook salmon.

9.2.6 Food Type Used, Daily Application Schedule, Feeding Rate Range (E.G. % B.W./day and lbs/gpm Inflow), and Estimates of Total Food Conversion Efficiency During Rearing (Average Program Performance)

Once the Chinook salmon alevins have absorbed their yolk sac they are placed on dry food manufactured by Bio-Oregon Inc. Fry are fed up to 12 times per day and the ideal amount of food per fish is 3% of their total body weight. Fish in the raceways are fed using a blower mounted feeder driven past the raceways. The amount of food fed is dependent on fish body weight, number of fish, general appetite, and feeding amounts and times are calculated weekly. Feeding is monitored closely to ensure a high conversion rate with little or no food wastage.

9.2.7 Fish Health Monitoring, Disease Treatment, and Sanitation Procedures

As described in Section 8.1.6., fish health is routinely monitored by the DFG Fish Health Laboratory personnel. Raceways are cleaned two to three times per week.

9.2.8 Smolt Development Indices (e.g., Gill ATPase Activity), if Applicable

No formal methods are used to indicate smolt development. However, visual indications such as “silvery” appearance and loosening of the scales are used as indicators of smolting.

9.2.9 Use of Natural Rearing Methods as Applied in the Program

No natural rearing methods are used at FRFH.

9.2.10 Measures Applied to Minimize the Likelihood for Adverse Genetic and Ecological Effects to Listed Fish under Propagation

Actions taken to minimize adverse genetic or ecological affects to listed natural fish under propagation include:

1. The best hatchery practices (as defined by HSRG) for propagation of listed salmonids are implemented and FRFH personnel are provided training as needed or required.
2. Eggs from spring-run Chinook salmon broodstock are identified and kept in incubators separate from fall run Chinook salmon.

3. Water quality during egg incubation and rearing is maintained at hatchery standards for rearing Chinook salmon.
4. Spring-run Chinook salmon groups are identified in rearing raceways and fish are not moved during rearing to ensure fish are not mixed.
5. Feeding schedules are monitored by hatchery personnel and adjusted weekly to ensure proper growth.
6. Efforts are made by hatchery personnel to reduce mortality of propagated fish at all life stages.
7. DFG fish pathologists are available for fish health inspections and treatments as needed.

10. RELEASE

10.1 Proposed Fish Release Levels

The FRFH conservation goal is to annually release up to 2.25 million spring-run Chinook salmon smolts (with a 10% buffer) at a minimum size of 60 fish per pound.

10.1.2 Specific Location(s) of Proposed Release(s)

All FRFH produced spring-run Chinook salmon are to be released at:

Boyd's Pump Launch Ramp, Feather River (river mile 22); Longitude 39.0698, Latitude -121.6060; South of Yuba City near the intersection of Oswald Road and the Garden Highway.

Alternative locations within the Feather River may be used for experimental groups to study the effects of release location on survival as described in Standard 4.

10.2 Actual Numbers and Sizes of Fish Released by Age Class through the Program

Since operation of FRFH began, over 51 million juvenile spring-run Chinook salmon have been released. During the past ten years, FRFH has released 21,078,159 spring-run Chinook salmon smolts at an average of 60 fish per pound and met the mitigation goal in 6 out of ten years (Figure 10-1).

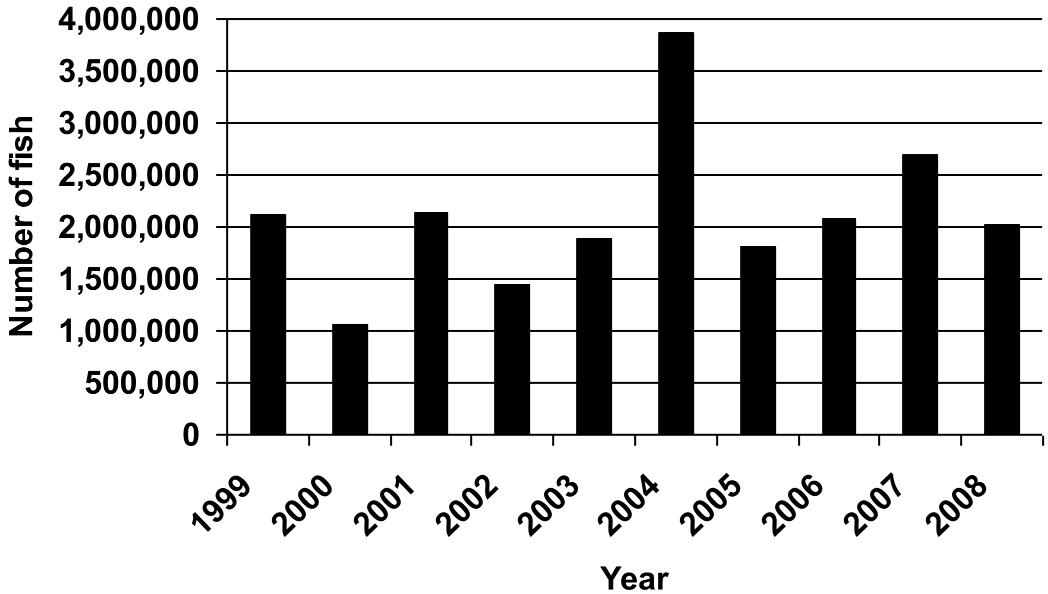

Figure 10-1. Number of juvenile spring-run Chinook salmon released from FRFH, 1999-2008.

10.3 Actual Dates of Release and Description of Release Protocols

Juvenile Chinook salmon are released as soon as possible after the fish reach an average size 60 per pound. Depending on water temperatures and growth rates, fish are typically released during April or May.

10.4 Fish Transportation Procedures

Juvenile Chinook salmon are transported to the release site using 2,800-gallon, 1,200-gallon, or 600-gallon fish transport tank trucks. Specific operations may come with each truck while Leitritz and Lewis (1976) described the general operation and maintenance of these trucks. The transport tank is filled with fresh water from the hatchery water supply and if necessary, the transport tank water may be chilled to cool the transport water to the recommended water temperature of 47 to 53^{o} F (Leitritz and Lewis 1976). Ice is not used to cool the water.

Fish transport tank trucks are typically loaded with fish at no more than one pound of fish per gallon of water. No salt is added to the water in fish transport trucks. Fish are transferred into the transport tank using Nielson fish pumps and an Aqua-Life Harvester Dewatering Tower.

10.5 Acclimation Procedures

Fish acclimation procedures prior to transportation and release follow guidelines provided by Leitritz and Lewis (1976). The fish transportation water is obtained from the same source as the rearing water and is maintained during transportation at recommend transportation temperatures to reduce rate of metabolism and oxygen uptake, and to improve survival. Hatchery personnel monitor the temperature of the release water at the time of release. Tempering the transportation tank water and release water is often recommended as a standard procedure however, smolts are not acclimated to river temperature before release.

Transportation time from the hatchery to the release site is typically less than 1 hour. Upon arrival at the release site, fish and water are released from the rear release gate of the fish transport tank truck directly into the water.

10.6 Marks Applied, and Proportions of the Total Hatchery Population Marked, to Identify Hatchery Adults

Since 2002 DWR has attempted to coded wire tag and adipose fin clipped 100% of spring-run Chinook salmon smolts produced and released. However, in 2003 less than 100% were marked. In 2004 all progeny from Hallprint tagged Chinook salmon were clipped and tagged, however a group of non-Hallprint tagged Chinook, spawned and defined as "late spring" were released at a mark rate of 18.6%. As described in Standard 2, a marking strategy targeted at achieving Program goals will be developed and approved by DWR, DFG and NOAA Fisheries.

In 2005, otolith thermal marking efforts were initiated at FRFH to identify origin (hatchery v. natural) of FRFH broodstock and race (fall v. spring) for hatchery origin Chinook salmon. Through scheduled manipulation of rearing water temperatures 100% of spring-run Chinook fry otoliths are "marked" with a pattern of dark and light bands.

10.7 Disposition Plans for Fish Identified at the Time of Release as Surplus to Programmed or Approved Levels

Juvenile spring-run Chinook produced by FRFH in excess of the numbers described in this HGMP will not be released into anadromous waters, except for juveniles needed for the San Joaquin River Restoration Program. If approved by the DFG Fisheries Branch Chief, the FERC Ecological Committee (established through the Oroville Facilities Settlement Agreement to weigh in on all aspects of the environmental actions codified in settlement), and related fishery regulators, surplus fish may be stocked into non-anadromous waters.

10.8 Fish Health Certification Procedures Applied Pre-release

Good hatchery management practices, including early detection and treatment of sick fish, will minimize the release of fish infected with pathogens. Although no formal fish health policy or process has been adopted by the FGC or DFG, a working policy to minimize the impact of diseases on fish, amphibians and aquatic invertebrates within California has been prepared by the DFG Fish Health Laboratory (FHL). Implementation of this working policy is achieved through:

1. Inspecting imported fish and aquatic species, or their gametes, obtained from other states and countries
2. Inspecting aquatic species raised in State, private and cooperative program hatcheries prior to approval for planting into public waters

3. Inspecting wild fish and aquatic species captured for transport to a different location
4. Inspecting wild fish and aquatic species to acquire information, useful for fishery management decisions, on the geographical distribution of pathogens
5. Recommending therapies and corrective measures, or stock destruction to minimize disease impacts

Fish health inspection reports are prepared and maintained by personnel from the DFG FHL. The DFG FHL may issue Biosecurity guidelines for individual hatcheries, conduct fish health inspections prior to fish release, and take other actions as deemed necessary to minimize any risks as a result of FRFH fish releases.

10.9 Emergency Release Procedures in Response to Flooding or Water System Failure

If emergency release of juvenile Chinook salmon is required and several days time is available, all fish held at FRFH can be transferred to the Annex. If time is not available and it is necessary to release juvenile Chinook salmon immediately, the fish screen can be removed and the gate opened at the bottom of the rearing channel, and all dam boards removed beginning with the lowest boards first. This procedure will empty the rearing channel and all fish and water will be released directly to the Feather River.

10.10 Measures Applied to Minimize the Likelihood for Adverse Genetic and Ecological Effects to Listed Fish Resulting from Fish Releases

The following measures either have been or will be implemented to minimize adverse genetic and ecological effects to listed fish resulting from FRFH fish releases:

1. Only progeny from parents that meet broodstock guidelines established in this HGMP will be released
2. All of the spring-run Chinook salmon production will be released in the Feather River at locations identified in section 10.1.2 of this HGMP
3. All juvenile spring-run Chinook salmon will be release at a size, time, and following procedures described in sections 10.2 through 10.5 of this HGMP
4. All spring-run Chinook salmon produced at FRFH will be marked and/or tagged as described in section 10.6 of this HGMP prior to release
5. No juvenile spring-run Chinook salmon in excess of the numbers described for release in this HGMP will be released in any anadromous water except as described in Section 10.7 above
6. All formal and informal fish health policies and guidelines in Section 10.8 will be followed

11. MONITORING AND EVALUATION OF PERFORMANCEINDICATORS

11.1 Monitoring and evaluation of “Performance Indicators” presented in Section 1.10.

11.1.1 Describe plans and methods proposed to collect data necessary to respond to each “Performance Indicator” identified for the program.

Table 11.1 indicates the proposed monitoring plan for the performance indicators presented in section 1.10. Many of the activities are currently implemented at the FRFH. Study plans and other actions described in this HGMP not currently implemented will be completed within two years of approval of this HGMP by NMFS and will be approved by the FRFH HGMP technical team. This will be a subgroup of the Feather River Technical Team and will be chaired by DWR. The team will be comprised of representatives from DWR, DFG, NMFS and appropriate consultant staff and others deemed appropriate by the representatives.

11.1.2 Indicate whether funding, staffing, and other support logistics are available or committed to allow implementation of the monitoring and evaluation program.

The Department of Water Resources has approved a budget for the implementation of the monitoring and evaluation component of this program.

11.2 Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic and ecological effects to listed fish resulting from monitoring and evaluation activities.

Study plans will be developed and activities will be carried out with the overall purpose of the program in mind. Only FRFH spring Chinook will be used for monitoring and evaluation purposes. Experimental releases will be timed (whenever possible) to avoid significant interactions with naturally produced Chinook. The monitoring plans will be reviewed by CDFG and NMFS to ensure plans consider and minimize adverse genetic and ecological effects to listed fish.

Table 11.1. Monitoring plan for FRFH performance indicators.

#	Performance Standard	Performance Indicator	Monitoring Plan
1	Program will attempt to meet but not exceed production goals.	Up to 1500 adults are taken annually. Up to 2.5 million spring-run Chinook salmon smolts 60 per pound or larger are reared and released annually.	Collect accurate adult counts Enumerate production and determine average # of fish/lb for each lot
2	All (100%) hatchery-produced juvenile spring-run Chinook salmon are marked. Mark types may include coded wire tag with adipose fin clip, otolith thermal mark, genetic tag or any other tag deemed acceptable by DWR, NOAA Fisheries and DFG.	Consistency between hatchery annual reports and tagged fish release reports indicating that all spring-run Chinook juveniles have been marked with an acceptable tag as defined above.	Assess mark and tag success for a representative sample of spring run juveniles. Assess marking strategy to determine best short term and long term mark type and rate.
3	Minimize straying and related genetic introgression of hatchery origin spring-run Chinook salmon with out-of-basin natural origin spring-run Chinook. When possible, releases will occur at a time when the potential impacts of water pumping from state and federal facilities are reduced or absent.	All (100%) FRFH spring-run juvenile Chinook salmon will be released into the Feather River between the Fish Barrier Dam and the Sacramento River confluence. FRFH spring-run Chinook salmon compose less than 5% of the natural origin spawning population in each tributary evaluated.	Report numbers and location of release Using RMIS database calculate stray rates to out of basin tributaries and hatcheries and/or monitor straying with a non-lethal genetic methodology, PBT

4	Survival of FRFH spring-run Chinook salmon releases are maximized while minimizing adverse interactions with natural-origin salmonids.	Reported locations, dates, and sizes of juvenile FRFH spring-run Chinook salmon releases and rationale for how these releases are expected to maximize survival while minimizing adverse interactions. Evaluate the effectiveness of in-river release strategies to increase survival and promote rapid emigration including but not limited to release methods, release locations, release times, and effects of stream flows and water quality.	Report release data and rationale for how survival was maximized and adverse interactions minimized Compare survival of smolts between different combinations of release location and time. Where possible evaluate the effect of stream flow and water quality on survival
5	Spring-run Chinook salmon broodstock are collected in a manner that minimizes introgression with fall-run Chinook salmon, and also approximates the distribution in age and size of natural-origin fish.	Analysis and report demonstrating fall-run Chinook (as determined by marks, tags, otolith and or genetics) represent less than 5% of FRFH spring-run Chinook broodstock. Collect data on age and size of hatchery broodstock and natural in-river spawning phenotypic spring run.	Use CWT, otolith, or genetic “tag” data to determine the number of fall run in the spring run broodstock. Use scale, CWT, otolith, or genetic “tag” data to compare age and size distribution of hatchery and natural spawning Chinook.

6	The percentage of first generation hatchery fish used for broodstock spawning will be minimized to reduce domestication traits associated with hatchery practices. Although a proportion of <15% hatchery origin fish is desirable (Lindley 2007), the current stock composition is unknown but presumed to be predominately composed of hatchery-origin fish.	Collect data from fish counting weir (as described in the FERC Settlement Agreement and FERC BO) and other sources on the proportion of natural origin and hatchery origin fish among FRFH spring-run broodstock and among fish spawning in the Feather River. DWR will develop and implement a plan for increasing proportion of natural origin spring-run Chinook in the FRFH and naturally spawning broodstock. Annual reports showing increasing proportion of known natural-origin fish among the FRFH broodstock and naturally spawning spring-run Chinook salmon.	Use otolith analysis or genetic "tag" data to determine the proportion of natural and hatchery origin fish within the hatchery broodstock and the river. Investigate methods to selectively increase natural origin fish in the broodstock (i.e. segregation weir, trap and haul) Use otolith or genetic "tag" to determine if the proportion of natural and hatchery origin fish within the hatchery broodstock is increasing. Calculate PNI.
7	The FRFH adult spring-run Chinook salmon broodstock will be spawned to more closely mimic natural size assortative mating: each spawner will be paired with a similar-sized mate. Jacks will make up no more than 2% of males spawned unless necessary to meet conservation goals.	Report data indicating sex and fork length for mating pairs consistent with Standard 7. Collect data on number of males, females and jacks spawned consistent with Standard 7.	Analyze FL and sex of each brood pair for consistency with standard. Use data to calculate % Jacks in the broodstock.

8	Genetic composition of Feather River Chinook salmon will be consistent with HGMP goals.	Collection of genetic samples of Feather River spring-run and fall-run Chinook salmon is conducted annually. Reports describing genetic analyses indicate natural and hatchery-origin fish are genetically similar and shows increasing divergence between FRFH spring- and fall-run Chinook salmon.	Annually collect tissues from representative samples of hatchery and natural origin spring and fall run Contract with a lab to analyze genetic composition of natural and hatchery origin spring and fall run
9	All Chinook entering the FRFH fish ladder after September 1 are processed in a manner that minimizes pre-spawning mortality.	Date, fork length, sex, adipose clip status, presence of other tags or marks are reported for each pre-spawning mortality. Dates of ladder operations, dates of FRFH fish processing, and related number of fish spawned, culled, or returned to round tanks (for holding) is reported.	Describe holding and sorting techniques used to minimize mortality. Collect and report data Collect and report data

10	FRFH spring-run Chinook salmon eggs, fry, or juvenile fish in excess of production needs (as defined in Standard 1) are disposed of in a manner that 1) increases the separation of spring and fall run broodstock and 2) is consistent with DFG policies on egg culling and fish disposal.	Spawn date (lot#), number, and method of disposal of excess FRFH spring-run juvenile Chinook salmon eggs, fry, or juvenile fish. Excess eggs, fry or juvenile salmon are not released, placed, or planted into any anadromous waters.	Follow protocols for disposition of eggs, fry, or juvenile fish that emphasizes separation of spring and fall run spawning (latest egg takes for spring run culled first). Collect data and report fate of excess eggs, fry, or juvenile salmon
11	FRFH spring-run Chinook salmon program is operated in compliance with DFG fish health policies and guidelines.	Number of broodstock sampled for pathogens, types and frequencies of observed infections, treatments prescribed are reported in FRFH annual reports. Survival rates for: 1) egg to fry and, 2) fry to juvenile fish released reported in FRFH annual reports. Results of fish health examinations. Number of juveniles sampled and pathogens observed immediately prior to release reported in FRFH annual reports.	Collect and analyze samples of broodstock following DFG fish health policies and guidelines Measure survival for representative samples of eggs, fry and juveniles. Report results of fish health examinations Follow policies to assess and report fish health immediately prior to release

12	FRFH effluent complies with the conditions and water quality limitations identified in the current National Pollutant Discharge Elimination System (NPDES) permit.	Dates, locations and number of water samples collected. Samples analyzed and results reported. Sampling and results consistent with NDPES permit.	Collect and analyze water samples following protocols in NPDES permit. Assess results for consistency with NPDES criteria
13	FRFH spring-run Chinook salmon carcasses are disposed of in a manner identified in the HGMP, and comply with DFG and NMFS criteria.	Carcass disposal is consistent with DFG policy and numbers of fish and disposition methods are reported in FRFH annual reports.	Collect data and report number and method of carcass disposition. Assess consistency with DFG policies.
14	Information on FRFH operations will be collected, reviewed and reported in a consistent and scientifically-rigorous manner, and available for public distribution at a time determined by the Feather River Technical Team.	Annual reports are prepared following DFG administrative report format (Appendix C) and made available for public distribution at a time determined by the Feather River Technical Team.	Collect data and prepare reports following a timeline tbd by the FRTT. Seek review of the FRTT or EC to ensure the information is collected, reviewed, and reported in a consistent and scientifically-rigorous manner.

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