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Mid-Pacific Region

Draft Nimbus Hatchery Steelhead Hatchery and Genetic Management Plan

U.S. Department of the Interior
Bureau of Reclamation
Central California Area Office
Folsom, California

March 2011

State of California
The Resources Agency
DEPARTMENT OF FISH AND GAME

Draft
Hatchery and Genetic Management Plan
Nimbus Fish Hatchery Winter Steelhead Program

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Hatchery and Genetic Management Plan
Nimbus Fish Hatchery Winter Steelhead Program [1]

By

Dennis P. Lee [2]

And

Jennifer Chilton[3]

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[1] Prepared by the California Department of Fish and Game under Contract 03CS200006 Modification 0004 with the U.S. Department of Interior, Bureau of Reclamation, Central California Area Office, 7794 Folsom Dam Road (CC-413), Folsom, CA 95630-1799,

[2] Supervising Fisheries Biologist (Retired Annuitant) Nimbus Fish Hatchery, North Central Region, 2001 Nimbus Road, Rancho Cordova, CA 95670

[3] Fish and Wildlife Scientific Aid (not currently employed), Nimbus Fish Hatchery, North Central Region, 2001 Nimbus Road, Rancho Cordova, CA 95670

Hatchery and Genetic Management Plan for the Nimbus Fish Hatchery Winter Steelhead Program

Hatchery Program	Nimbus Fish Hatchery Winter Steelhead
Species or Hatchery Stock	Steelhead (*Oncorhynchus mykiss*) (winter run)
Agency Operator	California Department of Fish and Game (Operator) United States Bureau of Reclamation (Contractor)
Watershed and Region	American River Sacramento River Drainage
Date Submitted	March 2011
Date Last Updated	

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List of Abbreviations

BOP	Biological and Conference Opinion
BY	Brood Year
CALFED	California (Water Policy Council) and Federal (Ecosystem Directorate)
CEQA	California Environmental Quality Act
CNFH	Coleman National Fish Hatchery
FGC	California Fish and Game Commission
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
IEP	Interagency Ecological Program
CWA	Clean Water Act
D-893	Decision 893
DSP	Delta Science Program
DFG	California Department of Fish and Game
Division	American River Division (of CVP)
DPC	Delta Protection Commission
DPS	Distinct Population Segment
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionary Significant Unit
FRH	Feather River Hatchery
HGMP	Hatchery and Genetic Management Plan
IEP	Interagency Ecological Program
NFH	Nimbus Fish Hatchery
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
OCAP	Operations, Criteria, and Plan (Bureau of Reclamation)
State	State of California
SWP	State Water Project
USFWS	United States Fish and Wildlife Service
VSP	Viable Salmonid Population
WQCB	Water Quality Control Board

Introduction

Section 7 of the Endangered Species Act (ESA), provides that federal agencies are obligated to consult with National Oceanic and Atmospheric Administration's (NOAA) 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 (July 10, 2000; 65 FR 42422) 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 (ESU's) (56 FR. 58613 1991, and 58 FR 17573 1993)).

The California Department of Fish and Game (DFG) operates and maintains Nimbus Fish Hatchery (NFH) under contract with the United States Department of the Interior, Bureau of Reclamation (Reclamation). Funding is provided to meet mitigation goals for the American River downstream from Folsom Dam (mitigation requirements as part of the American River Basin Development Act of October 14, 1949).

This HGMP for the NFH winter steelhead program describes hatchery operations and addresses impacts on anadromous salmonids listed under the ESA that are related to the production of fish required to meet the Bureau of Reclamation's mitigation goals contained in contract 03CS2000006 (Operations and Maintenance of Nimbus Fish Hatchery).

1. General Program Description

1.1 Name of hatchery or program

Nimbus Fish Hatchery (NFH)

1.2 Species and populations (or stock) under propagation and Endangered Species Act (ESA) status

Stock propagated: Steelhead *Oncorhynchus mykiss* (Walbaum 1792) NFH winter steelhead

The broodstock is a mixture of several stocks of which the Eel River winter steelhead genome is predominate.

ESA status: Not a part of the Central Valley steelhead Distinct Population Segment (DPS) and therefore not listed.

1.3 Responsible organization and individuals

NFH is operated by the DFG under contract with Reclamation.

Reclamation Contract Manager:

Michael R. Finnegan, Area Manager
Bureau of Reclamation Central California Area Office
7794 Folsom Dam Road (CC-413)
Folsom, CA 95630-1799,
(916) 988-1707
FAX (916) 989-7208
mfinnegan@usbr.gov

DFG Regional Manager:

Kent Smith, Regional Manager
1701 Nimbus Road
Rancho Cordova, CA 95670
(916) 358-2900
FAX: (916) 358-2912
ksmith@dfgt.ca.gov

Regional Hatcheries Supervisor:

Katherine Hill, Acting Senior Hatchery Supervisor
1701 Nimbus Road
Rancho Cordova, CA 95670
(916) 358-2935
FAX: (916) 358-2912
khill@dfg.ca.gov

NFH Manager:

Paula Hoover, Hatchery Manager II
2001 Nimbus Road
Rancho Cordova, CA 95670
(916) 358-2820
FAX: (916) 358-1466
phoover@dfg.ca.gov

NFH Assistant Manager

Bob Burks, Hatchery Manager I
2001 Nimbus Road
Rancho Cordova, CA 95670

(916) 358-2820
FAX: (916) 358-1466
NIMBUSFISH@dfg.ca.gov

1.4 Funding source, staff level, and annual program operational costs

NFH is operated by the CDFG and funded by Reclamation. NFH staff currently includes 11.5 permanent employees and the annual operating costs are approximately $1.4 million. Staff and operating costs include both the winter steelhead and fall Chinook salmon programs.

Position Title	Personnel Years
Hatchery Manager II	1
Hatchery Manager I	1
Fish and Wildlife Interpreter I	1
Fish and Wildlife Technician A/B	8
Office Technician –Typing	0.5

1.5 Location(s) of Hatchery and associated facilities

NFH is located adjacent to the American River approximately 15 miles east of the town of Sacramento, California, downstream from Nimbus Dam, at river mile 22 (kilometer 35.4) (Figure 1-1). The regional mark processing center code is 6FCSAAMN NBFH for NFH and 6FCSAAMN for the American River.

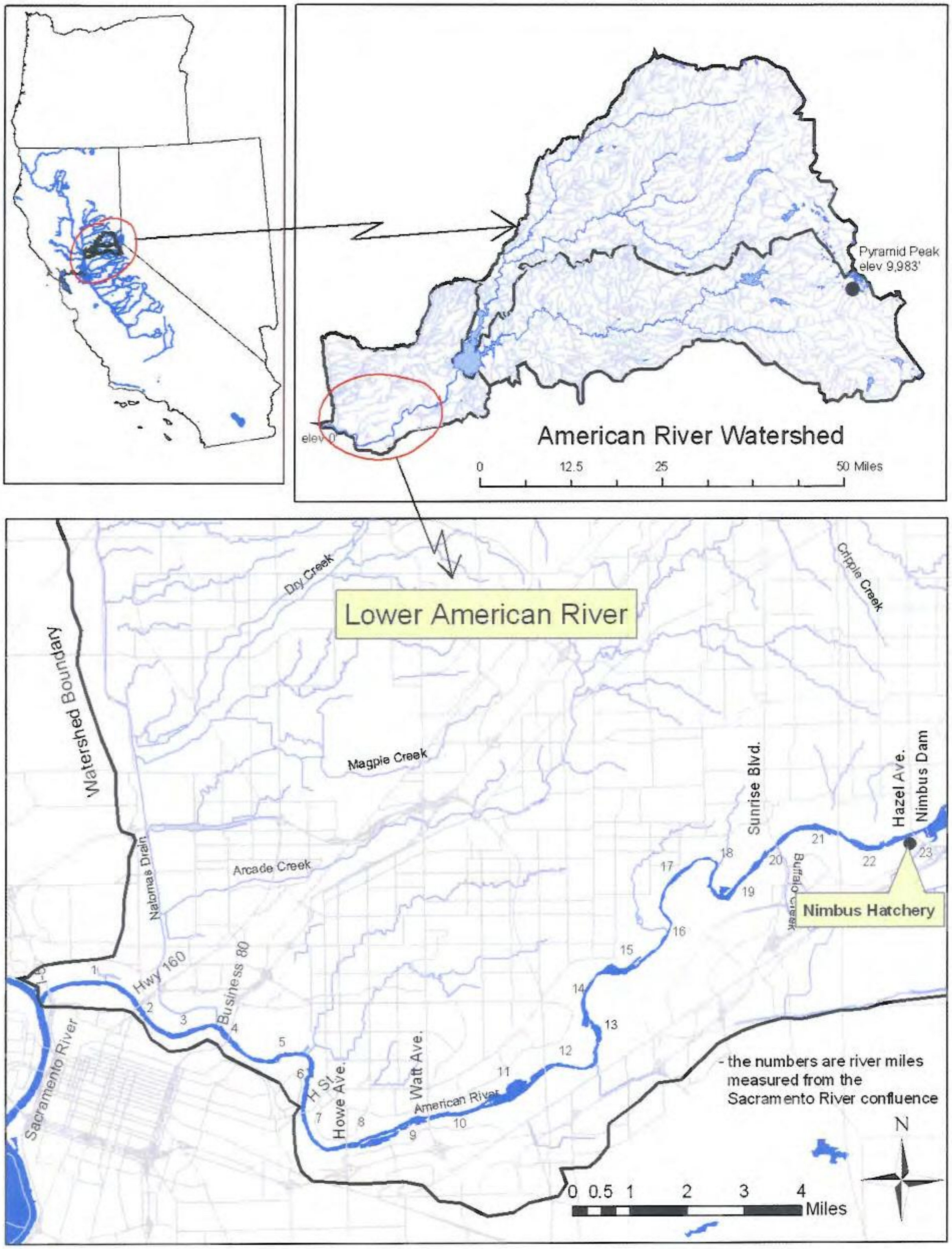


Figure 1-1. Nimbus Fish Hatchery location map.

NFH office location:

Longitude 121.225.4000 W, Latitude 38.633.6000 N

NFH office address:

Nimbus Fish Hatchery
California Department of Fish and Game, North Central Region
2001 Nimbus Road
Rancho Cordova, CA 95670

1.6 Type of program

The NFH steelhead program is an isolated-harvest program that propagates fish for recreational fishing opportunities and harvest. They are not produced to spawn in the wild or to be genetically integrated with any specific natural population.

1.7 Purpose (Goal) of program

The NFH winter steelhead program is conducted as mitigation to replace steelhead habitat eliminated by construction of Nimbus Dam. This is accomplished through the trapping and artificial spawning of adult steelhead, and the rearing and release of juvenile fish. Fish produced at NFH provide recreational fishing and harvest opportunities in the American River. Specific

1.8 Justification for the program

NFH is operated to help fulfill mitigation requirements for construction of Nimbus Dam as described in "Contract between the United States and the State of California for the Operation of the Nimbus Fish Hatchery" (Reclamation 1956). Artificially propagated fish are not intended to enhance or benefit survival of listed steelhead populations and program operations are conducted to minimize adverse effects on listed fish (integrated or isolated recovery programs).

The Central Valley Project (CVP) was originally conceived as a State project to protect the Central Valley from water shortages and floods. The CVP's priorities were flood control, improvement of navigation on Central Valley River, the development of hydroelectric power, irrigation, and municipal and industrial water supply, protection of the Sacramento-San Joaquin River Delta from seawater encroachment, and the protection and enhancement of fish and wildlife.

The American River Basin Development Act of October 19, 1949 created the American River Division (Division) of the CVP that consists of the Folsom and Auburn-Folsom South Units. Construction of Folsom Dam was completed in May 1956 and Nimbus Dam and Powerplant, located 6.8 river miles downstream from Folsom Dam, were completed in July 1955. Nimbus Dam re-regulates water released from Folsom Dam and diverts water into the Folsom South Canal.

Construction of Folsom and Nimbus dams eliminated steelhead access to all historical habitats in the American River. No estimates are available on the number of steelhead that historically migrated into the American River. At that time, steelhead runs in the upper Sacramento River (excluding the American and Feather rivers) were estimated to range from 14,000 to 26,000 fish annually (Hallock et al 1961).

Prior to construction of Folsom and Nimbus dams, the U.S. Fish and Wildlife Service (USFWS) had the responsibility of "preparing a plan of action for the conservation of salmon and steelhead affected by the construction of Nimbus Dam on the American River" (USFWS and DFG 1953). The plan concluded, "The need for a hatchery to mitigate for the construction of Folsom and Nimbus dams has been recognized for a long time" and the following eight recommendations were made:

1. A hatchery site be acquired,
2. A permanent fish rack be constructed,
3. Suitable initial water supply be developed,
4. A permanent water supply be provided,
5. An initial hatchery to handle fish eggs is constructed,
6. Consideration be given to testing an artificial spawning channel and stream improvements,
7. Reclamation construct a permanent hatchery, and
8. Reclamation and DFG enter into an agreement whereby DFG will operate the hatchery and Reclamation will pay for annual operating costs.

Based on these recommendations, NFH was constructed and placed into operation in 1955.

1.9 Species and population (or stock) under propagation, and Endangered Species Act (ESA) status

The NFH steelhead program traps and artificially spawns adipose fin marked (indicating hatchery origin) adult steelhead that seasonally enter the trapping facilities. Collected eggs are incubated at the hatchery and the resulting juvenile fish reared and released in the American River. The Broodstock is managed as distinct population and the originally broodstock was derived from several different founding populations and appears to cluster genetically with Eel River steelhead (NMFS 1998). Nielson et al (2005) reported that genetic analysis of the fish sampled for the American River and NFH indicated genetic similarity in microsatellite allelic frequencies. Garza and Pearse (2008) also reported similar results for fish sampled from the lower American River and NFH in spite of substantial heterogeneity within the fish sampled at the hatchery.

Steelhead reared at NFH are not listed, a candidate for listing, or a Species of Concern. Central Valley steelhead were listed as a federal threatened species on March 19, 1998; threatened status was reaffirmed on January 5, 2006. The DPS includes all naturally spawned anadromous O. mykiss (steelhead) populations below natural and manmade impassable barriers in the Sacramento and San Joaquin Rivers and their tributaries, excluding steelhead from San Francisco and San Pablo Bays and their tributaries, as well as two artificial propagation programs: the Coleman National Fish

Hatchery (CNFH), and Feather River Hatchery (FRH), steelhead programs. This definition includes steelhead naturally spawned in the American River downstream from Nimbus Dam but excludes steelhead propagated at NFH.

1.10 Program "Performance Standards"

"Program goals" are the purposes toward which an endeavor is directed. A program goal for a number of returning adult steelhead has not been established for NFH or the American River. Since the first year of operation, an average of 1,472 (range 51 - 5,155) adult steelhead has been annually trapped. Using the best available information, the estimated yearling to age 3 adult survival rate of NFH winter steelhead for 1999 through 2006 broodyears has averaged 0.85% (Table 1-1). The estimated in-river adult steelhead run has averaged slightly less than 3,400 fish annually during the same period (Table 1-1). Not included in these estimates are juvenile fish released and returning as age 2, age 4 or older adults, or fish that did not immigrate to the ocean or strayed in other rivers.

Slightly more than 1.7 million eggs are required to meet an annual goal of 430,000 yearling size fish for release. This estimate is based on a ten-year average of approximately 5,400 eggs per female fish spawned and an average 25% green egg to yearling size fish released rate. Approximately 320 females and commensurate number of male steelhead are required annually to produce this number of eggs. Any fish above this number are available to the sport fishery.

Table 1-1. Estimated percentage of yearling steelhead released from Nimbus Fish Hatchery returning to the American River, 1999 through 2006 broodyears.

Adult Spawning Year 1/	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	
Yearling steelhead brood year	1999	2000	2001	2002	2003	2004	2005	2006	Mean
Number of yearling size fish released	402,300	471,493	280,160	419,140	455,140	410,330	454,570	483,357	406,427
Estimated in-river steelhead spawning population 2/	300	343	330	266	300	150	50	50	224
Estimated number of natural origin steelhead in river spawning populations 3/	25	5	2	14	7	10	3	2	8
Estimated number of hatchery origin steelhead in-river spawning population	275	338	328	252	293	140	47	48	215
Total number of hatchery origin steelhead trapped	818	1,835	2,755	2,190	2,626	711	1,037	953	1,616
Total number of natural origin steelhead trapped at NFH	69	27	17	118	58	47	58	34	54
Total spawning escapement	4,162	4,347	4,320	3,995	3,266	1,096	1,145	1,037	2,921
Total estimated steelhead harvest 4/	462	483	480	443	363	122	731	706	474
Total estimated in-river run	4,624	4,830	4,800	4,438	3,629	1,218	1,876	1,743	3,395
Percent return 5/	1.15%	1.02%	1.71%	1.06%	0.80%	0.30%	0.41%	0.36%	0.85%

1/ Assumes all fish return as 3-year-old adult fish.

2/ USBR unpublished data

3/ Assumes same ratio of hatchery and naturally produced steelhead in river as trapped at NFH

4/ Assumes 10% harvest rate (Jackson 2007) and steelhead harvest reported by Titus (2008 and 2009).

5/ Number of marked adult/number of yearling fish release 2 years prior

"Performance Standards" are designed to help achieve program goals and are generally measurable, realistic, and time specific. Standards include indicators that help define and evaluate success towards the program goal

Standard 1: Program is operated to provide recreational fishing opportunities in the American River consistent with California sport fishing regulations and Fish and Game Commission policies.

> ***Indicator 1.1:*** Number of NFH produced adult steelhead meet recreational fishing objectives for the American River.

Standard 2: Program will attempt to meet but not exceed production and mitigation goals.

> ***Indicator 2.1***: 2.1 million steelhead eggs are taken annually.
>
> ***Indicator 2.2***: 1.8 million eyed eggs are produced annually (green to eyed egg survival meets 10 year average of 82%).
>
> ***Indicator 2.3***: 430,000 yearling-sized steelhead reared and released annually as a of NFH mitigation goals (eyed egg to juvenile release size meets 10 year average of 25%).

Standard 3: All (100%) hatchery-produced juvenile steelhead are adipose fin marked prior to release.

> ***Indicator 3.1***: Hatchery annual reports and marked fish release reports indicate that 100% of steelhead have been marked.

Standard 4: Minimize straying and related genetic introgression of hatchery origin steelhead with out-of-basin natural origin steelhead.

> ***Indicator 4.1***: All (100%) NFH juvenile steelhead are released into the American River.
>
> ***Indicator 4.2***: Adipose fin marked steelhead comprise less than 5% of the natural origin spawning population in Central Valley streams.

Standard 5: Survival of NFH steelhead releases minimizes adverse interactions with natural-origin salmonids.

> ***Indicator 5.1***: Juvenile fish are released when the highest proportion of fish demonstrate smolting characteristics.
>
> ***Indicator 5.2***: Location and date of juvenile NFH steelhead maximize survival while minimizing adverse interactions.

Indicator 5.3: In-river release strategies to increase survival and promote rapid emigration are evaluated and reported; and are not limited to transport methods, release methods, release locations, release times, and effects of stream flows and water quality.

Indicator 5.4: Juvenile fish are released at times that minimize adverse impacts to naturally produced fish.

Standard 6: Steelhead broodstock collection approximates the distribution in age and size of natural-origin American River steelhead.

Indicator 6.1: Data on age and size of hatchery broodstock is collected and reported in NFH annual or other appropriate reports.

Standard 7: Standard 7: All hatchery broodstock is derived from hatchery origin fish.

Indicator 7.1: Only hatchery origin (adipose fin marked adult steelhead) are used for broodstock and information on the mark status of broostock is collected and reported in NFH annual or other appropriate reports.

Indicator 7.2: Results reported in annual reports demonstrate attaining conditions of OCAP RPA II.6.2 and demonstrate a complete segregation of known natural-origin fish (adipose fin marked) fish in the NFH broodstock.

Standard 8: Steelhead broodstock mating protocols closely mimic natural size using selective mating practices (i.e. each adult fish will be paired with a similar-sized mate and fish <16 inches TL will not be included in the broodstock selection).

Indicator 8.1: Number and size of males and females spawned is reported in NFH annual reports and is consistent with Standard 7.

Standard 9: Genetic composition of the American River steelhead population is consistent with HGMP goals.

Indicator 9.1: Genetic samples of NFH steelhead are collected annually.

Indicator 9.2: Results of genetic analyses indicate NFH steelhead show similar levels of genetic diversity and inbreeding as natural spawning American River populations.

Standard 10: Steelhead trapped at NFH are processed in a manner that minimizes pre-spawning mortality.

Indicator 10.1: Mortality rate for adult steelhead is $\leq$1% of the total steelhead trapped.

Indicator 10.2: Date, fork length, sex, adipose clip status, presence of other tags or marks are reported for each pre-spawning mortality.

Indicator 10.3: All marked and unmarked steelhead trapped are returned to the river.

Indicator10.4: Annual dates of ladder operations, dates of NFH fish processing, and related number of fish spawned, culled, or returned to holding tanks are reported.

Standard 11: NFH steelhead eggs, fry, or juvenile fish in excess of production needs (as defined in Standard 1) are disposed of in a manner that is consistent with DFG policies on egg culling and fish disposal.

Indicator 11.1: Spawn date (lot number), number of eggs taken, and method of disposal of excess NFH steelhead eggs, fry, or juvenile fish.

Indicator 11.2: Excess eggs, fry or juvenile steelhead are not released, placed, or planted into any anadromous waters.

Standard 12: NFH steelhead program is operated in compliance with DFG fish health policies and guidelines.

Indicator 12.1: Number of broodstock sampled for pathogens, types and frequencies of observed infections, treatments prescribed are reported in NFH annual reports.

Indicator 12.2: Survival rates for egg to fry and, fry to juvenile fish released are reported in NFH annual reports and meet any standards established for NFH.

Indicator 12.3: Number of juvenile steelhead sampled and pathogens observed immediately prior to release meet DFG health standards.

Indicator 12.4: Results of fish health examinations are reported in NFH annual or other appropriate reports.

Standard 13: NFH effluent complies with the conditions and water quality limitations identified in the current National Pollutant Discharge Elimination System (NPDES) permit.

Indicator 13.1: Dates, locations and number of water samples collected.

Indicator 13.2: Samples analyzed and results reported.

Indicator 13.3: Sampling and results consistent with NDPES permit.

Standard 14: NFH steelhead carcasses are disposed of in a manner identified in the HGMP, and comply with DFG and NMFS criteria.

***Indicator 14.1**:* Carcass disposal is consistent with DFG policy and numbers of fish and disposition methods are reported in NFH annual reports.

Standard 15: Information on NFH operations is collected, reviewed and reported in a consistent and scientifically rigorous manner, and available for public distribution at a time determined by the NFH working group.

***Indicator 15.1**:* Annual reports are prepared following DFG administrative report format (Appendix 1) for public distribution within 12 months of the end of the cohort-spawning season.

1.10 Expected size of program

NFH personnel trap all steelhead that volitionally enter the fish ladder. From the adult steelhead trapped and artificially spawned, the program is expected to produce and release 430,000 yearling size fish in the American River.

1.11 Goal for number of returning fish

A goal for the number of returning adult steelhead has not been established for NFH. Since hatchery operations began in 1955, an annual average of 1,472 (range 51 - 5,155) adult steelhead has been trapped. During the past ten years, the in-river run has averaged slightly less that 3,400 fish annually.

1.12 Current program performance, including estimated smolt-to-adult survival rates, adult production levels, and escapement levels.

NFH personnel have met or exceeded releasing 430,000 yearling size fish during 5 of the past 10 years. During the past ten seasons, an average of 1,787 (range 758-2,877) adult steelhead have been trapped. During this later period, an average of 320 adult female steelhead have been artificially spawned each season to produce an average of 433,150 yearling size fish for release the following spring.

Using the best available information, the estimated return of yearling size fish released returning as age 3 adult fish for the 1999 through 2006 broodyears has averaged 0.85% (range 0.30% to 1.71%) (Table 1-1). Not included in these estimates are juvenile fish released and returning as age 2, age 4 or older adults, or fish that did not immigrate to the ocean or strayed in other rivers.

1.13 Date program started (years in operation), or is expected to start.

The NFH Steelhead Program began in 1955.

1.14 Expected duration of program

The NFH steelhead program is anticipated to continue as long as the Folsom

1.15 Watersheds targeted by program

Lower American River (mouth to Nimbus Dam)

1.16 Alternative actions considered for attaining program goals, and reasons why those actions are not being proposed.

No alternative actions are described for the NFH steelhead program for attaining current program goals due to the non-listed status of the current hatchery broodstock and limited salmonid rearing habitat in the American River.

Although future studies and actions have been described and recommended, the current management strategy to rear progeny of adipose fin marked (hatchery origin) adult steelhead trapped at NFH to yearling size and release them in a manner that minimizes adverse effects on listed species will continue. Alternative actions may be recommended and implemented from information gathered through future studies and included in the NFH HGMP.

2. Program Effects on NMFS ESA Listed Fish Populations

2.1 ESA permits or authorizations in hand for the hatchery program

NFH has ESA authorization for indirect take of listed steelhead at the fish ladder, and fish handling and release by hatchery staff, through June 2011. Authorization of take is through the Long-term Operations of the Central Valley Project and State Water Project biological opinion (NMFS 2009).

The DFG annually applies for and receives a permit for "Take Coverage for Anadromous Fish Research and Monitoring Activities Authorized under the Endangered Species Act 4(d) Rule Research Limit". This permit provides for the collection of listed species a part of fish health maintenance. All work is preformed by a DFG Fish Pathologist or entity working under contract for the DFG.

2.2 Descriptions, status, and projected take actions and levels for NMFS ESA-listed natural populations in the target area.

The target area is the American and Sacramento rivers and four listed fish species occur within the target area (Table 2-1). Williams (2006) reviewed information regarding salmon and steelhead that is relevant to the restoration or rehabilitation of Central Valley habitats and management of Central Valley rivers and the fish that they support.

Table 2-1. Common and scientific names and status of fish species listed by the U. S. Secretary of the Interior or the U. S. Secretary of Commerce and that occur within the target area defined for the NFH winter steelhead program.

Common name, ESU	Scientific name	Status
Chinook salmon, Winter-run	*Oncorhynchus tshawytscha*	Endangered
Chinook salmon, Spring-run	*Oncorhynchus tshawytscha*	Threatened
Steelhead, Central Valley	*Oncorhynchus mykiss*	Threatened
Green Sturgeon	*Acipenser medirostris*	Threatened

Winter-run Chinook salmon *Oncorhynchus tshawytscha*

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

Status: The Sacramento River winter 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. The productivity and abundance of the naturally spawning component of this ESU have exhibited marked 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.

ESU viability is assessed based on four Viable Salmon Population (VSP) criteria: abundance, productivity, spatial structure, and diversity. For this ESU, the 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 ESU is still "likely to become extinct within the foreseeable future."

Two artificial propagation programs are also part of the Sacramento River winter Chinook ESU. An artificial propagation program is continuing and a captive broodstock program for winter Chinook was carried out, both at the Livingston-Stone National Fish Hatchery (LVNFH) on the mainstem Sacramento River above Keswick Dam and at the University of California's Bodega Marine Laboratory. These programs (operated for conservation purposes since the early 1990s) were identified as high-priority recovery actions in the 1997 Draft Recovery Plan for this ESU. Because of increased escapement over the past several years, the captive broodstock programs have been terminated. An assessment of the effects of these artificial propagation programs on the viability of the ESU in total concluded that the programs decrease risk to some degree by contributing to increased ESU abundance and diversity, but have a neutral or uncertain effect on productivity and spatial structure. A second naturally spawning population is considered critical to the long-term viability of this ESU, and plans are under way (but not 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.

Date Listed: November 5, 1990; reclassified January 4, 1994; classification reaffirmed June 25, 2005

Legal Status: Endangered (reclassified from original listing as threatened)

Recovery Plan Status: A draft recovery plan for the Sacramento winter Chinook salmon ESU was issued in August 1997

Spring-run Chinook *salmon Oncorhynchus tshawytscha*

Description - The ESU includes all naturally spawned populations of spring-run Chinook salmon in the Sacramento River and its tributaries in California, including the Feather River, as well as the Feather River Hatchery spring-run Chinook program.

Status: The Central Valley (CV) spring-run Chinook salmon ESU has been reduced from an estimated 17 historical populations to only three extant natural populations with consistent spawning runs (on Mill, Deer, and Butte creeks, which are tributaries to the Sacramento River). These remaining natural populations reached low abundance levels during the late 1980s (67 to 243 spawners compared to a historic peak of about

700,000 spawners), and are within close geographic proximity, making them vulnerable to disease and catastrophic events. CV spring-run Chinook require cool water while they mature in freshwater over the summer. Summer water temperatures in the CV are suitable for Chinook salmon only above the 150 to 500 meter elevation. Most such habitat in the CV is now upstream of impassable dams. The upper Sacramento River supports a small spring-run population, but its status is poorly documented and the degree of hybridization with fall-run Chinook salmon is unknown. Of numerous Sierra Nevada stream populations only two remain – the Feather River and the Yuba River populations. The Feather River population is dependent on Feather River Hatchery (FRH) production (which is considered part of the ESU) but may have hybridized with fall-run Chinook. Production is offsite, which contributes to straying. The status of the Yuba River population is largely unknown, other than appearing to be small. An overall loss of diversity has resulted from the extirpation of spring-run populations in most of the CV, including all the San Joaquin tributaries.

The recent 5-year mean abundance for the three naturally spawning populations remains relatively small (500 to over 4,500 spawners); however, short- and long-term productivity trends are positive and population sizes have shown continued increases over the abundance levels of the 1980s. The BRT has noted moderately high risk for the VSP abundance, spatial structure, and diversity criteria, but a lower risk for productivity (reflecting the recent positive trends). Informed by this risk assessment, the strong majority opinion of the BRT is that the CV spring-run Chinook salmon ESU is "likely to become endangered within the foreseeable future." No artificially propagated populations of spring-run Chinook in this ESU mitigate the BRT assessment.

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

Legal Status: Threatened

Recovery Plan Status: A recovery plan has not been completed for this ESU.

California Central Valley *Steelhead Oncorhynchus mykiss*

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, and hatchery origin steelhead propagated at NFH.

Status: 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.

Steelhead above Red Bluff Diversion Dam (RBDD) constitutes a small population size and exhibit strongly negative trends in abundance and population growth rate. No escapement estimates have been made for the area above RBDD since the mid-1990s. A crude extrapolation from the incidental catch of out-migrating juvenile steelhead (captured in a midwater-trawl sampling program for juvenile Chinook salmon below the confluence of the Sacramento and San Joaquin rivers) estimated that, on average during 1998–2000, approximately 181,000 juvenile steelhead were naturally produced each year in the Central Valley by approximately 3,600 spawning female steelhead. Prior to 1850, there was 1 to 2 million spawners, and in the 1960s about 40,000 spawners. The 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.

Although steelhead appear to remain widely distributed in Sacramento River tributaries, the vast majority of historic spawning areas are currently located upstream of impassable dams.

Two artificial propagation programs are considered part of the CV steelhead DPS, CNFH, and FRH; both are located in the Sacramento River Basin and consist 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 Biological Review Teams 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."

Date Listed: March 19, 1998 (71 FR 834).

Legal Status: Threatened; classification reaffirmed January 5, 2006

Recovery Plan Status: A recovery plan has not been completed for Central Valley steelhead.

Green Sturgeon *Acipenser medirostris*

Description: Included in the listing is the green sturgeon population spawning in the Sacramento River and living in the Sacramento River, the Sacramento-San Joaquin Delta, and the San Francisco Bay Estuary.

Status: On April 7, 2006, the National Marine Fisheries Service (NMFS) issued a final rule listing the Southern DPS of North American green sturgeon as a threatened species under the United States Endangered Species Act. This threatened determination was based on the reduction of potential spawning habitat, the severe threats to the single remaining spawning population, the inability to alleviate these threats with the conservation measures in place, and the decrease in observed numbers of juvenile Southern DPS green sturgeon collected in the past two decades compared to those collected historically (NMFS 2006).

Date Listed: September 8, 2008 (50 FR 226)

Legal Status: Threatened

Recovery Plan Status: A Recovery Plan has not been completed for this species.

2.3 Hatchery activities, including associated monitoring, evaluation, and research programs that may lead to the take of NMFS listed fish in the target area, and provide estimated annual levels of take.

A fish weir is placed in the river to direct fall Chinook salmon into the hatchery and is removed in early December after the salmon run and prior to the period large numbers of steelhead enter the NFH fish ladder.

Adult steelhead from the American River volitionally enter the fish ladder and trap. A Smith Root Inc. Electro-anesthesia unit is used to immobilize the trapped fish. All steelhead trapped are sorted a minimum of once each week and morphological information and tissue samples collected. Hatchery personnel identify and record all marks and tags, and determine the sexual maturation of adipose fin marked steelhead. Sexually mature adipose fin marked steelhead are retained for artificial spawning.

As part of program activities, tissue and scale samples are collected from all unmarked fish and from a comparable sample of marked fish. After collection of samples, all unmarked and sexually immature steelhead, fish <16 inches TL, and spawned steelhead are marked with a hole punch in the lower caudal fin for identification and returned alive to the river.

An average of slight less than 3% of the adult steelhead trapped annually are unmarked (presumed natural-origin fish) and no take (mortality) of NMFS listed steelhead is anticipated due to trapping, sorting, sampling, or adult fish release activities. Since only non-listed steelhead are propagated at NFH, no take of NMFS listed fish is anticipated to occur during artificial spawning, incubation, rearing, or release activities.

3. Relationship of Program to Other Management Objectives

3.1 Alignment of the hatchery program with any ESU-wide hatchery plan or other regionally accepted policies. Explain any proposed deviations from the plan or policies.

DFG's salmonid restoration and enhancement goals for the Sacramento and San Joaquin river systems were outlined in The Central Valley Salmon and Steelhead Restoration and Enhancement Plan (DFG 1990) and Restoring Central Valley Streams: A Plan for Action (DFG 1993). Current NFH program activities have remained consistent with activities described in both plans.

McEwan and Jackson (1996) prepared a plan for restoration of California steelhead and reiterated goals that had been previously described in the Steelhead Restoration Plan for the American River (McEwan and Nelson 1991). The goals described for the American River were directed at naturally produced fish and not hatchery management.

Additional direction for steelhead management is provided by the California Legislature and the FGC through legislation and various policies. The Salmon, Steelhead Trout, and Anadromous Fisheries Program Act of 1998 was incorporated into Section 6902 of the Fish and Game Code as follows:

a) It is the policy of the state to significantly increase the natural production of salmon and steelhead trout by the end of this century. The DFG shall develop a plan and a program that strives to double the current natural production of salmon and steelhead trout resources.

b) It is the policy of the state to recognize and encourage the participation of the public in privately and publicly funded mitigation, restoration, and enhancement programs in order to protect and increase naturally spawning salmon and steelhead trout resources.

c) It is the policy of the state that existing natural salmon and steelhead trout habitat shall not be diminished further without offsetting the impacts of the lost habitat.

3.2 List all existing cooperative agreements, memoranda of understanding or agreement, other management plans, or court orders under which the program operates

- Contract No. 03CS200005 - Operation and Maintenance of Nimbus Fish Hatchery between Reclamation and the DFG:

This contract describes operations and maintenance for NFH.

- Formal Consultation on the Coordinated Operations of the Central Valley Project and State Water Project and the Operational Criteria and Plan (OCAP LAR 2004 and USFWS 2008):

In May 2008, Reclamation requested formal consultation with the Fish and Wildlife Service (USFWS) on the coordinated operations of the CVP and SWP in California. The USFWS conducted a comprehensive peer review of this biological opinion and formed an Internal Peer Review Team (IPRT), which consisted of individuals from throughout the Service who are experts in the development of complex biological opinions under the ESA. The USFWS also contracted with PBS&J, an environmental consulting firm, who formed an independent review team consisting of experts on aquatic ecology and fishery biology to conduct a concurrent review of the draft Effects Section of the biological opinion. The Service subsequently incorporated all comments and edits as appropriate into their biological opinion. A complete administrative record is on file at the Sacramento Fish and Wildlife Office (SFWO) and at:

http://www.fws.gov/sacramento/es/documents/SWP-CVP_OPs_BO_12-15_final_OCR.pdf

- NMFS Biological and Conference Opinion (NOAA 2009)

NMFS presented their biological and conference opinion (BOP) regarding Reclamation's long-term operations of the Central Valley Project (CVP) in coordination with the State Water Project (SWP) and their relation to the continued existence of listed anadromous fish species in the Central Valley.

As part of the BOP, NMFS recommended actions. Reclamation is pursuing study design and funding to support Action II.6.1.2 of the biological opinion with interagency and academic collaborators, and funding a genetic study of Central Valley steelhead. The study includes genetic analyses that will be useful in evaluating inbreeding and hybridization of NFH steelhead broodstock as well as gene flow among this hatchery and other Central Valley steelhead hatcheries. Additional proposals to support Action II.6.1.2 have been submitted to the Delta Science Program's (DSP) as either research grants or Delta Science Fellowships.

These proposals will support applied research on steelhead at NFH for evaluating gene flow, physiology, and life history diversity and theoretical research of NFH steelhead broodstock, evaluating incorporation of genetic objectives into the HGMP by modeling relative fitness, inbreeding, effective population size, and gene diversity in the population via life cycle modeling.

Additionally, Reclamation is working to develop a comprehensive study that would synthesize this information as well as undertake field research on NFH steelhead and American River *O. mykiss* for implementation of Action II.6.1.2.

3.3 Relationship to Harvest Objectives

NFH operation is not specifically directed towards fish harvest although the DFG has implied that the fish produced as part of any mitigation agreement are expected to provide recreational fishing opportunities and some fish will be harvested.
The FGC has authority for setting seasons and bag limits for ocean commercial and sport harvest within three miles of the California coast, and inland sport. California commercial and sport fishing regulations prohibit the taking of "steelhead rainbow trout" in the ocean. Presently, only hatchery origin adipose fin-clipped steelhead may be harvested from the American River (Title 14 California Code of Regulations).

From information provided in angler returns of Steelhead Report Cards, anglers were reported to have made an average of 3,542 trips annually to the American River during the three year period 2003-2005; and reported catching an average of 3,631 adult steelhead of which 2,160 (60%) were harvested annually (Jackson 2007). Included in the average annual catch were 382 (10.5%) adult steelhead identified as "wild".

Titus (2008 and 2009) reported that anglers reported releasing and keeping a combined 8,605 and 11,926 steelhead (rainbow trout ≥16 in TL) from the American River during the 2008-2009 and 2009-2010 seasons respectively (Table 2-1). These estimates are several times higher that the numbers reported from the Steelhead Report Cards during earlier seasons (Jackson 2007). In addition, the recent estimates include a very high number of fish reported caught by anglers that resulted in very high estimated catch rates. Catch rates for fish reported as "kept" were much lower and are likely more representative of the actual number of fish caught.

Table 3-1. Number of angler hours and steelhead reported caught from the American River, 2008-2009 and 2009-2010 seasons.

	Total angler hours 1/		No. steelhead reported caught 2/		No. steelhead kept		Catch per angler hour steelhead kept and released		Catch per angler hour steelhead kept	
River reach	2008-09 season 3/	2009-10 season	2008-09 Season	2009-10 season	2008-09 Season	2009-10 season	2008-09 Season	2009-10 season	2008-09 Season	2009-10 season
Discovery Park to Capitol City Freeway (Business 80) Bridge	31	248	358	2,105	0	0	11.55	8.49	0.000	0.000
Capitol City Freeway Bridge to Hazel Avenue Bridge.	37,913	46,522	4,621	8,702	323	568	0.12	0.19	0.009	0.012
Hazel Avenue Bridge to Nimbus Dam	31,845	24,814	3,626	1,119	242	138	0.11	0.05	0.008	0.006
Totals	69,789	71,584	8,605	11,926	565	706	0.12	0.17	0.008	0.010

1/ Includes anglers reporting targeting steelhead.

2/ Includes fish kept and reported released.

3/ Seasons extend from July 1 through June 30.

3.4 Relationship to habitat protection and recovery strategies

The American River watershed is characterized as having a moderate potential to support a viable steelhead population is assigned a Core 2 recovery focus for steelhead (NMFS 2009). The NFH steelhead program is managed to minimize affects to the recovery of CV steelhead DPS. The program is an isolated program, i.e., steelhead with intact adipose fins are not spawned with hatchery fish to prevent gene flow (introgression).

The program releases juvenile fish in the American River and at a time to encourage migration, discourage straying, and at a life stage that encourages rapid migration thereby minimizing predation on naturally produce salmonids. Adult hatchery steelhead that return to the American River are intended to provide recreational fishing opportunities and fish for harvest, and hatchery broodstock. All juvenile fish released from NFH are identified with an adipose fin mark, and all adult steelhead trapped at NFH are marked for identification prior to release. Management efforts identified in the

NFH steelhead program HGMP integrate recreational fishing and harvest objectives to protect and minimize risks to natural steelhead in the American River.

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. Individuals have been expressed views on the affects of hatchery fish on wild fish populations (Campton 1998 and Montgomery 2005). Some have reported ecological interactions and risks to wild populations (Nickelson et al. 1986, Chilcote 2003, Kostow et al. 2003, Kostow 2006, Kostow and Zhou 2006) and other have described genetic risks (Reisenbichler and McIntyre 1977, Weitkamp et al. 1995, Currens et al. 1997, Reisenbichler and Rubin 1999).

Adverse impacts are not necessarily inherent to hatchery programs and may be confused with ill-considered management goals, decisions, and other, unrelated factors (Campton 1995, Brannon et al. 2004). Hatcheries have been used to supplement natural populations, protect genetic resources, and provide for stream nutrient enrichment (Steward and Bjornn 1990; Cuenco et al. 1993). Some individuals feel that properly managed hatchery programs can provide for fisheries as well as mitigate for lost spawning habitat due to dams or supplement existing populations, while others doubt that this is the case (Waples 1999; Bilby et al. 2003).

Einum and Fleming (2001) reviewed the literature dealing with ecological interactions between wild and released salmonids and indicated fish reared in hatchery facilities may differ from their wild conspecifics for three reasons.

1. "Fish are highly phenotypically plastic and therefore their phenotypes may be shaped considerably by the rearing environment (e.g., Wootton 1994, Pakkasmaa 2000). The traditional way of rearing fish in hatcheries (i.e., high densities in flow-through tanks) shows little or no resemblance to natural rearing. In fact, most environmental characteristics that may influence fish development differ. This includes feeding regimes, density, substrate, exposure to predators, and interactions with conspecifics. It is not surprising that such differences can have substantial impacts on the resulting fish phenotype".

2. "Hatchery fish may differ from wild fish is that the intensity and direction of selection differs between the two environments. Perhaps most importantly, survival during egg and juvenile stages is substantially higher in the hatchery environment than in the wild (reviewed by Jonsson and Fleming 1993). This means that genotypes that potentially are eradicated in the wild, by predation or starvation, are artificially brought through the

vulnerable period of selection during early juvenile stages Elliott 1989, Einum and Fleming 2001). In theory, hatchery fish could also experience altered selection pressures. For example, the high juvenile density and abundance of food may select for behavioral and physiological traits that are disadvantageous in nature. The importance of such altered selection is unknown, but the intensity of selection may be limited due to the low levels of mortality. However, this may not necessarily be so, if traits such as body size attained in the hatchery are tightly linked to survival after release, a period of intense mortality among hatchery fish. Such genetic changes due to relaxed and/or altered selection are likely to accumulate in stocks being cultured over multiple generations (e.g., when brood stock is consistently chosen from adults originating from hatchery produced smolts). Multi-generation hatchery stocks are thus likely to differ more from wild fish than first generation stocks where most of the changes are likely to be of environmental origin."

3. "Hatchery fish may differ from wild fish is the use of non-native fish for stocking. Such procedures may introduce novel, genetically based characters into the wild population and break up co-adapted gene complexes that may lead to out breeding depression (e.g., Gharrett and Smoker 1991). Fortunately, the potential importance of local adaptations is being increasingly acknowledged (reviewed by Ricker 1972, Taylor 1991), and the practice of releasing non-native fish has therefore decreased in frequency."

3.5.1 Competition

Weber and Faush (2003) reported that competition between hatchery origin and wild salmonids in streams has frequently been described as an important negative ecological interaction, but differences in behavior, physiology, and morphology that potentially affect competitive ability have been studied more than direct tests of competition. They reviewed the differences reported, designs appropriate for testing different hypotheses about competition, and tests of competition reported in the literature.

Natural origin steelhead in California typically leave freshwater as one or two year old fish during periods of high stream flows mainly in the spring. McMichael et al. (1997 and 1998) investigated the effects of non-migrant (residual), juvenile hatchery steelhead on growth of wild rainbow trout and juvenile spring Chinook salmon. Their results suggested that there might be adverse effects on wild rainbow trout growth resulting from high densities (a doubling) of residual juvenile steelhead from hatchery releases.

To reduce competition, encourage out migration, and improve survival, the following actions have been implemented to reduce ecological interactions between NFH-produced juvenile steelhead and natural origin steelhead:

1. Released hatchery produced juvenile fish as yearling-sized fish
2. Release hatchery produced juvenile steelhead at a size of 4 per pound or larger
3. Released hatchery produced juvenile steelhead after January 15 but no later than March 31, and
4. Release hatchery produced juvenile steelhead in the American River

Alternatives to this release strategy would be to:

1. Release juvenile steelhead at a smaller or larger size
2. Release juvenile steelhead in the American River at or near NFH,
3. Release juvenile steelhead the Sacramento River, or
4. Release juvenile steelhead at a later date

Alternative 1 would most likely result in high mortality on smaller size juvenile steelhead, and greater numbers of fish not emigrating from freshwater and more fish assuming a resident trout life history pattern in the American River or other waters with resulting undesirable interactions between NMFS listed salmonids.

Alternative 2 would likely increase competition between hatchery and natural origin juvenile steelhead although the number of naturally produced juvenile fish is low. Additionally, Staley (1976) reported that angling mortality was exceptionally high on fish released in the American River as compared to the Sacramento River.

For a number of years juvenile steelhead have been released in the Sacramento River downstream from the confluence of the American River. It is unknown if Alternative 3 results in a higher survival rate, however, straying of returning adult steelhead may occur.

Alternative 4 would likely increase mortality of released juvenile fish. Staley (1976) reported lower angler mortality on fish released in March as compared to June. A later release date would make released juvenile fish more susceptible to in-river predators such as striped bass and Sacramento pike minnow. Additionally, it becomes more difficult to hold juvenile steelhead at NFH past the end of March due increasing water temperatures with commensurate rearing and disease issues.

3.5.2 Predation

Although predation is part of salmonid natural ecology, the significance is inversely related to population size. Predation by NFH-produced juvenile salmonids on natural origin salmonids may reduce the number of natural origin fish. However, juvenile Chinook salmon and steelhead are not reported to be highly picivorus and while in freshwater feed on a variety of food items of which aquatic insects and other invertebrates make up the greatest proportion (Shapavolov and Taft 1954, Pert 1993, Merz 2002, Unger 2004, Rundia and Lindely 2007).

Information on the specific feeding behavior of juvenile steelhead (hatchery or natural origin) from the American or Sacramento rivers is lacking. Merz (2002) examined the stomach contents of post yearling (1+) steelhead from the lower Mokelumne River and reported they fed primarily on hydropsychid larvae, chironomid pupae, zooplankton primarily daphniids and baetid subimago and nymphs. Although steelhead supplemented their diets with small terrestrial mammals, crayfish, and several species of fish (~20mm TL), the estimated mean prey item size ingested was less than 5 mm.

Juvenile steelhead primarily feed on insects and other aquatic invertebrates (Shapovalov and Taft 1954, Johnson and Johnson 1981, Angradi and Griffith 1990, and Merz and Vanicek 1996), although some juvenile steelhead feed will feed on small fish (Busby et al 1996 and Merz 2002). Juvenile steelhead typically migrate to the ocean before becoming highly piscivorous. Additionally, food abundance plays a role in determining what items are consumed and out migrating salmonids are available to resident predators for only a specific period during migration.

In general, larger rainbow trout (>10 inches), possibly resident trout, are more likely to be a predator on juvenile fishes than NFH-produced juvenile steelhead or salmon which are released at a smaller size. Changes in in-river conditions (i.e. lower water temperatures, increased flows) that encourage juvenile steelhead to residualize in freshwater may increase predation on juvenile salmonids.

3.5.3 Parasitism and disease transfers

Parasites and disease are easily transferred between fish, especially if held in close quarters. Disease transfer between natural- and hatchery origin fish may result in lower disease resistance and increased mortality of natural origin fish.

3.5.4 Behavioral influences

Behavior influences on natural origin fish by hatchery origin fish has been suggested as a factor that increases mortality of naturally-produce fish. McMichael et al. (1999) reported that the behavior of hatchery steelhead could pose risks to preexisting wild steelhead where the two interact and demonstrated that hatchery steelhead displaced wild steelhead in 79% of the contests observed between these groups in treatment and control streams.

3.5.5 Interbreeding

Hatchery origin steelhead may interbreed with natural origin steelhead in the American River. Some managers had expressed concerns with straying of hatchery fish due to potential negative impacts on wild populations through interbreeding with hatchery fish (Lindsay et al 2001). Chilcote et al. (1986) compared the relative reproductive success of naturally spawning, summer-run hatchery, and wild steelhead trout by electrophoretic examination of juveniles for a specific genetic marker. They concluded the success of hatchery fish in producing smolt offspring was only 28% of that for wild fish. Although reduce smolt production can affect the number of fish produced in the natural environment, it would not affect smolt production in an artificial hatchery environment.

The contribution of individual hatchery fish to the next generation may be higher than the contribution of natural-origin fish and has been identified as a mechanism that can depress the effective size of the population (Ryman and Laikre 1991, Ryman et al. 1995). Current data or information is not available that allows separation of separate American River environmental problems such as lack of habitat and poor water quality, with genetic issues such as interbreeding. Hannon and Deason (2005) estimated the number of in-river spawning steelhead fish observed holding on redds. They estimated an average of slightly more than 300 fish spawned in the American River annually from 2002 to 2005. The number of these fish that are NFH-produced is unknown, but most likely high. Since 2000, 97% of the steelhead trapped at NFH has been adipose fin clipped. If the incidence of natural origin steelhead spawning in the river is similar to the hatchery population, the number of non-adipose fin clipped steelhead spawning in the river may be less than 10 fish in many years.

Currently, NFH steelhead juveniles may be opportunistically captured by rotary screw trap, fyke net, and seine monitoring activities, and at salvage collection sites, along the Sacramento River and Delta, and at the Federal and State Pumping Facilities. It is difficult to determine whether incidentally trapped juvenile fish originate from NFH.

4. Water Source

4.1 Water source, water quality profile, and natural limitations to production attributable to the water source

Water for NFH comes from the American River watershed. Water released from Folsom Lake flows into Lake Natoma. Two small tributaries, Alder, and Willow creeks enter Lake Natoma. Water for the hatchery is delivered through a 1,415-ft long, primary 60-inch concrete pipe and a secondary 42-inch diameter parallel concrete pipe that runs from the south abutment of Nimbus Dam. The secondary 42" pipeline is used as an emergency back-up supply that could be used in the event of problems with the 60" primary supply pipeline. Both lines are connected through a series of gate valves that allow water to be directed into three areas as needed; the Terminal Structure, the American River Trout Hatchery, or directly into NFH. The volume of water used at NFH ranges between 20 and 50 cfs. Water supplied to either hatchery is not re-circulated or exchanged in any manner.

To minimize the effects of water level fluctuations on flow in the supply line, the DFG installed an electronically operated gate at the Terminal Structure. A series of manually operated valves control flow from the Terminal Structure to pipes leading to the rearing ponds, Hatchery Buildings, and the domestic water supply.

4.2 Measures applied to minimize the likelihood for the take of listed natural fish because of NFH water withdrawal, screening, or effluent discharge.

No listed fish species are known to occur in the lake and water withdrawal does not result in any take of a listed fish species.

Due to inadequate cold-water storage capabilities of Folsom and Natoma lakes, water temperatures suitable to salmonids may not be available in some years. NFH has experienced high water temperatures in some years and facilities or equipment to reduce temperatures is not available.

During periods of high water temperatures, fish often become more susceptible to disease outbreaks. Minor outbreaks of *Columnaris* are common during these periods and are controlled using salt, Potassium Permanganate, or Terramycin mixed in the fish food. It is anticipated that water temperatures will be detrimental to rearing; a portion of the juvenile fish may be released to reduce the number of fish in the hatchery.

The effluent discharge is located within critical habitat of steelhead, *O. mykiss* Central California Coast ESU (Threatened). Present levels of operation allow NFH to meet discharge water quality standards and minimize any take of this species. Since there are no plans to increase the level of operations at NFH, it is anticipated that NFH will continue to meet effluent discharge minimum standards

4.3 Water withdrawal and screening

Two intake pipes are located on the south side of Nimbus Dam to provide water for NFH. A 1/8 inch wire mesh screen is located on the 42-inch intake pipe. A 1/16 inch wire mesh traveling water (trash) screen is located on the 60-inch intake pipe. Both intake pipes enter a head box structure located on the southeast side of NFH grounds that allows water to be directed to the raceways, NFH Buildings 1 and 2, holding ponds, and the fish ladder.

4.4 Effluent discharge

There are three point source discharges from NFH: the fish ladder, NFH Buildings 1 and 2, and the settling ponds. Water for the fish ladder comes directly from the 60 inch intake pipe to provide attraction and transportation flows for salmon and steelhead and is discharged directly into the American River.

Water for NFH Building 1 comes from the head box structure to gain head pressure. Water for NFH Building 2 comes from the 60-inch intake pipe. Presently, effluent water from both NFH buildings is combined before direct discharge into the river 300 ft downstream from the entrance to the fish ladder. Direct river discharge will be discontinued in the near future and the effluent from both NFH Buildings will be directed to one of the settling ponds. This action is intended to improve effluent discharge water quality.

Two hatchery-settling ponds are located approximately 1,100 yards downstream from the entrance to the NFH fish ladder and adjacent to the American River, Water from the NFH raceways and the American River Trout Hatchery building is discharged into the north-settling pond. Water percolates from the settling ponds into the American River.

Water discharge requirements are provided by the California Regional Water Quality Control Board (WQCB) Central Valley Region under Order NO. R5-2005-0057 NPDES No. CA0004774. Federal regulations (40 CFR 122.44) require National Pollutant Discharge Elimination System (NPDES) permits to contain effluent limitations, including technology-based and water quality-based limitations for specific constituents and limitations based on toxicity.

Water samples are collected monthly at two sites by NFH personnel during discharge periods. The first sample (R1) is taken from the river immediately above the fish ladder entrance. The second sample (R2) is taken from the river 100 ft downstream from the settling pond seepage. Samples are analyzed by the DFG's Water Quality Laboratory and results are transmitted to the WQCB. Parameters analyzed include Ph, electronic conductivity, settable solids, total suspended solids, total dissolved solids, hardness, turbidity, and Mercury-EPA 1631. In addition, if iodine or potassium is used in the hatchery, these parameters are added to the analysis. Water samples taken from the river downstream from the settling pond includes overflow and percolation discharges from the American River Trout Hatchery that discharges into the adjacent south settling pond.

5. Description of the Facility

NFH facilities include a fish weir, fish ladder, gathering and holding tanks, hatchery buildings, rearing ponds, various office, shop, and storage buildings, fish transportation equipment, and miscellaneous equipment and supplies. A 1,600 square ft (40 ft by 40 ft) metal side building contains NFH office and office equipment, employee break room, and public restrooms.

The NFH broodstock collection facilities include a fish weir, fish ladder, gathering tank holding ponds, and a sorting area. No adult fish are transported to the hatchery and all broodstock is collected at the hatchery.

5.1 Fish weir

A fish weir was included as part of the original design of the hatchery (Romero et al 1996). Currently, the weir is installed to direct Chinook salmon into the fish ladder and removed at the end of the salmon run and prior to the steelhead run. Steelhead are attracted to and volitionally enter the fish ladder.

5.2. Fish Ladder

A fish ladder provides access for upstream migrating fish from the river to NFH Spawning Building. The ladder is 260 ft long and 9 ft wide and is made of concrete. The ladder steps are a series of one-foot drops, with an overall gradient of 8.3 percent. The pools and drops are created using flashboard dividers located about 12 ft apart. At the top of the ladder, migrating fish pass through a trap consisting of vertically hinged pipes. Approximately 40 cfs is directed into the fish ladder.

The fish ladder is opened after the weir is installed and river temperatures are at or below 60° F, and are expected to remain at that temperature or lower. This is generally in early November and the fish ladder remains open through late March.

Once fish ascend the ladder they enter the 60 ft long by 12 ft wide gathering tank at the top of the ladder. After entering the gathering tank, a hanging bar trap prevents downstream return.

5.3 Gathering Tank and Holding Ponds

An electric/hydraulic operated mechanical fish crowder can be moved to the far end of the gathering tank; a weir lowered to the bottom of the tank, and then slowly moved forward to push the fish towards NFH Building 2. Fish are pushed through a hatch into lift basket.

Adjacent to the fish ladder and Hatchery Building 2 are four concrete holding ponds. Each pond is 100 ft long, 14 ft wide and 6 ft deep and each is capable of holding approximately 800 adult salmon or steelhead. However, current practice is to return sexually immature steelhead to the river after sorting and not utilize the holding ponds for steelhead.

5.4 Sorting Area

The spawning deck provides facilities for handling, inspecting, sorting, and spawning adult salmon and steelhead. Upstream migrating adult fish are lifted from the gathering tank to the spawning deck by a hydraulic fish lift. A Smith Root Inc. Electroanesthesia unit is used to immobilize the fish. Fish are move with a mechanical lift from the tank to a stainless steel sorting table and inspected by NFH personnel for marks and tags, and sexual maturity. Tissue and scale samples and other information may be collected from individual fish during this process.

Sexually mature fish that freely express sperm and eggs are retained for artificial spawning. Fish not retained are returned to the river via 1 of 5, 15 inch diameter stainless steel tubes.

5.5 Rearing facilities

NFH rearing facilities include two hatchery buildings and six outdoor raceways.

Hatchery Building 2 is an 8,000 square ft (100 ft by 80 ft) sheet metal building with a concrete floor was constructed in 1992 to enhance NFH capabilities. The building includes a small laboratory and the spawning deck for inspecting, sorting, and spawning fish. A separate area is used for processing eggs, and egg incubation facilities.

The egg incubation facilities in Hatchery Building 2 include 12 fiberglass deep tanks, each 20 ft long, 4 ft wide, and 30 inches deep, and capable of holding 16 modified commercial Eagar hatching jars or 16 constructed PVC egg hatching jars constructed by hatchery personnel. Each hatching jars is capable of holding approximately 800 ounces of eggs. The egg hatching facilities also includes 36 16-tray vertical incubators with a capacity of approximately 10,000 eggs per tray. Water for the jars and incubators is supplied through overhead PVC plumbing.

Hatchery Building 1 is a 13,000 square ft (130 ft by 100 ft) sheet metal building. The building is the original hatchery building constructed in 1955 and houses 68 fiberglass deep tanks similar to those described in NFH Building 2. Water is supplied to the deep tanks via overhead PVC plumbing and directed into 4 ft long by 18-inch diameter vertically hung PVC filled with plastic Bio Barrels to remove gases (nitrogen) and aerate the water.

Three pairs (6) of concrete rearing ponds, also called raceways, are located on the east side of the hatchery grounds. Each raceway is 400 ft long, 10 ft wide, and 42 inches ft deep, and effectively capable of holding approximately 90,000 gallons. A flow of approximately 1.5 to 3.5 cfs of water (depending upon the size and number of fish) is typically released from the rearing pond head tank. Key-ways built into the raceway wall allow each raceway to be divided into up to seven individual rearing areas.

Water enters the head tank from an underground distribution conduit and the rate of flow can be adjusted with a 24-inch gate valve. Water is passed over a perforated metal plate to capture unwanted debris prior to entering the raceway. After passing through the raceway, water enters a collection area and is transported via an underground 10-inch diameter steel pipe to a pair of settling ponds located approximately 1,700 ft downstream from NFH grounds on the south side (left bank) of the river. Water from the settling ponds percolates through a gravel and rock substrate into the river.

A 20-ft tall chain link fence with wire mesh covering surrounds the raceways and functions as a bird ex-closure. Large gates along each side allow entrance to the raceways.

In addition to the two fish crowders used in the Gathering Tank and adult holding ponds, two gasoline operated mechanical fish crowders are available for use to move/push fish in the raceways.

One trailer-mounted Aqua-Life Harvester Dewatering Tower Model 1080 – P-1A (Fish Pump) manufactured by Magic Valley Heli-Arc and Manufacturing, Twin Falls, Idaho, is used to move juvenile fish from the rearing ponds into the fish hauling tank.

NFH is assigned one West-Mark Model ST-2800 NS 2,800-gallon, insulated, stainless steel, fishing hauling tank. The tank is mounted on single axle trailer (license number E16654) and capable of hauling up to 3,600 pounds of fish in a single load depending on species. A tractor is typically rented to move the tank.

5.6 Additional Facilities

A 425 square ft metal-sided building provides cold storage facilities for storage of semi-moist fish food, ice, and code-wire tagged fish heads collected by NFH personnel.

A visitor center is located adjacent to Hatchery Building 2 and offers natural resources interpretive displays for the public. The visitor center is operated by the Department and open daily to the public. NFH grounds are open to the public on a daily basis, with the exception of the office and buildings that are not open to the public.

Five additional metal buildings are located on the hatchery grounds and include:

- Garage - 5,600-square ft building with four over-sized roll-up doors to provide storage for large equipment

- Lawn Equipment Building – 450-sq ft building with one 10-ft by 10-ft roll-up door to provide storage for lawn equipment
- Processing Building - 10,000-sq ft building with 3 entrance doors and a 10-ft X 10-ft roll-up door
- Equipment, paint, and fuel storage building – 750-square ft building for equipment, paint, fuel, and tools with a single 10-ft-by-10-ft roll-up door
- Auto/Metal/Wood Shop Building - 2,600 square ft auto and metal shop building with two 10 ft by 12 ft roll-up door and a single entrance door.

Various power and hand tools and small equipment is included in NFH miscellaneous equipment inventory. This equipment is used for maintenance and construction projects associated with hatchery operations.

5.6 Back-up systems

Low water supply alarms are installed in the hatchery buildings and connected to the two residential houses located on the hatchery premises. Water temperatures and dissolved oxygen levels are monitored daily.

A back-up water supply is not available and no equipment or facilities to provide and alternate source of water are on hand. In the event that water is not available from the hatchery head tank due to a broken water line or repair need, auxiliary pumps can be rented locally and installed to furnish water to the raceways.

6. Broodstock origin and identity

6.1 Source

Broodstock for NFH has come from fish trapped from the American River and other non-indigenous sources.

The first Folsom Dam was completed in 1893 and was located near the town of Folsom, about 27 miles upstream from the mouth. It was reported to be an impassable barrier to salmon and most likely steelhead and until a fish ladder was built in1919 (Yoshiyama et al 2001).

Prior to construction of Folsom and Nimbus dams, counts of adult steelhead were made at the Old Folsom Dam. From 1943 to 1947, the majority (81%) of steelhead were counted during the months of May and June (Figure 6-1) as streamflows were dropping (Figure 6-2). Reynolds (1990) reported that the "American River spring-run steelhead was extirpated and the fall-run steelhead, which provided a fishery beginning in September in the American River, was severely decimated by Nimbus Dam".

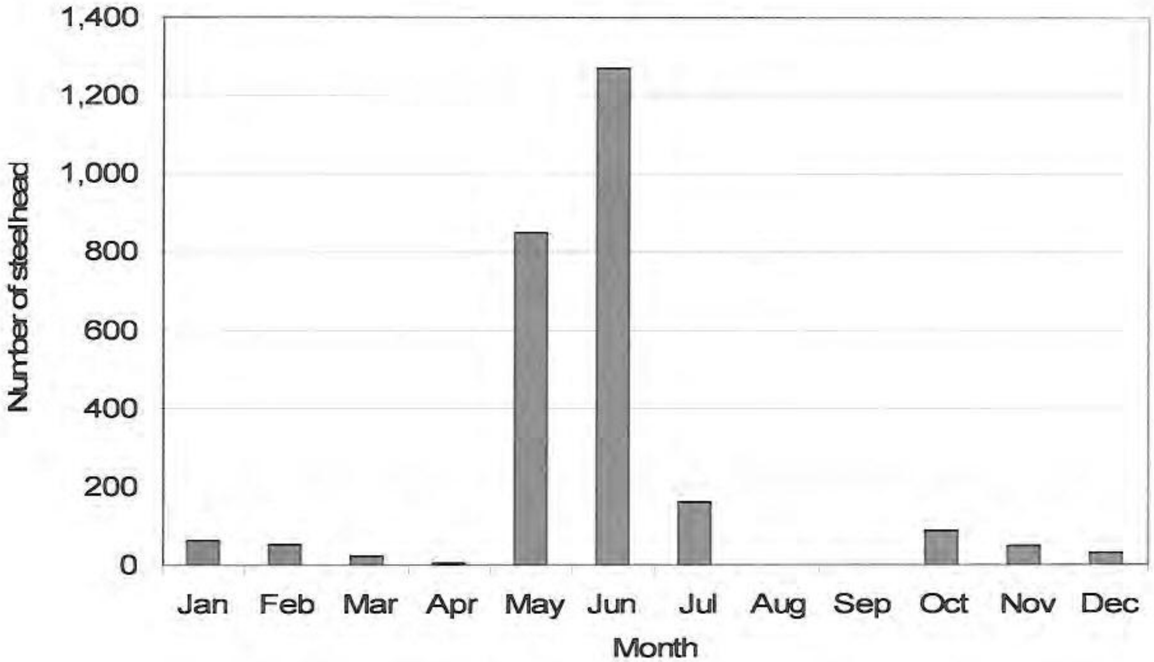


Figure 6-1. Total number of steelhead reported counted during four seasons at the Old Folsom Dam, 1943 to 1947.

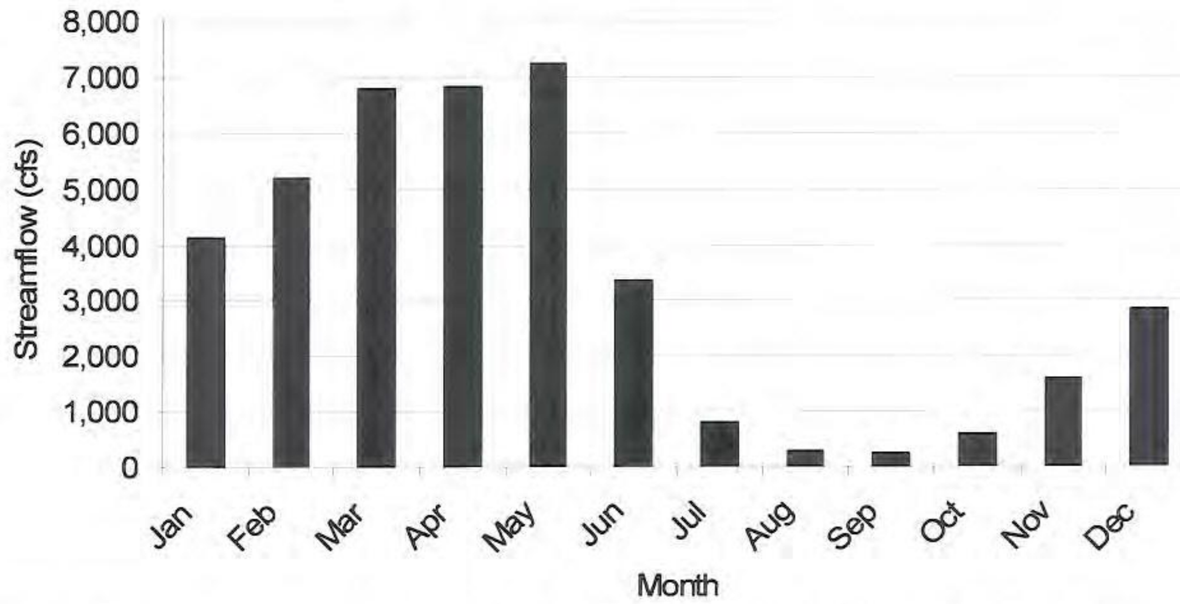


Figure 6-2. Mean monthly streamflows at USGS 11427000 American River, near Folsom, 1943 -1947.

In 1950, all migration over the dam again was blocked after storms destroyed the fish ladder. At that time, modern Folsom Dam was under construction a short distance upstream and it was deemed unnecessary to replace the ladder (Hinze et al. 1956). Subsequent completion of Nimbus Dam in 1955 downstream from Folsom Dam blocked all anadromous fish runs in the American River and no facilities were constructed to provide upstream migration.

During the first two seasons of operation in 1955 and 1956, NFH personnel trapped and artificially spawned adult steelhead from the American River. The progeny of these fish were reared and released into the American River. Due to the small number of eggs collected and fish reared, in 1958 and 1959, three broodyears (1957, 1958, and 1959) of Eel River steelhead eggs were transferred from the Eel River Snow Mountain Egg Collection Station to NFH for rearing and release (Table 6-1).

From 1970 through 1981, several groups of summer steelhead eggs from the N.F. Washougal River, Washington were shipped to NFH (Table 6-1).

From 1981 through 1992, other steelhead eggs were transferred from in-state sources to NFH (Table 6-1).

Table 6-1. Non-indigenous steelhead reared at the Nimbus Fish Hatchery 1955 - 2010.

Source of fish	River	Brood year	Release date	Release location	Number released	Release Size 1/	Comments 2/
Snow Mountain Egg Collection Station	Eel River, CA	1957	Mar-58	American River	823,971		Winter steelhead
Snow Mountain Egg Collection Station	Eel River, CA	1957	Mar-58	American River	100,218		Winter steelhead
Snow Mountain Egg Collection Station	Eel River, CA	1958	Aug - Dec-59	American River	337,500	fingerling	Winter steelhead
Snow Mountain Egg Collection Station	Eel River, CA	1958	Jan - Feb-59	American River	371,345	yearling	Winter steelhead
Snow Mountain Egg Collection Station	Eel River, CA	1959	Jul-59	American River	460,628	70	Winter steelhead
Skamania Fish Hatchery	N.F. Washougal River, WA	1969	Mar-70	Sacramento River – Clarksburg	18,700	8.5	Summer steelhead
Skamania Fish Hatchery	N.F. Washougal River, WA	1970	Mar-71	Sacramento River – Clarksburg	450	15.5-17	Summer steelhead
Skamania Fish Hatchery	N.F. Washougal River, WA	1970	Apr-71	Sacramento River – Clarksburg	7,990	7.5-7.6	Summer steelhead
Skamania Fish Hatchery	N.F. Washougal River, WA	1973	Jun-73	American River	12,240	24	Summer steelhead
Skamania Fish Hatchery	N.F. Washougal River, WA	1973	Feb-74	Sacramento River - Garcia Bend	104,598	4.4-9.0	Summer steelhead
Trapped	Sacramento River, CA	1973	Feb-74	Sacramento River - Miller Park	37,040	3.8-4.0	Sacramento River-Strain
Mad River Hatchery	Mad River, CA	1978	Jan - Apr-79	Sacramento River - Rio Vista	284,870	yearlings	Winter run
Skamania Fish Hatchery	N.F. Washougal River, WA	1979	Apr-80	Sacramento River - Rio Vista	148,220	yearlings	Summer steelhead
Skamania Fish Hatchery	N.F. Washougal River, WA	1980	Mar-81	Sacramento River - Rio Vista	56,440	yearlings	Summer steelhead
Coleman NFH	Battle Creek, CA	1980	Jan-81	Sacramento River - Rio Vista	51,461	yearlings	Summer/fall steelhead
Coleman NFH	Battle Creek, CA	1980	Mar-81	Sacramento River - Rio Vista	50,981	yearlings	Summer/fall steelhead

Coleman NFH	Battle Creek, CA	1980	Mar-81	Carquinez Straits	51,628	yearlings	Summer/fall steelhead
Warm Springs Hatchery	Dry Creek, Russian River, CA	1983	Apr-84	Sacramento River - Rio Vista	91,000	yearlings	Winter run
Mad River Hatchery	Mad River, CA	1988	Apr-88	American River - Garcia Bend	186,000	185	Late run
Mad River Hatchery	Mad River, CA	1989	Apr-89	American River - Discovery Park	134,620	61	Late run
Warm Springs Hatchery	Dry Creek, Russian River, CA	1990	Jan - Mar-90	Sacramento River - Clarksburg & Garcia Bend	235,295	3.9	Late run
Mad River Hatchery	Mad River, CA	1991	Jan - Feb-92	Sacramento River - Clarksburg & Garcia Bend	183,390	yearlings	Winter run

1/ Numbers are number per pound.
2/ Comments are from description in NFH annual report.

In the early 1970's, adult steelhead were trapped in the Sacramento River upstream from the confluence of the American River near the Interstate 80 Bridge and transported to NFH in efforts to establish an early steelhead run in the American River. Although no record of this effort is noted in NFH annual reports, the senior author was employed at NFH during this time and personally assisted in the trapping and transportation of Sacramento River steelhead to NFH. The disposition or status of these fish relative to the present hatchery broodstock is unknown.

6.2 Supporting information

Hinze et al. (1956) reported, "Little is known of the history of steelhead, *Salmo gairdnerii*, in the American River". McEwan (2001) reviewed the ecology and population biology of Central Valley steelhead but did not include specifics regarding runs in the American River. Yoshiyama et al. (2001) provided a few insights into the historical distribution of steelhead in the American River in their review of the distribution of Chinook salmon. They indicated that steelhead were historically reported to ascended portions of the South and North Forks of the American River.

Specific information on numbers of fish trapped during the early years of the hatchery; transfers of non-indigenous steelhead eggs, numbers of fish reared and stocked, and other hatchery related information can be found in NFH annual reports (Hinze et al 1956; Hinze 1959a, 1959b, 1961, 1962a, 1962b, 1963, 1964, 1965a, 1965b; Jochimsen 1967, 1968, 1970a, 1970b, 1971, 1972, 1973a, 1973b, 1974, 1976, 1978a, 1978b; Riley 1979, 1982a, 1982b, 1982c; Ducey 1983, 1984, 1987a, 1987b, 1987c, 1989, 1990, 1991a, 1991b, 1992, 1994a, 1994b, 1995; West unpublished manuscripts 1996 through 2006, Hoover and Burks unpublished manuscripts 2007 through 2009).

Studies have demonstrated that the present NFH winter steelhead are genetically and phenotypicaly different from Central Valley steelhead (Hallock et al. 1961, Staley 1976, Neilsen et al. 2005). The fish are typically larger and NFH trapping records indicated that adult migration occurs later in the year than the migration of Central Valley steelhead.

During the period 1955 through June 30, 2010, 79,810 adult steelhead and 1,442 fish listed as "half pounders" have been reported trapped at NFH although no "half pounders were reported prior to 1967 (Figure 6-3, and Table 6-2). The number of adult steelhead annually trapped has averaged 1,451 (range 51 to 5,155) fish.

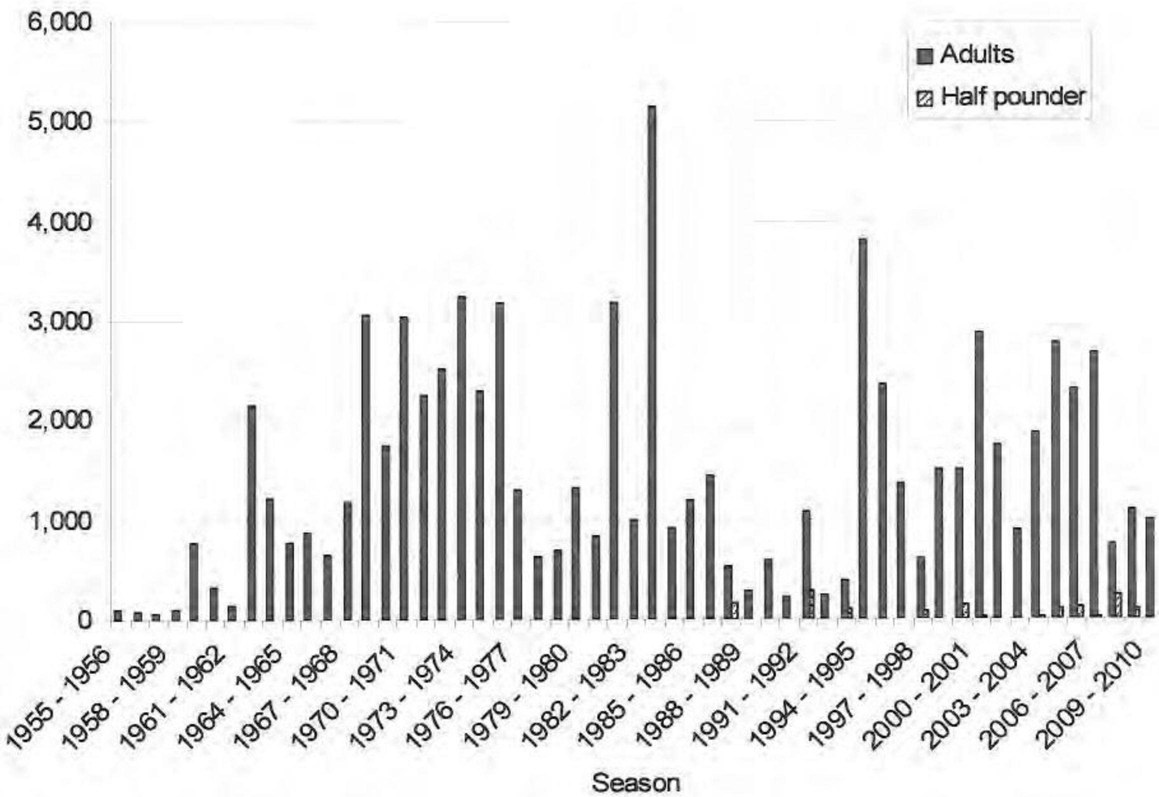


Figure 6-3. Number of steelhead trapped at the Nimbus Fish Hatchery, 1955-56 to 2009-1010 seasons.

Table 6-2. Number of adult and "half pounder" sized steelhead reported trapped at the Nimbus Fish Hatchery 1955-1956 through 2009-2010 seasons.

Season	Males	Females	Adults		Half pounder	Half pounder criteria	Total fish trapped
1955 - 1956	36	74	110			not listed	110
1956 - 1957	41	48	89			not listed	89
1957 - 1958	33	18	51			not listed	51
1958 - 1959	65	37	102			not listed	102
1959 - 1960	354	424	778			not listed	778
1960 - 1961	150	166	316			not listed	316
1961 - 1962	86	51	137	2/		not listed	137
1962 - 1963	1,226	915	2,141	2/		not listed	2,141
1963 - 1964	472	744	1,216			not listed	1,216
1964 - 1965	502	276	778			not listed	778
1965 - 1966	374	500	874			not listed	874
1966 - 1967	370	272	642			not listed	642
1967 - 1968	576	607	1,183			not listed	1,183
1968 - 1969	1,617	1,449	3,066			not listed	3,066
1969 - 1970	1,088	646	1,734			not listed	1,734
1970 - 1971	1,547	1,486	3,033			not listed	3,033
1971 - 1972	1,148	1,108	2,256			not listed	2,256
1972 - 1973	1,220	1,286	2,506			not listed	2,506
1973 - 1974	1,935	1,302	3,237			not listed	3,237
1974 - 1975	1,176	1,119	2,295			not listed	2,295
1975 - 1976	1,538	1,643	3,181			not listed	3,181
1976 - 1977	592	715	1,307			not listed	1,307
1977 - 1978	377	242	619			not listed	619
1978 - 1979	333	347	680			not listed	680
1979 - 1980	729	581	1,310			not listed	1,310
1980 - 1981	494	342	836			not listed	836
1981 - 1982	1,684	1,506	3,190			not listed	3,190
1982 - 1983	570	433	1,003			not listed	1,003
1983 - 1984	2,373	2,782	5,155			not listed	5,155
1984 - 1985	454	454	908	2/		not listed	908
1985 - 1986	729	464	1,193			not listed	1,193
1986 - 1987	750	681	1,431			not listed	1,431
1987 - 1988	287	249	536		169	not listed	705
1988 - 1989	133	156	289		7	not listed	296
1989 - 1990	328	266	594			not listed	594
1990 - 1991	154	69	223			not listed	223
1991 - 1992	561	506	1,067		292	≤22"	1,359

1992 - 1993	133	108	241	0	≤22"	241
1993 - 1994	210	175	385	111	≤22"	496
1994 - 1995	1,928	1,875	3,803	0	≤22"	3,803
1995 - 1996	1,206	1,154	2,360	0	≤22"	2,360
1996 - 1997	735	633	1,368	3	≤22"	1,371
1997 - 1998	427	173	600	80	<22"	680
1998 - 1999	833	674	1,507	0	<22"	1,507
1999 - 2000	813	695	1,508	148	<22"	1,656
2000 - 2001	1,412	1,465	2,877	17	<22"	2,894
2001 - 2002	982	760	1,742	10	<22"	1,752
2002 - 2003	488	399	887	0	<22"	887
2003 - 2004	999	863	1,862	25	<22"	1,887
2004 - 2005	1,444	1,328	2,772	101	<22"	2,873
2005 - 2006	1,243	1,065	2,308	115	<16"	2,423
2006 - 2007	1,396	1,277	2,684	11	<16"	2,695
2007 - 2008	432	326	758	248	<16"	1,006
2008 - 2009	597	498	1,095	96	<16"	1,191
2009 - 2010	514	473	987	9	<16"	996
Total	41,894	37,905	79,810	1,442		81,252
Mean	762	689	1,451	69		1,477

1/ Incorrect number reported in NFH annual report.

Anglers have reported catching half pounder steelhead from the American River. Half pounder steelhead are the progeny of both adult winter and summer steelhead and after their freshwater growth period and migration to the ocean, will return to freshwater after spending only a few months in the ocean, but do not over winter in the ocean during their first season in a saltwater environment. During the past 10 years, 632 half pounder-sized trout (<16 in TL) have been trapped at NFH. A large percentage (39%) of these were trapped during the 2007-2008 season and inspection of these fish during the sorting operation suggested that they were hatchery released juvenile steelhead (adipose fin marked) that did not migrate to the ocean.

Early hatchery records reported that most of the steelhead that entered the hatchery during the 1958-59 season were only 16 in long. These fish may have been steelhead that demonstrated a half pounder life history pattern (from the Eel River steelhead stock transferred to the hatchery) or fish that did not migrate to the ocean. Unfortunately, small fish trapped at NFH were not always reported in hatchery annual reports.

6.3 Genetic and Ecological Differences

6.3.1 Run Timing

McEwan (2001) reviewed the published literature dealing with the life history of Central Valley steelhead and reported that the peak period of migration before large-scale changes in hydrology appeared to have been in the fall, with a smaller winter-migrating component. He also suggested that before the era of large dam construction, there might have been a large summer-run steelhead component.

Steelhead migration in the Sacramento River upstream from the Feather River was studied by Hallock et al. (1961) who reported that:

"Steelhead migrate into the upper Sacramento River during most months of the year in one continuous run. Each season the first of the migration passes the mouth of the Feather River in July. The run in 1954 and 1955 was continuous until the middle of the following March. In 1954 very few, if any, adult steelhead moved from the Delta into the upper Sacramento between the middle of March and the middle of June. The bulk of the run passes the Feather River between early August and late November, and the peak of the migration usually occurs near the end of September. Above the mouth of the Feather River, most of the early migrant steelhead remain in the main stem of the Sacramento until about the middle of November or until flows increase sufficiently in tributary streams to encourage ingress. During October and November they concentrate on riffles occupied by spawning king salmon, *O. tshawytscha* (Walbaum 1792), and near the mouths of the larger tributary streams, principally between Hamilton City and Redding. Usually by the middle of November rain has swollen the entire river system, permitting the steelhead and the salmon which have not already spawned to fan out into spawning areas of the numerous tributaries."

As reported in Section 6.1, pre-Folsom Dam counts of adult steelhead at the Old Folsom Dam suggest that steelhead runs in the American River may have included several runs of which summer (spring-run) steelhead appeared to be the most numerous. Hinze (1962a) did report that during the first years of NFH operation, a few steelhead entered NFH during October though December but were returned to the river (Hinze 1962a). Storms and high flows during the second half of the 1955-1956 season precluded weir and trap operations.

Since operation of NFH, steelhead have been trapped as early as the 1st week of October (standard week 41) (Figure 6-4). Up until 1980, the ladder was often opened the first weeks of October to trap fall Chinook salmon and since 2000, the ladder has been first opened during the first weeks of November (week 44 through 46).

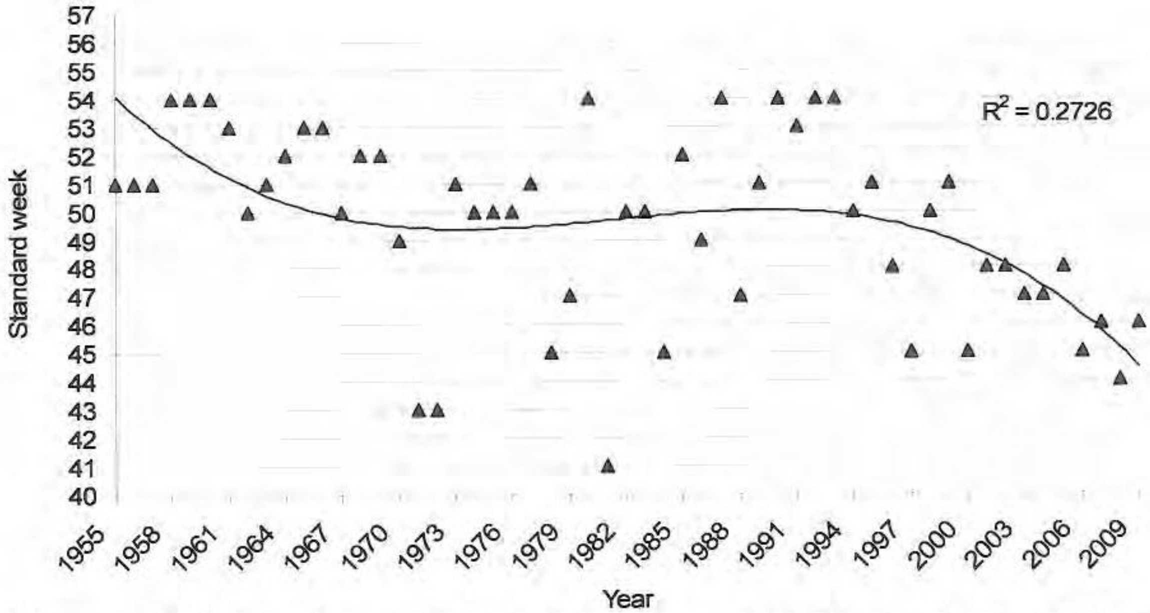


Figure 6-4. Standard week the first steelhead has been trapped at NFH, 1955 to 2009 (note: line is a third order polynomial trend).

The peak of the steelhead run at NFH is generally the later part of December, but may vary by several weeks. The last steelhead has been trapped as late as the second week of March (standard week 10) and in general, there has been a trend towards the last steelhead trapped later in the season and reflects a trend in hatchery operations to keep the ladder open longer (Figure 6-5) .

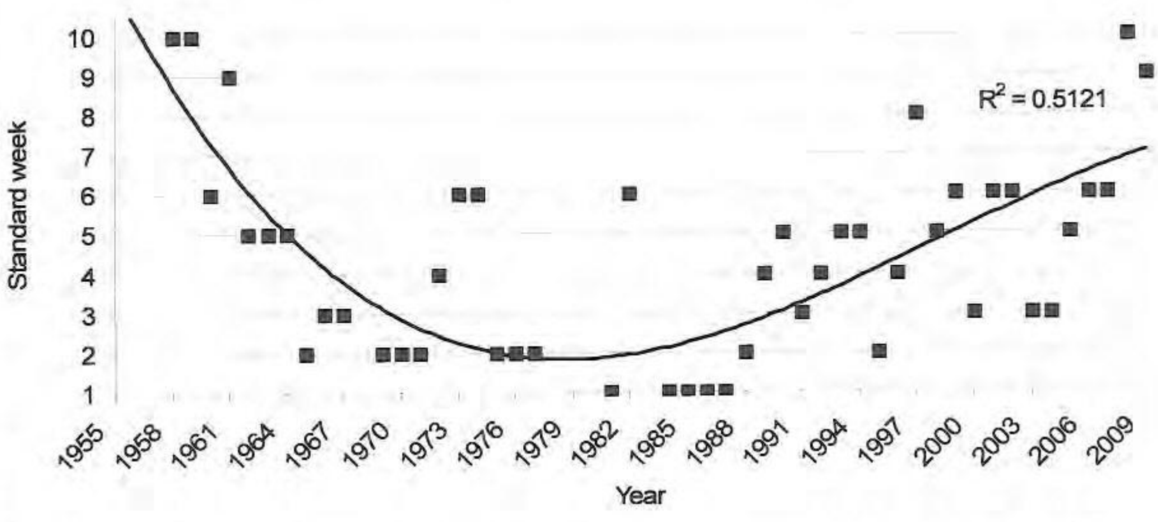


Figure 6-5. Standard week the last steelhead has been trapped at NFH, 1955 through 2009 (note: the line is a third order polynomial trend)

Winter steelhead entering NFH demonstrate a migration timing that is more similar to Eel River winter steelhead than Central Valley steelhead. Counts on the South Fork Eel River at Benbow Dam indicate the first steelhead was observed in November, the peak usually occurred January or February, and the last steelhead was usually counted in May (Gibbs 1954).

During the past 10 years in an effort to ensure steelhead from throughout the run are represented, the trap has been kept open longer and fish spawned later during the season. This strategy appears to have resulted in a general later finish to the run as compared to the previous years of operation, however; this may be an artifact resulting from trap operations rather than an actual change in run timing.

6.3.2 Past and proposed level of natural fish in broodstock

The first season of operation, Hinze et al (1956) reported that due to heavy storms, it was impossible to "get a true picture" of the 1955-1956 season steelhead run. Hatchery personnel trapped 110 adult steelhead and spawned 62 females from February 28 through March 26, 1956. A total of 205,674 eggs were taken that resulted in 105,000 fingerling fish. The following season, 115 steelhead were reported trapped and 48 female fish produced 198,029 eggs that resulted in 66,748 juvenile fish. All of these juvenile fish were released in the American River.

From 1958 through 1993, steelhead eggs were transferred to and juvenile fish reared at NFH for release in the American and Sacramento rivers. These transfers included eggs from the Snow Mountain Egg Collecting Station and Cedar Creek Hatchery, Eel River, CA; the Coleman National Fish Hatchery, Battle Creek, Sacramento River tributary, CA; Warm Springs Hatchery, Dry Creek, Russian River, CA; and Mad River Hatchery, Mad River, CA (Table 5-1). All of these stocks were described as either summer winter or late-run steelhead.

Hinze (1961) reported that in 1957 due to low numbers of eggs collected at NFH slightly more than a million eggs were received from the Snow Mountain Egg Collecting Station located on the Eel River. Subsequently, 924,189 1957BY Eel River juvenile steelhead from those eggs were released into the American River. Of the released fish, 100,218 (10.9% of 924,148) were marked with a right ventral fin clip. In addition to the juvenile Eel River steelhead released in 1958, an additional 101,440 yearling fish were released from eggs collected from adult steelhead that entered NFH during the 1957-58 season and could be considered from natural origin American River steelhead. In 1959, a second group of 460,628 1959 BY Eel River juvenile steelhead in addition up to 7,000 American River juvenile steelhead (7,000 fish were reported on hand at NFH in July) and released in the American River (Hinze 1961).

During the 1958-59 trapping season, 11 marked Eel River stock steelhead adults (all males) were reported collected at NFH; no marked fish were reported during the 1959-60 season, and an additional 9 marked fish (1 male and 8 females) steelhead were reported collected during the 1960-61 season. However, Hinze (1961, 1962a,b) reported that a total of 155 marked steelhead from this group was collected in all years suggesting that 135 marked fish returned to NFH during the 1959-60 season but were not mentioned in NFH annual report.

During the during the 1958-59, 1959-60, and 1960-61 seasons 102, 778, and 316 steelhead were reported trapped, respectively. Hinze (1961) reported that during the 1958-59 season, the majority of steelhead entering NFH were less than 16 inches in length. Unmarked Eel River adult steelhead comprised approximately 90% of all 1957 BY steelhead released in 1958 and Eel River steelhead may have comprised a major portion of the age-2 fish returning to NFH. These small steelhead were most likely immature and not spawned and Eel River steelhead runs historically included a "half pounder" steelhead life history component. During the 1960-61 season, up to 90 (28% of 316) of the age-3 adults trapped may have been from Eel River steelhead releases based on the proportion of marked fish observed.

Based on NFH records, we conclude that Eel River juvenile steelhead comprised approximately 85% of the juvenile steelhead released in 1958 and 1959; and those same fish returning as adults may have comprised the majority of steelhead trapped and spawned at NFH during the 1960-61 through 1962-63 seasons.

There have been attempts to change the steelhead runs in the American River. Staley (1976) reviewed the DFG's American River steelhead management during the period 1956-1974 and reported that one of the goals was to "increase the proportion of the annual steelhead run entering the hatchery during the fall" thereby increasing angler catches during the fall months. He did recognize that this action would lead to conflicts with angling regulation closures on the river for fall spawning Chinook salmon.

Prior to 1973, adult steelhead entering NFH were separated into early- and late-run fish and spawned separately and the progeny fin-marked. Staley (1976) reported that that based on the results of those marking experiments a greater proportion of the progeny from early migrants returned to NFH prior to the end of December than did progeny of later migrants.

The DFG also attempted to establish a summer steelhead run in the American River during the early 1970's by the introduction of summer steelhead from the Skamania Fish Hatchery, Washington (Table 6-1). Eggs were transferred to NFH and hatched and all or a portion of the fish were fin marked and released. In for some years eggs were taken from returning marked adult fish and their progeny stocked in the American and Sacramento rivers (Meyer 1985).

Efforts to establish summer and "early" runs of steelhead in the American River were eventually discontinued due to difficulties distinguishing returning marked adult fish (Jochimsen 1978b) and problems holding adult summer and early fall run steelhead at the hatchery. Riley (1979) reported that no attempt was made during the 1977-78 run to spawn early run steelhead (those arriving prior to October 29) due to the small number of fish collected.

Prior to 2001, the percentage of naturally spawned steelhead in NFH broodstock is unknown. Since 1999, all hatchery origin juvenile steelhead released have been marked and all adult steelhead trapped with an adipose fin are presumed to be natural origin. Information on the number of unmarked steelhead included in the broodstock is not available prior to the 2008-2009 season, however, since then, only marked hatchery origin adult steelhead have been used as broodstock.

6.3.3 Genetic Differences

Genetic analysis of naturally spawning and hatchery broodstocks is important for effective management. Variations in steelhead populations within geographical areas have been described. For example, Reisenbichler and Phelps (1989) found variation at 19 gene loci in steelhead from nine drainages in northwestern Washington (primarily the Olympic Peninsula).

The genetic makeup of the present NFH winter steelhead has been examined in past years. Cramer et al. (1995) suggested that based on the transfers of eggs from the Eel River and run timing, the NFH winter steelhead stock is similar to Eel River winter steelhead. The WCBRT (1997) reported the in their analysis of steelhead population structure, all of the Central Valley samples except for those from the American River cluster closely together and form a genetic group distinct from all coastal samples. In contrast, the American River samples (NFH and a sample of naturally spawned juveniles from the American River) cluster with samples from northern California populations and are genetically most similar to a sample from the Eel River.

Later, Nielsen et al (2005) reported that the NFH winter steelhead were genetically most similar to Eel River stock. They examined genetic variation at 11 microsatellite loci in efforts to describe the population genetic structure of *Oncorhynchus mykiss* in the Central Valley and also indicated that the clustering of rainbow trout populations from the upper portions of the Tuolumne, Stanislaus, American, and Yuba rivers could be due to two alternative factors: (1) shared ancestry among native, ancestral populations not influenced by hatchery steelhead or other anadromous populations downstream from the four dams found on these rivers; or (2) the influence of introduced rainbow trout from hatchery populations that have been stocked extensively in reservoirs throughout California. They also indicated that genetic differentiation between the major drainages within the Central Valley, Sacramento and San Joaquin Rivers, were not great supporting a close evolutionary relationship among steelhead populations throughout the Central Valley.

Garza and Pearse (2008) reported that in general, although structure was found, all naturally spawned populations within the Central Valley basin were closely related, regardless of whether they were sampled above or below a known barrier to anadromy. They also indicated that the below-barrier populations are most closely related to populations in far northern California, specifically the genetic groups that include the Eel and Klamath Rivers. The rationalized that since Eel River origin broodstock were used for many years at Nimbus Hatchery on the American River, it is likely that Eel River genes persist there and have also spread to other basins by migration, and that this is responsible for the clustering of the below-barrier populations with northern California ones. However, this does not account for the relationship with Klamath River groups since there is no record of Klamath River steelhead having been transferred to the Central Valley.

Adult steelhead are artificially spawned at NFH slightly earlier than steelhead that spawn naturally in the river. This is due to the practice of artificially spawning the fish rather than an actual difference in spawning timing. Earlier steelhead spawning results in earlier hatching steelhead eggs and ultimately slightly larger fry as compared to fish that spawn naturally in the river.

6.3.4 Age structure, fish size, fecundity, and sex ratio

Age structure - We were unable to find any age structure evaluations of American River steelhead prior to NFH operation. Hinze et al. (1956) reported that during the first year of operation, 62 female steelhead that were trapped and spawned produced an average of 4,200 eggs per fish at 278 per ounce. These fish likely averaged 4 to 8 pounds based on the number of eggs per fish and size of eggs collected, and would have been at least 3 years of age (T. West, NFH Hatchery Manager II, personal communication).

During the 1963-64 season, measurements were made of returning fin-marked 1960 BY adult steelhead at NFH. A total of 273 males averaged 66 cm (26 in) in length, while 283 females average 63 cm (24.8 in) after 2 years of ocean growth. The following year, two males from the same release group averaged 71 cm (28 in) and three females averaged 70 cm (27.6) after 3 years of ocean growth. Twenty fin-marked 1962 BY steelhead returning to NFH during the 1963-64 season averaged 49 cm (19.3 in) after 1 year of ocean growth (Hinze 1964). The report did not indicate if the measurements were fork or total length.

During the past 10 years, the majority of adult steelhead trapped at NFH appears to be 3 years of age (personal communication, T. West, Hatchery Manager II). A small number of half pounder size fish are trapped each year at NFH. Half pounder steelhead were first described from the Eel River by Snyder (1925) and are sexually immature steelhead that after migrating to the ocean for the first time, return to freshwater after only a few months.

Prior to 1987, smaller-sized steelhead were not reported at NFH. However, Hinze (1961) did indicate that most of the steelhead that entered the hatchery during the 1958-59 season were 16 in. in length and may have been steelhead that demonstrated a "half pounder" life history pattern (Eel River stock) or fish that did not migrate to the ocean.

Although definite correlations are not apparent, numbers of "half pounder" sized steelhead returning to NFH appear to have been higher following years when fingerling-size juvenile steelhead were released in the American River. Prior to 1997, large numbers of fingerling-sized steelhead were routinely released from NFH. Since then, only one group of 133,114 2001 BY fingerling steelhead were released in the Sacramento River at Garcia Bend in 2001 and only ten fish less than <22 in TL were reported trapped at NFH the following season.

During the 2007-2008 trapping season at NFH, 33% of the fish trapped (248 of 1,006) were recorded as "half pounder" sized fish. These fish were examined during spawning operations and most of the fish were adipose fin marked indicating hatchery origin, and many of the fish were sexually mature male fish that demonstrated a defined lower jaw kype, distinct red stripe, and numerous spots, while the female fish were with mature eggs. Steelhead that demonstrate a classical half pounder life history are immature and do not spawn the first season of freshwater entry (Kesner and Barnhart 1972, Everest 1973, Barnhart 1986).

During the period from the 2000-2001 to 2009-2010 trapping seasons, 1,442 (annual mean of 68) "half pounder" size fish have been reported trapped. Many of the reported "half pounder" steelhead trapped at NFH may be hatchery origin juvenile steelhead that have not migrated to the ocean and taken on resident rainbow trout coloration and life history characteristics.

Fish size - Historical size information is lacking for steelhead that entered NFH prior to recorded introductions of non-indigenous steelhead. Most individuals presume that the indigenous American River steelhead would have been phenotypically similar to Sacramento River steelhead (Central Valley steelhead). As part of evaluations of hatchery-reared steelhead in the Sacramento River system, Hallock et al (1961) reported that:

"Sacramento River steelhead were generally smaller than those found in other California streams, except the Klamath River. During the 6 years that the traps were operated near the mouth of the Feather River, over 19,000 steelhead were captured.

Fork length measurements were made of 18,671 of these fish. The measurements showed that during most years there was a bimodal length distribution; one mode was 15.5 inches and the other 20.5 inches. The smaller fish consist principally of age classes which have spent 2 years in fresh water and one year at sea. The larger steelhead spent 2 years in fresh water followed by 2 years in the ocean. Including lengths of all fish measured, the average size of a Sacramento River steelhead was found to be 18.1 inches in fork length, with a rather large standard deviation of 3.4 inches. Omitting fish under 14 inches in length, a good portion of which are apparently seaward bound instead of ascending the river, the average length becomes 18.7 inches. Sacramento steelhead average about three pounds in weight. Fish up to eight pounds are common, while those over 13 pounds are rare. The largest steelhead recorded during the study weighed 15.5 pounds."

Although information on the size of fish that entered NFH during the first years of operation is not available, information on the number of eggs per female from fish was collected. In general, the size of the egg depends upon the size and age of the parent fish; larger specimens produce more and larger eggs (Leitritz and Lewis 1976). The number and size of eggs taken from steelhead trapped at NFH during the first year of operation and prior to the introduction of any non-indigenous steelhead is more comparable to larger steelhead. For example, winter steelhead from the Snow Mountain Station, Eel River produced an averaged of 4,304 eggs per females at 221 eggs per ounce (range 200 – 240) (Leitritz and Lewis 1976), as compared to Sacramento River steelhead spawned between 1952 and 1957 that were reported to produce only 2,570 eggs per female (Hallock et al 1961). This suggests that the steelhead trapped at NFH prior to any introductions of non-indigenous steelhead may have been physically larger than the typical Sacramento River steelhead.

The majority of steelhead trapped during the past 15 years at NFH are three years of age and range from 60 to 75 cm TL (T. West, NFH Hatchery Manager II, personal communication). There does not appear to be any size difference between steelhead artificially spawned at NFH and the estimated size range of steelhead observed holding on redds in the American (unpublished data, Bureau of Reclamation) (Figure 6-6).

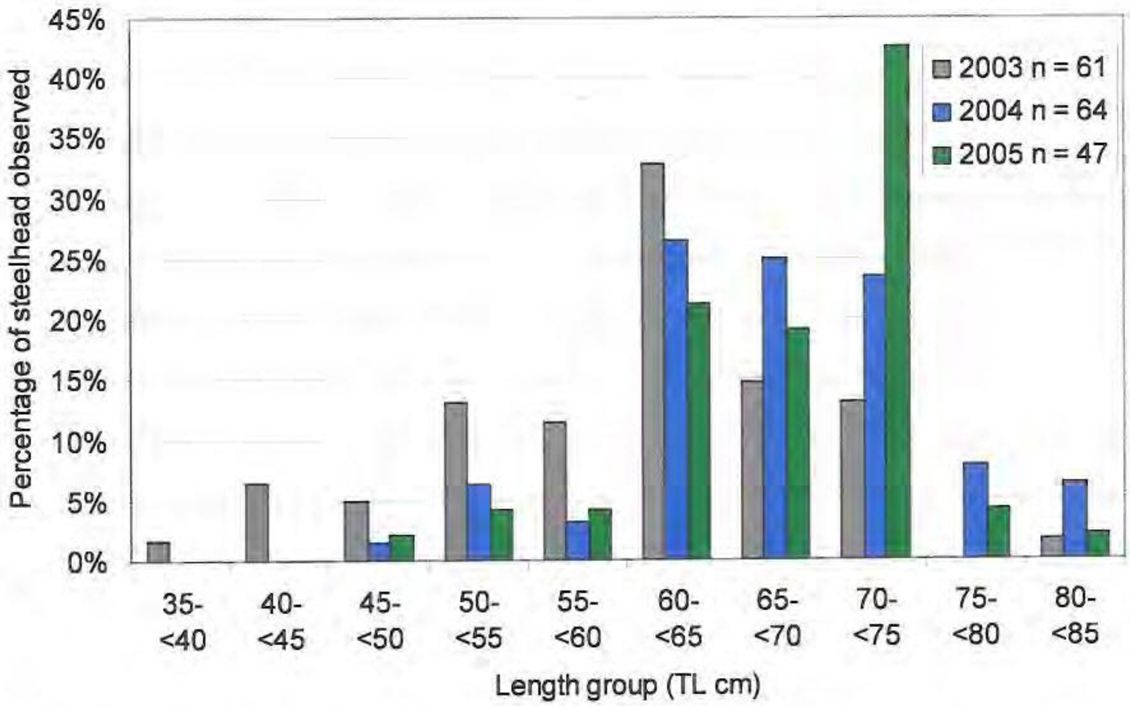
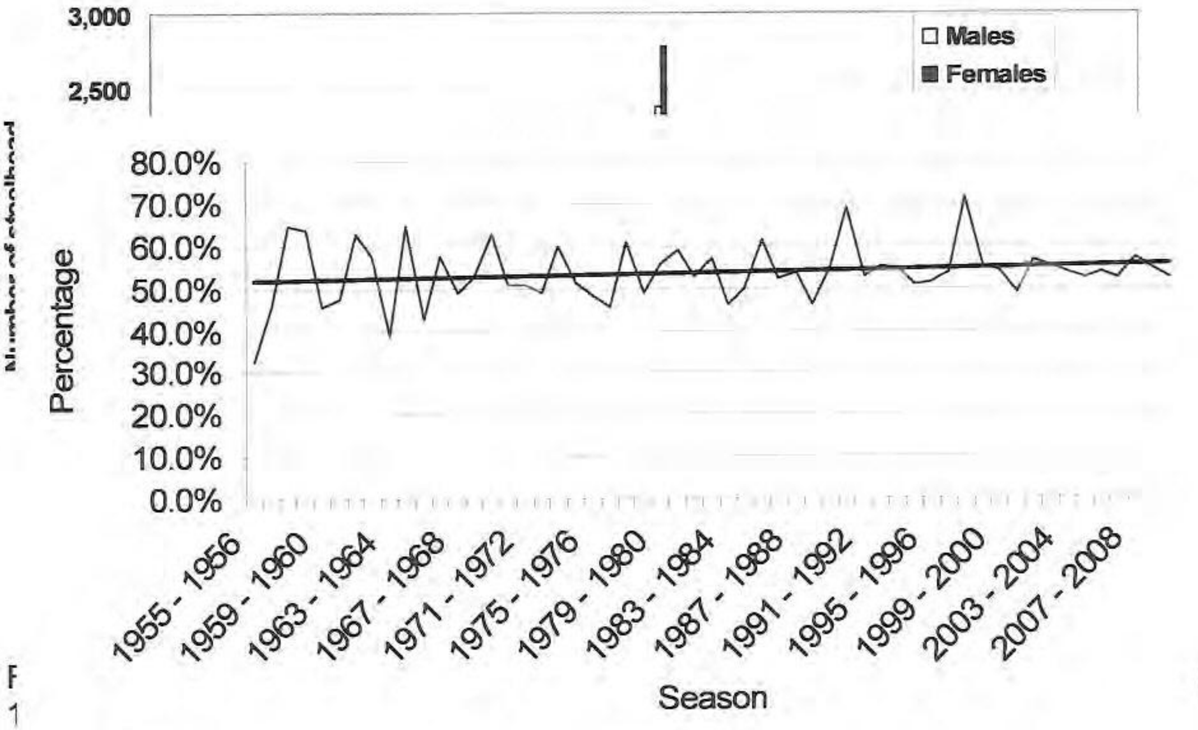


Figure 6-6. Size of adult steelhead observed on redds in the American River.

Fecundity – Hinze et al. (1956) reported that during the first year of operation, 62 female steelhead trapped and spawned at NFH produced an average of 4,200 eggs per fish at 278 eggs per ounce. Hallock et al. (1961) reported that the average female steelhead spawned at Coleman National Fish Hatchery (CNFH) in the early 1950's yielded 2,808 eggs but that number was not an indication of average fecundity since many smaller fish were not used Estimates of the number of eggs collected by artificial spawning methods are routinely reported in hatchery annual reports. However, the number of eggs collected from a female by artificial spawning may not be an accurate estimate of fecundity due to variations in spawning and egg taking methods.

During the past 5 years of operation, American River winter female steelhead artificially spawned have produced an average of slightly more than 5,500 eggs per fish (range 4,461–6,235).

Sex ratio – During the period 1955 to 2009, the percentage of male steelhead trapped comprising the total number of steelhead trapped has varied from 33 to 71% (mean of all years 54%); but only during 15 years (28% of the 53) years has the number of females exceed the number of males (Figure 6-7). During this same period there has also been a very slight increase in the percentage of male steelhead trapped annually (Figure 6-8).



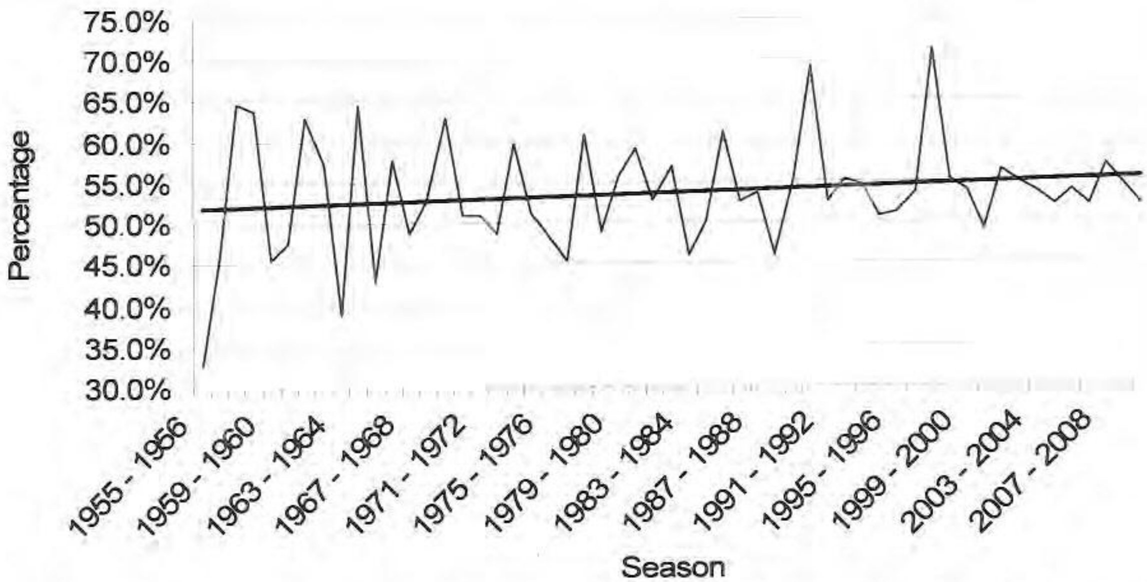


Figure 6-8. Percentage of male steelhead trapped at NFH, 1955-1956 to 2009-2010 seasons.

6.3.5 Reasons for choosing broodstock

During the initial years of NFH operation, an insufficient number of steelhead entered the facility to produce the number of eggs needed to meet the mitigation goals. To make up the difference, three different broodyears of Eel River winter steelhead eggs were transferred to NFH during the first 2 years of operation.

Although specific information is lacking, Eel River winter steelhead stock were most likely selected because of the time eggs were available and large size of the fish (T. West, NFH Hatchery Manager II, personal communication). Additionally, American River water temperatures were recorded above 60 $^{\circ}$ F in early October during the first years of NFH operation and water temperatures did not become suitable for spawning steelhead and holding eggs until November and December, the same time that eggs from Eel River winter stock were available.

Other non-indigenous steelhead stocks were transferred to NFH and released during the period 1970 through 1993 in attempts to establish spring, summer, and fall sport fisheries in the American River. These programs were subsequently abandoned due to difficulties identifying marked fish and problems associated with holding adult steelhead at NFH.

6.4 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.

The Central Valley steelhead ESU includes steelhead naturally produced in the American River but not steelhead reared and released at NFH. American River fall-run Chinook salmon are listed as a species of special concern.

The following measures are implemented to reduce adverse genetic or ecological effects on listed natural fish because of broodstock collection practices:

1. Unmarked naturally produced steelhead are not included in the hatchery broodstock and are returned to the river,
2. Excess hatchery origin adult steelhead may be harvested by anglers while unmarked natural origin steelhead may not be retained. The bag limit on hatchery origin steelhead is two fish per day per angler, and
3. Artificially spawned steelhead (kelts) are returned to the river in a manner that encourages angler harvest.

7. Broodstock collection

7.1 Life-history stage to be collected (adults, eggs, or juveniles)

NFH artificially spawns and collects eggs from marked hatchery origin steelhead $\geq$16 in. TL.

7.2 Collection or sampling design

A fish weir is generally installed in September and fish ladder opened after river water temperatures are at or below 60° F and are expected to remain at that temperature or lower. This occurs prior to the fall Chinook salmon run and prior to steelhead entering the American River. The fish weir is removed in December after the fall Chinook salmon run. Some steelhead may be trapped prior to removal of the fish weir but steelhead are not retained and return to the river.

The fish ladder and trap remain open through the end of the steelhead run when fish are no longer trapped, typically around the end of March. The fish ladder is accessible to any upstream migrating fish.

Fish are crowded into the lift basket and anesthetized prior to sorting. Prior to the 2007-2008 season, carbon dioxide was used as an anesthesia. Starting with the 2007-2008 trapping season, a Smith-Root Electroanesthesia unit was installed and placed in operation.

All steelhead that enter the adult gathering tank are sorted a minimum of once each week during the run, examined for marks, and the degree of sexual maturity determined. Only unmarked fish ≥16 inches are retained for broodstock and all fish <16 total length are immediately returned to the river. All unmarked sexually mature adult steelhead are retained for artificial spawning and are typically spawned a minimum of once a week. Sexually immature marked and unmarked adult steelhead are immediately returned to the river via the stainless steel return tubes. Sexually immature marked adult steelhead are identified by removing a notch from the upper lobe of the caudal fin prior to being returned to the river. If recaptured, these steelhead trapped are marked with a second mark on the lower caudal fin and processed as before.

7.3 Identification of broodstock

Adipose fin marked fish <16 in. TL may be non-migrant hatchery origin fish. Sexually mature fish < 16 in. TL are most likely resident trout or juvenile fish that did not migrate to the ocean. Since the 2000-2001 trapping season when all the returning hatchery origin steelhead would have been adipose fin marked, 514 (2.9%) unmarked steelhead have been reported trapped (Table 7-1).

Table 7-1. Number and percentage of unmarked steelhead trapped at the Nimbus Fish Hatchery, 2000-2001 through 2009-2010 seasons.

Season	Number of steelhead trapped	Number of marked steelhead	Number of unmarked steelhead	Percentage of marked steelhead
2000-2001	2,877	2,813	64	(2.2%)
2001-2002	1,742	1,692	50	(2.9%)
2002-2003	887	818	69	(7.8%)
2003-2004	1,862	1,835	27	(1.5%)
2004-2005	2,772	2,755	17	(0.6%)
2005-2006	2,308	2,218	90	(3.9%)
2006-2007	2,684	2,626	58	(2.2%)
2007-2008	758	711	47	(6.2%)
2008-2009	1,095	1,037	58	(5.3%)
2009-2010	987	953	34	(3.4%)
Total	17,972	17,458	514	
Mean	1,797	1,746	51	(2.9%)

7.4 Number of Broodstock collected

No established broodstock goal has been established for NFH. An annual released of 430,000 yearling steelhead has been the accepted mitigation for construction of Nimbus Dam. Based on historical survival rates from green egg to juvenile fish released, hatchery personnel take approximately 2 million green. Based on a 10-year average of approximately 5,500 eggs per female, approximately 365 female steelhead and a similar number of males are required for broodstock.

During the past 10 years, NFH has trapped an annual average of 1,797 steelhead and egg collection has met the 2 million green egg goal. Additional steelhead have been spawned throughout the season to ensure that sufficient eggs are taken throughout the steelhead run period to meet both the mitigation goal and to represent the entire steelhead run period .

7.5 Disposition of hatchery-origin fish and eggs collected in surplus of brood stock needs

All sexually immature steelhead are returned to the river via the stainless steel return tubes during the sorting process. Experience has demonstrated that sexually immature adult steelhead held at NFH are subject to disease, injury, and high mortality. Since steelhead previously trapped and returned to the river have demonstrated a strong tendency to return to the fish ladder and trap, no attempt is made to hold adult steelhead.

Eggs in excess of NFH need are disposed of through DFG contractual agreement with a private processing/rendering company.

7.6 Adult fish transportation and holding methods

No adult steelhead are transported to or from NFH. Adult fish with an adipose fin (indicating a naturally spawned fish) and sexually immature fish are returned immediately to the river via 1 of 5 tubes described in Section 4.1.6. After spawning, all live adult steelhead are returned immediately to the river.

7.7 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 and washed, eggs are immersed for 20 minutes in a 100 ppm PVP Iodine (10% Povidone-Iodine Complex) to help eliminate pathogens. PVP-Iodine is effective against a broad spectrum of disease-causing microorganisms and is used to kill bacteria, viruses, fungi, protozoa, and yeasts on contact. PVP iodine is also applied to eggs during incubation to control fungus.

7.8 Disposition of carcasses

All dead adult steelhead or Chinook salmon collected as part of the broodstock collection program, and any dead carcasses of juvenile fish collected during the rearing process are frozen, stored, and routinely disposed of through DFG contractual agreement with a private processing/rendering company.

7.9 Measures applied to minimize the likelihood for adverse genetic or ecological effects to listed natural fish resulting from the broodstock collection program.

The following measures are applied at NFH to minimize the likelihood for adverse genetic or ecological effects to listed natural fish resulting from the broodstock collection program.

1. No listed natural fish are used for NFH broodstock.
2. All listed natural fish collected are immediately returned to the river after sorting and identification.

8. Mating

8.1 Selection method

Only sexually mature adipose fin marked steelhead (>16 inches TL) are selected for spawning. All mating and paring of adult fish is done randomly and no attempt is made to select fish for any morphological characteristic.

Steelhead redd surveys on the American River have been conducted by Reclamation in past years. Based on information from 2005 and 2007, redd construction and most likely spawning appears during a 15 week period from standard week 52 (week beginning December 24) through standard week 11 (week beginning March 11), with the peak during from mid-February through early March (Figure 8-1). Additional fish are typically spawned and eggs taken to ensure that representative egg lots are taken throughout the spawning period of NFH winter steelhead.

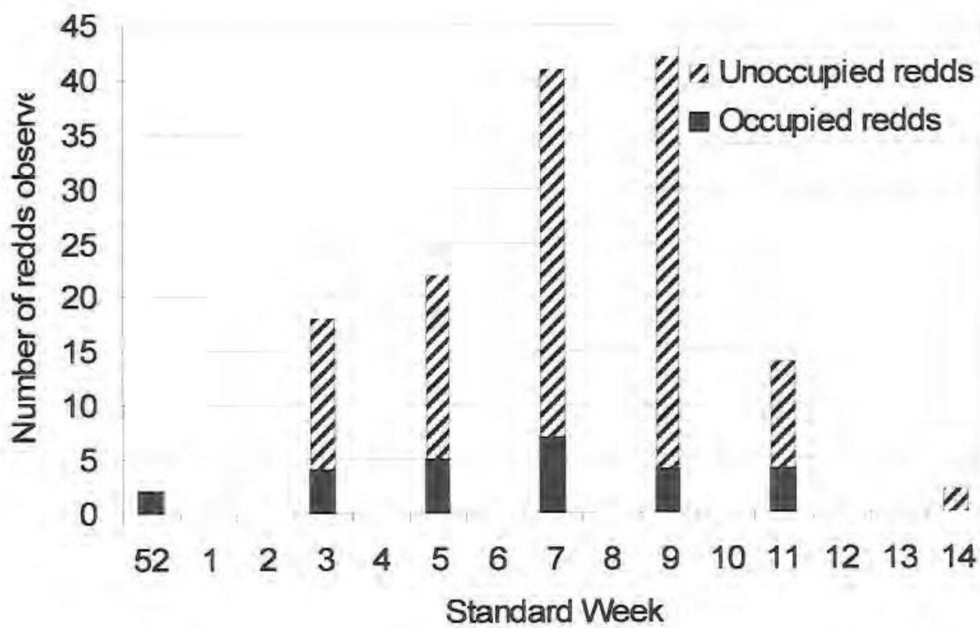


Figure 8-1. Timing of steelhead redd construction in the American River (data from Reclamation surveys).

To ensure representative egg lots are taken throughout the steelhead run, a recommended minimum number of females to be spawned weekly were determined for a 15-week period (Figure 8-2). Although the mean number of steelhead trapped weekly during the past 10 years demonstrates a bi-modal distribution with peaks occurring at the end of the year during week 52 (week starting December 24) and a second peak week 5 (week starting January 29), the graph was depicted as a normal distribution.

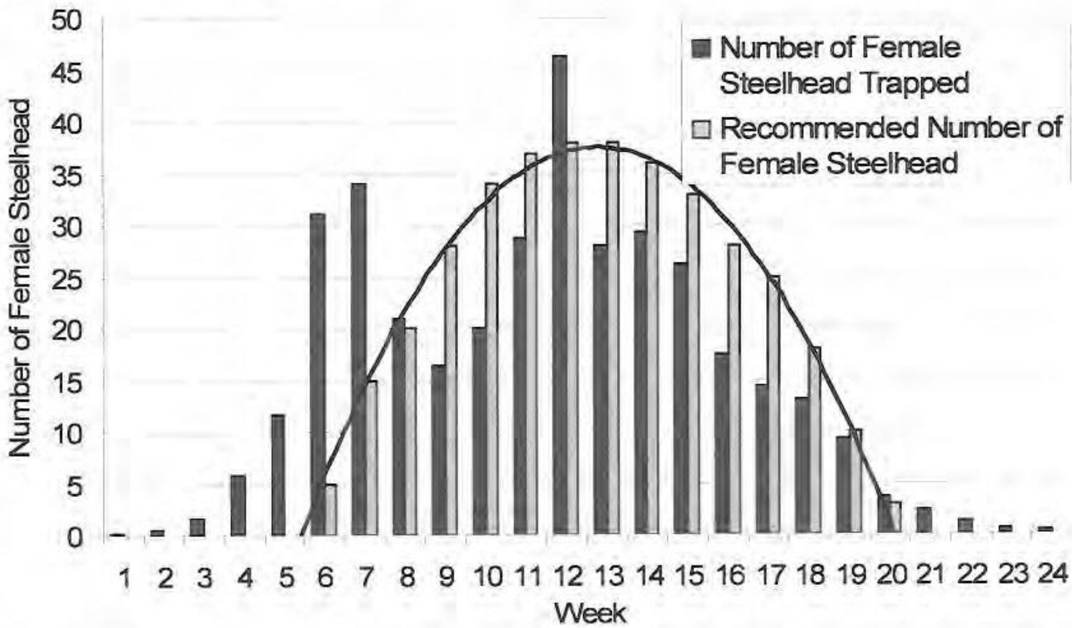


Figure 8-2. Graphic representation of the recommended minimum number of female steelhead to be spawned by standard week.

The representative spawning numbers are based on number of fish trapped and Reclamation personnel observations of redd construction by steelhead in the American River. The graph is meant to be a recommendation since it is not feasible to match the exact numbers due to varying maturation times and mortality associated with holding sexually immature adult steelhead.

8.2 Males

Only sexually mature adipose fin marked adult (> 16 in TL) male steelhead that demonstrate free flowing sperm are selected. Selection is done randomly (e.g., all sexually mature male fish have an equal chance of being selected).

8.3 Egg collection and fertilization

Air spawning as described by Leitritz and Lewis (1976) is used to collect steelhead eggs. To expel eggs from female steelhead, compressed air (3.5 psi) is injected into the female's abdomen by a hypodermic needle. Air pressure causes the eggs to be expelled out through the vent and into a spawning pan. A single male fish is randomly selected from the trapped fish and sperm expressed in to the pan with eggs by hand stroking the male fish's abdomen area. Approximately 8 ounces of a 30% saline solution is added to the pan to cover the eggs; the salt solution holds the albumen from the broken eggs in solution, keeps the micropyle from becoming clogged, and prevents agglutination of the sperm. After eggs are fertilized, they are washed in fresh water and drained in a colander. The eggs are place in a bucket with fresh water and transferred to hatching jars or incubators.

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. An attempt is made to retain representative egg lots to mimic the natural spawning period of winter steelhead from the American River.

8.4 Cryopreserved gametes

No steelhead eggs or sperm are preserved at NFH.

8.5 Measures applied to minimize the likelihood for adverse genetic or ecological effects to listed natural fish resulting from the mating scheme

Only adipose fin marked adult steelhead and no identifiable listed steelhead (unmarked steelhead) are included in the mating scheme. As such, no known adverse genetic or ecological effects are anticipated from the mating scheme.

9. Incubation and Rearing

9.1 Incubation

Trout and salmon eggs undergo a continuous developmental change from the time they are taken that is dependent on water temperature. The incubation period or average hatching time of the eggs is not fixed for a given temperature and the incubation period may vary as much as 6 days between egg lots taken from different parent fish. Leitritz and Lewis (1976) reported that steelhead eggs take 30 days at 51° F to hatch. Water temperatures at NFH during the period of steelhead egg incubation varies annually but are typically between 49 and 51° F.

9.2 Number of eggs taken and survival rates to eye-up and/or ponding

During the 2000-2002 through 2009-2010 seasons, 17,296,329 steelhead eggs were taken from 3,195 female steelhead for an average of 5,913 eggs per female (Table 9-1). These eggs resulted in a total of 14,160,610 eyed eggs for a 10-year average survival rate to the eyed stage of 82.1%.

Table 9-1. Number of female steelhead spawned and number of eggs taken 1998-99 through 2000-2001 through 2009-2010 seasons.

Season	Number of female steelhead spawned	Total number of eggs collected	Mean number of egg per female	Number of eyed eggs produced	Percentage
2000 - 2001	431	2,043,545	4,741	1,696,142	(83.0%)
2001 - 2002	190	1,168,244	6,149	946,278	(81.0%)
2002 - 2003	170	1,060,490	6,238	943,836	(89.0%)
2003 - 2004	163	1,000,120	6,136	770,092	(77.0%)
2004 - 2005	578	2,580,366	4,464	2,327,490	(90.2%)
2005 - 2006	422	2,154,768	5,106	1,943,601	(90.2%)
2006 - 2007	630	2,891,666	4,590	1,937,416	(67.0%)
2007 - 2008	145	1,063,649	7,336	811,564	(76.3%)
2008 - 2009	218	1,680,002	7,706	1,554,002	(92.5%)
2009 - 2010	248	1,653,479	6,667	1,230,188	(74.4%)
Totals/Means	3,195	17,296,329	5,913	14,160,610	(82.1%)

9.3 Cause for, and disposition of surplus egg takes.

No surplus eggs are intentionally taken at NFH. However, as part of efforts to mimic the natural run and spawning period, some eggs may become surplus to the mitigation requirements of NFH. Eggs that are determined not needed to meet mitigation requirements are disposed of through DFG contractual agreement with a local processing/rendering company.

9.4 Loading densities applied during incubation.

All steelhead eggs are placed in NFH modified hatching jars with to a maximum loading density of 300 ounces of eggs per hatching jar.

Hatching jars are not be used for smaller egg lots or for egg lots that would not fill the hatching jars to a minimum of 50%. In these instances, vertical stacked tray incubators may be used. The maximum loading density for each vertical tray is 150 ounces.

All eggs incubated in the vertical trays and hatching jars remain until 90% of the alevins have absorbed their yolk sacks (buttoned-up). When the majority of eggs have hatched, all the remaining eggs and alevins are carefully poured into the deep tanks.

9.5 Incubation conditions

During incubation, fresh water is circulated through the hatching jars through a hose attached to the bottom, allowing water to travel up through the eggs and overflow out the top. The rate at which water enters the hatching jars and later the deep tanks varies with the size of the eggs but is generally less than 35 gpm. Water temperature during steelhead egg incubation varies and can range from 46°-55° F. Hatched fry are allowed to escape from the hatching jars into the deep tanks.

9.6 Ponding (raceways)

Alevins are held in the deep tanks until they reach a weight of 30 to 80 fish per pound. During this time, salt is added to the tank to produce a light solution of 0.01 to 0.2 percent salt to induce mucus sloughing and help reduce and eliminate microorganisms. Alevins remain in the deep tanks until they are moved to the raceways. Juvenile steelhead remain in the raceways until they are released.

9.7 Fish health maintenance and monitoring

Fish health is routinely monitored by the DFG's Fish Health Laboratory personnel. If deemed necessary, emergency fish health inspections can be conducted and any treatment or drugs prescribed by the DFG's Fish Pathologist/Veterinarian.

9.8 Measures applied to minimize the likelihood for adverse genetic and ecological effects to listed fish during incubation

No state or federally listed salmonids are propagated at NFH.

9.9 Rearing

After hatching, steelhead alevins remain in deep tanks until they reach a weight of 30 to 80 fish per pound at which time they are move to the concrete raceways. Fish density in the ponds varies based on water temperature and size of fish but due to the number of ponds and number of juvenile steelhead is not a limiting factor at NFH.

During the juvenile fish rearing period dorsal fin erosion often occurs. There is extensive literature on the causes of fin erosion in salmonids (Bosakowski and Wagner 1995; Arndt et al. 2002; Pelis and McCormick 2003; Latremouille 2003; St Hilaire et al. 2006) and in general, diet composition influences the rate of dorsal fin erosion because of metabolic, behavioral, or a combination of these influences. Exposure to sun has been also suggested as a contributing factor. To help improve the health of juvenile steelhead reared in raceways, 50% (200 ft) of each raceway was experimentally covered with shade cloth in 2007. Observations suggested that the incidence of dorsal fin erosion and sunburn in juvenile steelhead was reduced (T. West, Hatchery Manager II, personal communication)

9.10 Survival rate data (average program performance) by hatchery life stage (fry to fingerling; fingerling to smolt) for the most recent ten years, or 'for years dependable data are available'.

During the 10-year 2000-2001 to 2009-2010 seasons, 14,160,610 eyed eggs produced 4,381,703 released fingerlings and yearling juvenile steelhead for an estimated rate of 25.3%.

9.11 Density and loading criteria (goals and actual levels)

Fish rearing densities are dependent upon a number of factors and are typically determined for individual facilities (Leitritz and Lewis 1976). At NFH, deep tanks have been determined capable of holding approximately 1,500 gallons of water although the depth is varied from egg hatching through rearing. Each tank at maximum depth is capable of holding approximately 70,000-75,000 steelhead fry at a density of approximately 50 fish per gallon.

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. At maximum depth of approximately 36 inches (approximately 90,000 gallons) and flow rate of 3.5 cfs. NFH personnel have determined that each raceway is capable of holding approximately 85,000 steelhead fry (0.95 fish per gallon) and approximately 75,000 yearling-sized juvenile steelhead (0.8 fish per gallon).

9.12 Fish rearing conditions

Once the steelhead fry have become free swimming and feeding, the depth of the water in each of the deep tank is slowly increased from 10 inches to 27 inches to prevent overcrowding. Fry remain in the deep tanks for approximately 6 months until they reach 250-300 to the pound, at which time they are moved to raceways for the remainder of their rearing period.

9.13 Fish growth information (average program performance), including length, weight, and condition factor data collected during rearing, if available.

Biweekly or monthly fish growth information is not available due to inconsistent reporting in the annual reports.

9.14 Monthly fish growth rate and energy reserve data (average program performance).

Monthly growth rates of juvenile steelhead at NFH were estimated from information in NFH annual reports (Figure 9-1).

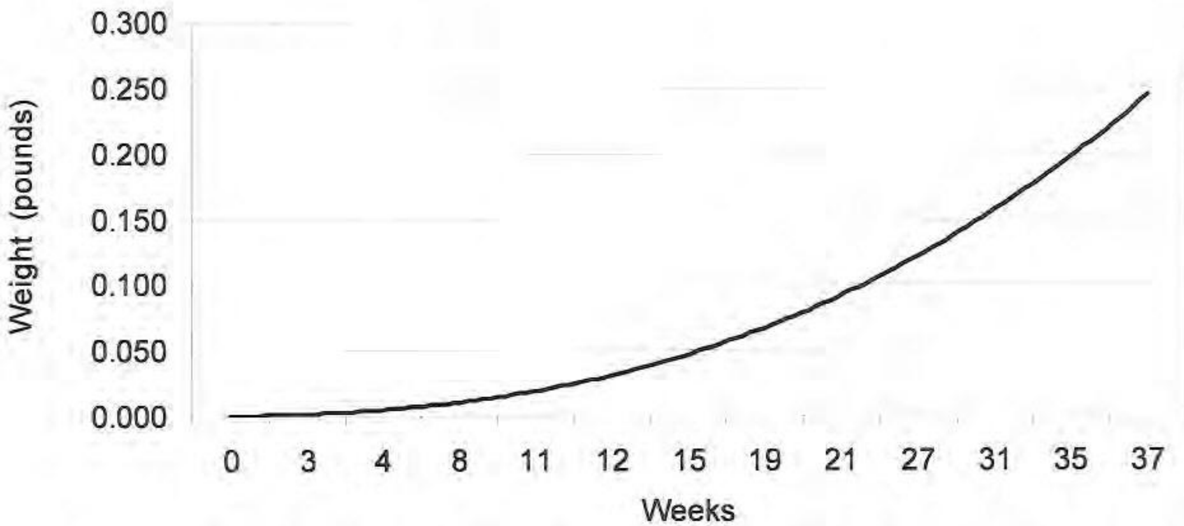


Figure 9-1. Estimated monthly growth rate of juvenile steelhead at NFH (data from NFH daily food charts).

9.15 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).

After the steelhead alevins have absorbed their yolk sac, they are placed on a diet of semi-moist fish food in sizes #0, #1, #2, 1.2mm, and 1.5mm for the first 5 months. Then for remaining 9 months, they are fed a dry, floating pellet food (brand varies depending on annual fish food contracts) with a packet of Vitamin A added. Fry are fed up to 12 times per day.

The amount of food fed through the rearing period is dependent on fish body weight and fish appetite although the ideal amount of food per fish is 3% of their total body weight (Leitritz and Lewis 1976). Approximately 120,000 lbs of fish food is fed to the juvenile fish for an average conversion rate of 1.11:1. The juvenile fish are typically fed a dry feed composed of 1.25% phosphorus, 16% fat and 9 to 12% ash. Initially the fish are fed 16 times per day, which is reduced to 6 times per day when they are 300 fish/lb, and 3 times per day after they reach a size of 100 fish/lb.

Moist feed is stored in a freezer to maintain freshness. Dry feed is purchased in bulk and stored in large feed bins that keep it dry. All feed orders are sized and timed so that the feed is used up before the expiration date, minimizing waste. Fish feed is stored according to manufacturers' recommendations to reserve the nutrient quality and prevent waste. Humidity is kept to a minimum as conditions allow to preventing growth of molds or bacteria on feed. Manufacturers' recommendations for feed shelf life are followed.

Juvenile fish in the hatchery buildings are hand fed while juvenile fish in the raceways are fed using a blower mounted feeder that is driven past the raceway. Moist feed is disbursed by hand and a mechanical feed cart to transport the food. Dry food is all disbursed mechanically using a motorized cart mounted blower-type feeder. Feeding is directed to the fish and feeding behavior monitored to ensure good growth and feed conversion, and to reduce the accumulation of solids in the tanks and raceways. Manufacturer's guidelines for feeding fish are followed and hatchery personnel are encouraged to observe fish behavior at all times, especially during feeding.

Juvenile steelhead are inventoried to determine number and weight at least every 2 weeks but may be made weekly, particularly if the water is over 55° F and the fish are growing rapidly. The feed schedule is adjusted each time the weight counts are made to minimize food waste and solid accumulation. Juvenile Chinook salmon are inventoried when transferred from the hatchery building to the raceways. Weight counts (average size of fish) are determined using standard methods described by Leitritz and Lewis (1976).

Fish are routinely not fed prior to handling (i.e. moving them to another pond, loading them onto trucks for release and tagging) to minimize stress and mortality, and expulsion of excess solids.

9.16 Fish health monitoring, disease treatment and sanitation procedures

Fish health is routinely monitored by the DFG's Fish Health Laboratory personnel and Biosecurtiy procedures followed by NFH personnel. Disease treatments are recommended by a Fish Pathologists and a veterinarian assigned to the Fish Health Laboratory

Standard sanitation practices included:

- Routine cleaning of all fish rearing facilities,

- Hatchery building PVC pipes in the drain on the posterior side of the metal screen in the deep tanks are changed to maintain a higher water depth of approximately 27 in. to increase the amount of water in each tank,
- Hatchery tanks are cleaned daily when fish are present,
- Raceways are cleaned weekly or more often as necessary when fish are present, debris is carefully "swept" from the upper (upstream) section of the pond towards the lower (downstream) section of the pond using long handled brooms.
- Raceways are drained and cleaned using a power washer annually, and
- CDFG Fish Health Laboratory Biosecurity procedures are followed.

9.17 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 to the juvenile fished body and loosening of the scales are used as general indicators of smolting.

9.18 Indicate the use of "natural" rearing methods as applied in the program.

No natural rearing methods are used at NFH.

9.19 Indicate measures that will be applied to minimize the likelihood for adverse genetic and ecological effects to listed fish under propagation

No listed salmonids are propagated at NFH.

10. Release

10.1 Proposed fish release levels

Mitigation goals are for the annual release of 430,000 juvenile steelhead at a size of 4 per pound or larger prior to release. In years when the quality of water delivered to the hatchery does not meet fish rearing standards, a portion of the fish may be released at a smaller size to provide improve rearing conditions for the remaining fish.

10.2 Specific location(s) of proposed release(s)

Presently, all juvenile steelhead are in the American River approximately one mile upstream from the confluence with the Sacramento River.

10.3 Actual numbers and sizes of fish released by age class through the program

Since 1955, NFH has released approximately 16 million fingerling and 17 million yearling size juvenile steelhead in anadromous waters within the Central Valley. With the exception of 2008, fingerling size fish have not been released since 1994 (Figure 10-1). Fingerling size fish were released the spring of 2008 to reduce the number of juvenile steelhead reared at NFH in anticipation of high hatchery water temperatures.

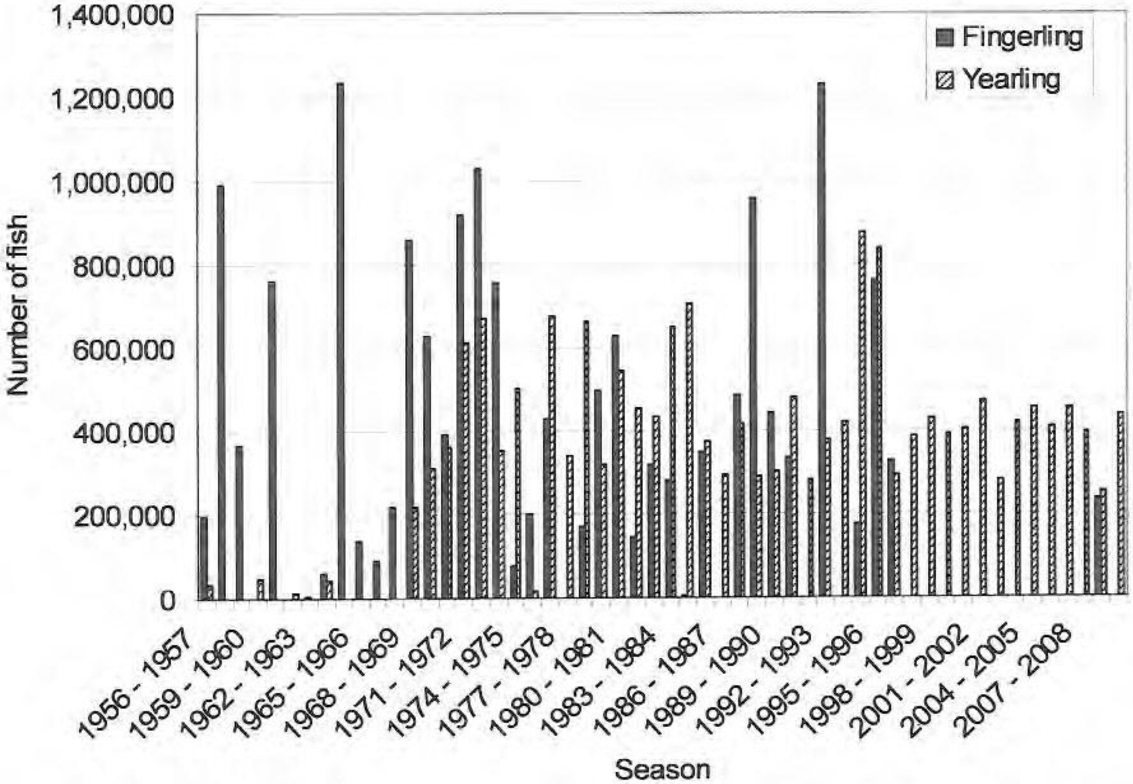


Figure 10-1. Numbers of fingerling and yearling size juvenile steelhead released from Nimbus Fish Hatchery 1956-1957 to 2009-2010 seasons.

10.4 Actual dates of release and description of release protocols

Yearling size juvenile steelhead are released during the period January through March and specific release dates are dependent on fish size; and equipment and personnel availability. Fish are typically released as yearlings after approximately one year of growth at a size of approximately 4 fish per pound. Regardless of size, juvenile steelhead are not held past March 30th due to increasing hatchery water temperatures and to encourage springtime outmigration.

If releases occur during periods of low flows in the Sacramento River and possibly the American River, some released fish migrate back to NFH rather than migrating downstream. These fish may take up residency in the river and contribute to a resident trout population. Anglers often report catching smaller "half pounder" adipose fin marked steelhead in the lower American River in the fall and spring.

Additionally, juvenile fish are released during the months of February and early March to coincide with the State Water Resources Control Board Decision 1641 that the Delta Cross Channel Gates will be closed from February 1 through May 20. Releasing fish during the period of gate closure reduces straying into the Delta. , When possible, releases of NFH-produced steelhead should coincide with higher flow releases (>30,000 cfs) in the Sacramento River to encourage out migration and during the period from February 1 through May 20 to reduce straying and increase survival.

As noted in Section 9.1, some portion of juvenile fish may be released at an earlier date if rearing conditions are expected to result in fish losses. This typically occurs during dry years when reservoir storage is reduced and cold water releases are limited.

Fingerling size fish have not been released since 1996 with the exception of 2008 when it was decided to reduce the number of juvenile steelhead reared in the hatchery in anticipation of unusually high summertime water temperatures.

10.5 Fish transportation procedures

Juvenile steelhead are transported to the release site in a 2,800-gallon fish transportation tank. In addition to fresh water from the hatchery water system, approximately 50 pounds of kiln-dried salt is added to the tank. A maximum of 2,300 pounds of fish are hauled in each load. Fish are transferred into the tank using the Aqua-Life Harvester Dewatering Tower. Fish and water are released from the rear release gate at the release site.

10.6 Acclimation procedures

No acclimation procedures are conducted prior to fish release. An effort is made to maintain tank and river water temperatures at the same temperature during transportation by adding ice to the transportation tank.

10.7 Marks applied, and proportions of the total hatchery population marked, to identify hatchery adults

Prior to 1998, various groups of juvenile steelhead have been marked by fin clipped or coded-wire tag (CWT) as part of experiments and studies. Starting with the 1998 BY, all of NFH-produced juvenile steelhead have been marked with an adipose-fin clip denoting a hatchery origin fish.

10.8 Disposition plans for fish identified at the time of release as surplus to programmed or approved levels

Specific plans are not provided for the release of fish surplus to the existing mitigation goals. The DFG's Operation Manual provides that if approved by the Chief of the DFG Fisheries Branch, surplus fish may be stocked in waters where they do not and will not conflict with existing management goals or policies. These locations have included both anadromous and inland waters.

10.9 Fish health certification procedures applied pre-release.

All juvenile steelhead are certified disease-free by DFG Fish Pathologists prior to release. Certification procedures are described in the DFG's Operation Manual. Diagnostic procedures for pathogen detection follow American Fisheries Society professional standards as described in Thoesen ed. (1994).

10.10 Emergency release procedures in response to flooding or water system failure

If the hatchery rearing ponds become flooded because of high flow releases from Nimbus Dam and it becomes necessary to release all the juvenile steelhead from the raceways, the trailer-mounted Aqua-Life Harvester Dewatering Tower can be moved to the lower end of the raceways and a flexible hose attached to the discharge pipe. The discharge end is then placed in the lowest section the fish ladder and fish can be crowded to the downstream portion of the raced and pumped from the raceway directly into the American River. This process can be continued until all raceways are empty of fish.

If it becomes necessary to release juvenile steelhead from the deep tanks located in either hatchery building, the tank screen and drainpipe can be removed allowing the fish and water to discharge directly into the American River via an underground discharge pipe. The outfall for the discharge is located approximately 250 feet downstream from the entrance to the fish ladder.

If the water system becomes disrupted while juvenile steelhead are being reared, an alternative water source can be provided. For example, in June 2007, due to leak in one of the main water supply lines, an alternative water source was installed. Four 10-inch intake pipes were installed into head box attached to four diesel water pumps with a maximum capacity of moving up to 3 cfs. Water was pumped from the head box into four 10-inch aluminum pipes to provide water to the head box of each raceway and successfully provided an adequate alternative supply.

If installing an alternative water source is not feasible, it may become necessary to implement emergency fish release procedures. Emergency release procedures include increasing the hatchery fish hauling ability through acquiring additional hauling tanks from other DFG facilities and increasing the number of fish transported daily. This procedure will continue until all the fish are released or the emergency is abated, whichever is first.

10.11 Measures applied to minimize the likelihood for adverse genetic and ecological effects to listed fish resulting from fish releases

Concern for straying of NFH winter steelhead into other Central Valley rivers systems has been expresses. Schroeder et al. (2001) reported the two predominant factors that contributed to straying of Oregon steelhead were releases of stocks transplanted from their natal basins and releases into adjacent basins. They suggested that to reduce straying, strategies might include:

1. Using local brood stocks
2. Rearing and releasing fish within their natal basins
3. Reducing the numbers of hatchery fish released
4. Eliminating some hatchery releases altogether.

Yearling steelhead produced at NFH are released in the American River upstream from the confluence with the Sacramento River. NFH personal uses broodstock collected from the American River although it is recognized that the majority of winter steelhead returning to the American River are comprised mainly of hatchery-produced fish that are not an indigenous stock. Straying could be reduced by reducing or eliminating the number of hatchery fish reared, however, current release numbers are established as mitigation.

Releasing juvenile steelhead in the American River helps reduce straying of returning adult fish while ensuring sufficient returns of adult steelhead to NFH to maintain broodstock.

It is recognized that NFH winter steelhead may stray into other Central Valley rivers; and conversely, non-NFH produced steelhead may have been trapped at NFH. All adipose-marked steelhead are of hatchery origin but are not tagged with unique identification tags or marks, and as such, it is not possible to identify specific stocks of hatchery origin steelhead during broodstock collection. Nonetheless, the winter upstream migration timing and larger physical size of NFH winter steelhead help identify this stock from the smaller size Central Valley steelhead (A. Kastner, FRH Hatchery Manager II, personal communication).

Hatchery origin adult steelhead have the opportunity to spawn with natural origin steelhead in the American River. Behavioral traits, resistance to disease, physical features, and other adaptations that favor survival of salmon and steelhead spawned in their native stream have been described (Ricker, 1972; Nicholas and Hankin 1988). In addition, Riesenbichler and McIntyre (1977) found that interbreeding of hatchery and wild steelhead in Trout Creek (Deschutes River, Oregon) led to decreased smolt survival even though the hatchery broodstock was of local origin. McIntyre (1984) also reported decreased survival resulting from unintended selective pressure in the hatchery that led to changes in behavior or some other trait within just a few generations.

NFH-produced juvenile steelhead are released at a time that encourages out migration and helps reduce competition with and predation on winter- and spring-run juvenile Chinook salmon that are migrating in the Sacramento River. If NFH-produced juvenile steelhead are released during a period of higher Sacramento River flows, out migration is encouraged. In years of low flows in the Sacramento River, some juvenile NFH-produced steelhead have been observed returning upstream and entering the NFH ladder a short time after release (T. West, NFH Hatchery Manager II, personal communication). It is also likely that fewer fish will be captured in water export pumping operations in the Delta during periods of higher flows.

11. Monitoring and Evaluation of Performance Indicators

Performance Standards and Indicators for the NFH steelhead program are listed in Section 1.10. Performance Standards are designed to help achieve the program goal and are generally measurable, realistic, and time specific. Standards include indicators that help define and evaluate success towards the program goal

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

The majority of the responsibility for monitoring performance indicators listed in Section 1.10 and reporting results is the responsibility of NFH personnel (Table 11-1). Some monitoring and reporting, and the majority of effort associated with evaluating the results are the responsibility of DFG fisheries management staffs. In some instances, monitoring actions such as genetic analysis of tissue samples is done through state contracts with appropriate contractors. DFG fisheries management and administrative staffs are responsible for preparing and implementing contracts.

Table 11-1. Performance standards, performance indicators, and monitoring actions for the NFH steelhead program.

Performance Standard	Performance Indicator	Monitoring Action
1. Program is operated to provide recreational fishing opportunities in the American River consistent with California sport fishing regulations and Fish and Game Commission policies.	*Indicator 1.1:* Number of NFH adult steelhead caught and kept by anglers meets recreational fishing objectives for the American River established by the DFG.	The number of steelhead caught and kept by anglers will be monitored by DFG personnel and results reported in annual Sport Fish Restoration Act reports or other appropriate formats (i.e. DFG Administrative reports or Cal Fish and Game Quarterly articles.
Standard 2: Program will attempt to meet but not exceed production and mitigation goals.	*Indicator 2.1:* 2.1 million steelhead eggs are taken annually. *Indicator 2.2:* 1.8 million eyed eggs are produced annually (green to eyed egg survival meets 10 year average of 82%). *Indicator 2.3:* 430,000 yearling-sized steelhead reared and released annually as a of NFH mitigation goals (eyed egg to juvenile release size meets 10 year average of 25%).	NFH personnel will record number of eggs taken; number of eyed eggs produced; and number and size of yearling-size fish released and report information in NFH annual reports.
Standard 3: All (100%) hatchery-produced juvenile steelhead are adipose fin marked prior to release.	*Indicator 3.1:* Hatchery annual reports and marked fish release reports indicate that 100% of steelhead are marked.	NFH personnel (or contractor) will adipose fin mark 100% of the juvenile fish reared for release and report numbers in NFH annual reports.
Standard 4: Minimize straying and related genetic introgression of hatchery origin steelhead with out-of-basin natural origin steelhead.	*Indicator 4.1:* All (100%) NFH juvenile steelhead are released into the American River. *Indicator 4.2:* Adipose fin marked steelhead comprise less than 5% of the natural origin spawning population in Central Valley streams.	NFH personnel will transfer all fingerling fish reared for release to appropriate release sites in the American River. Release information will be reported in NFH annual reports. DFG personnel (or other appropriate personnel) will monitor natural original Central Valley steelhead and report number of marked and unmarked fish in the populations in other appropriate format (i.e. DFG Administrative reports or Cal Fish and Game Quarterly articles.

Standard 5: Survival of NFH steelhead releases minimizes adverse interactions with natural-origin salmonids.	*Indicator 5.1:* Juvenile fish are released when the highest proportion of fish demonstrate smolting characteristics. *Indicator 5.2:* Location and date of juvenile NFH steelhead maximize survival while minimizing adverse interactions. *Indicator 5.3:* In-river release strategies to increase survival and promote rapid emigration are evaluated and reported; and are not limited to transport methods, release methods, release locations, release times, and effects of stream flows and water quality. *Indicator 5.4:* Juvenile fish are released at times that minimize adverse impacts to naturally produced fish.	NFH personnel will monitor juvenile fish smolting characteristics and determine when the highest proportions of juvenile fish are smolthing. Release dates and locations will be reported in NFH annual reports. DFG personnel will monitor success of any experimental release strategies and report results in appropriate formats (i.e. DFG Administrative reports or Cal Fish and Game Quarterly articles.
Standard 6: Steelhead broodstock collection approximates the distribution in age and size of natural-origin American River steelhead.	*Indicator 6.1:* Data on age and size of hatchery broodstock is collected and reported in NFH annual or other appropriate reports.	NFH personnel will collect scale samples and length frequencies from a minimum of 300 fish used as broodstock annually and report collected information in NFH annual reports. DFG personnel will mount and read scales samples and report other appropriate format (i.e. DFG Administrative reports or Cal Fish and Game Quarterly articles. DFG or other appropriate personnel will collect information on number, length frequencies, and incidence of marked and unmarked fish spawning in the American River. Results will be reported in appropriate formats (i.e. DFG Administrative reports or Cal Fish and Game Quarterly articles.

Standard 7: All hatchery broodstock is derived from hatchery origin fish.	*Indicator 7.1:* Only adipose fin marked adult steelhead are used for broodstock and information on the mark status of broostock is collected and reported in NFH annual or other appropriate reports. *Indicator 7.2:* Results reported in annual reports demonstrate attaining conditions of OCAP RPA II.6.2 and demonstrate a complete segregation of known natural-origin fish (ad-clip intact) fish in the NFH broodstock.	NFH personnel will collect information on number, incidence of marked and unmarked fish collected for broodstock, and number of adipose fin marked fish used as broodstock. Results will be reported in NFH annual reports.
Standard 8: Steelhead broodstock mating protocols closely mimic natural size using selective mating practices (i.e. each adult fish will be paired with a similar-sized mate and fish <16 inches TL will not be included in the broodstock selection).	*Indicator 8.1:* Number and size of males and females spawned is reported in NFH annual reports and is consistent with Standard 7 and 8.	NFH personnel will collect information on number and length frequencies, incidence of marked and unmarked fish collected for broodstock, and number of adipose fin marked fish used as broodstock. Results will be reported in NFH annual reports.
Standard 9: Genetic composition of the American River steelhead population is consistent with HGMP goals.	*Indicator 9.1:* Genetic samples of NFH steelhead are collected annually. *Indicator 9.2:* Results of genetic analyses indicate NFH steelhead show similar levels of genetic diversity and inbreeding as natural spawning American River populations.	DFG personnel or their contractors will collect appropriate numbers of tissue samples from NFH broodstock, and conduct or contract with appropriate personnel analysis. Results will be reported in appropriate formats (i.e. contract final reports, DFG Administrative reports or Cal Fish and Game Quarterly articles and evaluated by DFG fishery mangers.

Standard 10: Steelhead trapped at NFH are processed in a manner that minimizes pre-spawning mortality.	*Indicator 10.1:* Mortality rate for adult steelhead is ≤1% of the total steelhead trapped. *Indicator 10.2:* Date, fork length, sex, adipose clip status, presence of other tags or marks are reported for each pre-spawning mortality. *Indicator 10.3:* All marked and unmarked steelhead trapped are returned to the river. *Indicator10.4:* Annual dates of ladder operations, dates of NFH fish processing, and related number of fish spawned, culled, or returned to holding tanks are reported.	NFH personnel will record information on the number of steelhead mortalities that occur during trapping and artificial spawning; collect information on length frequencies and sex; presence of any marks and tags; status of marked and unmark fish; and other information related to the operations of NFH relating to Standard 10. Results will be reported in NFH annual reports.
Standard 11: NFH steelhead eggs, fry, or juvenile fish in excess of production needs (as defined in Standard 1) are disposed of in a manner that is consistent with DFG policies on egg culling and fish disposal.	*Indicator 11.1:* Spawn date (lot number), number of eggs taken, and method of disposal of excess NFH steelhead eggs, fry, or juvenile fish. *Indicator 11.2:* Excess eggs, fry or juvenile steelhead are not released, placed, or planted into any anadromous waters.	NFH personnel will record information on the number of female fish spawned, number of eggs taken, disposition of any culled eggs or fry, and report information
Standard 12: NFH steelhead program is operated in compliance with DFG fish health policies and guidelines.	*Indicator 12.1:* Number of broodstock sampled for pathogens, types and frequencies of observed infections, treatments prescribed are reported in NFH annual reports. *Indicator 12.2:* Survival rates for egg to fry and, fry to juvenile fish released are reported in NFH annual reports and meet any standards established for NFH. *Indicator 12.3:* Number of juvenile steelhead sampled and	DFG Fish Pathologists will report results of fish health monitoring using standard protocols and provide reports to NFH personnel. Results of fish health reports or issues will be reported in NFH annual reports. NFH personnel will record numbers of green eggs taken, eyed eggs, fry, and juvenile fish released and report results in NFH annual reports.

	pathogens observed immediately prior to release meet DFG health standards. *Indicator 12.4:* Results of fish health examinations are reported in NFH annual or other appropriate reports.	
Standard 13: NFH effluent complies with the conditions and water quality limitations identified in the current National Pollutant Discharge Elimination System (NPDES) permit.	*Indicator 13.1:* Dates, locations and number of water samples collected. *Indicator 13.2:* Samples analyzed and results reported. *Indicator 13.3:* Sampling and results consistent with NDPES permit.	NFH personnel will collect water samples and deliver samples to DFG Water Quality Laboratory personnel or other appropriate individuals in a manner and timeframe as indicated in NDPES permit. Results of sampling will be reported in NFH annual reports.
Standard 14: NFH steelhead carcasses are disposed of in a manner identified in the HGMP, and comply with DFG and NMFS criteria.	*Indicator 14.1:* Carcass disposal is consistent with DFG policy and numbers of fish and disposition methods are reported in NFH annual reports.	NFH personnel will collect information on numbers and disposition of any fish mortalities and report results in NFH annual reports.
Standard 15: Information on NFH operations is collected, reviewed and reported in a consistent and scientifically rigorous manner, and available for public distribution at a time determined by the NFH working group.	*Indicator 15.1:* Annual reports are prepared following DFG administrative report format (Appendix 1) for public distribution within 12 months of the end of the cohort-spawning season.	NFH personnel will prepare draft annual reports and submit draft reports to the DFG Fisheries Branch personnel for review, editing, publishing, and distribution.

11.2 Describe plans and methods proposed to collect data necessary to respond to each "Performance indicator" identified for the program.

NFH personnel have the responsibility for collecting the majority of information identified as "monitoring actions". This information is routinely collected and recorded as part of hatchery operations and logged into hard copy "log books" or entered in hatchery databases. A hatchery report is prepared for each fiscal year (July 1 though June 30) following the DFG anadromous fish hatchery annual report format and is available for review (Appendix 1).

Other actions relating to certain performance indicators are identified but are not with the purview of NFH personnel. These actions include analysis, evaluation, and reporting of information collected from angler sampling programs, scale analysis, genetic analysis, fish health monitoring and reporting, water quality analysis, or development and implementation of studies related to the release of juvenile fish or kelts. DFG Fishery managers and biologists, Reclamation personnel, and contractors may be identified and monitoring plans developed.

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

Funding for operation of NFH is provided by Reclamation while staffing and day-to-day operation is provided by DFG. Historically, both funding and staffing have been provided for operation of NFH and are described in contractual agreements between Reclamation and DFG. Funding is anticipated to continue through project life.

As reported in Section 3.2, Reclamation is pursuing study design and funding to support Action II.6.1.2 of the biological opinion with interagency and academic collaborators, and funding a genetic study of Central Valley steelhead. Additionally, Reclamation is working to develop a comprehensive study that would synthesize this information as well as undertake field research on NFH steelhead and American River *O. mykiss* for implementation of Action II.6.1.2. Results from this research will likely make adaptive changes to the final HGMP. Funding status for these actions is unknown at this time.

11.4 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.

During the past eleven years, 2.9% (514 of 17,972) of the steelhead trapped at NFH have been unmarked and presumed to be naturally produced steelhead. As part of monitoring and evaluation activities, scale and tissue samples are generally taken from each unmarked fish, and information on marks, sex, and length is recorded prior to release. To reduce the risk of any adverse effect to listed fish, techniques described by Neilsen and Johnson (1983) are followed. No mortalities to listed fish, or adverse genetic or ecological effects from NFH monitoring and evaluation activites is anticiapted. No listed fish are propagtate at NFH.

12. Research

12.1 Objective and Purpose

Operation and management of NFH are the responsibility of the DFG. Activities of the DFG are directed by the Commission and it is the research policy of the Commission that:

I. Research, including the investigation of disease, shall be performed to provide scientific and management data necessary to promote the protection, propagation, conservation, management or administration of fish and wildlife resources of this state when such data is not available by other means.

II. Whenever possible and advantageous, the services of the University of California or other academic or research institutions, or federal, state, or local agencies shall be used.

III. The Department shall review the following information, which must be clearly stated in any proposed research programs: (a) goals and objectives of proposed research, including benefits to be derived from such research; (b) pertinent background information, including a literature review which supports this research; (c) experimental design, including methods of data collection and analysis; (d) estimated cost of program; (e) its estimated duration; and (f) how results will be presented to the Department.

As reported in Section 3.2 and 11.3, Reclamation is pursuing study design and funding to support Action II.6.1.2 of the biological opinion with interagency and academic collaborators, and funding a genetic study of CV steelhead. Included in these proposals is evaluation of a recommendation to replace the current non-indigenous NFH steelhead broodstock with a broodstock more compatible with Central Valley steelhead or representative of historical American River steelhead (Fisch et al 2010).

Satterthwaite et al (2009) concluded that the greatest management concern with respect to preserving anadromy in the American River is reduced survival of emigrating smolts, although large changes in freshwater survival or growth rates are potentially also important. Success of naturally produce juvenile steelhead is critical to enhancing naturally reproducing stocks of steelhead in the American River.

12.2 Cooperation and Funding

Cooperation is typically conducted between DFG and Reclamation personnel. Funding for hatchery management and research activities can be provided by either entity. Funding has been requested by Reclamation for future research activities but the status is unknown at this time.

12.3 Status of stocks not currently under propagation but may be considered.

USFWS (1953) suggested that since the fish ladder at old Folsom Dam had been destroyed in 1950, "the steelhead run had been virtually eliminated". No information other than antidotal information is available on the historical status, life history, or biology of indigenous American River steelhead.

Efforts to determine the genetic status of *O. mykiss* above Folsom Dam have been made. Nielsen et al (2005) reported that samples collected in 2002 from the Middle Fork American River (above Nimbus and Folsom dams) and Lower American River (below Nimbus Dam) based on pairwise comparisons of allelic frequencies between the two locations were significantly different. Garza and Pearse (2008) also reported that *O. mykiss* samples collected in 2005 from the Middle Fork and North Fork American River were similar, as were samples from NFH and the American River below Nimbus Dam. They indicated that above-barrier populations clustered with one another and below-barrier populations clustered with one another in all tree analyses.

Nielsen el al (2005) suggested that many of the Central Valley steelhead population pairs showing genetic similarity in microsatellite allelic frequencies was not surprising, including samples from NFH and lower American River. They reported these data suggest genetic similarities among hatchery populations and geographically proximate rainbow trout populations with high levels of gene flow. They suggested that gene flow among these populations may be high due to the straying of hatchery fish into adjacent wild populations and it is equally possible that this similarity of genetic structure between wild steelhead and hatchery populations reflects a common ancestry.

Information provided in Sections 6.1, 6.3.1, and 6.3.4 suggests that the historical American River steelhead run was dissimilar to the current Central Valley steelhead. The success of locating a population of American River population of *O. mykiss* that represents the historical indigenous American steelhead, and difficulties converting a wild *O. mykiss* to anadromy; coupled with changes in the American River due to project construction and current operations make the success of such an endeavor doubtful.

12.4 Alternatives and risk aversion measures that will be applied to minimize the likelihood for adverse ecological effects, injury, or mortality to listed fish as a result of the proposed research activities.

No research alternative research activities are proposed as part of this HGMP to those described in Section 12.1 and no listed fish are included as part of any proposed research activities. No adverse ecological effects, injury, or mortality to listed fish are anticipated as a result of any ongoing or proposed genetic analysis.

13. Attachments and Citations

16 USC 1531. 2002. Conservation: Endangered Species: Congressional findings and declarations of purposes and policy. United States Code, 16 USC § 1531(b).

16 USC 1531. 2002. Conservation: Endangered Species: Definitions. United States Code, 16 USC § 1532(16).

40 CFR 122.44. Environmental Protection Agency Administered Permit Programs: Establishing limitations, standards, and other permit conditions. United States Code of Federal Regulations, 40 CFR § 122.44.

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14. Certification Language and Signature of Responsible Party

Appendix 1 Anadromous Fish Hatchery Annual Report Format

State of California
The Resources Agency
DEPARTMENT OF FISH AND GAME

SEASON ANNUAL REPORT
HATCHERY NAME

By

Author Name
Region Name
Fisheries Branch

Inland Fisheries

Administrative Report No. 200X-X

200X

SEASON ANNUAL REPORT
HATCHERY NAME

by

Author Name
Region Name
Fisheries Branch

ABSTRACT

This report describes the operation of *Hatchery Name* from *mm/dd/year* through *mm/dd/year.*

Include the following:

1. *Number of Chinook salmon Oncorhynchus tshawytscha trapped*
   A. *Number of adult female Chinook salmon and female grilse artificially spawned*
   B. *Number of eggs produced.*
2. *Number of steelhead Oncorhynchus mykiss trapped*
   A. *Number of female steelhead artificially spawned*
   B. *Number of eggs taken*
3. *Number of advanced fingerling and fingerling Chinook salmon released*
4. *Number of steelhead released during this reporting period.*

[1] Fisheries Branch Administrative Report No. 200X-X Edited by *editor's name*, Department of Fish and Game, 1416 Ninth Street, Sacramento, CA 95814.

[2] California Department of Fish and Game, *Region name and address*

1. INTRODUCTION (Centered)
   A. Describe the hatchery location
   B. Describe the hatchery goals and objectives
   C. List the operator, owner, and contractor as appropriate
   D. Include period covered by this report mm/dd/year through mm/dd/year

2. PRODUCTION SUMMARY (Centered)
   A. Report number of eggs by broodyear taken or received
   B. Report number of adult fish spawned
   C. List number of fish released.
   D. Summarize in table (see example Table 1)

3. HATCHERY OPERATIONS (Centered)
   A. Fish Weir and Ladder
      a. Date of installation
      b. Any additional pertinent information
   B. Water Supply
      a. Describe the hatchery water source
      b. Describe any temperature controls
      c. Report daily minimum and maximum water temperatures
      d. River Flows
      e. Include additional pertinent information - For example: Water flows were measured by the US Geological Survey at a gauging station located at latitude 38°38'08", longitude 121°13'36" referenced to North American Datum of 1927, in SE ¼ NE ¼ sec.17, T.9 N., R.7 E., Sacramento County, CA, Hydrologic Unit 18020111, on the right bank, 2,100 ft downstream from Nimbus Dam, 2.4 mi east of the town of Fair Oaks at river mile 22.2
      f. Include any graphs or tables (see example Figure 1 and Appendix Table 4 from: http://waterdata.usgs.gov/ca/nwis/rt
   C. Disposal of Salmon Carcasses
      a. List pounds, number, and disposal methods(s) for Chinook salmon carcasses

4. PUBLIC RELATIONS (Centered)
   A. List number of visitors and method of counts
   B. Describe any other related pertinent information
   C. Include Table 2. (See example and double click on the table to bring up imbedded MS Excel spreadsheet)

5. CHINOOK SALMON MAINTENANCE PROGRAM (Centered)
   A. Chinook Salmon Broodstock Collection
      a. Report date of opening fish ladder and operations
      b. Report first spawning date

c. Report total number of Chinook salmon trapped (See attached Weekly Anadromous Fish Count form)
d. Report number of adults trapped
e. Report number of males and females trapped
f. Report number of grilse (identify size criteria i.e. grilse are Chinook salmon 60 cm (23.6 inches) fork length or smaller) trapped
g. Report length frequencies for sample of fish trapped (see attached Anadromous Fish Length Frequency form)
h. Report number of mortalities in ponds or tanks
i. Report number of fish released to river.
j. Summarize numbers of Chinook salmon trapped (see Table 3 example)
k. Include weekly numbers in Appendix Table 1.

B. Sorting and Spawning
   a. List dates of spawning
      (1) Report start and end dates
      (2) Report number of fish spawned by weekly summary
      (3) Describe methods of artificially spawning (i.e. only Chinook salmon that expel free flowing eggs demonstrating they are sexually mature and ready to spawn were euthanized and spawned. Prior to spawning, adult female Chinook salmon were euthanized with a pneumatic knife inserted into the spinal cord immediately posterior to the head. Males are euthanized with a single forceful blow to the dorsal area of the head).
   b. Mating protocols
      (1) Describe mating protocols (i.e. all mating and paring of fish was done randomly. Fish were not selected for any morphological characteristics)
      (2) Report number of grilse (jack or jill Chinook salmon) included the spawning process for every 100 adult Chinook salmon spawned
   c. Length frequency of fish spawned
      (1) Report length frequency of random sample of males and females weekly (~10 fish of each sex)
      (2) Prepare graph or table of length frequency of fish spawned and date.
   d. Eggs Taken
      (1) Report total number taken
      (2) Report number of females spawned by weekly summary
      (3) Report number of eggs taken by weekly summary
      (4) Report number of eggs per female
      (5) Report size of eggs per ounce
      (6) Report fertility rates
      (7) See attached Weekly Anadromous Fish Count and Egg Take form, and Anadromous Fish Egg Lot Report forms
   e. Report all marked Chinook Salmon Recoveries
   f. Report the total number of fish examined

C. Marks and tags observed
   a. List total number of fish examined
   b. Number of marks and tags observed by weekly summary
   c. List CWT's recovered from data provided by DFG Ocean Salmon Project (include as Appendix Table 2, see example).
   d. Report and tissue or scale samples taken and by whom

D. Chinook Salmon Releases
   a. *Year* Brood Year
      (1) Report number and size of fish on hand or released.
      (2) Report number of fish marked
      (3) Report rates for egg, to fry, to smolt
      (4) See Table 4 example
      (5) Repeat as need for more than one broodyear

E. Chinook salmon disease Information
   a. Describe any outbreaks of pathogens or disease
      (1) Include control information
      (2) Describe any medicated feed.
      (3) Describe any routine treatments

6. STEELHEAD MAINTENANCE PROGRAM (Centered)
   A. Steelhead Broodstock Collection
      a. Report date of opening fish ladder and operations
      b. Report first spawning date
      c. Report total number of fish trapped (see Appendix Table 1 example)
      d. Report number of adults
      e. Report Number of males and females trapped
      f. Report number of grilse (identify size criteria i.e. grilse are steelhead <40.6 cm (16 inches fork length or smaller) trapped
      g. Number of mortalities in ponds or tanks
      h. Number of fish released to river.
   B. Sorting and Spawning
      a. Report start and end dates
      b. Report number of fish spawned by weekly summary (See Table 5 example)
      c. Describe method of artificially spawning (i.e. only adult steelhead that expel free flowing eggs demonstrating they are sexually mature and ready to spawn).
      d. Mating protocols
         (1) Describe mating protocols (i.e. all mating and paring of fish was done randomly. Fish were not selected for any morphological characteristics)
      e. Length frequency of fish spawned
         (1) Random sample of males and females weekly (~10 fish of each sex)

(2) Graph or table of length frequency of fish spawned and date.

f. Eggs Taken
   (1) Total number
   (2) Number of females spawned by weekly summary
   (3) Number taken by weekly summary
   (4) Size of eggs per ounce
   (5) Fertility

C. Marked Steelhead Recoveries
   (1) Total number of fish examined
   (2) Number of marks and tags observed by weekly summary
   (3) List CWT's recovered.
   (4) Report any tissue or scale samples taken and by whom.

D. Steelhead Incubation and Ponding
   a. Incubation methods
   b. Egg density
   c. Size and dates of ponding

E. Steelhead Rearing Conditions
   a. Rearing facilities
   b. Describe any natural rearing methods
   c. Diet and feeding regiment
   d. Method of feeding.

F. Steelhead Marking and Tagging
   a. Number of fish marked and tagged
   b. Marks and tags applied
   c. Methods of marking and tagging

G. Steelhead Released
   a. *Year* Brood Year
      (1) Number and size of fish on hand or released.
      (2) Number of fish marked
      (3) Survival rates for egg, to fry, to smolt
      (4) See Table 6 example
   b. *Year* Brood Year
      (1) Number and size of fish on hand or released.
      (2) Number of fish marked
      (3) Survival rates for egg, to fry, to smolt
      (4) See Table 6 example

H. Steelhead Disease Information
   a. Describe any outbreaks of pathogens or disease
      (1) Include control information
      (2) Describe any medicated feed.
      (3) Describe any routine treatments

7. Historical Summary of Fish Trapped (Center)

A. Summarize all fish trapped for all years of operation (see example Appendix Table 3)

8. Literature Cited
   A. Add any Literature Cited references here using the CBE (Council of Biology Editors) Style Manual.
   B. Note - Hatchery annual reports are published by the Department of Fish and Game as Fisheries Branch Administrative Reports. See Inland Fisheries - Informational Leaflet No. 44 INSTRUCTIONS TO AUTHORS OF INLAND FISHERIES ADMINISTRATIVE REPORTS.

9. Appendix
   A. Appendix Table 1. Example Weekly Adult Salmon and Steelhead Trapping Data for *hatchery name, mm/dd/year - mm/dd/year.*
   B. Appendix Table 2. Example Chinook Salmon Coded Wire Tag Recoveries. Preliminary Data, *hatchery name, mm/dd/year - mm/dd/year.* (Information obtained from CDFG Ocean Salmon Project, Marine Branch)
   C. Appendix Table 3. Example Summary of Chinook salmon and steelhead trapped at the *hatchery name, year to present*
   D. Appendix Table 4. Example Daily Water Temperature recorded at *hatchery name, mm/dd/year - mm/dd/year.* (Information obtained from http://waterdata.usgs.gov/

E. Example Table 1. Production Summary for *hatchery name, mm/dd/year - mm/dd/year.*

Species	Eggs Taken or Received	Eggs or Fish Transferred	Fingerlings Planted	Advanced Fingerlings or Yearlings Planted	Total Weight Planted (lbs)
CHIN					
2005 BY	0	0	0	0	0
2006 BY	13,289,655	1,532,678	4,094,300	951,600	76,200
SH					
2006 BY	0	0	0	394,293	71,930
2007 BY	2,857,838	0	0	0	0
Total	16,147,493	1,532,678	4,094,300	1,345,893	148,130

Example Table 2. Monthly number of visitors to *hatchery name, mm/dd/year - mm/dd/year.*

July	Aug	Sept	Oct	Nov	Dec	
33,420	30,630	92,700	121,770	341,400	183,360	
Jan	Feb	Mar	Apr	May	Jun	Total
38,422	50,160	64,230	15,730	17,381	20,797	1,010,000

Example Table 3. Chinook salmon trapped, *hatchery name, mm/dd/year - mm/dd/year.*

Unmarked Chinook salmon trapped				
Adult Males	Adult Females	Total Adults	Grilse	Total unmarked salmon
100	100	200	100	300
Adipose marked Chinook salmon trapped				
Adult Males	Adult Females	Total Adults	Grilse	Total Adipose marked salmon
100	100	200	100	300
Total Chinook salmon trapped				
Adult Males	Adult Females	Total Adults	Grilse	Total Chinook salmon
200	200	400	200	600

Example Table 4. Planting Data for 2006 Brood Year Chinook salmon, *hatchery name, mm/dd/year - mm/dd/year.*

Month	Release Site	Fingerlings	Advanced Fingerlings	Total Fingerlings	Average Size/lbs	Weight (lbs)
May	Crockett	0	473,800	473,800	52	9,200
	Crockett	272,000	0	272,000	68	4,000
June	Crockett	0	477,800	477,800	54	8,900
	Crockett	3,822,300	0	3,822,300	71	54,150
Total		4,094,300	951,600	5,045,900	61	76,250

Example Table 5. Number of Steelhead trapped at the *hatchery name, mm/dd/year - mm/dd/year*.

Date	Spawned and Released		Pre-Spawning Mortality		Unspawned Steelhead			
	Males	Females	Males	Females	Males	Females	Half-pounder	Total
Nov 8	0	0	0	0	7	7	3	17
Nov 13	0	0	0	0	9	11	0	20
Nov 14	0	0	0	0	23	4	1	28
Nov 15	0	0	0	0	22	5	0	27
Nov 16	0	0	0	0	4	0	0	4
Nov 20	0	0	0	0	0	7	0	7
Nov 21	0	0	0	0	29	19	0	48
Nov 22	0	0	0	0	29	14	0	43
Nov 27	0	0	0	0	9	7	1	17
Nov 28	0	0	0	0	2	1	0	3
Nov 29	0	0	0	0	83	58	0	141
Nov 30	0	0	0	0	37	25	0	62
Dec 4	0	0	0	0	34	37	0	71
Dec 5	0	0	0	0	19	22	0	41
Dec 6	0	0	0	0	37	18	0	55
Dec 11	3	3	0	0	126	107	0	239
Dec 12	2	2	0	0	48	63	2	117
Dec 13	0	0	0	0	93	71	0	164
Dec 20	16	16	0	0	110	110	2	254
Dec 27	41	41	0	0	115	142	0	339
Dec 28	28	28	0	0	94	113	0	263
Jan 3	54	54	0	0	44	76	0	228
Jan 10	44	44	0	0	62	68	0	218
Jan 18	61	61	0	0	67	56	0	245
Jan 24	64	64	0	0	44	46	0	218
Jan 31	55	55	0	0	37	55	0	202
Feb 7	54	54	0	0	56	37	0	201
Feb 14	60	60	0	0	65	26	0	211
Feb 21	67	67	0	0	27	30	2	193
Feb 28	62	62	0	0	47	29	0	200
Mar 7	17	17	0	0	12	8	0	54
Mar 14	2	2	0	0	5	5	0	14
Total	630	630	0	0	1,396	1,277	11	3,944

Table 6. Example Planting and Transfer Data, 2006 Brood Year Steelhead, *hatchery name, mm/dd/year - mm/dd/year.*

Month	Release Site	Fingerlings	Yearlings	Average Size/lbs	Weight (lbs)
February	Garcia Bend	0	237,025	5.50	39,955
March	Garcia Bend	0	157,267	5.40	29,275
Total		0	394,292	5.45	69,230

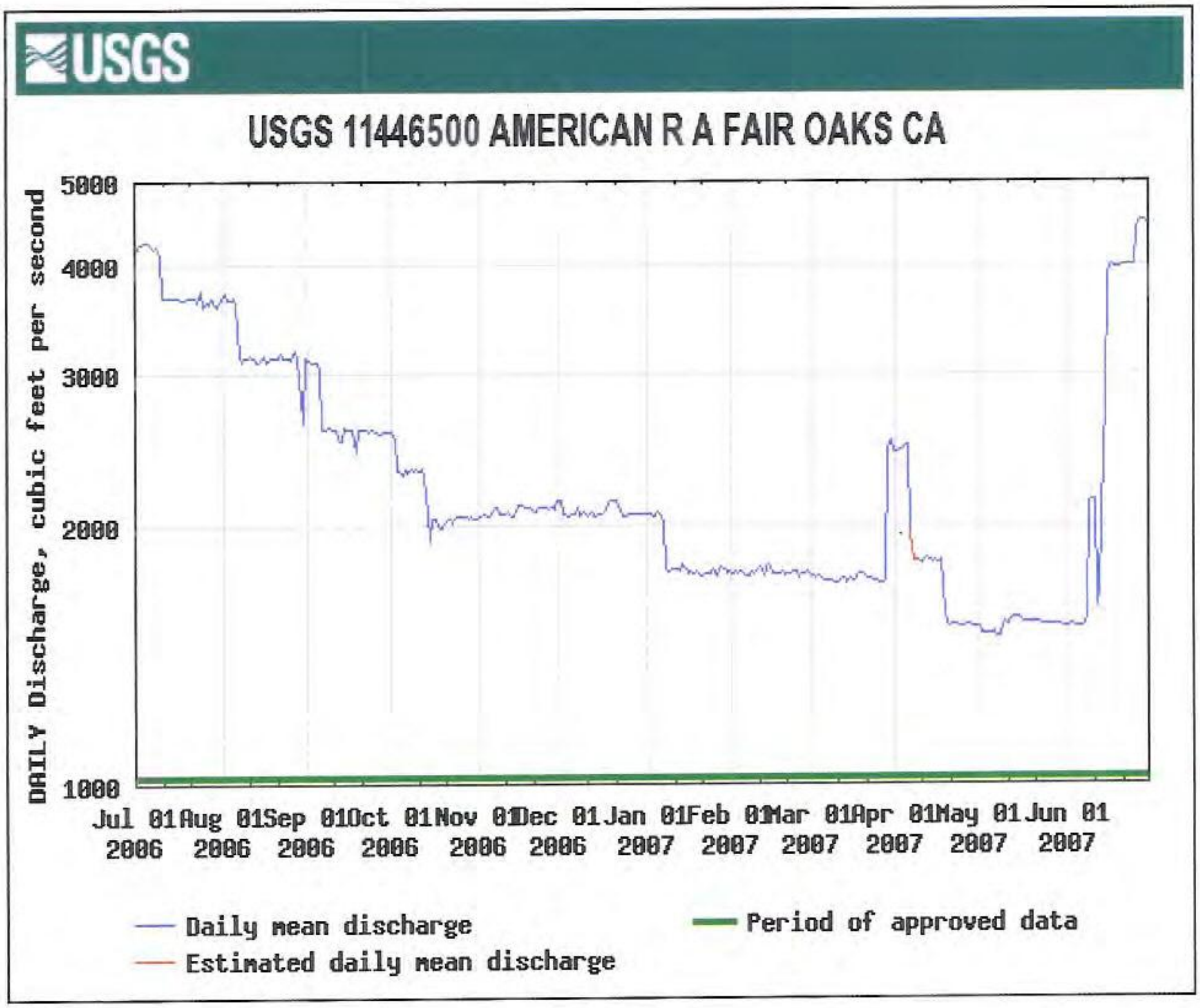

Figure 1. Flows in the American River as measured by the US Geological Survey at the Fair Oaks Gauging station June 2006 – July 2007

Appendix Table 1. Example Weekly Adult Salmon and Steelhead Trapping Data for *hatchery name, mm/dd/year - mm/dd/year.*

		Chinook salmon					Steelhead			
Standard Week	Date	Male	Female	Total	Grilse	Total	Male	Female	<16 in FL	Total
35	27-Aug									
	28-Aug									
	29-Aug									
	30-Aug									
	31-Aug									
	1-Sep									
	2-Sep									
36	3-Sep									
	4-Sep									
	5-Sep									
	6-Sep									
	7-Sep									
	8-Sep									
	9-Sep									
37	10-Sep									
	11-Sep									
	12-Sep									
	13-Sep									
	14-Sep									
	15-Sep									
	16-Sep									
38	17-Sep									
	18-Sep									
	19-Sep									
	20-Sep									
	21-Sep									
	22-Sep									
	23-Sep									
39	24-Sep									
	25-Sep									
	26-Sep									
	27-Sep									
	28-Sep									
	29-Sep									
	30-Sep									
40	1-Oct									
	2-Oct									
	3-Oct									
	4-Oct									
	5-Oct									

Appendix Table 2. Example Chinook Salmon Coded Wire Tag Recoveries. Preliminary Data, *hatchery name, mm/dd/year - mm/dd/year.*

CWT Code	Species	Fork Length	Run	Sex	Run Name	Brood year	Hatchery	Release Site	Stock Name	F
052283	Chinook	71	Fall	F	Late Fall	2004	Coleman National Fish Hatchery	Sherman Island Op Jesy	Coleman National Hatchery	
051778	Chinook	89.8	Fall	F	Late Fall	2003	Coleman National Fish Hatchery		Coleman National Hatchery	
051781	Chinook	88	Fall	M	Late Fall	2003	Coleman National Fish Hatchery	Ryde-Koket	Coleman National Hatchery	
051774	Chinook	64	Fall	F	Late Fall	2003	Coleman National Fish Hatchery	West Sacramento	Coleman National Hatchery	
052290	Chinook	68	Fall	M	Late Fall	2004	Coleman National Fish Hatchery		Coleman National Hatchery	
052282	Chinook	71	Fall	F	Late Fall	2004	Coleman National Fish Hatchery	Port Chicago	Coleman National Hatchery	
062408	Chinook	84	Fall	F	Fall	2003	Feather River Hatchery	San Pablo Bay	Feather River	
050104040**	Chinook	83	Fall	F	Fall	2003	Feather River Hatchery	West Sacramento	Feather River	
062408	Chinook	84	Fall	M	Fall	2003	Feather River Hatchery	San Pablo Bay	Feather River	
062408	Chinook	92.1	Fall	M	Fall	2003	Feather River Hatchery	San Pablo Bay	Feather River	
052064	Chinook	82	Fall	M	Fall	2003	Feather River Hatchery	Port Chicago	Feather River	
060108080**	Chinook	86	Fall	M	Fall	2002	Feather River Hatchery	West Sacramento	Feather River	
050104040**	Chinook	72	Fall	F	Fall	2003	Feather River Hatchery	West Sacramento	Feather River	
062785	Chinook	100	Fall	M	Spring	2002	Feather River Hatchery	Benicia	Feather River	
062760	Chinook	97	Fall	F	Spring	2002	Feather River Hatchery	Benicia	Feather River	
062409	Chinook	85	Fall	F	Fall	2003	Feather River Hatchery	San Pablo Bay	Feather River	
062751	Chinook	89.5	Fall	M	Fall	2002	Merced River Fish Facility	Jersey Pt./San Joaquin River	Merced River	
064588	Chinook	65.2	Fall	M	Fall	2004	Merced River Fish Facility	Jersey Pt./San Joaquin River	Merced River	
062751	Chinook	82.4	Fall	F	Fall	2002	Merced River Fish Facility	Jersey Pt./San Joaquin River	Merced River	
064580	Chinook	81.5	Fall	M	Fall	2003	Merced River Fish Facility	Jersey Pt./San Joaquin River	Merced River	
062751	Chinook	75	Fall	F	Fall	2002	Merced River Fish Facility	Jersey Pt./San Joaquin River	Merced River	
062751	Chinook	90.4	Fall	M	Fall	2002	Merced River Fish Facility	Jersey Pt./San Joaquin River	Merced River	
064580	Chinook	90.5	Fall	M	Fall	2003	Merced River Fish Facility	Jersey Pt./San Joaquin River	Merced River	
064580	Chinook	80.8	Fall	M	Fall	2003	Merced River Fish Facility	Jersey Pt./San Joaquin River	Merced River	
064700	Chinook	65.3	Fall	M	Fall	2004	Merced River Fish Facility	Jersey Pt./San Joaquin River	Merced River	
064580	Chinook	82.9	Fall	F	Fall	2003	Merced River Fish Facility	Jersey Pt./San Joaquin River	Merced River	
064580	Chinook	91	Fall	M	Fall	2003	Merced River Fish Facility	Jersey Pt./San Joaquin River	Merced River	
064580	Chinook	78.5	Fall	M	Fall	2003	Merced River Fish Facility	Jersey Pt./San Joaquin River	Merced River	
064580	Chinook	80.9	Fall	M	Fall	2003	Merced River Fish Facility	Jersey Pt./San Joaquin River	Merced River	
060331	Chinook	69.5	Fall	M	Fall	2004	Mokelumne River Hatchery	New Hope Landing	Mokelumne River	
060289	Chinook	92	Fall	F	Fall	2002	Mokelumne River Hatchery	Mokelumne River Fish Ins	Mokelumne River	
060290	Chinook	93	Fall	M	Fall	2002	Mokelumne River Hatchery	Mokelumne River Fish Ins	Mokelumne River	
060284	Chinook	92.5	Fall	M	Fall	2002	Mokelumne River Hatchery	New Hope Landing	Mokelumne River	
060333	Chinook	71	Fall	M	Fall	2004	Mokelumne River Hatchery	New Hope Landing	Mokelumne River	
060289	Chinook	93	Fall	M	Fall	2002	Mokelumne River Hatchery	Mokelumne River Fish Ins	Mokelumne River	
060330	Chinook	63.5	Fall	M	Fall	2004	Mokelumne River Hatchery	New Hope Landing	Mokelumne River	
060323	Steelhead	56	Winter	F	Winter	2004	Mokelumne River Hatchery	New Hope Landing	Mokelumne River	
060321	Steelhead	62	Winter	M	Winter	2004	Mokelumne River Hatchery	New Hope Landing	Mokelumne River	
060321	Steelhead	58	Winter	F	Winter	2004	Mokelumne River Hatchery	New Hope Landing	Mokelumne River	
060340	Steelhead	47	Winter	F	Winter	2005	Mokelumne River Hatchery	New Hope Landing	Feather River	
060323	Steelhead	56	Winter	F	Winter	2004	Mokelumne River Hatchery	New Hope Landing	Mokelumne River	
060321	Steelhead	62	Winter	M	Winter	2004	Mokelumne River Hatchery	New Hope Landing	Mokelumne River	
060321	Steelhead	58	Winter	F	Winter	2004	Mokelumne River Hatchery	New Hope Landing	Mokelumne River	
060340	Steelhead	47	Winter	F	Winter	2005	Mokelumne River Hatchery	New Hope Landing	Feather River	
062668	Chinook	106	Fall	M	Fall	2001	Nimbus Fish Hatchery	Wickland Oil Net Pen	American River	
100000	Chinook	77	Fall	F		0				
100000	Chinook	61	Fall	M		0				
100000	Chinook	64.4	Fall	F		0				
100000	Chinook	88.5	Fall	F		0				
100000	Chinook	76.9	Fall	F		0				
100000	Chinook	72	Fall	F		0				

Appendix Table 3. Example Summary of Chinook salmon and steelhead trapped at the *hatchery name, year to present.*

	Chinook Salmon					Steelhead				
Year	Males	Females	Grilse	Grilse criteria	Total	Males	Females	Half-Pounder	Half-pounder criteria	Total
1955	4,427	3,012	1,771	not listed	9,210	36	74		not listed	110
1956	267	502	774	not listed	1,543	41	48		not listed	89
1957	297	341	252	not listed	890	33	18		not listed	51
1958	4,471	3,689	2,050	not listed	10,210	65	37		not listed	102
1959	3,003	7,366	2,866	not listed	13,235	354	424		not listed	778
1960	13,455	6,487	9,331	not listed	29,273	150	166		not listed	316
1961	3,446	9,257	1,638	not listed	14,341	86	51		not listed	137
1962	5,088	4,138	3,442	not listed	12,668	1,226	915		not listed	2,141
1963	1,213	1,215	813	not listed	3,241	472	744		not listed	1,216
1964	7,209	8,799	4,436	not listed	20,444	502	276		not listed	778
1965	5,295	7,595	744	not listed	13,634	374	500		not listed	874
1966	2,434	5,098	550	not listed	8,082	370	272		not listed	642
1967	2,022	2,392	733	not listed	5,147	627	556		not listed	1,183
1968	1,318	2,740	1,175	not listed	5,233	1,617	1,449		not listed	3,066
1969	1,061	1,488	521	not listed	3,070	1,088	646		not listed	1,734
1970	3,027	4,827	770	not listed	8,624	1,547	1,486		not listed	3,033
1971	3,384	4,493	1,269	not listed	9,146	1,148	1,108		not listed	2,256
1972	2,195	3,252	1,659	not listed	7,106	1,220	1,286		not listed	2,506
1973	5,155	5,704	1,676	≤60.7cm or 23.9"	12,535	1,935	1,302		not listed	3,237
1974	2,783	4,746	671	<60cm or 23.6"	8,200	1,176	1,119		not listed	2,295
1975	2,734	3,833	846	<60cm or 23.6"	7,413	1,538	1,643		not listed	3,181
1976	2,002	2,340	894	<60cm or 23.6"	5,236	592	715		not listed	1,307
1977	3,496	2,874	498	<60cm or 23.6"	6,868	377	242		not listed	619
1978	2,348	3,767	2,047	≤60cm or 23.6"	8,162	333	347		not listed	680
1979	4,779	2,394	3,067	≤60cm or 23.6"	10,240	729	581		not listed	1,310
1980	6,122	7,553	2,068	≤60cm or 23.6"	15,743	494	342		not listed	836
1981	10,497	7,286	2,805	≤60cm or 23.6"	20,588	1,684	1,506		not listed	3,190
1982	4,535	3,813	2,576	≤60cm or 23.6"	10,924	570	433		not listed	1,003
1983	3,081	3,486	2,514	<60cm or 23.6"	9,081	2,373	2,782		not listed	5,155
1984	4,548	5,748	1,953	≤60cm or 23.6"	12,249	456	454		not listed	910
1985	3,349	4,439	1,305	≤60cm or 23.6"	9,093	729	464		not listed	1,193
1986	2,168	2,617	910	≤60cm or 23.6"	5,695	750	681		not listed	1,431
1987	1,759	1,586	2,913	≤60cm or 23.6"	6,258	287	249	169	not listed	705
1988	3,777	4,187	661	≤60cm or 23.6"	8,625	133	156	7	not listed	296
1989	4,105	5,125	511	≤60cm or 23.6"	9,741	328	266		not listed	594
1990	1,773	2,251	826	≤60cm or 23.6"	4,850	154	69		not listed	223
1991	3,245	3,524	359	≤60cm or 23.6"	7,128	561	506	292	≤22"	1,359
1992	2,458	2,649	1,349	≤60cm or 23.6"	6,456	133	108	0	≤22"	241
1993	3,181	4,162	3,313	≤60cm or 23.6"	10,656	210	175	111	≤22"	496
1994	3,382	4,247	892	≤60cm or 23.6"	8,521	1,917	1,867	0	≤22"	3,784
1995	2,950	2,178	1,370	≤60cm or 23.6"	6,498	1,206	1,154	0	≤22"	2,360
1996	3,532	3,802	459	≤60cm or 23.6"	7,793	744	1,154	3	≤22"	1,901
1997	3,253	2,566	323	≤60cm or 23.6"	6,142	427	173	80	≤22"	680
1998	4,980	4,961	1,853	≤60cm or 23.6"	11,794	805	657	115	≤22"	1,577
1999	2,878	2,063	3,420	≤60cm or 23.6"	8,361	813	695	150	≤22"	1,658
2000	6,211	4,108	841	≤60cm or 23.6"	11,160	1,856	1,912	17	≤22"	3,785
2001	6,569	3,222	1,836	≤60cm or 23.6"	11,627	813	546	106	≤22"	1,465
2002	3,752	2,479	3,586	≤60cm or 23.6"	9,817	482	392	10	≤22"	884
2003	6,868	5,007	3,012	≤60cm or 23.6"	14,887	1,114	955	25	≤22"	2,094
2004	7,327	5,414	13,659	≤60cm or 23.6"	26,400	1,458	1,327	101	≤22"	2,886
2005	8,290	12,279	1,780	≤60cm or 23.6"	22,349	1,243	1,065	127	≤22"	2,435
2006	3,814	4,508	406	≤60cm or 23.6"	8,728	1,396	1,277	11	≤22"	2,684
Total	205,313	217,609	101,587		524,915	40,772	37,370	1,324		79,466

Appendix Table 4. Example Daily Water Temperature recorded at *hatchery name*, *mm/dd/year - mm/dd/year*.

	July				August				September				October				November				December			
	High		Low		High		Low		High		Low		High		Low		High		Low		High		Low	
Date	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F
1	15.0	59.0	15.0	59.0	15.6	60.0	15.6	60.0	16.1	61.0	16.1	61.0	16.7	62.0	16.7	62.0	15.6	60.0	15.6	60.0	12.2	54.0	12.2	54.0
2	15.0	59.0	15.0	59.0	15.6	60.0	15.6	60.0	16.1	61.0	16.1	61.0	16.7	62.0	16.7	62.0	16.1	61.0	16.1	61.0	12.2	54.0	12.2	54.0
3	15.0	59.0	15.0	59.0	15.6	60.0	15.6	60.0	16.1	61.0	16.1	61.0	17.2	63.0	16.7	62.0	17.2	63.0	17.2	63.0	12.8	55.0	12.2	54.0
4	15.0	59.0	15.0	59.0	15.6	60.0	15.6	60.0	16.1	61.0	16.1	61.0	16.7	62.0	13.3	56.0	17.2	63.0	16.7	62.0	12.2	54.0	12.2	54.0
5	15.0	59.0	15.0	59.0	15.6	60.0	15.6	60.0	16.7	62.0	16.7	62.0	16.7	62.0	16.7	62.0	17.2	63.0	16.7	62.0	12.2	54.0	12.2	54.0
6	15.6	60.0	15.6	60.0	16.1	61.0	16.1	61.0	16.7	62.0	16.7	62.0	16.7	62.0	16.7	62.0	15.0	59.0	15.0	59.0	12.8	55.0	12.8	55.0
7	15.6	60.0	15.6	60.0	16.1	61.0	16.1	61.0	16.7	62.0	16.7	62.0	16.7	62.0	16.7	62.0	15.0	59.0	15.0	59.0	12.2	54.0	12.2	54.0
8	15.6	60.0	15.6	60.0	16.1	61.0	16.1	61.0	16.7	62.0	16.7	62.0	16.7	62.0	16.7	62.0	15.6	60.0	15.6	60.0	12.8	55.0	12.2	54.0
9	15.6	60.0	15.6	60.0	16.1	61.0	16.1	61.0	16.7	62.0	16.7	62.0	16.7	62.0	16.7	62.0	15.6	60.0	15.6	60.0	12.2	54.0	12.2	54.0
10	18.3	65.0	16.7	62.0	16.7	62.0	16.7	62.0	16.7	62.0	16.7	62.0	16.7	62.0	12.8	55.0	15.0	59.0	14.4	58.0	12.2	54.0	12.2	54.0
11	16.7	62.0	16.7	62.0	15.6	60.0	16.1	61.0	16.7	62.0	16.7	62.0	16.7	62.0	16.7	62.0	15.0	59.0	15.0	59.0	11.7	53.0	11.7	53.0
12	16.7	62.0	16.7	62.0	16.1	61.0	16.1	61.0	16.7	62.0	16.7	62.0	16.7	62.0	16.7	62.0	14.4	58.0	14.4	58.0	11.7	53.0	11.7	53.0
13	15.0	59.0	15.0	59.0	16.1	61.0	16.1	61.0	16.7	62.0	16.7	62.0	16.7	62.0	16.7	62.0	14.4	58.0	14.4	58.0	11.7	53.0	11.7	53.0
14	15.0	59.0	15.0	59.0	16.1	61.0	16.1	61.0	16.7	62.0	16.7	62.0	16.7	62.0	16.7	62.0	13.9	57.0	13.9	57.0	11.7	53.0	11.7	53.0
15	15.0	59.0	15.0	59.0	16.1	61.0	16.1	61.0	16.7	62.0	16.7	62.0	16.7	62.0	16.7	62.0	13.9	57.0	13.9	57.0	11.7	53.0	11.7	53.0
16	15.0	59.0	15.0	59.0	16.1	61.0	16.1	61.0	16.1	61.0	16.1	61.0	16.7	62.0	16.7	62.0	14.4	58.0	13.9	57.0	11.7	53.0	11.7	53.0
17	15.6	60.0	15.0	59.0	16.1	61.0	16.1	61.0	16.1	61.0	16.1	61.0	16.7	62.0	16.7	62.0	14.4	58.0	14.4	58.0	11.7	53.0	11.7	53.0
18	16.1	61.0	16.1	61.0	16.7	62.0	16.1	61.0	16.1	61.0	16.1	61.0	16.7	62.0	16.7	62.0	14.4	58.0	14.4	58.0	10.6	51.0	10.0	50.0
19	16.1	61.0	16.1	61.0	16.7	62.0	16.1	61.0	16.1	61.0	16.1	61.0	16.7	62.0	16.1	61.0	14.4	58.0	14.4	58.0	10.6	51.0	10.0	50.0
20	16.1	61.0	15.6	60.0	16.7	62.0	16.7	62.0	16.7	62.0	16.7	62.0	16.7	62.0	16.1	61.0	14.4	58.0	14.4	58.0	10.0	50.0	10.0	50.0
21	16.1	61.0	16.1	61.0	16.7	62.0	16.1	61.0	16.7	62.0	16.7	62.0	16.7	62.0	16.7	62.0	14.4	58.0	14.4	58.0	10.6	51.0	10.6	51.0
22	16.1	61.0	16.1	61.0	16.7	62.0	16.1	61.0	16.7	62.0	16.7	62.0	16.7	62.0	16.7	62.0	14.4	58.0	14.4	58.0	10.6	51.0	10.6	51.0
23	16.1	61.0	16.1	61.0	16.7	62.0	16.7	62.0	16.7	62.0	16.7	62.0	16.7	62.0	16.7	62.0	13.9	57.0	13.9	57.0	10.6	51.0	10.6	51.0
24	16.1	61.0	16.1	61.0	16.7	62.0	16.7	62.0	16.7	62.0	16.7	62.0	16.7	62.0	16.7	62.0	13.9	57.0	13.9	57.0	10.0	50.0	10.0	50.0
25	15.6	60.0	15.6	60.0	16.1	61.0	16.1	61.0	16.7	62.0	16.7	62.0	17.2	63.0	16.7	62.0	13.9	57.0	13.3	56.0	10.6	51.0	10.6	51.0
26	16.1	61.0	15.6	60.0	16.7	62.0	16.7	62.0	17.2	63.0	16.7	62.0	16.7	62.0	16.7	62.0	13.3	56.0	13.3	56.0	10.6	51.0	10.0	50.0
27	16.1	61.0	15.6	60.0	16.7	62.0	16.7	62.0	16.7	62.0	16.7	62.0	17.2	63.0	17.2	63.0	13.3	56.0	13.3	56.0	10.0	50.0	10.0	50.0
28	15.6	60.0	15.6	60.0	17.2	63.0	16.7	62.0	17.2	63.0	16.7	62.0	17.2	63.0	17.2	63.0	13.3	56.0	13.3	56.0	10.0	50.0	10.0	50.0
29	15.6	60.0	15.6	60.0	17.2	63.0	16.7	62.0	17.2	63.0	16.7	62.0	15.6	60.0	15.6	60.0	12.8	55.0	12.8	55.0	9.4	49.0	9.4	49.0
30	15.6	60.0	15.6	60.0	16.7	62.0	16.1	61.0	16.7	62.0	16.7	62.0	15.6	60.0	15.6	60.0	12.8	55.0	12.2	54.0	8.9	48.0	8.9	48.0
31	16.1	61.0	15.6	60.0	16.1	61.0	16.1	61.0					15.6	60.0	15.6	60.0					8.9	48.0	8.9	48.0

Appendix Table 4 continued