State of California
The Resources Agency
DEPARTMENT OF FISH AND GAME

Draft
Hatchery and Genetic Management Plan for Nimbus Fish Hatchery Winter-Run Steelhead Program

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Draft
Hatchery and Genetic Management Plan for Nimbus Fish Hatchery Winter-Run Steelhead Program [1]

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Hatchery and Genetics Management Plan for Nimbus Fish Hatchery

Hatchery Program	American River winter-run steelhead
Species or Hatchery Stock	Winter-run steelhead (*Oncorhynchus mykiss*)
Agency Operator	California Department of Fish and Game under contract with the United States Bureau of Reclamation
Watershed and Region	American River/Sacramento River Drainage
Date Submitted	
Date Last Updated	

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

Introduction

Under Section 7 of the Endangered Species Act (ESA), federal agencies are obligated to consult with National Marine Fisheries Service (NMFS) on any activities that may affect a listed anadromous fish species, including hatchery programs (16 USC 1531. 2002). Hatchery and Genetic Management Plans (HGMPs) are described in the final salmon and steelhead 4(d) rule (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).

The United States Department of the Interior, Bureau of Reclamation (Reclamation) contracts with the California Department of Fish and Game (Department) to provide funding for the operation and maintenance of the Nimbus Fish Hatchery (NFH). NFH was constructed to meet production objectives for anadromous fish in the American River downstream from Folsom Dam (mitigation requirements as part of the American River Basin Development Act of October 14, 1949). On October 22, 2004, Reclamation received a Biological Opinion (BO) following formal consultation with the NMFS pursuant to Section 7 of the Endangered Species Act on the effects of the proposed long-term operations, criteria, and plan (OCAP) for the Central Valley Project (CVP) on threatened and endangered fish species. The OCAP BO issued by the NMFS did not address the effects of hatchery operations but did highlight the requirement for Reclamation to enter into consultations on the effects of the hatchery operations on potentially affected listed species. A primary pre-requisite to completing the required consultation is a description of the Department's fish production management practices and discretions used to meet Reclamation's mitigation requirements.

This HGMP for the NFH winter-run 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. Project 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.

Steelhead (*Oncorhynchus mykiss*) (Walbaum 1792) American River winter-run

ESA status: Not listed and not a candidate for listing

1.3 Responsible organization and individuals

NFH is operated by the California Department of Fish and Game (Department) under contract with U.S. Department of Interior Bureau of Reclamation (Reclamation).

Reclamation Contract Manager:

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

NFH staff currently includes 11.5 permanent employees. The annual operating budget is approximately $1.7 million and includes $210,000 for temporary help personnel.

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 kilometer 35.4 (Figure 1-1 and 1-2). The regional mark processing center code is 6FCSAAMN NBFH for NFH and 6FCSAAMN for the American River.

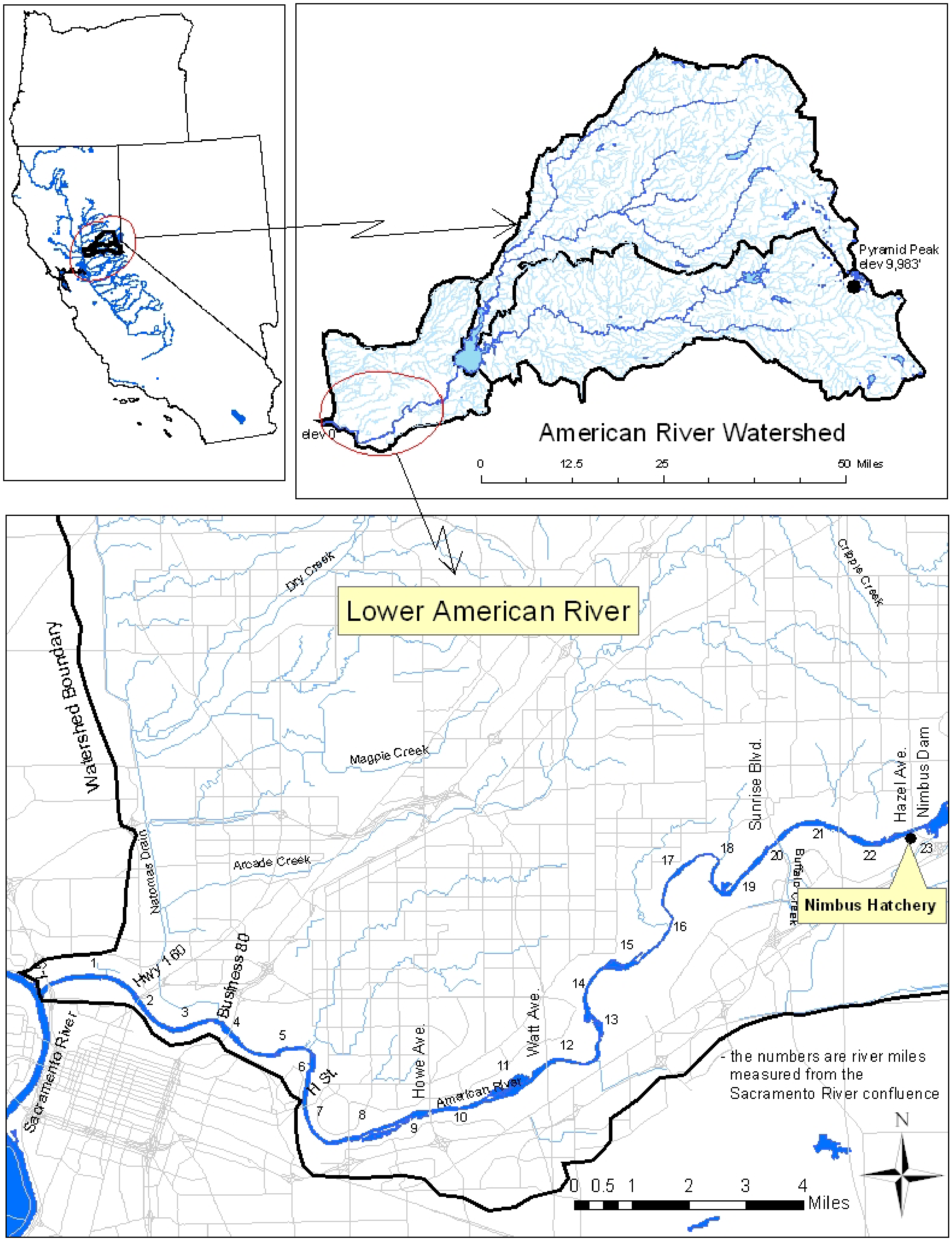

Figure 1-1 Location of Nimbus Fish Hatchery on the lower American River.

Figure 1-2. Aerial photo of Nimbus Fish Hatchery showing parking lot on the left, raceways in the center left, and hatchery buildings to the right of the raceways. The three largest buildings and raceways on the right of photo are American Rive Trout Hatchery.

NFH office is located at:

Longitude 121.225.4000 W, Latitude 38.633.6000 N

The office address is:

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

1.6 Type of program

NFH personnel implement an artificial production program for Central Valley fall-run Chinook salmon and American River winter-run steelhead.

1.7 Purpose (Goal) of program

The goal of NFH winter-run steelhead program is to mitigate for steelhead spawning habitat eliminated by construction of Nimbus Dam. This is accomplished through the trapping, artificial spawning, rearing, and release of steelhead. Mitigation goals are to annually release 430,000 yearling American River winter-run steelhead that average 4 fish per pound.

1.8 Justification for the program

Nimbus Fish Hatchery 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” (Appendix 1).

1.8.1 Early History

Before gold was discovered at Sutter's Mill in 1848, California was considered "virgin" land. As described by S.T. Harding in his 1960 "Water in California," there were no substantial settlements, only missions and ranches along the coast and a few early pioneers like John Sutter. The streams ran uncontrolled, and during the wet seasons, large areas became wetlands filled with thousands of waterfowl and other wildlife. The discovery of gold lured immigrants, dubbed the Forty-niners, from all over the world. These mining activities severely impacted natural water courses including the American River. As gold panning and mining became less productive, Californian's turned to farming and began devising systems to move water and irrigate crops.

In the late 1800’s, Californians concluded a dam was needed to regulate the erratic flows and develop the waters of the American River. Subsequently, the U.S. Army Corps of Engineers (USACE) included such a recommendation in a survey of western watersheds made under the direction of President Ulysses S. Grant. The recommendation was received, but no action was taken.

During the first 20 years of the 19th century, various private power companies, municipalities, farm groups, and the State of California (State) reviewed the USACE' old survey. The State envisioned a giant multipurpose water project and purchased a potential dam site on the Middle Fork of the American River just east of the City of Auburn. Subsequently, the Great Depression of the late 1920’s forced a halt to further planning. Reclamation also conducted studies of various possibilities in the American River Basin in connection with a comprehensive plan for California’s Central Valley.

1.8.2 Central Valley Project

Eventually, the studies conducted by various agencies evolved into the State Central Valley Project, a long-term plan for the use of the water of the

Sacramento River basin for the benefit of the Sacramento and San Francisco Bay areas, the farmlands of the San Joaquin Valley, and areas south of the Tehachapi Mountains. After repeated attempts by State officials to obtain grants or loans to aid in financing the project, the Federal Government was asked to undertake the construction of a portion of the Central Valley Project (CVP). The first authorization of the CVP was by the Rivers and Harbors Act of August 30, 1935. 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 CVP is operated by Reclamation and includes 22 reservoirs that have a combined storage of 11 million acre-ft. More that 3 million acres of farmland are annually irrigated by water provided by the CVPin addition to providing drinking water to nearly 2 million consumers. The CVP has long-term contracts with more than 250 contractors in 29 of California’s 58 counties.

1.8.3 American River Division

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. The Division is located about midway between the northern and southern extremes of the Central Valley in El Dorado, Placer, Sacramento, and San Joaquin counties. Division lands stretch from the City of Folsom in the north to Stockton in the south. Most lands served by the Division lie in the Sacramento metropolitan area.

The American River originates in the mountains of the Sierra Nevada range, drains a watershed of approximately 1,895 square miles, and enters the Sacramento River at river mile 60 in the City of Sacramento.

Folsom Dam is located on the American River and is part of the American River Division of the CVP. The project was originally authorized by Congress in 1944 as a 355,000 acre-ft flood control unit but was reauthorized as a 1,000,000 acre-ft multiple-purpose facility. The USACE constructed Folsom Dam and transferred it to Reclamation for coordinated operation as an integral part of the CVP.

The construction of Folsom Dam began in October 1948 and was completed in May 1956. Folsom Dam is a concrete gravity dam 340 ft high and 1,400 ft long. The main section is flanked by two earth fill wing dams. The right wing dam is 6,700 ft long and 145 ft high, and the left wing dam is 2,100 ft long and 145 ft high. In addition to the main section and wing dams, there is one auxiliary dam and eight smaller earth-fill dikes. Water was first stored in February 1955. Folsom Dam forms Folsom Lake with a capacity of 1,010,000 acre-ft with a surface area of 11,450 acres.

Nimbus Dam and Powerplant are located 6.8 river miles downstream from Folsom Dam. The project was completed and accepted by the Federal government in July 1955. Nimbus Dam is a concrete gravity dam 1,093 ft long and 87 ft high, with 18 radial gates, each 40 ft by 24 ft, to control flow releases. Nimbus Dam forms Lake Natoma, with a capacity of 8,760 acre-ft and a surface area of 540 acres. The dam re-regulates water released from Folsom Dam and diverts water into the Folsom South Canal. Water not diverted is released into the American River through the radial gates.

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

The ESA was adopted by Congress in 1973 and provided a program for the conservation of endangered and threatened species, recognizing that conservation of listed species may be facilitated by artificial means (16 U.S.C. § 1531 (b) (1973))

When Congress amended the ESA in 1978, it redefined “species” as “any subspecies of fish . . . and any distinct population segment (DPS) of any species . . . which interbreeds when mature” (56 FR 58613 199116 and USC 1532 2002).

It is the mission of the NMFS to conserve, protect and manage Pacific salmon, groundfish, halibut, and marine mammals and their habitats under the ESA and other laws. Because Congress did not define distinct population segment (DPS), the NMFS introduced the term “evolutionary significant unit” (ESU) to interpret DPS under the statute*.* The agency guidance, issued in 1991, explained that “a stock of pacific salmon will be considered a distinct population, and hence a ‘species’ under the ESA, if it represents an ESU of the biological species” (56 F.R. 58613 1991). For a stock to be considered an ESU, it must (1) be substantially reproductively isolated from other conspecific population units; and (2) represent an important component in the evolutionary legacy of the species (56 F.R. 58,6131991) (Waples 1991).

Two years after the ESU policy, NMFS issued its “Hatchery Policy” stating that the ESA requires NMFS to focus its recovery efforts on “natural populations” and that “although hatchery populations may be included as part of a listed species, the NMFS policy is that it should be done sparingly because artificial propagation could pose risks to natural populations” The NMFS includes hatchery fish in the listed species if they are “essential for recovery” (58 F.R. 17,573, 17, 575 1993).

NMFS also established a Species of Concern list and described the factors to consider when identifying Species of Concern. The NMFS also solicits information and comments concerning the status of, research and stewardship opportunities for, and the factors for identifying species of concern.

Steelhead reared at NFH are considered to be American River winter-run steelhead and are not listed, a candidate for listing, nor a Species of Concern.

Specific information on the status of indigenous American River steelhead is lacking. Hinze et al. (1956) reported that based on counts of steelhead from 1943 to 1947, steelhead passed the area of Folsom during every month except August and September and the majority of the run was during May and June. This suggests that the river may have supported a spring-run of summer steelhead in addition to a winter-run steelhead. McEwan (2001) reported that presently, only California north coast drainages support runs of summer steelhead and Central Valley drainages support only winter-run steelhead. Construction of Folsom and Nimbus dams most likely extirpated any spring-run summer steelhead in the American River.

Central Valley steelhead were listed as a 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 does not include steelhead propagated at NFH.

1.10 Program "Performance Standards"

"Program goals" are the purposes toward which an endeavor is directed. "Performance Standards" are designed to achieve the program goal and are generally measurable, realistic, and time specific.

Program Goal

The goal of NFH is to mitigate for American River steelhead spawning habitat eliminated by construction of Nimbus Dam. This is accomplished through the trapping, artificial spawning, rearing, and release of steelhead.

Specific numbers of eggs and fish relative to the mitigation goals are:

- Annually release of 430,000 yearling steelhead that average 4 fish per pound

A goal for numbers of returning adult steelhead has not been established for NFH although since construction, an average of 1,472 adult steelhead have been trapped. Using the best available information, the estimated yearling to adult survival rate of American River winter-run steelhead from the period of adult returns 2003 through 2006 has averaged 1.15% (range 0.78% to 1.71%) (Table 1-1).

Table 1-1. Estimated return percentage of adult American River steelhead returning to the American River from Nimbus Fish Hatchery releases, 2003-2007.

Adult Spawning Year	**2002-03**	**2003-04**	**2004-05**	**2005-06**	**2006-07**	
Yearling steelhead brood year	**1999**	**2000**	**2001**	**2002**	**2003**	**Means**
Number of yearlings released	402,300	460,000	280,160	419,140	455,140	403,348
Estimated number of naturally produced steelhead in river spawning populations 1/	6	3	2	9	7	5
Estimated number of NFH steelhead in natural spawning population 1/	294	340	328	257	293	303
Total estimated in-river adult steelhead spawning population	300	343	330	266	300	308
Total number of hatchery produced steelhead trapped	3,499	3,637	3,645	3,354	2,615	3,350
Total number of naturally produced steelhead trapped	69	27	17	118	58	58
Total number of steelhead trapped	3,568	3,664	3,662	3,472	2,673	3,408
Estimated in-river steelhead run	3,868	4,007	3,992	3,738	2,973	3,716
Total estimated NFH steelhead harvest 2/	774	801	798	748	595	743
Total estimated NFH produced in-river steelhead	4,642	4,808	4,790	4,486	3,568	4,459
Percent return	1.15%	1.05%	1.71%	1.07%	0.78%	1.15%

1/ Assumes same ratio of hatchery and naturally produced steelhead trapped

2/ Assumes 20% arbitrary harvest rate

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

Performance Standards

Steelhead

Standard 1. Program contributes to mitigation requirements.

Indicator: Number of 4 per pound or larger yearling steelhead reared and released.

Standard 2. Fish produced for mitigation (and harvest) are released in a manner enabling effective harvest while avoiding overharvest of non-target species

Indicator: Contribution of NFH-released steelhead river sport fisheries.

Standard 3. 100% of yearling steelhead released with adipose fin mark

Indicator: Number of yearling steelhead marked in relation to the total number released.

Standard 4. Number of eggs taken is representative of the timing and age distribution of the steelhead trapped.

Indicator: Number and temporal distribution of eggs collected in comparison to the number of steelhead trapped

Standard 5. Annually release NFH-produced yearling steelhead at a location and manner that ensures adequate returns to the American River and NFH and minimizes impacts on listed species.

Indicator: Release location(s) and method(s)

Standard 6. Life history characteristics of the natural population do not change as a result of this artificial production program.

Indicator: Specific life history characteristics to be measured in the artificial produced population include:

- Adult return timing
- Adult return age and sex composition
- Adult size at return
- Spawn timing and distribution
- Fecundity and egg size
- Egg hatching time and survival
- Juvenile rearing densities, distribution and behavior
- Juvenile growth rates, condition factors, and survival to release
- Diet composition and availability
- Juvenile size at release

Standard 7. Annual release numbers to not exceed habitat capacity.

Indicator: Number of yearling steelhead released

Indicator: Timing of yearling steelhead releases

Indicator: Location of yearling steelhead releases

Standard 8. Patterns of genetic variation within and among natural population does not change significantly as a result of artificial production

Indicator: Genetic profiles of American River winter-run steelhead and naturally-produced American River steelhead

Standard 9. Collection of broodstock does not adversely impact genetic diversity of naturally spawning populations

Indicator: Size and age distribution of naturally-produced steelhead in the population

Indicator: Timing of broodstock collection and in-river run

Standard 10. Yearling steelhead released at smolt stage.

Indicator: Date of smolt release

Indicator: Size of smolts at release.

Indicator: Percentage of observed smolts in release groups

Standard 11. NFH is operated in compliance with all applicable fish health guidelines

Indicator: Annual Department Fish Pathology reports

Standard 12. Effluent from NFH does not detrimentally affect natural populations

Indicator: Monthly water quality reports

Standard 13. NFH water use does not affect American River flow releases

Indicator: Water withdrawal meets facility needs with minimal waste

Standard 14. Releases do not introduce pathogens not already in existing populations or significantly increase present levels.

Indicator: Department Fish Pathology Fish Health Assessment and Fish Pathologist Reports of NFH-produced and naturally-produced yearling steelhead

Standard 15. All adult steelhead returned to the river after spawning

Indicator: Number of adult steelhead returned to the river

Standard 16. Adult broodstock collection does not significantly alter spatial and temporal distribution of naturally produced populations

Indicator: Spatial and temporal distribution of NFH steelhead trapped and annual reports of in-river run

Standard 17. Weir and trapping operations do not result in stress, injury, or mortality in natural populations.

Indicator: Estimated annual number of in-river adult steelhead

Indicator: Number of stressed, injured, or dead naturally-produced adult steelhead observed during trapping operations

Standard 18. Predation by artificially produced fish on naturally produced fish does not significantly affect numbers of natural fish.

Indicator: Estimated annual number of American River naturally-produced steelhead

2. Relationship of Program to Other Management Objectives

2.1 Alignment of the Hatchery program with Central Valley-wide hatchery plan or other regionally accepted policies. Explain any proposed deviations from the plan or policies.

The Department has not prepared a Central Valley-wide hatchery plan to specifically address steelhead management. General direction for management is provided by the California Legislature and the Fish and Game Commission 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 department 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.

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:

- Minimum flow standards were established by judicial action for East Bay Municipal Utility District when they exercise their right to divert American River water. The State Water Resources Control Board should adopt these standards so that they apply to all users of American River water.

- Flows during the steelhead spawning and incubation season should be constant so that stranding of redds does not occur.

- Investigate the relationship between flow, temperature, and reservoir storage and establish a minimum storage level for Folsom Reservoir so that adequate temperatures can be provided during late summer and fall.

- Reclamation should correct the water temperature problem at NFH. NFH experiences significant problems from high water temperatures almost every year. In the summer of 1992, all yearling steelhead were transported to other rearing facilities because of intolerably high water temperatures at NFH.

- Investigate the feasibility of restoring steelhead to the upper American River watershed by transporting adults and juveniles around Nimbus and Folsom dams.

Several of these measures have been incorporated into present management of the American River. High water temperatures remain a problem in some years at NFH and may not be resolved with the current facilities due to Folsom Lake water storage capabilities and limits on the amount of water available from the watershed.

2.1.1 U.S. Corps of Engineers Section 10 of the Rivers and Harbors Act of 1899 – Section 404 of the Clean Water Act (CWA)

In 1972, amendments to the Federal Water Pollution Control Act added what is commonly called Section 404 authority (33 U.S.C. 1344) to the program. The Secretary of the Army, acting through the Chief of Engineers, is authorized to issue permits, after notice and opportunity for public hearings, for the discharge of dredged or fill material into waters of the United States at specified disposal sites. Selection of such sites must be in accordance with guidelines developed by the Environmental Protection Agency (EPA) in conjunction with the Secretary of the Army. These guidelines are known as the 404(b)(1) Guidelines. The discharge of all other pollutants into waters of the U. S. is regulated under Section 402 of the CWA which supersedes Section 13 permitting authority mentioned above. The Federal Water Pollution Control Act was further amended in 1977 and given the common name of "Clean Water Act" and was again amended in 1987 to modify criminal and civil penalty provisions and to add an administrative penalty provision.

NFH complies with all appropriate regulations of the Clean Water Act.

2.1.2 Upper Sacramento River Fisheries and Riparian Habitat Management Plan (USRFRHMP).

The USRFRHMP, also known as the "1086 Plan" after California Senate Bill 1086, was enacted into state law in 1986. The bill did not specifically identify the American River but required the Wildlife Conservation Board (WCB) to inventory the lands along the upper Sacramento River and described and prioritize those lands of value to fish and wildlife.

SB 1086 also created an advisory council composed of specified members, and required the advisory council to develop, for submission to the Legislature, the USRFRHMP to provide for the protection, restoration, and enhancement of fish and riparian habitat and associated wildlife for the area between the Feather River and Keswick Dam. The bill provided for an action team with specified members to develop proposed plan elements. The provisions of this bill were repealed on January 1, 1989.

2.1.3 Central Valley Salmon and Steelhead Restoration Plans and Monitoring programs

Pursuant to the Salmon, Steelhead Trout, and Anadromous Fisheries Program Act of 1998, the Central Valley Salmon and Steelhead Restoration and Enhancement Plan (CDFG 1990) and Restoring Central Valley Streams: A Plan for Action (CDFG 1993) outline the Department's restoration and enhancement goals for salmon and steelhead in the Sacramento and San Joaquin river systems and provide management direction for the programs.

Since 2001, Reclamation has conducted an annual steelhead redd survey in the lower American to estimate the number of steelhead spawing. In 2006, the Department instigated a Central Valley angler survey to estimate numbers of fish caught by anglers. This survey will included estimates of steelhead caught in the American River.

In response to the need to coordinate and improve escapement monitoring programs in the Central Valley, the Interagency Ecological Program (IEP) Salmonid Escapement Project Work Team (SEPWT) was formed in 2001. The team, which includes biologists assigned to various agencies and departments works on salmon escapement monitoring surveys throughout the Central Valley. The group is a satellite team of the IEP Central Valley Salmonid Project Work Team (CVSPWT). In 2004, the SEPWT completed a proposal for the development of a comprehensive monitoring plan for Central Valley adult Chinook salmon escapement. The goal of the plan is to improve monitoring survey data for use in assessing the success of restoration activities, evaluating progress toward recovery of listed stocks, and sustainable management of ocean and inland fisheries.

NFH staff does not conduct any monitoring programs or is funding for monitoring provided in NFH operating budget.

2.1.4 Central Valley Project Improvement Act

Congress passed the Central Valley Project Improvement Act (CVPIA) in 1992. One of the goals of the Act is to protect, restore, and enhance fish, wildlife, and associated habitats in the Central Valley and the Trinity River basin of California. Some of the programs developed to address CVPIA provisions focus on listed and other sensitive species that occur in the area. Reclamation and U.S. Fish and Wildlife Service (USFWS) developed the CVP Conservation Program to work with other programs to protect, restore, and enhance the habitat and related needs of special-status species in areas affected by the CVP. Implementation of this program is meant to facilitate the comprehensive Section 7 consultation on CVP operations, including implementation of the CVPIA. The objectives of the CVP Conservation Program are to 1) address the needs of threatened and endangered species in an ecosystem-based manner, 2) assist in the conservation of biological diversity, and 3) improve existing conditions for threatened and endangered species and reduce conflicts with future projects.

The CVPIA directs the U.S. Fish and Wildlife Service (USFWS) to develop and implement a series of restoration programs and actions for fish and wildlife purposes. The Act specifies that these actions should ensure that the natural production of anadromous fish in Central Valley streams will be sustainable, on a long-term basis, at levels not less than twice the average levels during 1967-1991. The Anadromous Fish Restoration Program (AFRP) established pursuant to CVPIA developed anadromous fish production targets based on the baseline fish production numbers.

NFH goals and purposes are intended to work in conjunction with the anadromous fish restoration objectives of the CVPIA where applicable and appropriate.

2.1.5 CALFED

The CALFED Bay-Delta Program is comprised of 25 state and federal agencies with a mission to improve water supplies in California and the health of the San Francisco Bay/Sacramento-San Joaquin River Delta. In 2000, CALFED drafted a 30-year plan that is described in the programmatic Record of Decision (ROD). The ROD set forth general goals and laid out a science-based planning process which, through collaborative efforts, was able to facilitate better, more informed decisions on future projects and programs within their purview. Congress adopted the plan in 2004 and the California Bay-Delta Authority was created to oversee the program implementation.

Restoration of Central Valley Chinook salmon and steelhead populations is an important goal of the CALFED program. The DFG administers the Ecosystem Restoration Program (ERP), one of the primary CALFED program elements. The ERP Program includes the goals of achieving recovery of at-risk native species and maintaining and/or enhancing populations of selected species for sustainable commercial and recreational harvest. Since 2000, the ERP has provided millions of dollars for projects to restore Central Valley salmon and steelhead populations.

NFH is not directly involved with or funded through CALFED, although the goals and purpose of NFH are of interest to CALFED cooperators.

2.1.6 California Fish and Game Code

California Law consists of 29 codes that include the Fish and Game Code. The Fish and Game Code includes various chapters dealing with fish and wildlife and includes the policies of the Fish and Game Commission (Appendix 2).

NFH staff complies with all applicable regulations and policies.

2.1.7 California Fish and Game Commission Policies

The California Fish and Game Commission (Commission) is composed of up to five members, appointed by the Governor and confirmed by the Senate. The Commission meets publicly to discuss various proposed regulations, permits, licenses, management policies and other subjects within its areas of responsibility. It also holds a variety of special meetings to obtain public input on items of a more localized nature, requests for use permits on certain streams or establishment of new ecological reserves. The Commission is responsible for the formulation of general policies for the conduct of the Department. Several of those policies are relevant to NFH and are found in the Fish and Game Code (Appendix 2). The Commission also has general regulatory powers under which it decides seasons, bag limits, and methods of take for game animals and sport fish.

NFH staff complies with all applicable Commission policies.

2.1.8 Department Operations Manual

The Department's Operations Manual contains sections that provide direction and guidance to the Department for anadromous fish management, and fish production and distribution, including fish health policies and procedures (Appendix 3).

NFH staff complies with all applicable sections of the Department Operations Manual.

2.2. Existing cooperative agreements, memoranda of understanding, memoranda of agreement, or other management plans or court orders under which the Hatchery operates.

Operations of NFH that involved both Reclamation and the Department are directed by several acts, agreements, contracts, and decisions.

2.2.1 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (16 U.S.C. 661-667e; the Act of March 10, 1934; Ch. 55; 48 Stat. 401), as amended by the Act of June 24, 1936, Ch. 764, 49 Stat. 913; the Act of August 14, 1946, Ch. 965, 60 Stat. 1080; the Act of August 5, 1947, Ch. 489, 61 Stat. 770; the Act of May 19, 1948, Ch. 310, 62 Stat. 240; P.L. 325, October 6, 1949, 63 Stat. 708; P.L. 85-624, August 12, 1958, 72 Stat. 563; and P.L. 89-72, 79 Stat. 216, July 9, 1965, authorizes the Secretaries of Agriculture and Commerce to provide assistance to and cooperate with Federal and State agencies to protect, rear, stock, and increase the supply of game and fur-bearing animals, as well as to study the effects of domestic sewage, trade wastes, and other polluting substances on wildlife.

The Act also directs the Bureau of Fisheries to use impounded waters for fish-culture stations and migratory-bird resting and nesting areas and requires consultation with the Bureau of Fisheries prior to the construction of any new dams to provide for fish migration. In addition, this Act authorizes the preparation of plans to protect wildlife resources, the completion of wildlife surveys on public lands, and the acceptance by the Federal agencies of funds or lands for related purposes provided that land donations received the consent of the State in which they are located.

Central Valley-wide plans for anadromous fish generally include two economically important native species, Chinook salmon and steelhead; and in the past, plans usually emphasized Chinook salmon (USFWS and DFG 1953). McEwan and Jackson (1996) suggested that the biggest problem with focusing on salmon (referencing Central Valley stocks) is that it has resulted in inattention and lack of effort to assess the status of steelhead populations, particularly native populations.

To help address many of the concerns and problems with loss of Chinook salmon and steelhead, numerous plans, acts, and codes have been specifically developed to help restore anadromous salmonids in the Central Valley.

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

This contract (Appendix 4) describes the scope of operations for NFH necessary to meet the steelhead mitigation goal related to fish production:

- Annually rear and release 430,000 yearling steelhead that average 4 fish per pound

2.2.3 State Water Resources Control Board Decision 893 (D-893)

Although indirectly affecting NFH operations, Decision 893 requires minimum flows in the American River downstream from Nimbus Dam and states, in the interest of fish conservation, releases should not ordinarily fall below 250 cfs between January 1 and September 15 or below 500 cfs at other times. However, D-893 releases are rarely the controlling objective of CVP operations at Nimbus Dam (D. Robinson, Environmental Scientist, Bureau of Reclamation, personal communication).

2.2.4 NOAA Fisheries Formal and Early Section 7 Endangered Species Consultation on the Coordinated Operations of the Central Valley Project and State Water Project and the Operational Criteria and Plan (OCAP LAR 2004)

This consultation included actions for the American River Division including:

- Established temperature objectives for the American River downstream from

Nimbus Dam:

> "Reclamation shall, to the extent possible, control water temperatures in the lower river between Nimbus Dam and the Watt Avenue Bridge (River mile 9.4) from June 1 through November 30, to a daily average temperature of less than or equal to 65^{o} F to protect rearing juvenile steelhead from thermal stress and from warm water predator species. The use of the cold water pool in Folsom Reservoir should be reserved for August through October releases."

These release criteria affect the operation of Folsom Dam shutters and the availability of cold water needed to rear salmonids at NFH. In at least 1 year during the last 10 years, summer water temperatures at NFH reached 68^{o} F. and created fish rearing problems associated with high water temperatures. The OCAP does provide that NFH personnel may confer with Reclamation to determine a comprise operation of the temperature shutter at Folsom Dam for the release of cooler water.

- Minimize the adverse effects of flow fluctuations associated with Folsom Reservoir and Nimbus Dam operations on Central Valley steelhead spawning, egg incubation, and fry and juvenile rearing within the American River.

This action does not directly affect NFH operations; however, increased production of naturally-produced steelhead in the American River may result in a greater number of unmarked steelhead entering NFH.

2.3 Relationship to Harvest Objectives

Operation of NFH is not specifically directed to include harvest objectives although the Department has implied that a portion of the fish produced as part of the mitigation agreement are expected to be harvested.

The California Fish and Game Commission has authority for setting seasons and bag limits for California ocean commercial and sport harvest within three miles of the coast, and inland sport and tribal fisheries and California commercial and sport fishing regulations prohibit the taking of "steelhead rainbow trout" in the ocean.

Presently, only hatchery-produced adipose fin-clipped steelhead may be harvested (Title 14 California Code of Regulations).

2.4 Relationship to habitat protection and recovery strategies.

Operation of NFH does not include any habitat protection or ESA listed species recovery efforts. However, there are a number of management plans and habitat enhancement programs with strategies that may have implications to NFH operations.

2.4.1 Steelhead Restoration Plan for the American River

Goals for steelhead management for the lower American River were originally outlined by McEwan and Nelson 1991 and reintegrated in the Department's Steelhead Management Plan (McEwan and Jackson 1996) as described in Section 2.1.6 of this report.

Central Valley steelhead were not listed as a threatened species prior to publication of the management plan, however, most aspects of the plan are still applicable. McEwan and Jackson (1996) did report that steelhead in the American River were "almost entirely supported by NFH" and that the American River provided "inadequate conditions" for juvenile rearing.

Two of McEwan and Jackson's (1996) goals and recommendations that affect NFH are:

1. Reclamation should correct the water temperature problem at NFH. Nimbus Fish Hatchery experiences significant problems from high water temperatures almost every year. In the summer of 1992, all juvenile steelhead were transported to other rearing facilities because of intolerably high water temperatures.

   Comment - Reclamation has attempted to alleviate water temperature problems at NFH and during the past 5 years water temperatures at NFH have not been critical. Additionally, due to inadequate cold water storage capabilities of the present facilities, water temperatures suitable to salmonids may not be available in some years.

2. Investigate the feasibility of restoring steelhead to the upper American River watershed by transporting adults and juveniles around Nimbus and Folsom dams.

   Comment - We are unaware of any current investigations into the feasibility of this recommendation. Concern has been expressed by Department Fish Pathologists that salmonid populations immediately upstream from hatcheries could create potential problems for increased disease transmission and is not a recovery strategy they would support (Dr. W. Cox, Senior Fish Pathologist, Department of Fish and Game, personal communication).

2.4.2 U.S. Fish and Wildlife Service Biological Opinion on the CVP-Operation Criteria and Plan

On July 30, 2004, the USFWS released their Formal and Early Section 7 Endangered Species Consultation on the Coordinated Operations of the CVP and State Water Project and the OCAP (USFWS 2004) (Appendix 5). The biological opinion includes an effects determination and take statements and also objectives that may affect operation of NFH.

2.4.3 Delta Protection Commission

The Delta Protection Commission (DPC) produced a strategic plan for 2006-2011 (Delta Protection Commission 2006). Strategies are limited to the Sacramento-San Joaquin Delta but habitat improvements may enhance recovery of listed species. The Mission of the DPC is to protect, maintain, and where possible, enhance and restore the overall quality of the Delta environment consistent with the Delta Protection Act and the Regional Plan, including, but not limited to agriculture, wildlife habitat, and recreational activities, to ensure orderly, balanced conservation and development of Delta land resources and improved flood protection. The DPC has no authority regarding operation of NFH.

2.4.4 U.S Fish and Wildlife Service Anadromous Fish Restoration Program

The U.S. Fish and Wildlife Service (USFWS) Anadromous Fish Restoration Program (AFRP) is tasked by the CVPIA to make "all reasonable efforts to at least double natural production of anadromous fish in California's Central Valley streams on a long-term, sustainable basis". Since 1992, the AFRP has provided several million dollars of funding for habitat projects to restore Central Valley salmon and steelhead populations.

Two USFWS AFRP projects that involve the American River are:

1. In-stream flow studies in the Sacramento, American, and Merced Rivers

This project was conducted from 1997 through 2001 with the objective of developing flow/habitat relationships for all life stages of fall-, late fall-, spring-, and winter-run Chinook salmon inhabiting the upper mainstem Sacramento River. We are unaware of any published information regarding this study.

2. Lower American River Temperature Reduction Modeling Project

This project was initiated in 2003 and is ongoing. The objective is to develop predictive tools that will 1) reduce to the extent possible the uncertainties in the performance of identified temperature control actions that could be implemented to improve the management of cold water resources in the Folsom/Natoma Reservoir system and the lower American River, and 2) be available for daily operations, planning, and salmon and steelhead habitat studies by other project operators and other stakeholders.

2.4.5 Water Forum – Initial Fisheries and In-stream Habitat Management and Restoration Plan for the Lower American River

The Water Forum is a group of business and agricultural leaders, citizens groups, environmentalists, water managers, and local governments in the Sacramento Region with two co-equal objectives:

- Provide a reliable and safe water supply for the region's economic health and planned development to the year 2030, and
- Preserve the fishery, wildlife, recreational, and aesthetic values of the Lower American River.

Since 1999, the Water Forum, in conjunction with Reclamation, the USFWS, the NMFS, the Department, and other agencies, has been working toward an updated and improved Flow Management Standard (FMS) for the lower American River to be presented to the State Water Resources Control Board. The proposed FMS has three elements:

1. Prescriptive Element: Improve the regulatory baseline for the lower American River to account for appropriate minimum flow, water temperature, ramping rate, and flow fluctuation criteria.

2. River Management Element: Establish a River Management Group (RMG) and process for Folsom Reservoir and lower American River operations to implement the FMS, document management decisions made and the results of those decisions.

3. Monitoring and Reporting Element: Collect, organize, and report data and information on lower American River hydrologic and biologic conditions to resource managers.

   The Water Forum’s Lower American River Draft Policy Document Flow Management Standard (Water Forum 2004) implements the Initial Fisheries and In-stream Habitat Management and Restoration Plan for the Lower American River Fisheries (FISH Plan) (Water Forum 2001). This document constitutes the aquatic habitat management plan for the lower American River. Development of the habitat management element was deemed necessary to comply with the California Environmental Quality Act (CEQA), as described in the Water Forum Draft Environmental Impact Report (Draft EIR). The FISH Plan is consistent with the mitigation described and certified in the Draft EIR and associated mitigation, monitoring, and reporting plan. The FMS is intended to result in improved conditions for fish in the lower American River, particularly fall-run Chinook salmon and steelhead. The Water Forum also anticipates that the FMS Standard will comply with California Fish and Game Code Section 5937, that stipulates:

"The owner of any dam shall allow sufficient water at all times to pass through a fishway, or in the absence of a fishway, allow sufficient water to pass over, around or through the dam, to keep in good condition any fish that may be planted or exist below the dam. During the minimum flow of water in any river or stream, permission may be granted by the department to the owner of any dam to allow sufficient water to pass through a culvert, waste gate, or over or around the dam, to keep in good condition any fish that may be planted or exist below the dam, when, in the judgment of the department, it is impracticable or detrimental to the owner to pass the water through the fishway."

The primary purpose of the proposed FMS is to maximize the annual production and survival of the anadromous fall-run Chinook salmon and steelhead in the lower American River, within water availability constraints and in consideration of Reclamation's obligation to provide for multi-purpose beneficial uses of the project. With improved habitat conditions for salmonids, the proposed FMS Standard also is expected to benefit other fish species within the lower American River.

2.5 Ecological Interactions

Concern has been expressed over the affects of hatchery fish on wild fish populations (Campton 1998, Montgomery 2005, Kostow 2006). Some authors 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). Ecological interactions may include competition, predation, parasitism and disease transfers, and behavioral influences, while genetic interactions may occur from interbreeding between hatchery and wild fish. Interbreeding may affect the fitness of wild fish and result in the loss of genetic diversity.

Adverse impacts are not necessarily inherent to hatchery programs and may be confused with ill-considered management goals and decisions and other, unrelated factors (Campton 1995, Brannon et al. 2004). Hatcheries have been used to supplement natural populations and production, 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 that:

> "Fish reared in hatchery facilities may differ from their wild conspecifics for three reasons. First, 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. The second reason why 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. The third reason why 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 outbreeding 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."

2.5.1 Competition

In ecology, competition is the interaction between two or more organisms, or groups of organisms, that use a common resource in short supply. There can be competition between members of the same species and competition between members of different species.

Weber and Fausch (2003) reported that competition between hatchery-produced 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. Many studies provided circumstantial evidence for competition, but the effects of competition were confounded with other variables. Most direct experiments of competition used additive designs that compared treatments in which hatchery fish were introduced into habitats containing wild fish with controls without hatchery fish. These studies are appropriate for quantifying the effects of hatchery fish at specific combinations of fish densities and stream carrying capacity. However, the authors indicated they do not measure the relative competitive ability of hatchery versus wild fish because the competitive ability of hatchery fish is confounded with the increased density that they cause.

Naturally-produced steelhead leave freshwater as one or two year old fish during the spring. McMichael et al. (1997 and 1998) investigated the effects of nonmigrant (residual), juvenile hatchery steelhead (anadromous rainbow trout), on growth of wild rainbow trout and juvenile spring Chinook salmon to examine how increased densities of residual hatchery steelhead might affect the growth of preexisting wild rainbow trout and Chinook salmon. Their results suggested that adverse effects on wild rainbow trout growth resulting from high densities (a doubling), of residual juvenile steelhead from hatchery releases may be significant.

Strategies to reduce competition between juvenile steelhead released from hatchery and naturally produced salmonids is desirable. However, it should be recognized that hatchery-produced juvenile steelhead are replacements for juvenile steelhead that were naturally produced in the American River upstream from Nimbus Dam and that competition has historically occurred between naturally produced salmonids. Nonetheless, to reduce competition and improve survival, NFH-produced yearling steelhead are released in the Sacramento River downstream from the confluence of the American River after January 1.

Alternatives to this release strategy would be to:

1. Release juvenile steelhead in the American River at or near NFH,
2. Release juvenile steelhead further downstream in the Sacramento River, and
3. Release juvenile steelhead at a later date.

Alternative 1 is expected to increase competition between hatchery- and naturally-produced juvenile steelhead. Additionally, Staley (1976) reported that angling mortality was exceptionally high on fish released in the American River as compared to the Sacramento River. He also reported that releases of hatchery-produced steelhead in the Sacramento River at Clarksburg (River mile 40) result in a much greater percentage of fish returning to NFH as compared to fish released at NFH. It is unknown if Alternative 2 would result in a higher survival rate, however, undesirable straying of returning adult steelhead may increase. Finally, Staley (1976) reported lower angler mortality on fish released in March as compared to June, suggesting that a later release date (Alternative 3) is undesirable. Additionally, it becomes more difficult to hold juvenile steelhead past the end of March due increasing water temperatures with commensurate rearing problems.

2.5.2 Predation

Although predation is part of salmonid natural ecology, the significance is inversely related to population size. Predation by NFH-produced juvenile salmonids on naturally-produced salmonids may reduce the number of naturally-produced 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, Unger 2004, Rundia and Lindely 2007). More specificially, Unger (2004) reported that yearling steelhead primarily feed on insects and other aquatic invertebrates, but older juvenile steelhead feed increasingly on small fish. The minimum size at which juvenile steelhead become piscivorous is typically assumed to be about 11 in (25 cm), based on studies on brown trout (Bachman 1991). Juvenile steelhead typically migrate to the ocean at a smaller size and do not become piscivorous until in the marine environment. 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.

Information on the feeding behavior juvenile steelhead (hatchery or naturally-produced) from the Sacramento River is lacking. 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.

2.5.3 Parasitism and disease transfers

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

2.5.4 Behavioral influences

Behavior influences on naturally-produced fish by hatchery-produced fish has been suggested as a factor that increases mortality of naturally-produce fish. Presently, NFH-produced fish are released at locations at size to encourage migration and reduce interactions with naturally produced fish.

McMichael et al. (1999) reported that the behavior of hatchery steelhead can 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. Releasing

NFH-produced juvenile steelhead in the Sacramento River downstream from the confluence of the American River and in an area that does not support year round salmonid habitat reduces the opportunity that these fish may exert behavioral influences on naturally-produced fish. Conversely, downstream releases may increase straying of returning NFH-produced steelhead.

2.5.5 Interbreeding

Interbreeding is defined differently by different individuals. Populations, subspecies, and species all describe regions on the spectrum of interbreeding, from nearly complete interbreeding (a single population) to never interbreeding (separate species). NFH-produced steelhead are intentionally interbred through artificial spawning. Such interbreeding results in domestication of a species. A fundamental distinction of domesticated and naturally-produced fish is that domesticated fish are created by human labor to meet specific requirements and become adapted, either intentionally or unintentionally to the conditions people maintain for them. Although difficult to put into sustained application, the first generation of fish from wild stock has been demonstrated to produce the greatest returns (Anonymous 2007).

Anadromous fish spend only a short portion of their lives in the hatchery environment before being released into the wild. Those hatchery fish that do return have survived the same perils as wild fish since the majority of their lives are spent adapting to and surviving in the wild. Domestication has been show to result in a loss of fitness for natural rearing (Reisenbichler and McIntyre 1977; Leider et al. 1990, Sekino et al 2002) and domestication of a hatchery population may also lead to problems when hatchery fish interbreed with wild fish either accidentally or as the intended result of supplementation programs (Waples 1999).

Hatchery-produced steelhead may also interbreed with naturally-produced steelhead in the natural environment. Homing to a natal site is characteristic of salmonids, but mature fish that migrate to and spawn in a stream other than their natal one are considered strays. Straying is a natural component of salmonid behavior that enables fish to colonize new habitat and to avoid locally unfavorable conditions. However, some managers had expressed concerns with straying of hatchery fish due to potential negative impacts on wild populations through interbreeding with hatchery fish (Lindsay 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.

Reisenbichler and Rubin (1999) suggested that although several studies have shown genetic differences between hatchery and wild anadromous Pacific salmon (*Oncorhynchus* spp.), none provided compelling evidence that artificial propagation poses a genetic threat to conservation of naturally spawning populations. However, they suggested that when the published studies and studies in progress are considered collectively, they provide strong evidence that the fitness for natural spawning and rearing can be rapidly and substantially reduced by artificial propagation

In many instances, supplementation hatcheries have been constructed as a substitute for habitat protection and harvest regulation, and are intended to supplement the natural fish population. NFH was constructed to mitigate for the loss of steelhead spawning habitat and not supplement natural populations. Presently, the steelhead population in the American River is almost entirely supported by NFH produce steelhead. McEwan and Jackson (1996) reported that over the past decade (1986 through 1996) the American River steelhead run has declined significantly due to adverse water temperature conditions, rapid flow fluctuations, inadequate water releases from Nimbus Dam, increased CVP and SWP water exports, and the 1986-92 droughts. They indicated that presently, most steelhead natural spawning occurs in the upper reach and the number of naturally spawning adult steelhead is small. More recent trapping records from NFH (1996 to 2006) indicate that almost twice as many steelhead have been trapped at NFH as compared to the previous decade, and current numbers are even greater than the first 30 years of NFH operation. This does not suggest that current steelhead population levels in the American River are comparable to pre-project levels; however, it does indicate that the NFH has played a major role in maintaining, albeit a hatchery population, of steelhead in the American River.

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 annually since 2002 spawned in the American River. The number of these fish that are NFH-produced is unknown, but we think high. During the past 5 years, only 2.9% of the steelhead trapped at NFH were not adipose fin clipped. If the incidence of naturally-produced 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. This supposition is supported by genetic analysis that demonstrated naturally-produced rainbow trout from the lower American River are similar to American River winter-run steelhead from NFH.

Because survival of hatchery juveniles to adulthood is often higher than natural-origin juveniles (Bilby et al. 2003); the contribution of individual hatchery fish to the next generation may be higher than the contribution of natural-origin fish. This has been identified as a mechanism that can depress the effective size of the population (Ryman and Laikre 1991, Ryman et al. 1995). Unfortunately, it is not possible with current information to separate American River environmental problems such as lack of habitat and poor water quality with genetic issues such as interbreeding. Evidence is lacking that releases of NFH-produced juvenile steelhead have a detrimental ecological effect on naturally-produced steelhead from the American River during freshwater out migration or ocean life, or that interbreeding of hatchery-produced and naturally-produced adult steelhead contributes to the small number of naturally-produced steelhead observed in the American River.

2.5.6 Strategies to reduce ecological and genetic interactions

Juvenile steelhead produced at NFH are released as yearlings in the Sacramento River at Garcia Bend (Sacramento River mile 49), approximately 9 miles downstream from the mouth of the American River, and at a size to encourage out migration. 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" steelhead in the lower American River in the fall and spring that appear to be adipose fin clipped.

Additionally, juvenile steelhead are released during the months of February and 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 and predation on juvenile steelhead.

Lacking supporting information, the present procedure of releasing NFH-produced steelhead in the Sacramento River at Garcia Bend appears to be the best management strategy. However, 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.

The diet of NFH-released juvenile steelhead may include fry of wild-origin salmonids, including Central Valley steelhead and Central Valley spring-run Chinook salmon during their downstream migration. Unger (2004) recommended measures to reduce this potential impact by modifying FRH release practices for steelhead as follows: 1) Steelhead would be released earlier in the year, before wild salmon and steelhead have emerged from their redds, or 2) steelhead would be released at smaller sizes, which are less likely to prey on fish, including salmonid fry. While such measures may reduce immediate predation, both of these measures have the potential of increasing predation by postponing migration of pre-smolt size fish and encouraging residency of released fish.

Juvenile steelhead typically migrate to the ocean at a size of 6 to 8 inches in length. To encourage out migration of NFH-produced juvenile steelhead and increase survival, the current strategy is to release fish at a size of 4 per pound or larger (approximately 8 inches in length)

In the American River, the number of naturally spawning adult steelhead is small. Hannon and Deason (2005) estimated the number of in-river spawners based steelhead observed holding on redds to average slightly more than 300 fish annually since 2002. Since the DPS for Central Valley steelhead includes all naturally spawned anadromous steelhead populations below natural and manmade impassable barriers in the Sacramento and San Joaquin Rivers and their tributaries, the definition includes steelhead naturally spawned in the American River downstream from Nimbus Dam. Although all hatchery-produced steelhead are marked with an adipose fin mark, a mechanism for separating marked and unmarked steelhead in the river does not exist, and it is not possible to prevent hatchery-produced steelhead from spawning in the American River. In fact, the contribution of hatchery-produced steelhead spawning in the American River steelhead and producing unmarked juvenile steelhead may be interpreted as contributing to Central Valley steelhead numbers.

The Formal and Early Section 7 Endangered Species Consultation OCAP suggested that it was desirable to minimize the adverse effects of flow fluctuations associated with Folsom Reservoir and Nimbus Dam operations on Central Valley steelhead spawning, egg incubation, and fry and juvenile rearing within the American River. While this action does not directly affect NFH operations; increased production of Central Valley steelhead in the American River may increase the number of unmarked steelhead entering NFH. This should have minimal implications on the genetic makeup of steelhead entering NFH since American River winter-run steelhead and rainbow trout from the American River show genetic similarity in microsatellite allelic frequencies (Nielsen et al. 2005).

3. Water Source

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

Water for NFH comes from Lake Natoma, a 525-surface acre afterbay for Folsom Lake. Folsom Dam impounds the south and north forks of the American River and has a drainage area of approximately 1,895 square miles. The American River basin is located east of the City of Sacramento in the Sierra Nevada range.

Folsom Lake was originally authorized in 1944 as a 355,000 acre-ft flood control unit, and reauthorized in 1949 as a 1,000,000 acre-ft multiple-purpose facility. The USACE constructed Folsom Dam and transferred it to Reclamation for coordinated operation as an integral part of the CVP. Construction of the dam began in October 1948 and was completed in May 1956; however, water storage began in earlier February 1955.

Folsom Dam is a concrete gravity dam 340 ft high and 1,400 ft long. The main section is flanked by two earthfill wing dams. The right wing dam is 6,700 ft long and 145 ft high, and the left wing dam is 2,100 ft long and 145 ft high. In addition to the main section and wing dams, there is one auxiliary dam and eight smaller earthfill dikes.

Nimbus Dam is located 6.8 miles downstream from Folsom Dam and re-regulates the water released from Folsom Lake. Nimbus Dam is a concrete gravity dam 1,093 ft long and 87 ft high and forms Lake Natoma with a capacity of 8,760 acre ft. Eighteen radial gates, each 40-ft by 24-ft, control the flows. The total of 121,100 cubic yards of material was used in the dam’s construction. Reclamation operates the dam. Nimbus Dam and Powerplant was completed and accepted by the Federal Government in July 1955.

Water is supplied to NFH -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. Both lines are connected through a series of gate valves that allow water to be directed into 3 areas as needed; the Terminal Structure, the American River Trout Hatchery, or directly into NFH.

To minimize the effects of water level fluctuations on flow in the supply line, the Department 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.

The original contract provides that Reclamation would furnish up to 30 cfs of water to the hatchery although currently, Reclamation may furnish up to 60 cfs for operation of both Nimbus Fish Hatchery and nearby American River Trout NFH.

Naturally produced juvenile steelhead typically rear for 1 or 2 years in freshwater before migrating to the ocean. Historically, the American River below Nimbus Dam does not provide optimum conditions for rearing and spawning. Late summer and early fall water temperatures were reported to exceed 70^{o} F; too high for rearing and spawning and in 1962 Reclamation installed a shutter system at Folsom Dam to release cooler water (Staley 1976). This solution did not resolve the problem and McEwan and Jackson (1996) reported that:

> "Because Folsom Reservoir is relied upon extensively for irrigation and delta salinity control, it is usually drawn down to very low levels by late summer or early fall. This results in depletion of the cold water pool at the bottom of the reservoir, consequently warmer water that is harmful to salmonids is released into the river during summer and fall in most years. This situation is worsened because the water release structure, which releases water to the river via the powerhouse, does not allow maximum conservation of the cold water pool. The structure has several ports at variable water depths, but, because the lowermost seven ports are fused and do not operate individually, cold water from the bottom of the reservoir is released early in the irrigation season during periods when water temperatures in the river are not critical. As a result, the cold water pool is usually exhausted by late summer or early fall, when cold water releases are necessary to maintain suitable temperatures in the river for salmon and steelhead."

3.2 Measures that will be applied to minimize the likelihood for the take of listed natural fish as a result of NFH water withdrawal, screening, or effluent discharge.

There are no known federally listed fish species in either Lake Natoma or Folsom Lake.

The effluent discharge is located within critical habitat of only fish species, steelhead, *Oncorhynchus mykiss* Central California Coast ESU (Threatened). Present levels of operation allow NFH to meet Federal effluent 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

3.3 Water withdrawal and screening

Two intake pipes are located on the south side of Nimbus Dam to provide water for NFH. A1/8 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.

3.4 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 direct the effluent from both NFH Buildings to the settling ponds. This action is intended to improve effluent discharge water quality.

Water from the raceways is discharged into two settling ponds located approximately 1,100 yards downstream from the entrance to the fish ladder and adjacent to the American River. 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 during discharge periods by NFH personnel. 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 Department's Water Quality Laboratory and results are transmitted to the WQCB.

4. Description of the Facility

NFH facilities include a fish weir, fish ladder, gathering and holding ponds, NFH buildings, rearing ponds, various office, shop, and storage buildings, fish transportation equipment, and miscellaneous equipment and supplies (Figure 4-1).

Figure 4-1. Nimbus Fish NFH.

4.1.1 Broodstock collection facilities and methods

Broodstock for NFH is comprised of fish that volitionally enter NFH ladder and fish trap.

4.1.2 Fish weir

No facilities are provided for fish to migrate above Nimbus Dam. To divert upstream migrating salmon and steelhead into NFH, a linear type structure (fish rack or weir) that spans the river was included as part of the project (Figure 4-2).

Figure 4-2. Fish weir with racks facing north on the left bank.

To provide a foundation for the structure, concrete abutments were constructed on each side of the river approximately 1,500 ft downstream from the Nimbus Dam and adjacent to NFH at longitude 121.22571 W, latitude 38.63566 N.

When installed, the fish weir is 306 ft long. Eight concrete supporting piers were permanently embedded in the river bed evenly across the river between the abutments (Figure 4-3). A rack support frame is attached to the upstream side of each pier.

Figure 4-3. Concrete supporting piers in the river facing north on the left bank.

To form a barrier to upstream migrating fish, 20 pipe rack frames, each holding 75 galvanized pipe pickets, are placed vertically on the upstream side of the rack support frames. A steel wire fabric mat 7 ft wide was initially installed 6 to12 inches below the surface of the river bed but has since deteriorated. Each of the pipe pickets is driven into the river bed to form a barrier.

An electric overhead hoist located on the south side (left bank) of the river is used to assist in the installation and removal of the racks frames and rack support frames each year (Figure 4-4).

Figure 4-4. Electric hoist used to install and remove the weir on the left bank.

Modifications and repairs to the fish weir have been made since the original construction. The rack and weir system can be affected by seasonal high flows and maintenance is required before annual fall installation. Although NFH personnel attempt to make the fish weir a complete barrier, some fish may pass through the weir and become available to anglers in the short reach upstream to Nimbus Dam. Romero et al. (1996) provide an architectural description of the structure.

Generally, the fish weir support framework is installed in the fall with the objective to have the framework installed and the weir pickets in place on or after September 15. The weir is typically removed after the Chinook salmon run or if flow releases >5,000 cfs are anticipated.

4.1.3 Fish Ladder

A fish ladder provides access for upstream migrating fish from the river to NFH Spawning Building and the entrance is located at: longitude 121.2254 W. latitude 38.6353 N.

Upstream migrating fish are diverted into the ladder by the fish weir at the south side (left bank) and ascend approximately 10 ft vertical elevation difference between the river bed and the holding ponds (Figure 4-5). The fish ladder is 502 ft long and contains 30 ft wide by 16 ft long by 5 ft deep pools.

Figure 4-5. Bottom of the fish ladder on the left bank facing west.

At the top of the ladder, migrating fish pass through a trap consisting of vertically hung swinging pipes (Figure 4-6). Fish are unable to pass downstream through the trap and are held upstream of the trap prior to inspection and sorting in a 60 ft long by 12-ft wide gathering tank.

Figure 4-6. Fish trap at the top of the fish ladder facing north.

The fish ladder is opened after river temperatures are at or below 60^{o} F and are expected to remain at that temperature or lower. This occurs generally about six weeks after the fish weir is installed. The fish ladder remains open to fish through approximately the first of April.

4.1.4 Gathering tank

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 (Figure 4-7). Fish are pushed through a hatch into the dope tank and into a lift basket contained within the dope tank. Carbon dioxide is released into the dope tank/lift basket water to immobilize the fish.

Figure 4-7. Electric/hydraulic fish crowder in the adult holding pond.

4.1.5 Adult Fish Holding Ponds

Adjacent to the fish ladder and NFH Building 2 are four concrete holding ponds. Each pond is 100 ft long, 14 ft wide, and 6 ft deep and each pond is capable of holding approximately 800 adult salmon or steelhead (Figure 4-8). Fish are transported to holding ponds via tubes from the spawning deck located in NFH Building 2. Fish can be pushed from the holding ponds into the gathering tank with a gasoline/hydraulic mechanical operated fish crowder.

Figure 4-8. Concrete holding ponds adjacent to NFH Building 2 facing west.

4.1.6 Spawning Deck

The spawning deck provides facilities for handling, inspecting, sorting, and spawning adult salmon and steelhead (Figure 4-9). Upstream migrating adult fish are lifted from the gathering tank to the spawning deck by a hydraulic fish lift (Figure 4-10). Carbon dioxide gas is injected into the dope tank area to immobilize the fish. Fish are lifted from the dope tank to a stainless steel sorting table where they are inspected for marks and tags and sorted based on sexual maturity. Fish not retained for spawning can be returned to the holding ponds or river via 1 of 5, 15 inch diameter stainless steel tubes (Figure 4-11).

Figure 4-9. Spawning deck in NFH Building 2.

Figure 4-10. Hydraulic Fish Lift and Dope Tank in NFH Building 2 with immobilized steelhead to be spawned.

Figure 4-11. Stainless steel tubes that lead to either the holding ponds or the river.

4.2 Rearing facilities

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

4.2.1 NFH Building 2

This 8,000 square ft (100 ft by 80 ft) sheet metal building with a concrete floor was constructed in 1992 to enhance NFH capabilities (Figure 4-12). The building includes a small laboratory and the spawning deck for inspecting, sorting, and spawning fish; an area for processing eggs, and egg incubation facilities (Figure 4-13).

Figure 4-12. Exterior of NFH Building 2.

Figure 4-13. Interior of NFH Building 2.

The egg incubation facilities in NFH Building 2 include 12 fiberglass deep tanks. Each deep tank is 20 ft long, 4 ft wide, and 30 inches deep (Figure 4-14) and capable of holding a total of 16 NFH-modified commercial Eagar hatching jars or 16 NFH-constructed PVC egg hatching jars (Figure 4-15). 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 (Figure 4-16). Water for the jars and incubators is supplied through overhead PVC plumbing.

Figure 4-14 Fiberglass deep tanks used in NFH Buildings 1 and 2.

Figure 4-15. PVC hatching jars in deep tanks.

Figure 4-16. Vertical 16-tray egg incubators in NFH Building 2.

4.2.2 NFH Building 1

This 13,000 square ft (130 ft by 100 ft) sheet metal building is the original NFH building (Figure 4-17). This building houses 68 fiberglass deep tanks similar to those described in NFH Building 2 (Figure 4-18). 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 (Figure 4-19).

Figure 4-17. Exterior of NFH Building 1.

Figure 4-18. Interior of NFH Building 1.

Figure 4-19. Vertical PVC water supply system to NFH Building 1 and 2.

4.2.3 Rearing ponds

Three pairs (6) of concrete rearing ponds, also called raceways, are located on the east side of NFH grounds. Each raceway is 400 ft long, 10 ft wide, and 42 inches ft deep, and effectively capable of holding approximately 90,000 gallons (Figure 4-20). 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.

Figure 4-20. Concrete raceway ponds facing north.

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 (Figure 4-21).

Figure 4-21. Chain link and wire mesh enclosure surrounding the raceways.

4.2.4 Fish crowders

In addition to the two fish crowders used in the Gathering Tank and adult holding ponds, two additional gasoline operated mechanical fish crowders are available for use to move/push fish in the raceways (Figure 4-22).

Figure 4-22. Gasoline operated mechanical fish crowder in the raceway.

4.2.5 Fish pump/loader

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 (Figure 4-23).

Figure 4-23. Aqua-Life Harvester Dewatering Tower loading juvenile steelhead.

4.2.6 2,800-gallon 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 (Figure 4-24). A tractor is typically rented to move the tank.

Figure 4-24. 2,800-gallon West-Mark ST-2800 NS fish hauling tank with tractor.

4.2.7 Headquarters/office building

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 (Figure 4-25).

Figure 4-25. Exterior of the Fish NFH Headquarters/Office Building.

4.2.8 Freezer building

A 425 square ft metal sided building provides cold storage facilities for NFH and storage for semi-moist fish food, ice, and code-wire tagged fish heads collected by NFH personnel (Figure 4-26).

Figure 4-26. Freezer building.

4.2.9 Visitor center

A visitor center is located adjacent to NFH Building 2 and offers natural resources interpretive displays for the public (Figure 4-27). 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 which are not open to the public.

Figure 4-27. Nimbus NFH Visitor Center.

4.2.10 Auto/wood/metal shops and storage buildings

In addition to NFH Building 1 and 2, and the office and freezer buildings, five additional metal buildings are located on NFH grounds. These include:

Garage - 5,600-square ft building with four over-sized roll-up doors to provide storage for large equipment (Figure 4-28).

Figure 4-28. Garage.

Lawn Equipment Building – 450-sq ft building with one 10-ft by 10-ft roll-up door to provide storage for lawn equipment (Figure 4-29).

Figure 4-29. Lawn Equipment Building.

Processing Building - 10,000-sq ft building with 3 entrance doors and a 10-ft X 10-ft roll-up door (Figure 4-30).

Figure 4-30. Processing Building.

Equipment, paint, and fuel storage building – 750-square ft building for miscellaneous tools with a single 10-ft by 10-ft roll-up door (Figure 4-31).

Figure 4-31. Equipment, Paint, and Fuel Storage Building.

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 (Figure 4-32).

Figure 4-32. Auto/Metal/Wood Shop Building.

4.2.11 Miscellaneous equipment

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 NFH operations.

5. Broodstock origin and identity

Steelhead are native to the American River drainage but very limited information is available on their historical status. NFH broodstock originally included both indigenous steelhead from the American River in addition to other out-of-basin steelhead transferred to the NFH.

Specific information on transfers of non-indigenous steelehead, 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).

5.1 Steelhead

The term “steelhead” is used to identify the adult sea-run or anadromous form of rainbow trout. The origin of the name “steelhead” is unclear but has been suggested that it refers to the metallic appearance or possibly the hardness of the fish’s head.

The fish was first noted by Dr. Meredith Gairdner in 1833 while employed by the Hudson Bay Company. Dr. Gairdner sent a specimen collected at Observatory Inlet, Columbia River, to Sir John Richardson who subsequently described the species for science as *Salmo gairdnerii* (Richardson 1836). Later in 1855, Dr. William P. Gibbons, founder of the California Academy of Science, described another trout from San Leandro Creek (tributary to San Francisco Bay, Alameda County, California) as rainbow trout, *Salmo iridea*.

Early confusion existed regarding the relationship between the anadromous and resident forms of rainbow trout. Snyder (1928, 1940) recognized that the anadromous steelhead and resident rainbow trout were the same species and Wales (1939) suggested that the “rainbow” trout group should be divided into three subspecies:

> Sea-run “Steelhead” *Salmo gairdnerii gairdnerii*
> Non-migratory “rainbow” trout, *Salmo gairdnerii Shasta*, and
> Non-migratory kamloops trout, *Salmo gairdnerii kamloops*

Shapovalov and Taft (1954) used the common name steelhead rainbow trout irrespective of the habitat, size, or sexual condition of the individuals concerned and for brevity, referred to the fish using the unofficial common name "steelhead". They reported that when individuals remain in a stream throughout their lifetime they grew at a much slower rate than those individuals which have entered the ocean, and will also take on the typical bright coloration of "stream trout" or "rainbow trout."

Presently, rainbow trout, including both resident and anadromous forms are considered the same species although different races, runs, or stocks of steelhead are recognized. Also, the specific name *mykiss* Walbaum (1792) has been shown to be a senior synonym to *gairdnerii*. *Mykiss* was first used to describe a Kamchatkan *Salmo* species by Johann Julio Walbaum, although Briggs (1965) suggested the fish had been reported earlier in 1740 by George Wilhelm Steller. The relationship between the Kamchatkan *Salmo* and western rainbow trout was reviewed by Behnke (1966), who concluded that the Kamchatkan *Salmo* consisted of a single species with both anadromous and non-anadromous populations and has its closest affinities with the rainbow trout. Additionally, the generic name for the species was changed from *Salmo* to *Oncorhynchus* and reflects a belief that all species of trout from western North America share a common lineage with Pacific salmon.

The present endemic distribution of steelhead extends from the Kamchatka Peninsula, Asia, east and south, along the Pacific coast of North America to Malibu Creek in southern California (Burgner et al. 1992).

Currently, the Department recognizes coastal rainbow trout as a common name that includes steelhead. Similar to Pacific salmon, *Oncorhynchus* means hook snout, referring to the hooked jaw of a breeding male and m*ykiss* is presumed to be a derivative of *mikizha* or *mykz,* the Kamchatkan word for trout.

Rainbow trout generally exhibit one of two distinct life history patterns: 1) a non-anadromous or resident trout pattern, and 2) a sea-run or anadromous steelhead pattern. Although the topic has been the subject of studies and scientific discussion, it is unclear whether anadromy in rainbow trout is a genetic adaptation or an opportunistic behavior related to habitat conditions. There are no major physiological differences between rainbow and steelhead trout; however, the nature of their differing life histories results in differences in color, shape, size, and general appearance.

Genetic studies comparing freshwater resident rainbow trout and steelhead within individual river basins have consistently suggested polyphyletic origins for these two life histories resulting from parallel evolution rather than two distinct life-history lineages (Phelps et al. 1994; McCusker et al. 2000; Docker and Heath 2003). More recently, Clemento (2006) found minimal genetic variation between the three sample years of adult summer steelhead trout but significant genetic differences among juvenile collections from upper Middle Fork Eel tributaries. Although closely related to the summer steelhead trout population, the resident groups did not appear to be exchanging migrants with the anadromous form at present.

Resident and anadromous life history patterns are not limited to rainbow trout. Other salmonids that demonstrate both life histories include cutthroat trout *O. clarkii*, Atlantic salmon, *Salmo salar*, brown trout *S. trutta*, and several chars. Charles et al (2005) observed no significant genetic differences between anadromous and resident forms of brown trout *S. trutta* from the Oir River (Normandy) using microsatellite markers.

Naturally-spawning rainbow trout, including steelhead, spawn annually in the late winter or early spring. However, the spawning time of rainbow trout has been altered through fish cultural practices and domesticated stocks spawn every month of the year. Steelhead egg taking operations and hatcheries have been operated in California for over 100 years (Leitritz 1970).

Natural spawning of steelhead is similar to other salmonids and occurs in places where the streambed is composed of gravelly substrate, usually in riffles or the tail out of pools. The female fish digs a redd and will deposit 200 to 12,000 eggs, depending upon body size (typically about 2,000 eggs per kg of body weight). Steelhead redds are typically not as large or deep as Chinook salmon redds, since female steelhead are smaller in body size. After spawning, surviving steelhead return to saltwater but some fish may remain in freshwater for a period of time.

Steelhead eggs hatch in 60 to 90 days, depending upon water temperature (Leitritz and Lewis 1959). After hatching, the young fish emerge from the gravel and gradually work their way to the surface of the stream bed. Juvenile fish (called parr) may spend one or more years in freshwater before migrating to the ocean. The time of freshwater residency depends upon various environmental factors, the stock of fish, and growth rate. In California, naturally-produced steelhead typically reside in freshwater for 1-2 years. Hatchery-produced juvenile steelhead released at a size of <6 inch total length (TL) may remain in freshwater for an additional year as compared to fish released at a larger size that will migrate to saltwater immediately.

Although it is generally believed that the majority of juvenile fish produced from steelhead parents will migrate to the ocean, Shapovalov and Taft (1954) reported that in their studies of Waddell Creek, California, a certain proportion, in some cases perhaps a considerable proportion, of the steelhead may remain in the stream, attain sexual maturity, and spawn without descending to the ocean. The instream behavior and downstream migration of juvenile steelhead was described in detail by Shapavolov and Taft (1954):

> “The freshly-emerged fish first take up residence in the shallow gravel areas, especially at the sides of the stream. At first they tend to congregate in schools, but as time passes and the fish grow these schools break up and the fish spread up and down the stream, selecting individual small "territories", from which they drive other fish of the same size or somewhat larger. The fry in the shallows feed avidly and grow rapidly. The individual fry rise to nearly every small object drifting downstream or falling into the water, selecting those that are suitable and ejecting those that are not. Following their rise, they return to the original position.

> As the fish grow, they gradually move into deeper water and eat coarser food. However, unlike the silver salmon, in late summer the young steelhead do not appear to move into the deep, quiet pools, but inhabit the moderately swift portions of the stream. Diurnal movements within limited areas may occur, but have not been studied in any detail. At this time the growth rate of the fish begins to slow down (probably not as early nor as markedly as in the case of the silver salmon) in association with the period of maximum stream temperatures and minimum flow, with some evidence to indicate that the former plays the greatest part. During the period of heavy rainfall and lowest temperatures, December through February, feeding is generally quite light and growth negligible, according to measurements and scale readings. It appears that during this period of floods and great turbidity the young steelhead, like the silver salmon, are not swept downstream and do not migrate downstream voluntarily in large numbers, but make use of backwater and eddies in maintaining their position in the stream.
>
> Following the period of maximum precipitation, the fish start making extremely rapid growth (usually in March), as witnessed by the sharp increase in average size of fish and new growth registered on the scales. The resumption of heavy feeding is probably influenced both by rising temperatures and an abundance of aquatic food organisms. Although a steady lowering of stream flow takes place during the ensuing months, adverse water conditions ordinarily are not reached before midsummer."

Prior to migration, juvenile fish enter a phase called smoltification, characterized by a "silvery" appearance and loss of some scales. At this phase, the juvenile fish is called a smolt. In most rivers, juvenile steelhead smolts descend to the ocean in the spring during periods of increased flows.

Steelhead smolts enter the river estuary and ocean where they begin feeding on estuarine invertebrates and krill, and then focus on fish. Most California steelhead remain in saltwater for 1-2 full years before returning to their natal stream. Homing to natal streams is an important biological characteristic of salmonid fishes,(Quinn 1993; Altukhov and Salmenkova 1994; Quinn et al. 2001). Stock-specific, genetically-based adaptations include size and age at sexual maturity, adult return and spawn timing, pre-hatch developmental rate, length of freshwater residence prior to outmigration, and marine migration patterns (e.g., Smoker et al. 1998). Natural straying also plays an important role related to colonization of new habitats and maintaining connectivity between geographically adjacent populations (Shapovolov and Taft 1954; Milner 1997; Quinn 1997). Many studies have shown that salmon and steelhead seek alternative spawning habitats if no appropriate habitat is immediately available (Pascual and Quinn 1994). This becomes apparent when natal streams are blocked by catastrophic, environmental events. For example, siltation resulting from the 1980 eruption of Mount St. Helens resulted in significant numbers of Chinook salmon and steelhead straying from the Cowlitz River to the Kalama and Lewis rivers (Leider 1989; Quinn et al. 1991).

Some steelhead may return to freshwater after spending only a few months in the ocean. The half-pounder life history characteristic of steelhead was first described by Snyder (1925). Steelhead demonstrating this life history spend only 2-4 months in the ocean before returning to fresh water in the late summer or early fall months. They over-winter in fresh water and migrate downstream to re-enter salt water again the following spring. The upstream migrations has been described as a false spawning migration, as few half-pounders are sexually mature, although the fish may actively feed while in freshwater

Half-pounder steelhead are typically small compared to adult steelhead although there is some variability in criteria for defining half-pounders. Kesner and Barnhart (1972) described Klamath River half-pounders as being 250-349 mm in length, while Everest (1973) used 406 mm as the upper limit on the Rogue River. The Department's Operations Manual defines "half-pounder" steelhead as less that 15.9 in. in (404 mm) in length and the California Sport Angling Regulations define a steelhead as a rainbow trout > 16 inches (406 mm) total length (TL) caught from anadromous waters.

Half-pounders have been reported from the Rogue, Klamath, Mad, and Eel River drainages of southern Oregon and northern California (Snyder 1925, Kesner and Barnhart 1972, Everest 1973, Barnhart 1986). Similar sized fish have been occasionally reported from other California anadromous streams, including the American River, but in small numbers. The lack of greater numbers of half-pounder-sized steelhead outside the Rogue, Klamath, Mad, and Eel rivers suggests that if it occurs in other locations, the half-pounder life-history strategy is less successful. Additionally, winter steelhead broodstock for Cole Rivers Hatchery on the Rogue River in Oregon were initially selected for fish without evidence of the half-pounder life history, yet there is evidence that among winter steelhead subsequently returning to the hatchery, approximately 30% underwent a half-pounder migration (Evenson 1993), suggesting that this is not strictly a genetic trait.

Steelhead have been reported to spawn up to four times per life span although the incidence of repeat spawning varies annually and the mortality rate between successive spawning cycles is high (Shapovalov and Taft 1954)

5.1.1 Hatchery broodstock source

Presently, NFH steelhead broodstock is comprised of adult steelhead that volitionally enter NFH and are called American River winter-run steelhead.

Steelhead broodstock for NFH was originally obtained from several sources including naturally-produced fish from the American River that entered NFH ladder, and non-indigenous fall- and winter-run steelhead stocks from the Eel, Mad, Sacramento, and Russian rivers that were transferred to NFH (Table 5-1). In addition, spring-run summer steelhead were transferred from the Roaring and North Fork Washougal rivers (Table 5-1). However, returning non-indigenous spring-run summer steelhead were physically larger, less robust, highly colored, and were fin-marked, and not integrated into the American River winter-run broodstock.

Table 5-1 Non-indigenous steelhead reared at the Nimbus Fish Hatchery 1955 - 2006.

Source of fish	River	Brood year	Release date	Release location	Number released	Release Size [1]	Comments
Snow Mountain Egg Collection Station	Eel River, CA	1957	Mar-58	American River	823,971		
Snow Mountain Egg Collection Station	Eel River, CA	1957	Mar-58	American River	100,218		
Snow Mountain Egg Collection Station	Eel River, CA	1958	Aug - Dec-59	American River	337,500	fingerling	
Snow Mountain Egg Collection Station	Eel River, CA	1958	Jan - Feb-59	American River	371,345	yearling	
Snow Mountain Egg Collection Station	Eel River, CA	1959	Jul-59	American River	460,628 [2]	70	
Skamania NFH	N.F. Washougal River, WA	1969	Mar-70	Sacramento River – Clarksburg	18,700	8.5	Summer steelhead
Skamania NFH	N.F. Washougal River, WA	1970	Mar-71	Sacramento River – Clarksburg	450	15.5-17	Summer steelhead
Skamania NFH	N.F. Washougal River, WA	1970	Apr-71	Sacramento River – Clarksburg	7,990	7.5-7.6	Summer steelhead
Roaring River NFH	Roaring River, South Santiam River, OR	1971	Dec-71	American River	23,200	yearling	Summer steelhead
Roaring River NFH	Roaring River, South Santiam River, OR	1971	Mar-72	Sacramento River – Clarksburg	68,124	yearling	Summer steelhead
Skamania NFH	N.F. Washougal River, WA	1973	Jun-73	American River	12,240	24	Summer steelhead
Skamania NFH	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	Mad River,	1978	Jan - Apr-	Sacramento	284,870	yearlings	Winter run

Hatchery	CA		79	River - Rio Vista			
Skamania NFH	N.F. Washougal River, WA	1979	Apr-80	Sacramento River - Rio Vista	148,220	yearlings	Summer steelhead
Skamania NFH	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	
Coleman NFH	Battle Creek, CA	1980	Mar-81	Sacramento River - Rio Vista	50,981	yearlings	
Coleman NFH	Battle Creek, CA	1980	Mar-81	Carquinez Straits	51,628	yearlings	
Warm Springs Hatchery	Dry Creek, Russian River, CA	1983	Apr-84	Sacramento River - Rio Vista	91,000 [3]	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	
Warm Springs Hatchery	Dry Creek, Russian River, CA	1990	Jan - Mar-90	Sacramento River - Clarksburg & Garcia Bend	235,295 [5]	3.9	Late run
Mad River Hatchery	Mad River, CA	1991	Jan - Feb-92	Sacramento River - Clarksburg & Garcia Bend	183,390 [4]	yearlings	Winter run
Mad River Hatchery	Mad River, CA	1993	Jan-94	Sacramento River - Clarksburg & Garcia Bend	122,820	3.8-4.3	

In addition to adipose-marked hatchery origin steelhead trapped at NFH, a small number of non-marked steelhead have been trapped. Since the 2001-2002 trapping season, 339 (2.8%) steelhead with adipose fin have been reported (Table 5-2). This percentage unmarked steelhead is within the expected error for hand marking fish suggesting that unmarked steelhead trapped at NFH may be unmarked NFH –produced steelhead as a resulting of marking error, or steelhead naturally produced in the American River.

Table 5-2. Number and percentage of unmarked steelhead trapped at the Nimbus Fish Hatchery, 2001 to present.

Year	Total number of steelhead trapped	Number of unmarked steelhead observed	
2001-2002	2,877	50	1.7%
2002-2003	1,253	69	5.5%
2003-2004	873	27	3.1%
2004-2005	1,741	17	1.0%
2005-2006	2,772	118	4.3%
2006-2007	2,673	58	2.2%
Total	12,189	339	2.8%

5.1.2 Supporting information

American River winter-run steelhead are genetically and phenotypicaly different, and demonstrate a later upstream migration period than Central Valley steelhead (Hallock et al. 1961, Staley 1976, Neilsen et al. 2005). These differences are most likely due to the mixing of various steelhead brood stocks of which the Eel River winter run is considered the predominate stock.

5.1.3 History

Hinze et al. (1956) reported that “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. (2000) provided a few insights into the historical distribution of steelhead in the American River in their review of the distribution of Chinook salmon.

Steelhead ascended portions of the South and North Forks of the American River but migration was blocked after storms in 1950 destroyed a fish ladder over the Pacific Gas and Electric Dam near the town of Folsom. Folsom Dam was under construction a short distance upstream and it was deemed unnecessary to replace the ladder (Hinze et al. 1956). Subsequently, completion of Nimbus Dam in 1955 blocked all anadromous fish runs in the American River.

5.1.4 Annual size

Historical information on the number of the steelhead that migrated into the American River is lacking and the first counts are from NFH annual reports. Although Chinook salmon were enumerated for seven years during the period 1944 through 1952, we were unable to locate any records that provided information on the number of steelhead during that same period.

NFH fish ladder was placed into operation on October 5, 1955 and a total of 25 adult steelhead was reported to have entered NFH before the weir was removed due to high flows on December 22, 1955 (Hinze et al. 1956). An additional 85 fish entered NFH through June 30, 1956. The first eggs were taken on February 28 and the last on May 10, 1956.

During the period 1955 through June 30, 2007, 76,541 half-pounder and adult steelhead were reported trapped at NFH (Figure 5-1, Table 5-3, and Appendix 6). The number of adult steelhead annually trapped has averaged 1,469 (range 18 2,373) fish since 1955.

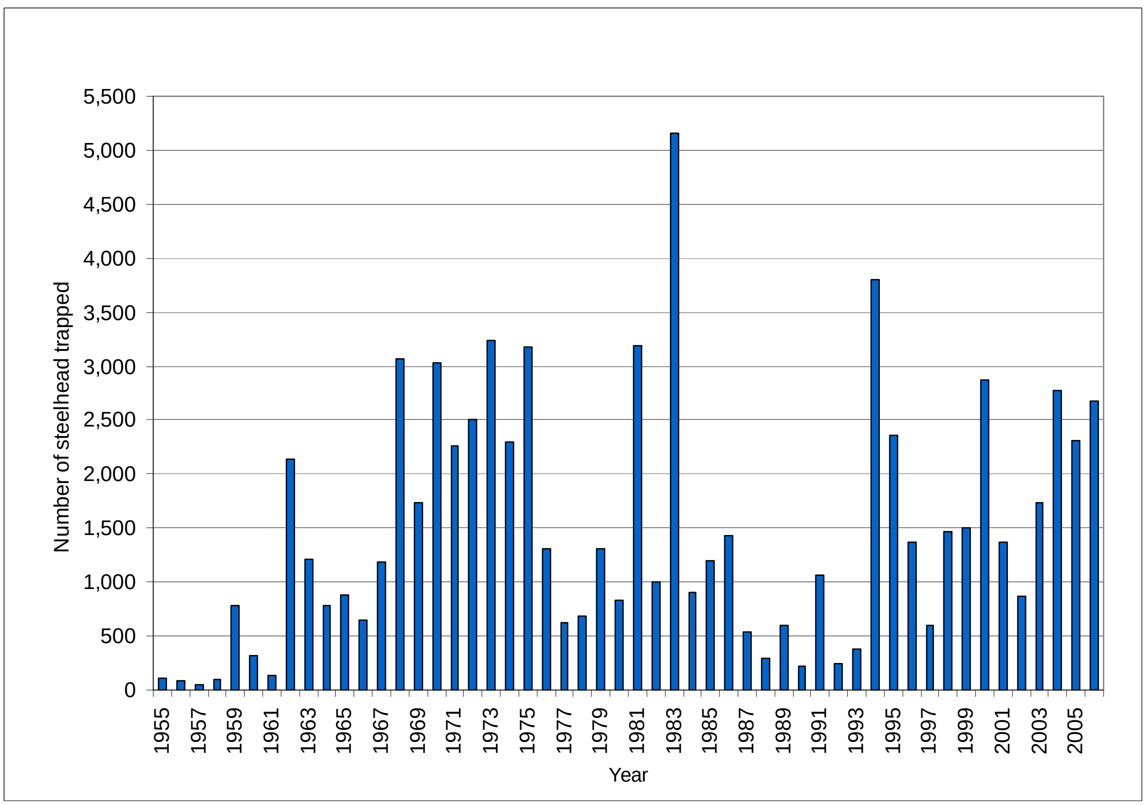

Figure 5-1. Number of steelhead trapped at the Nimbus Fish Hatchery, 1955 to 2006.

Table 5-3. Number of adult steelhead reported trapped at the Nimbus Fish Hatchery 1955-2006.

	Steelhead			
Year [a]	Male	Female	Half-pounder	Total fish
1955	36	74		110
1956	41	48		115 [3]
1957	33	18		51
1958	65	37		102
1959	354	424		778
1960	150	166		316
1961	86	51		135 [1]
1962	1,226	915		2,154 [1]
1963	472	744		1,216
1964	502	276		780 [1]
1965	374	500		874
1966	370	272		444
1967	576	607		1,183
1968	1,617	1,449		3,066
1969	1,088	646		1,734
1970	1,547	1,486		3,033
1971	1,148	1,108		2,861 [3]
1972	1,220	1,286		2,986 [3]
1973	1,935	1,302		3,237
1974	1,176	1,119		2,295
1975	1,538	1,643		3,181
1976	592	715		1,307
1977	377	242		619
1978	333	347		680
1979	729	581		1,310
1980	494	342		836
1981	1,684	1,506		3,808 [2]
1982	570	433		1,003
1983	2,373	2,782		5,155
1984	456	454		763 [3]
1985	729	464		1,193
1986	750	681		1,431
1987 [4]	287	249	169	705
1988	133	156	7	296
1989	328	266		594

1990	154	69		223
1991	561	506	292	1,359
1992	133	108	0	241
1993	210	175	111	496
1994	1,928	1,875	0	3,803
1995	1,206	1,154	0	2,360
1996	735	633	3	1,371
1997	427	173	80	680
1998	805	657	115	1,577
1999	813	695	148	1,658 [1]
2000	1,412	1,465	17	2,895 [1]
2001	815	548	106	1,556 [1]
2002	482	391	10	885 [1]
2003	965	776	25	1,800 [1]
2004	1,444	1,328	101	2,873
2005	1,243	1,065	127	2,435
2006	1,396	1,277	11	2,684
Total [3]	40,169	36,233	1,322	76,541
Means	772	987		1,472

[a] Year is fiscal year i.e., 1955-1956.

[1] Mathematical error in daily fish count totals in the Annual Report.

[2] Includes 618 fish which may or may not have been released or spawned.

[3] Daily fish count does not agree with the summary number in Annual Report.

[4] First year half-pounder size steelhead reported in annual reports.

5.1.5 Run timing

We were unable to located information on the timing of historical steelhead runs in the American River. Presently, the American River steelhead are considered a winter-run fish which enter the river in the late fall and winter.

Migratory behavior has been demonstrated to be a quantitative trait under partial genetic and environmental controls. Briggs (1953) observed that winter-run steelhead in the Mad River (Humboldt Co) reacted and migrated more closely to temperature changes than to fluctuations in increases in water volume. Temperature records and information on run timing of naturally produced American River steelhead prior to operation of NFH is lacking.

Differentiation based on timing of upstream migration in steelhead has been investigated by genetic methods. Allendorf (1975) and Utter and Allendorf (1977) found that summer and winter steelhead of a particular coastal stream tended to resemble one another genetically more than they resembled populations of adjacent drainages with similar run timing. Later allozyme studies have supported these conclusions in a variety of geographical areas (Chilcote et al. 1980, Reisenbichler and Phelps 1989, Reisenbichler et al. 1992). In each of the more recent studies, the summer-run stocks have had some extent of hatchery introgression and therefore may not represent the indigenous population. Furthermore, in at least some cases, interpretation of the results may be complicated by difficulties in determining run timing of the fish sampled.

Hinze et al. (1956) reported that some steelhead passed the City of Folsom every month of the year except August and September, and the peak of the run occurred in May or June, suggesting that the river supported several different races or runs of steelhead prior to dam construction. The source of this information is unknown and we could not find any collaborating data. He 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).

A review of historical stream flows in the American River prior to 1954 indicates that flows were starting to drop during May and June from higher winter flows. As such, we believe that it is possible that more fish may have ascended the American during periods of higher flows but were not as easily observed as fish during May and June. Steelhead entering freshwater in May and June and spawning the following spring are typically described as a spring-run “summer” steelhead. Runs of summer steelhead occur in California in the Middle Fork Eel River, and several tributaries of the Klamath River, however, their numbers are small compared to the fall and winter runs.

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 may have been a large summer-run steelhead component.

Steelhead migration in the Sacramento River was studied by Hallock et al. (1961) 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."

Since operation of NFH, steelhead have been trapped as early as the 1st week of October (standard week 41) and as late as the 2nd week of April (standard week 15) (Figure 5-2) with one or more peaks in the number of steelhead trapped weekly. There has been a general trend towards an earlier date for the first steelhead trapped although the trend is not significant (R^2 = 0.0924, N = 51). This slight earlier trend may be due to ladder and trapping operations, and lack of reporting of steelhead trapped and not returned to the river in the early part of the season during the early years of NFH operations.

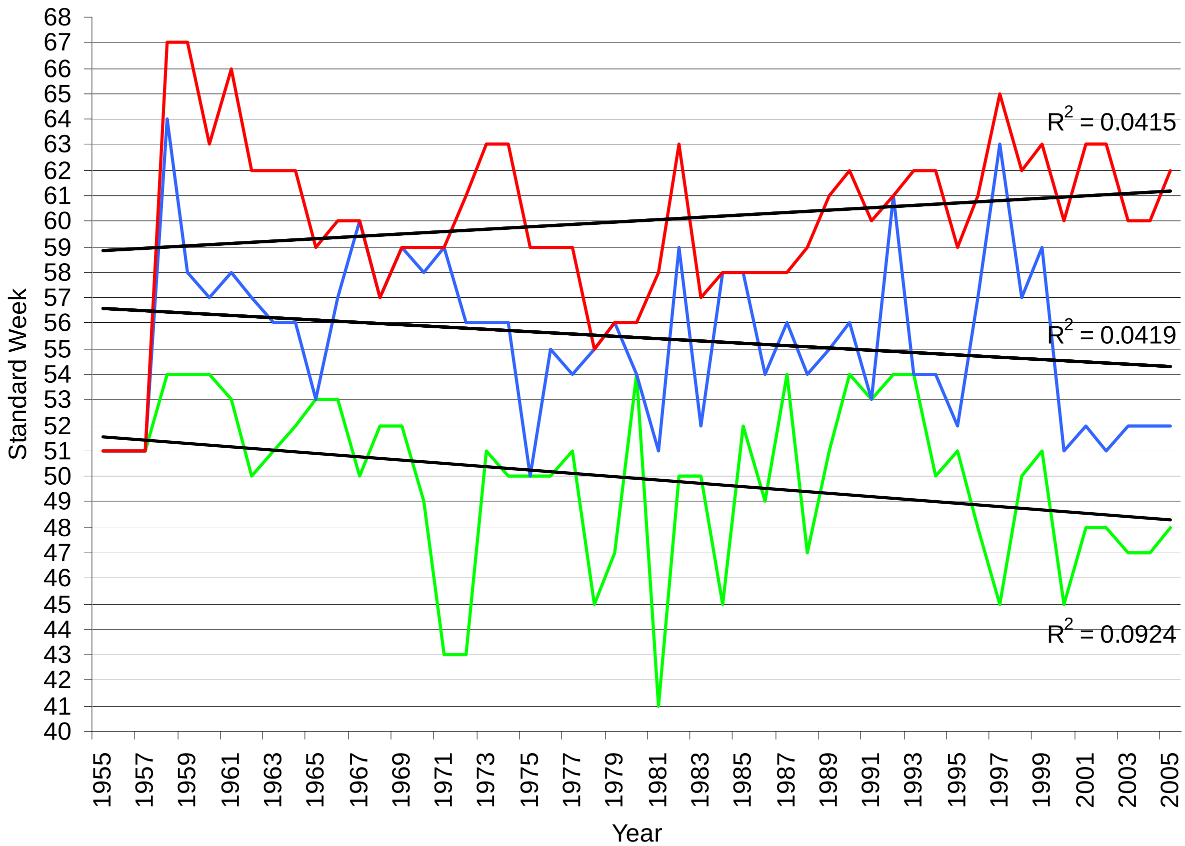

Figure 5-2. Time of first steelhead trapped, peak entry and last fish trapped at NFH, 1955 to present (note – Standard Week 1 starts January 1 but is noted as Standard Week 53 for analysis purposes, etc).

The time period the greatest numbers of steelhead have been trapped at NFH has also varied by a much as 8 weeks during the 51 years of operation (Figure 5-2). There has been a slight trend to an earlier date although again, regression analysis suggests the trend is not significant (R^2 = 0.0419, n = 50) due to the high variability of the dates (range from standard week 3 to 11, mid-January to mid-March).

The time period the last steelhead has been trapped has also varied (range from standard week 3 to 15, mid-January to early April) and most likely reflects operation of the fish ladder and trap (Figure 5-2).

The present run of American River winter-run steelhead demonstrate a freshwater entry timing that is more similar to winter-run Eel River steelhead than Central Valley steelhead. Counts on the South Fork Eel River at Benbow Dam indicate the first steelhead was counted 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 in NFH egg take, and the trap has been kept open longer and fish spawned later during the season. This strategy appears to have resulted in a general earlier start and later finish to the run as compared to the previous 25 years of operation, however; this may be an artifact resulting from trap operations rather than an actual change in run timing.

5.1.6 Past and proposed level of natural fish in broodstock

From 1958 through 1993, non-native steelhead eggs were transferred to and 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; Warm Springs Hatchery, Dry Creek, Russian River, CA; and Mad River Hatchery, Mad River, CA (Table 5-1). Each of these stocks could be described as fall or winter-run steelhead.

The Department also attempted to establish a summer steelhead run in the American River during the early 1970’s by the introduction of summer steelhead from Washington and Oregon hatcheries. Eggs from summer-run steelhead stocks were transferred from two northwestern hatcheries to NFH (Table 5-4). Eggs were hatched and all or a portion of the fish were fin marked and released. Marked adults were recorded as returning to NFH and for some brood years eggs were taken and progeny stocked in the American and Sacramento rivers (Meyer 1985).

Some authors have speculated as to the genetic makeup of the present American River winter-run steelhead. For example, Cramer et al. (1995) suggested that based on the transfers of eggs from the Eel River and run timing, NFH winter-run steelhead stock is Eel River. Also the WCBRT (1997) reported:

> "In our new 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."

Information is available on early non-indigenous steelhead transferred to NFH. Hinze (1961) reported that in 1958, a total of 924,189 juvenile steelhead from the Snow Mountain Egg Collecting Station, Eel River was planted in the American River. Of these, 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 steelhead naturally produced from the American River. In the following year in 1959, a final 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) (Hinze 1961) were stocked in the American River.

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.

Totals of 98, 751, and 316 adult steelhead were reported entering NFH during the 1958-59, 1959-60, and 1960-61 seasons, respectively. Since unmarked Eel River adult steelhead comprised approximately 90% of all steelhead released in 1958, unmarked 1957 BY Eel River adult steelhead may have comprised a major portion of the age-2 fish returning to NFH in 1959-60. Hinze (1961) reported that during the 1958-59 season, the majority of steelhead entering NFH were less than 16 inches in length. These small steelhead were most likely immature and not spawned. The following year during the 1960-61 season, up to 90 (28% of 316) of the age-3 adults 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 Department'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. 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.

Also, in the early 1970’s steelhead trapped in the Sacramento River upstream from the confluence of the American River near the Interstate 80 Bridge were transported to NFH in an attempt to establish an early steelhead run in the American River. As reported by Staley (1976), steelhead entering NFH prior to October 31 were spawned separately from the later winter-run fish. Also, out-of-state summer steelhead were transferred to NFH and released in the American River from 1970 through 1981 in an attempt to establish a summer run of steelhead. These efforts to establish summer and “early” runs of steelhead in the American River were discontinued due to difficulties distinguishing returning marked adult fish (Jochimsen 1978b). 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.

The historical percentage of naturally spawned steelhead in NFH broodstock is unknown. However, since all hatchery-produced juvenile steelhead have been marked since the 1998 BY, all adult steelhead with an adipose fin are presumed to be naturally-produced. Presently, about 2.9% of the adult steelhead trapped at NFH have an adipose fin and are included in NFH broodstock.

5.1.7 Genetic or ecological 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 9 drainages in northwestern Washington (primarily the Olympic Peninsula).

As mentioned above, American River winter-run steelhead have been demonstrated to be genetically most similar to Eel River stock (WCBRT1997, Nielsen 2005). More specifically, Nielsen et al. (2005) examined genetic variation at 11 microsatellite loci in efforts to describe the population genetic structure of *Oncorhynchus mykiss* in the Central Valley, California. They 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.

Nielsen et al. (2005) findings regarding the distribution of American River winter-run steelhead are not surprising in light of the historical mixing of steelhead stocks coupled with the transfers of American River winter-run steelhead to the Mokelumne River hatchery and the potential for straying of hatchery-produced returning adult steelhead. Similarly, observations on the clustering of rainbow trout from areas above major dams (i.e. above Folsom Dam and below Nimbus Dam) is also not surprising when compared with a 100 year history of stocking a variety of domesticated hatchery rainbow trout stocks in the north and south Forks of the American River and tributaries.

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. However, juvenile steelhead in the river quickly make up the size difference and surpass NFH fish in size by the end of the summer (J. Hannon, Regional Fish Biologist, Bureau of Reclamation, personal communication).

Our review of NFH records and genetic evaluations suggests that naturally-produced steelhead from the American River, non-indigenous steelhead from Battle Creek, and the Eel and Mad rivers have contributed to the current genetic makeup of both natural spawning and NFH-reared American River steelhead. While American River winter-run steelhead are “genetically most similar” (WCBRT1997) to Eel River stock, the combination of stock mixing, hatchery operations, and environmental conditions has created a “naturalized” (having become permanently established after being introduced) stock of steelhead in the American River.

5.1.8 Age structure, fish size, and fecundity

Age structure – We did not find any early evaluations of the age structure 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 (T. West, NFH Hatchery Manager II, personal communication) and would have exhibited at least 2 years of ocean growth. Central Valley steelhead of this weight range would have varied in length from 52 to 65 cm (Hallock et al 1961).

Typically, steelhead from California coastal streams are dominated by fish that demonstrate 2 year of freshwater growth and 2 years of ocean growth (Shapavolov and Taft 1954). Hallock et al. (1961) sampled Sacramento River steelhead and reported that the majority (74%) of fish were three and four years of age. Of the 3-year-old fish, 73% had spent 2 years in fresh water and 1 in salt water and 24% had stayed 1 year in the river and 2 years in the ocean. Of the 4-year-old fish 79% had lived 2 years in fresh water and 2 years in salt water."

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 from both American and Sacramento River release sites 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 appear to be 3 years of age (personal communication, T. West, Hatchery Manager II) while the number of half-pounder steelhead trapped during the same period has been less than 2% (range from 0.4% to 13.3%) of the total number of steelhead trapped. Although specific data is not available, numbers of half-pounder steelhead returning to NFH were reported in greater numbers following years when fingerling-size juvenile steelhead were released in the American River. During the early years of operation, small sized steelhead were not often 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 and may have been steelhead that demonstrated a half-pounder life history pattern or fish that did not migrate to the ocean. During the past 5 seasons no fingerling size juvenile steelhead have been released and the percentage of half-pounder steelhead trapped has been declining.

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 rainbow trout 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 specimen's producing more and larger eggs (Leitritz and Lewis 1976). Hinze et al. (1956) reported that during the first year of operation and prior to the introduction of any non-indigenous steelhead, 62 female steelhead from the American River were spawned and produced an average of 4,200 eggs per fish at 242 eggs per ounce. This egg number and size is more comparable to 461 wild female winter-run steelhead from the Snow Mountain Station, Eel River that averaged 221 eggs per ounce (range 200 – 240) and 4,304 eggs per females (Leitritz and Lewis 1976). Winter-run Eel River steelhead are much larger than Sacramento River steelhead (Hallock et al. 1961) and suggests the American River steelhead initially trapped at NFH during may have been physically larger than Sacramento River steelhead prior to any documented steelhead introductions to the American River.

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 5-3).

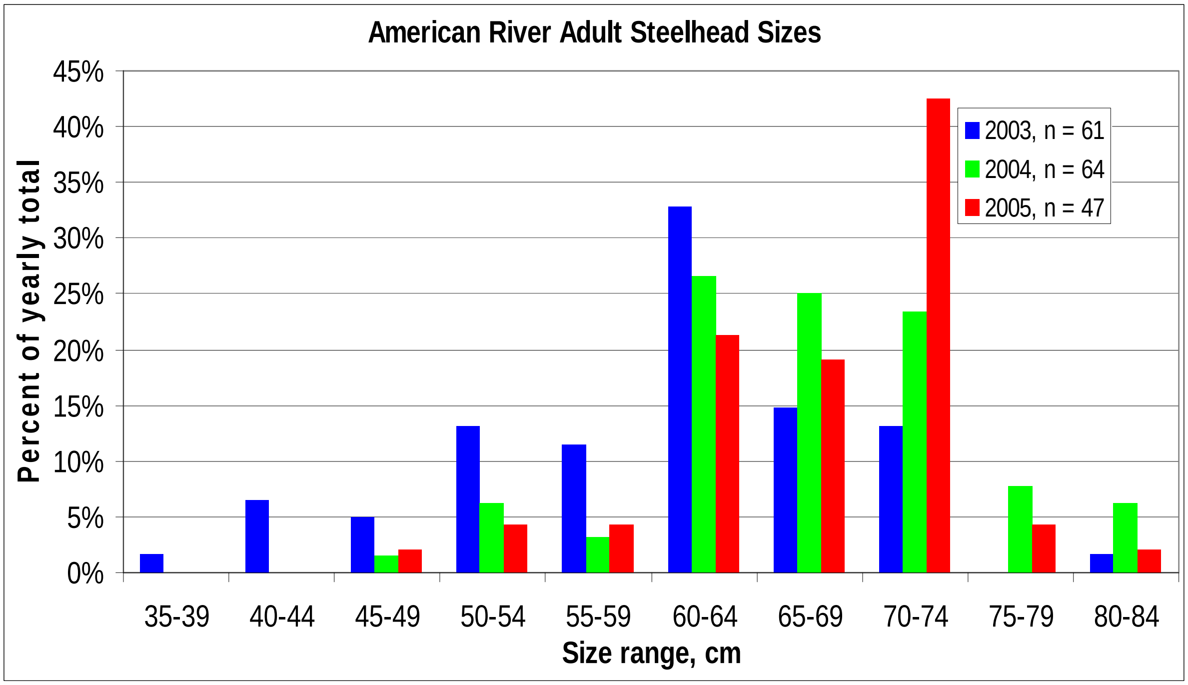

Figure 5-3. Size of adult steelhead observed on redds in the American River.

Fecundity – Accurate estimates of fecundity are lacking for American River and Central Valley steelhead. 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 Additionally, the number of eggs collected from a female during by artificial spawning does not necessarily indicate the actual number of eggs due to variations in spawning and egg taking methods.

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

Sex ratio – During the period 1955 to 2006, 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 14 years (27.5% of the 51) years has the number of females exceed the number of males (Figure 5-4). During this period there has been a slight increase in the percentage of male steelhead trapped annually but this trend is not significant (n= 51, R^2 = 0.0308) (Figure 5-5).

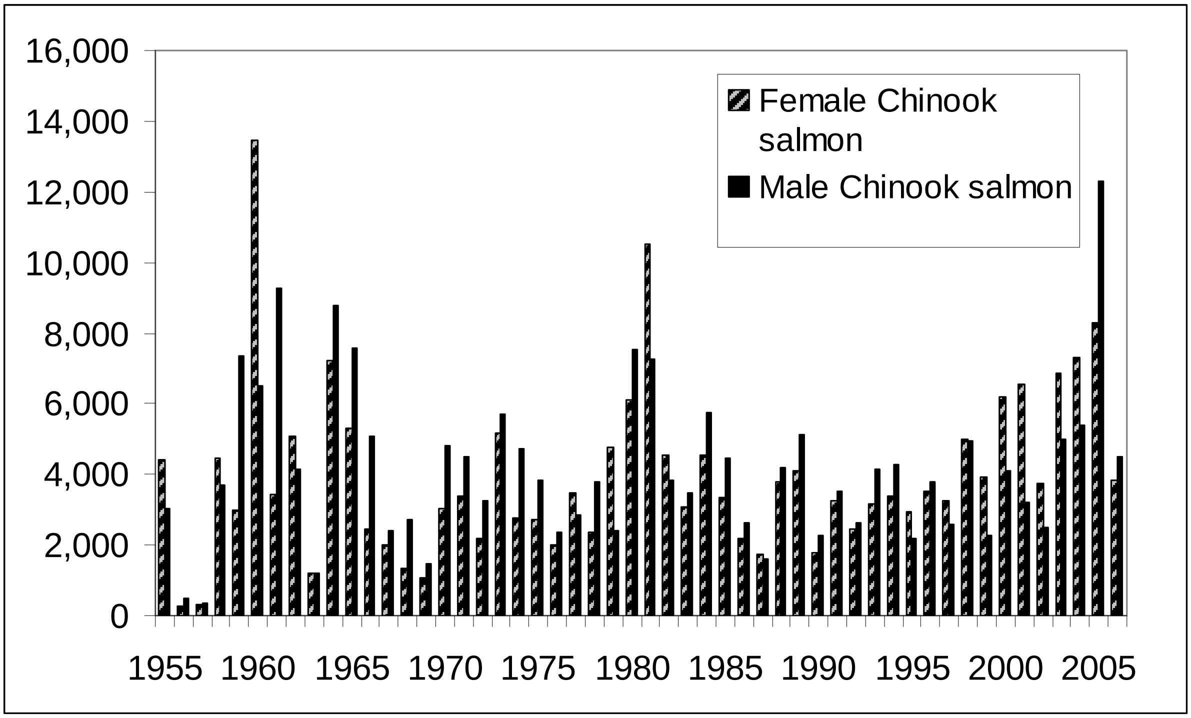

Figure 5-4. Number of female and male Chinook salmon trapped at Nimbus Fish Hatchery, 1955 to 2006.

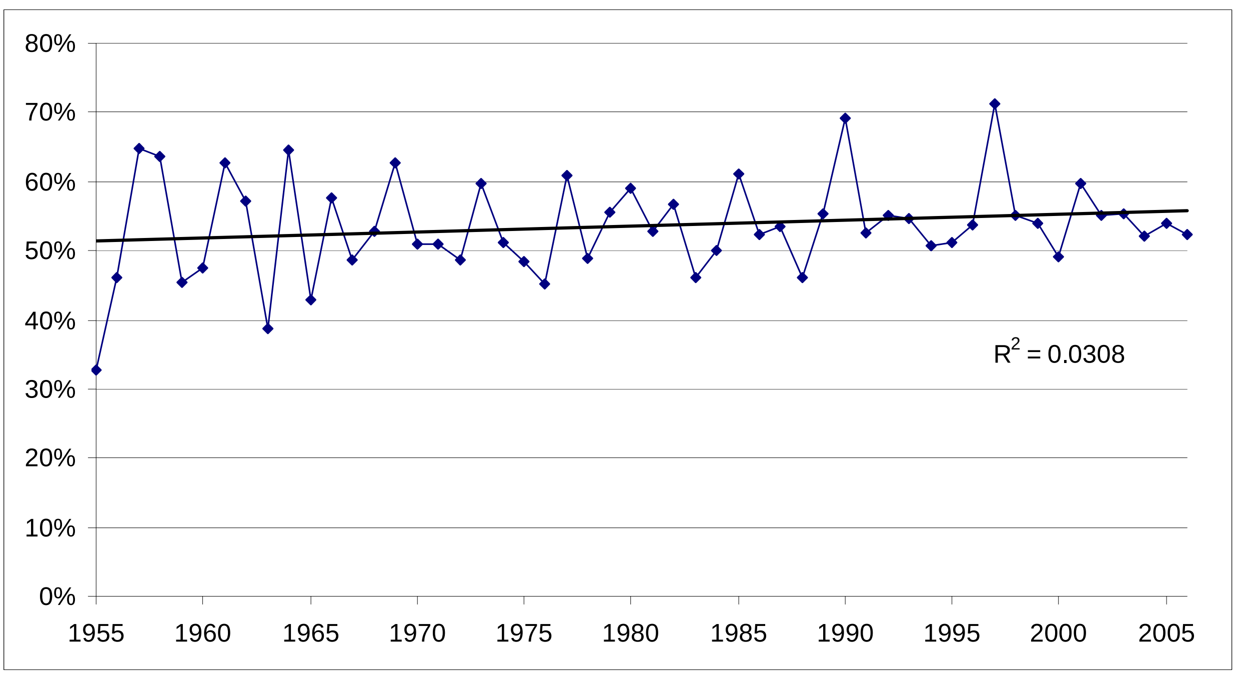

Figure 5-5. Percentage of male steelhead trapped annually at NFH, 1955 to 2006.

5.1.9 Reason for choosing broodstock

During the initial operation of NFH, 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, Eel River winter-run steelhead eggs were transferred to NFH during the first 3 years of operation.

Although specific information is lacking, Eel River winter-run 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 ^{o} 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 period that eggs from Eel River winter-run 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 abandoned due to problems identifying marked fish and difficulties associated with holding adult steelhead at NFH due to unsuitable water temperatures.

5.1.10 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.

There are no known runs of listed anadromous fish that enter the American River or are trapped at NFH. American River fall-run Chinook salmon are listed as a species of special concern.

In an effort to reduce harvest of naturally produce steelhead in California anadromous streams, all hatchery-produced juvenile steelhead have been marked with an adipose fin clip since 1998. Since the 2001-2002 trapping season at NFH when 100% of returning adult steelhead would have been fin clipped, less than 3% of the steelhead trapped have not been adipose fin clipped (Table 5-2). Unmarked fish are believed to be either naturally-produced steelhead, most likely from the American River, or fish that were not marked during fin clipping. Additionally, American River winter-run steelhead and juvenile rainbow trout from the American River demonstrate genetic similarity in microsatellite allelic frequencies (Nielsen et al. 2005) suggesting that the majority of fish that enter the NFH broodstock collection facilities are of American River origin.

Nonetheless, an unknown but small portion of the un-marked steelhead trapped at NFH may be naturally-produced non-origin American River steelhead that have strayed into the NFH broodstock collection facilities. However, present facilities are not available to enable hatchery personnel to differentiate these fish from un-marked American River winter-run steelhead. If included with the American River winter-run steelhead broodstock, no adverse genetic or ecological effect on the winter-run stock is anticipated and may increase the genetic diversity of the existing stock. Additionally, if trapped at NFH, these stray non-American River origin fish do not have the opportunity to contribute to their river of origin. As such, no adverse genetic or ecological effect on steelhead naturally produced in the American River is expected to occur as a result of hatchery broodstock selection practices.

6. BROODSTOCK COLLECTION

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

NFH collects adult winter-run steelhead from the American River.

6.2 Collection or sampling design

The fish ladder is opened after river temperatures are at or below 60^o F and are expected to remain at that temperature or lower. This generally occurs in the early fall prior to the Chinook salmon run and prior to steelhead entering the American 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. Only steelhead that volitionally enter the fish ladder and adult gathering tank are used for broodstock. 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. Fish ≥16 total length are immediately returned to the river.

All sexually mature adult steelhead are retained for artificial spawning and are typically spawned a minimum of once a week.

Sexually immature adult steelhead are immediately returned to the river via the stainless steel return tubes. Sexually immature 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 lower caudal fin mark and processed as before.

6.3 Number of Broodstock collected

6.3.1 Program goal (assuming 1:1 sex ratio for adults)

There are no goals for the number of adult winter-run steelhead annually trapped or spawned at NFH. However, there is the mitigation goal to release 430,000 yearling steelhead that average 4 fish per pound annually from the facility. We estimate that a minimum of 400 female steelhead and a commensurate number of males must be spawned (10 year average of approximatyley 5,500 eggs per female) to produce 2,000,000 green eggs.

6.3.2 Broodstock collection levels

During the past 10 years, NFH has trapped an annual average of 1,818 steelhead (980 males and 838 females) and easily produced the mitigation goal of 2,000,000 green eggs from this broodsock. However, 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 .

6.5 Disposition of hatchery-origin fish 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. Past 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.

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-run steelhead from the American River. Eggs in excess of NFH need are disposed of through Department contractual agreement with a private p rocessing/rendering company.

6.6 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 via 1 of 5 tubes described in Section 4.1.6.

6.7 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 on contact bacteria, viruses, fungi, protozoa, and yeasts. PVP iodine is also applied to eggs during incubation to control fungus.

6.8 Disposition of carcasses

Dead adult steelhead collected as part of the broodstock collection program are disposed of through Department contractual agreement with a private processing/rendering company.

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

There are 10 salmonids listed by the U. S. Secretary of the Interior or the U. S. Secretary of Commerce that occur within the distributional range of salmonids produced and released from NFH (Table 6-1).

Table 6-1. 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 distributional range of salmonids produced and released from Nimbus Fish Hatchery.

Common name, ESU	Scientific name	Status
Chinook salmon, Winter-run	*Oncorhynchus tshawytscha*	Endangered
Chinook salmon, California coastal	*Oncorhynchus tshawytscha*	Threatened
Chinook salmon, Spring-run	*Oncorhynchus tshawytscha*	Threatened
Coho salmon, Central California Coast	*Oncorhynchus kisutch*	Endangered
Coho salmon, So. Oregon/No. California	*Oncorhynchus kisutch*	Threatened
Steelhead, Northern California	*Oncorhynchus mykiss*	Threatened
Steelhead, Central California Coast	*Oncorhynchus mykiss*	Threatened
Steelhead, South/Central California Coast	*Oncorhynchus mykiss*	Threatened
Steelhead, Southern California	*Oncorhynchus mykiss*	Endangered
Steelhead, Central Valley	*Oncorhynchus mykiss*	Threatened

None of the species listed in Table 6-1 are known to presently occur in the American River. The NMFS reports that the Central Valley (CV) steelhead DPS are 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”. Presently NMFS considers naturally-produced steelhead from the American River as Central Valley steelhead although genetic analysis has indicted that this is incorrect. Naturally-produce rainbow trout from American River are genetically similar to winter-run steelhead propagated at NFH. As such, we do not expect any adverse genetic or ecological effects to listed natural fish resulting from the broodstock collection program.

It is possible that Central Valley steelhead may stray into the NFH broodstock collection system. However, the incidence of un-marked steelhead collected at NFH has averaged less than 3% of the total number of adult steelhead collected since 2001 and there is a high probability that these fish are either naturally-produced American River steelhead or un-marked NFH-produced steelhead. We surmise that no identifiable Central Valley steelhead are trapped at NFH and as such, no adverse effects on threatened or endangered steelhead are anticipated as a result of collecting un-marked steelhead at NFH.

7. MATING

7.1 Selection method

Sexually mature steelhead are spawned at NFH throughout the period that the fish are trapped. The egg take goal is set each year to achieve a total production of 430,000 steelhead smolts. This number is approximately 2,000,000 green eggs; however, additional fish are sometimes spawned and eggs taken to ensure that representative egg lots are taken throughout the spawning period of American River winter-run steelhead. Only adult steelhead (fish $\geq$ 16 inches) 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. Both adipose (naturally-spawned) and non-adipose (hatchery-spawned) steelhead are used in the spawning process.

Current mating protocols include hatchery x hatchery and hatchery x natural pairings and is based identification of adipose marked and unmarked adult steelhead. Natural x natural pairings are possible, and although less than 3% of the adult steelhead trapped are un-marked.

Some research has found that hatchery-produced fish have lower fitness or reproductively capabilities as compared to native wild fish (Reisenbichler and McIntyre 1977; Chilcote et al. 1986, Leider et al. 1990, Sekino et al 2002). Domestication of hatchery stocks is often cited as contributing to the reduced fitness. Additionally, genetic analysis of anadromous steelhead collected from the Hood Canal was used to analyze generational lines and what role hatchery fish played in supplementing or undermining the runs. Steelhead from native wild eggs that were reared in a hatchery had a reproductive success rate that was indistinguishable from wild fish. However, direct generations of hatchery-bred fish affected the ability of the fish to revive deleted stocks (Anonymous 2007). This information suggests that the inclusion of naturally-produced fish in the broodstock population is desirable. Unfortunately, known naturally-produced steelhead comprise a very small percentage of the NFH broodstock.

To ensure that representative eggs lots are taken throughout the steelhead run, a recommended minimum number of females to be spawned weekly was determined (Figure 7-1). 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 with a slight increase at the end of the run.

The representative spawning numbers are based on number of fish trapped and not actual spawning times (sexual maturation). To effectively represent the run, steelhead would have to be uniquely marked to identify the week trapped, held until sexually mature, and similarly marked male and females spawned together. Due to varying maturation periods and problems holding adult steelhead, it would be difficult to implement this strategy.

Although the relationship between run timing and steelhead stocks such as summer and winter has been investigated (see Section 5.1.5), we were unable to fish supporting literature for a genetic relationship within a stock between run timing and spawn timing. For example, Phelps et al. (1994) found a high degree of genetic similarity among samples from winter-run steelhead hatcheries. Dahl (2004) demonstrated that for Atlantic salmon, the spawning migration peak was strongly correlated with mean monthly sea and river temperatures during spring: salmon arrived earlier when temperatures were higher and later when temperatures were lower and river discharge explained little of the variation in migration timing.

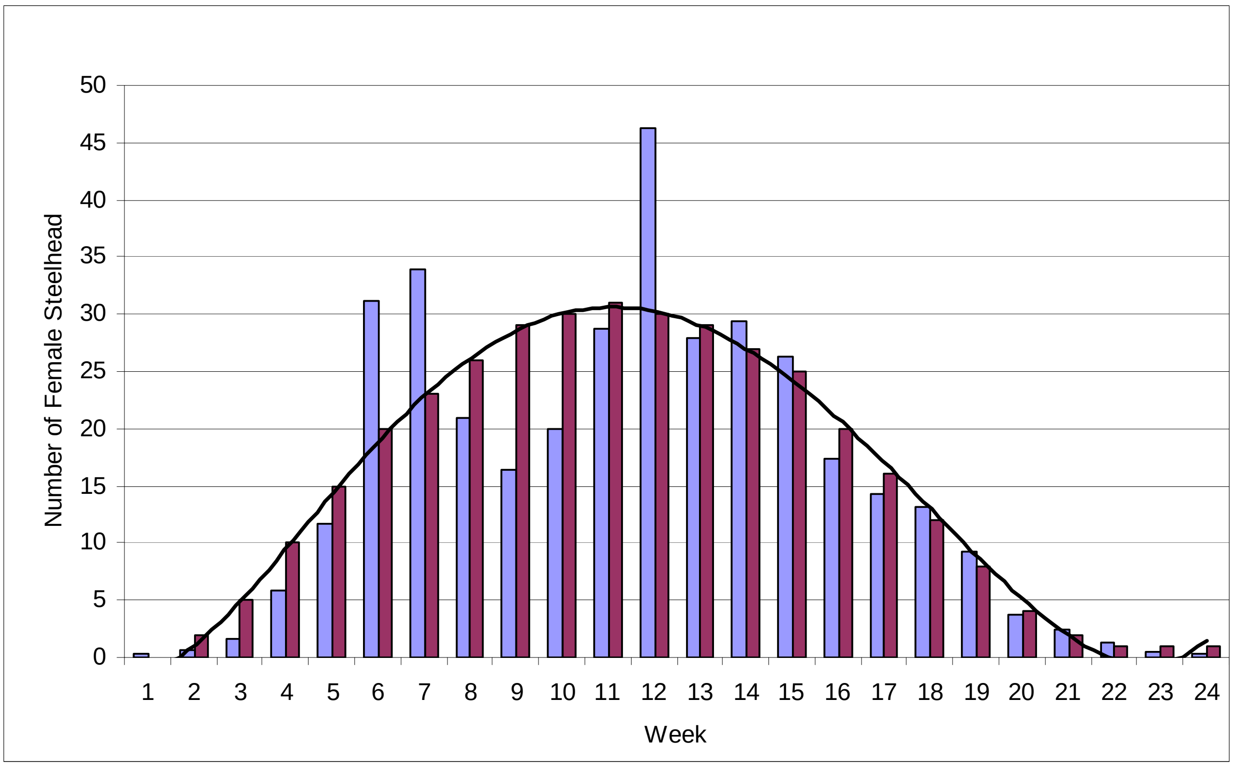

Figure 7-1. Graphic representation of the minimum number of female steelhead to be spawned by standard week to mimic the number of fish trapped throughout the run period (blue bars represent mean number of fish trapped and maroon bars represent the estimated number of fish to be spawned)

7.2 Males

Only sexually mature adult males 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.

7.3 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 and eggs by hand stroking the male fish's abdomen area.

Approximately 8 ounces of a 30% saline solution (saltwater) is added to the pan to improve fertilization. A sufficient amount of the solution is added to the empty pan to fully cover the number of eggs to be taken, The salt solution holds the albumen from the broken eggs in solution and keeps the micropyles from becoming clogged. It also 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.

7.4 Cryopreserved gametes

No steelhead eggs or sperm are preserved at NFH.

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

Known listed steelhead are not purposefully included nor is it anticipated that any listed steelhead are included in the mating scheme. If any listed steelhead was included in the mating scheme, no known adverse genetic or ecological effects are anticipated. Inclusion of listed fish in the mating scheme for American River winter-run steelhead might be considered a favorable.

8. INCUBATION AND REARING

8.1 Incubation

Trout and salmon eggs undergo a continuous developmental change from the time they are taken that is dependent on water temperature. During this period there are several changes or stages:

1. Fertilization. This takes place within seconds after the eggs are taken and is dependent on several factors, such as degree of ripeness of the male and female fish, viability of both sperm and ova, and technique of the individual spawning the fish.

2. Water hardening. This is the period during which the egg absorbs water and becomes firm and slick. From the time the egg becomes water-hardened and for a period up to 48 hours, depending on water temperature, trout and salmon eggs may be measured and shipped if carefully done.

3. Tender period. Trout and salmon eggs become progressively more tender during a period extending roughly from 48 hours after water hardening until eyed. The extreme critical period for steelhead trout eggs is entered into on the 7th day

in water having a temperature of 51 °F. and extends through the 9th day at which time the blastopore is completely closed. It is common practice to work or pick eggs from the second day after taking until the critical period is reached. Then they are not touched until the critical period has passed. This is usually referred to as the period during which the eggs are closed. Even though the critical period for steelhead eggs has passed on the 9th day at 51° F., the eggs remain tender until the 16th day, when the eyes are sufficiently pigmented to be visible.

4. Eyed stage. As the term implies, this is the stage from the time the eye spot become visible until the egg hatches. During the eyed stage, eggs are can be addled, cleaned, re-measured, or moved.

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.

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

During the 10 year period 1997 to 2006, a total of 18,362,221 steelhead eggs were taken from 3,656 female steelhead for an average of 5,013 eggs per female (Table 8-1). These eggs resulted in a total of 14,488,721 eyed eggs for a 10-year average survival rate to the eyed stage of 79%.

Table 8-1. Number of female steelhead spawned and number of eggs taken 1997-98 through 2006-2007 trapping season.

Season of return	Number of female steelhead spawned	Total number of eggs collected	Mean number of egg per female
1997-98	139	709,534	5,105
1998-99	389	2,080,534	5,348
1999-00	544	2,636,954	4,847
2000-01	431	2,043,545	4,741
2001-02	190	1,168,244	6,149
2002-03	170	1,060,490	6,238
2003-04	163	1,000,120	6,136
2004-05	578	2,580,366	4,464
2005-06	422	2,154,768	5,106
2006-07	630	2,891,666	4,590
Totals	3,656	18,326,221	5,013

8.1.2 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 Department contractual agreement with a local processing/rendering company.

8.1.3 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.

8.1.4 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.

8.1.5 Ponding (raceways)

Alevins are held in the deep tanks until they reach a size 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 help eliminate single-cell protozoans. Alevins remain in the deep tanks until they are moved to the raceways. They remain in the raceways until they are released as yearling steelhead.

8.1.6 Fish health maintenance and monitoring

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

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

No listed salmonids are propagated at NFH. To help preserve the genetic diversity of American River winter-run steelhead propagated at NFH, adults are spawned on a 1:1 ratio, with a minimum of 250 pairing adults during any one spawning season.

8.2 Rearing

After hatching, steelhead alevins remain in the deep tanks until they reach a size 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 and due to the number of ponds and number of juvenile steelhead is not a limiting factor at NFH.

During the period juvenile steelhead are reared in the raceways, dorsal fin erosion often occurs resulting in less fit fish. 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 as a result of metabolic, behavioral, or combined changes. Additionally, trout held in outdoor raceways can suffer from sunburn.

To improve the health of juvenile steelhead reared in raceways, in 2007 50% (200 ft) of each raceway was experimentally covered with shade cloth. Observations to date suggest that the incidence of dorsal fin erosion and sunburn in juvenile steelhead has been reduced (T. West, Hatchery Manager II, personal communication)

8.2.1 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.

Eyed egg stage to fingerlings and yearlings: During the 10-year period 1996 to 2005, a total of 14,488,721 eyed eggs produced 4,222,128 fingerlings and yearlings for any estimated survival rate of 29%.

8.2.2 Density and loading criteria (goals and actual levels)

Fish rearing densities are dependent upon a number of factors and are typically determine 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 of water.

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).

8.2.3 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. Beginning July 1, steelhead are placed on a maintenance diet consisting of feeding 3 days on and 4 days off to slow down growth.

8.2.4 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.

8.2.5 Indicate monthly fish growth rate and energy reserve data (average program performance), if available.

Monthly growth rates of juvenile steelhead at NFH were estimated from information provided in various NFH annual reports (Figure 8-1).

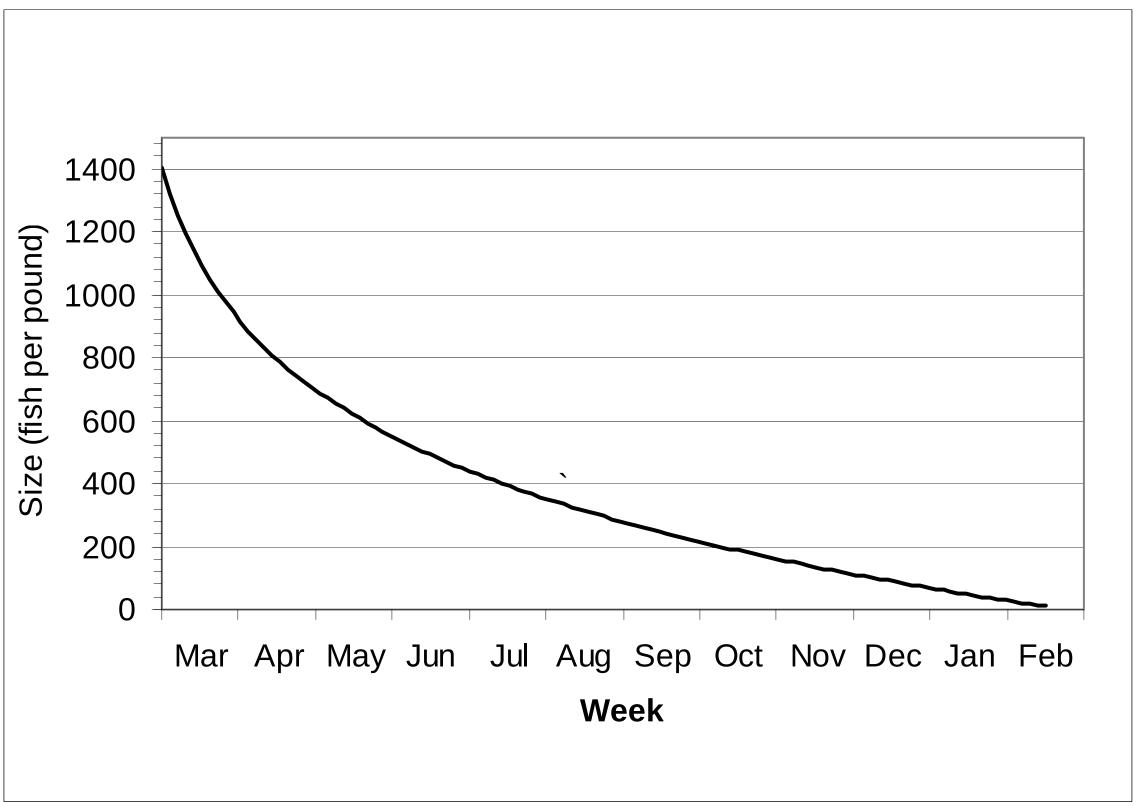

Figure 8-1. Estimated monthly growth rate of juvenile steelhead at NFH.

8.2.6 Food type used, daily application schedule, feeding rate range (e.g. % B.W./day and lbs/gpm inflow), and estimates of total food conversion efficiency during rearing (average program performance).

After the steelhead alevins have absorbed their yolk sac, they are placed on a diet of semi-moist BioVita Crum #0, #1, #2, 1.2mm, and 1.5mm fish food manufactured by Bio-Oregon Incorporated 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).

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.

8.2.7 Fish health monitoring, disease treatment and sanitation procedures

As described in Section 8.1.6., fish health is routinely monitored by the Department's Fish Health Laboratory personnel. Routine cleaning of fish rearing facilities also helps prevent fish health problems. In the Hatchery Building, the PVC pipe 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. Daily cleaning of the tank is performed by NFH personal.

8.2.8 Smolt development indices (e.g. gill ATPase activity), if applicable

No formal methods are used to indicate smolt development. However, visual indications such as "silvery" appearance to the juvenile fished body and loosening of the scales are used as general indicators of smolting.

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

No natural rearing methods are used at NFH.

8.2.10 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.

9. RELEASE

9.1 Proposed fish release levels

Mitigation requirements are for the annual release of 430,000 juvenile steelhead. NFH personnel attempt to grow the fish to 4 per pound or larger prior to release.

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

Presently, all juvenile steelhead are released in the Sacramento River at the Garcia Bend Boat Ramp (river mile 49 located approximately 10.5 miles downstream from the confluence of the American River).

In past years, NFH has also planted juvenile steelhead in the Sacramento River at the confluence of the American River and in the American River at NFH.

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

Appendix 11 summarizes all fish reared and released at Nimbus Fish Hatchery during the period 1955 through 2006.

9.4 Actual dates of release and description of release protocols

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 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.

9.5 Fish transportation procedures

Juvenile steelhead are transported to the release site using the 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.

9.6 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.

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

Prior to 1998, various groups of juvenile steelhead have been fin clipped or coded-wire tagged (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-produced fish.

9.8 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 Department'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 in the past included both anadromous and inland waters.

9.9 Fish health certification procedures applied pre-release.

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

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

It is possible that the hatchery rearing ponds may become flooded due to high flow releases from Nimbus Dam; or the water system may become disrupted while juvenile steelhead are being reared. If the water system is disrupted, it may be possible to provide an alternative water source.

In June 2007, an alternative water source was installed due to a leak in one of the main water supply lines. 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.

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 Department 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.

In the event that it becomes necessary to immediately release all the juvenile steelhead from the raceways for any reason, the trailer-mounted Aqua-Life Harvester Dewatering Tower will be move to the lower end of the raceways and a flexible hose attached to the discharge pipe. The discharge end will be placed in the lowest section the fish ladder. Fish will be crowded to the downstream portion of the raced and the fish pumped from the raceway directly into the American River. This process will continue until all the 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 drain pipe will 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.

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

Yearling steelhead produced at NFH are released in the Sacramento River at the Garcia Bend Boat Ramp approximately 10.5 miles downstream from the confluence of the American River.

The Garcia Bend site may increase the risk of NFH-produced fish straying into other Sacramento River tributaries. Straying of naturally-produced steelhead occurs as a result of both natural and artificial factors. 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 may 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.

NFH implements the first two of these strategies. The latter two strategies are not possible to implement due to mitigation requirements. Additionally, Staley (1976) found that harvest of steelhead released into the American River at NFH was much higher than for those released in the Sacramento River and was considered not the best management practice. The present release location was selected to:

1. Encourage downstream migration NFH-produce juvenile steelhead
2. Reduce competition between NFH- and naturally-produced steelhead
3. Reduce predation on naturally-produced Chinook salmon
4. Reduce angler harvest of juvenile steelhead in the American River during downstream migration, and
5. Ensure sufficient returns of adult steelhead to NFH to maintain broodstock.

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

Hatchery-produced adult steelhead have the opportunity to spawn with naturally-produced 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. Unfortunately, the present American River steelhead stock is not native; both the hatchery and river populations have been identified genetically as one stock; and the stock has become naturalized to the American River. Information is not available to allow documentation in the indigenous American River steelhead stock that was eliminated by construction Folsom Dam.

NFH-produced juvenile steelhead are released during times that winter- and spring-run juvenile Chinook salmon are migrating in the Sacramento River. The effect any predation on these fish by NFH-produced steelhead on these stocks is most likely similar to other release sties and comparable to historic ecological effects from downstream migrating naturally-produced juvenile steelhead prior to construction of Folsom and Nimbus dams.

If NFH-produced juvenile steelhead are released during a period of higher stream flows, the fish are captured in down stream sampling programs and export pump salvage operations in the Delta soon after release. In years of low flows in the Sacramento River, some juvenile NFH-produced steelhead have been observed entering the NFH ladder a short time after release (T. West, NFH Hatchery Manager II, personal communication). Unfortunately, water flows and releases in the Sacramento River are dictated by other needs.

10. EFFECTS ON ESA-LISTED SALMONID POPULATIONS

10.1 ESA permits or authorizations in hand for the hatchery program.

The Department annually applies for and has received a permit for “Take Coverage for Anadromous Fish Research and Monitoring Activities

Authorized Under the Endangered Species Act 4(d) Rule Research Limit". The most recent permit is dated January 29. 2007 and covers the period January 1, 2007 to December 31, 2007. This permit provides for the collection of listed species a part of fish health maintenance. Generally, no listed fish are knowingly collected at NFH, however, it is possible that naturally-produced adult steelhead of unknown origin may be collected.

All work is preformed by a Department Fish Pathologist or entity working under contract for the Department. Collected fish are euthanized by an overdose of an aesthetic, a necropsy conducted and the fish examined grossly for pathological lesions. Bacterial isolations are attempted from sterile tissues such as kidney; viral isolations are attempted from suspect tissues or from kidney/spleen samples; tissues for immunological diagnostic methods are prepared if deemed prudent; tissues for DNA diagnostic methods may also be taken; examinations of tissues for protozoan or metazoan parasites will be done by direct microscopy or from tissues otherwise prepared; histological specimens will be taken as appropriate.

10.2 Descriptions, status, and projected take actions and levels for NMFS

Twelve fish populations are listed by the U. S. Secretary of the Interior or the U. S. Secretary of Commerce and occur within the distributional range of salmonids produced and released from NFH including ten salmonids (Table 6.1). Section 10.2.1 provides a description and status of these populations.

No known listed salmonids are projected to be taken at NFH. Beginning with the 1999 BY steelhead, all juvenile steelhead released from NFH have been adipose fin marked. During the past six years, NFH personnel have trapped 339 (2.8% of 12,189) adult steelhead with an adipose fin. Although technically these fish are included as part in the Central Valley steelhead DPS, they are most likely the progeny of American River winter-run steelhead that spawned in the American River or unmarked NFH –produced steelhead resulting from marking error (lack of mark). It is anticipated similar numbers of non-adipose fin marked steelhead will continued to be trapped in the future.

10.2.1 Description of NMFS ESA-listed salmonid population(s) affected by the program

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

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

Status: The Sacramento River winter-run Chinook salmon ESU is represented by a single extant population. Construction of the Shasta and Keswick dams completely displaced this ESU from its historical spawning habitat. Cold-water releases from the reservoir behind Shasta Dam artificially maintain the remaining spawning habitat. 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 on the basis of four Viable Salmon Population (VSP) criteria: abundance, productivity, spatial structure, and diversity. For this ESU, the Biological Recovery Team (BRT) found extremely high risk for each of the four VSP categories, with the highest concern for spatial structure and diversity, and significant concern for abundance and productivity. While encouraged by somewhat recent increases in abundance of the single population, the majority opinion of the BRT was that the naturally-spawned component of the Sacramento River winter-run ESU is still “likely to become extinct within the foreseeable future.”

Two artificial propagation programs are also part of the Sacramento River winter-run Chinook ESU. An artificial propagation program is continuing and a captive broodstock program for winter-run 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 yet implemented) to attempt establishment of a second population in the upper Battle Creek watershed, using the artificial propagation program as a source for fish. The artificial propagation program has contributed to maintaining diversity of the ESU through careful use of spawning protocols to maximize genetic diversity of propagated fish and minimize impacts on the naturally spawning population. In addition, the artificial propagation and captive broodstock programs have contributed to preserving the genome of this ESU.

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-run Chinook salmon ESU was issued in August 1997.

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

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

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

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

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

Legal Status: Threatened

Recovery Plan Status: No recovery plan has been completed for this ESU.

Chinook salmon - Central Valley Spring-run *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 3 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.

Coho Salmon - Central California Coast *Oncorhynchus kisutch*

Description: The Distinct Population Segment (DPS) includes all coho salmon naturally-produced in streams between Punta Gorda in Humboldt County, CA, southward including the San Lorenzo River in Santa Cruz County, CA.

Status: The decline of southern Coho is primarily due to unfavorable climate conditions in recent decades. Droughts during the 1970s and 1990, intense floods in the 1980s and late 1990s, and recent unfavorable ocean conditions have all contributed substantially to the continuing decline of southern Coho salmon. Very poor (warm, nutrient-poor) ocean conditions in the fall of 1997 resulted in most adult Coho returning to central coast streams having very poor fertility. In addition most of the limited production from this group of adults was probably destroyed by extraordinarily high rainfall amounts in February 1998, and associated high levels of streambed scour. More favorable ocean and precipitation conditions during the winter of 1998-99 produced a substantial 1999 year-class. Fall 1999 juvenile surveys have found evidence of successful reproduction in Pescadero, Gazos, Scott, Waddell, and San Vicente creeks.

Date Listed: October 31, 1996 (61 FR 56138); re-listed June 28, 2005

Legal Status: Threatened relisted to Endangered

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

Coho Salmon – So. Oregon/ No. California Coast *Oncorhynchus kisutch*

Description: Southern Oregon/Northern California Coast Coho (SONCC) includes all naturally spawned populations of Coho salmon in coastal streams between Cape Blanco, Oregon, and Punta Gorda, California including the Mattole River (Humboldt Co) and all streams northward to the Elk River, Oregon. It also includes three artificial propagation programs: Cole River Hatchery in the Rogue River Basin, and Trinity River and Iron Gate hatcheries in the Klamath-Trinity River Basin. NMFS has determined that these artificially propagated stocks are no more than moderately diverged from the local natural populations.

Status: The estimated historical abundance of the SONCC Coho ESU is 150,000 fish. The recent mean abundance is 5,170 fish, which is the highest since 1980. However, this estimated abundance is derived from the only reliable time series of adult abundance for the naturally spawning component of the SONCC Coho ESU – the Rogue River population in southern Oregon. The California portion of the ESU is characterized by a paucity of data, with only a few available indices and presence-absence surveys of spawning fish. Less reliable indices of spawning fish abundance in several California populations exist, and suggest flat or declining trends. Relatively low levels of observed presence in historically occupied Coho streams (32–56% from 1986 to 2000) indicate continued low abundance in the California portion of this ESU. Currently, indications of weak 2006 Coho salmon returns in several California populations are expected. Only three rivers have hatchery populations and natural populations are depressed throughout the range of the ESU. Although extant populations reside in all major river basins within the ESU, there is concern about the loss of local populations in the Trinity, Klamath, and Rogue River systems. The high hatchery production in these systems may mask trends in ESU population structure and pose risks to ESU diversity.

The overall ESU trend since the time of listing or first review shows that productivity has remained unchanged, and population abundance has remained unchanged.

Date Listed: May 6, 1997; reaffirmed June 28, 2005

Legal Status: Threatened

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

Steelhead - Northern California *Oncorhynchus mykiss*

Description: Includes all naturally spawned populations of steelhead (and their progeny) in coastal river basins ranging from Redwood Creek in Humboldt County, California to the Gualala River, inclusive, in Mendocino County, California.

Northern California steelhead face a wider array of threats than salmon. These threats include loss of habitat critical to juvenile and smolt survival (e.g., loss of side channel and stream complexity), as well as threats from water impoundments, diversions, and water pollution from numerous sources. Little quantitative abundance information exists for most of these historic populations. The Russian River supports the largest spawning population of Central California Coast Steelhead, but its population is believed to have declined since the mid-1960s.

Status: The Northern California (NC) steelhead Distinct Population Segment (DPS) includes all naturally spawned populations of steelhead in California coastal river basins from Redwood Creek (inclusive) southward to the Russian River (exclusive). Two artificial propagation programs are considered part of the DPS: the Yager Creek Hatchery and the North Fork Gualala River Hatchery (Gualala River Steelhead Project).

Little historical abundance information exists for the naturally spawning portion of the NC steelhead DPS. Although data were relatively limited, analysis by the original Biological Review Team (BRT) in the 1996 status review (Busby et al. 1996) suggested the following conclusions: (1) population abundances were low relative to historical estimates, (2) recent trends were downward, and (3) summer-run steelhead abundance was “very low.” The BRT was also concerned about the negative influences of hatchery stocks, especially from the Mad River Hatchery which is not considered part of the DPS. The Mad River Hatchery program was terminated in 2004, thus reducing the genetic risks associated with propagation of these fish.

The two artificial propagation programs that are part of the NC steelhead DPS are thought to decrease risk of extinction to some degree by contributing to increased abundance. Additionally, changes to regulations concerning sport fishing likely reduce the extinction risk for the DPS. Ultimately, however, the most recent status review concluded that steelhead in the NC DPS remain likely to become endangered in the foreseeable future (Good et al. 2005)

Date Listed: June 7, 2000; reaffirmed January 5, 2006

Legal Status: Threatened

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

Steelhead - Central California Coast *Oncorhynchus mykiss*

Description: The CCC steelhead DPS includes all naturally spawned populations of steelhead in coastal streams from the Russian River to Aptos Creek, and the drainages of San Francisco, San Pablo, and Suisun bays eastward to Chipps Island at the confluence of the Sacramento and San Joaquin rivers; and tributary streams to Suisun Marsh including Suisun Creek, Green Valley Creek, and an unnamed tributary to Cordelia Slough (commonly referred to as Red Top Creek), exclusive of the Sacramento-San Joaquin River Basin of the California Central Valley. Two artificial propagation programs are considered part of the DPS: the Don Clausen Fish Hatchery (Warm Springs Hatchery), and Kingfisher Flat Hatchery/Scott Creek (Monterey Bay Salmon and Trout Project).

Status: Central California coast steelhead were listed as a threatened species on August 18, 1997; threatened status reaffirmed on January 5, 2006. Information on abundance and productivity trends for the naturally spawning component of the CCC steelhead DPS is extremely limited. There are no time series of population abundance for the naturally spawned adult component of the DPS; however, estimates of steelhead statewide show a reduction in numbers from 603,000 in the early 1960s to 240-275,000 in the 1980s (McEwan and Jackson 1996), indicating a potential decline of at least 54%. Within the CCC steelhead DPS, estimates of run sizes in the largest river system, the Russian River, have gone from 65,000 in the 1960s to 1,750-7,000 in the 1990s (Busby et al. 1996; Good et al. 2005), indicating a potential decline of at least 89%. Abundance in smaller streams within the DPS was assessed as stable but at low levels (Busby et al. 1996). Small populations of steelhead occur in watersheds throughout the DPS, however, impassible dams have cut off substantial portions of habitat in some basins, generating concern about the spatial structure of the naturally spawning component of the DPS. For the DPS as a whole, 22% of historical habitat is estimated to be behind recent (usually man-made) barriers (Good et al. 2005).

The two artificial propagation programs that are part of the CCC steelhead DPS are thought to decrease risk of extinction by contributing to increased abundance. Additionally, changes to regulations concerning sport fishing likely reduce the extinction risk for the DPS. Ultimately, however, the most recent status review concluded that steelhead in the CCC DPS remain likely to become endangered in the foreseeable future (Good et al. 2005).

Date Listed: August 18, 1997 (62 FR 43937); reaffirmed January 5, 2006 (71 FR 834)

Legal Status: Threatened

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

Steelhead – South/Central Coast *Oncorhynchus mykiss*

Description: South-Central California Coast steelhead Includes all naturally spawned populations of steelhead (and their progeny) in streams from the Pajaro River (inclusive), located in Santa Cruz County, California, to (but not including) the Santa Maria River.

Status: The steelhead population within the South-Central California Steelhead DPS has declined dramatically from estimated annual runs totaling 25,000 adults to less than 500 returning adult fish. Of the 36 watersheds historically supporting steelhead runs, approximately 90% continue to support runs, though run sizes have been sharply reduced in most watersheds. All of the four largest watersheds (Pajaro, Salinas, Nacimiento/Arroyo Seco, and Carmel rivers) have experienced declines in run sizes of 90% or more. Present population trends within individual watersheds continuing to support runs is generally unknown and may vary widely between watersheds

Date Listed: August 18, 1997 (62 FR 43937); reaffirmed January 5, 2006 (71 FR 834)

Legal Status: Threatened

Recovery Plan Status: A recovery plan has not been completed for the South-Central California Steelhead DPS.

Steelhead - California Central Valley *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.

Species: The Central Valley (CV) steelhead DPS is thought to have occurred historically from the McCloud River and other northern tributaries to Tulare Lake and the Kings River in the southern San Joaquin Valley. It is estimated that more than 95% of historical spawning habitat is now inaccessible to this DPS, and little information is available regarding the viability of the naturally spawning component of the CV DPS. 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 were 1 to 2 million spawners, and in the 1960s about 40,000 spawners. The Biological Review Team (BRT) reported that recent spawner surveys of small Sacramento River tributaries (Mill, Deer, Antelope, Clear, and Beegum Creeks) and incidental captures of juvenile steelhead via monitoring on the Calaveras, Cosumnes, Stanislaus, Tuolumne, and Merced rivers confirmed that steelhead are distributed throughout accessible streams and rivers.

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. Coastal steelhead are widely distributed in the Central Valley basin, with approximately half of the available habitat upstream of impassable dams.

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

Date Listed: March 19, 1998
Legal Status: Threatened; classification reaffirmed January 5, 2006

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

Steelhead - Southern California
(Oncorhynchus mykiss)

Description: The DPS includes all naturally spawned anadromous *O. mykiss* (steelhead) populations below natural and manmade impassable barriers in streams from the Santa Maria River, San Luis Obispo County, California, (inclusive) to the U.S.-Mexico Border.

Status: The steelhead populations within the Southern California Steelhead DPS have declined dramatically from estimated annual runs totaling 55,000 adults to less than 500 returning adult fish. Populations from over half of the 46 watersheds historically supporting steelhead runs are believed to have been extirpated. All of the four largest watersheds (Santa Maria, Santa Ynez, Ventura, and Santa Clara rivers) in the northern portion of the DPS have experienced declines in run sizes of 90% or more. In the southern range extension (from Malibu to the U.S.-Mexico border), adult steelhead have been documented in only three watersheds since the original listing of the Southern California Steelhead DPS. Present population trends within individual watersheds continuing to support runs is unknown, but may vary widely between watersheds, and are likely declining in a majority of the watershed within the Southern California Steelhead DPS.

Date Listed: August 18, 1997 (62 FR 43937), Southern Range Extension May 1, 2002 (50 CFR Part 224); reaffirmed January 5, 2006 (71 FR 834)

Legal Status: Endangered

Recovery Plan Status: A recovery plan has not been completed for the South-Central California Steelhead DPS,

10.2.2 Status of NMFS ESA-listed salmonid population(s) potentially affected by the program

The following ESA-listed salmonid populations could be potentially affected the operation of NFH:

Chinook salmon, Winter-run, *Oncorhynchus tshawytscha* (Endangered), Chinook salmon, Spring-run, *Oncorhynchus tshawytscha* (Threatened), and Steelhead, Central Valley, *Oncorhynchus mykiss (*Threatened). Status of these species is described in Section 10.2.1.

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

NFH does not implement any monitoring, evaluation, or research programs that might result in the take of any NHFS listed fish.

Release of fall-run Chinook salmon and winter-run steelhead may result in an unknown level of take through various ecological interactions.

12. Recommendations

Broodstock collection –

1. Steelhead that enter the fish ladder and adult gathering tank will be sorted each week, examined for marks, and the degree of sexual maturity determined. (current status)

2. Sexually immature adult steelhead will be immediately returned to the river via the stainless steel return tubes and identified by removing a notch from the upper lobe of the caudal fin and returned to the river via the stainless steel return tubes. Sexually immature steelhead trapped with an upper lobe caudal fin mark will be marked with a lower caudal fin mark and returned to the river. (current status)

3. All sexually mature adult steelhead will be retained for artificial spawning unless it is determined that eggs are not needed to meet mitigation goals and run timing criteria needs. (current status)

4. The fish ladder will remain open through the end of the steelhead run when no additional steelhead are trapped, typically around the end of March. (current status)

Mating

5. Only adult steelhead (fish $\geq$ 16 inches) will be selected for spawning. (current status)

6. Only adult males that demonstrate free flowing sperm will be selected for spawning from fish trapped and all mating and paring of adult fish will be done with no attempt to select fish for any morphological characteristic. (current status)

7. Both adipose (naturally-spawned) and non-adipose (hatchery-spawned) steelhead will be used in the spawning process. Due to the small number of non-adipose marked sexually mature steelhead trapped during any one spawning date, no mating protocols are recommended (current status)

8. The air spawning method described Leitritz and Lewis (1976) will continue to be used to collect steelhead eggs. (current status)

9. Current egg handling and processing protocols will remain.

Incubation and Rearing

10. No surplus eggs will be intentionally taken at NFH. However, as part of efforts to mimic the natural run and spawning period of American River

winter-run steelhead salmon, some eggs may be taken that are not needed to the mitigation requirements of NFH. Eggs subsequently determined unnecessary to meet mitigation goals and run timing will be disposed of through a rendering company. (current status)

11. All steelhead eggs will be incubated in NFH modified hatching jars with a maximum loading density of 300 ounces of eggs per hatching jar. (current status)

12. For smaller egg lots or for egg lots that would not fill the hatching jars a minimum of 50%, vertical stacked tray incubators may be used. The maximum loading density for each vertical tray is 150 ounces. (current status)

13. All eggs incubated in the vertical trays and hatching jars remain until 95% the alevins have buttoned-up at which point all the remaining eggs and alevins will be carefully poured into the deep tanks. (current status)

14. Alevins will remain in the deep tanks until they reach a size of 30 to 80 fish per pound at which time they are moved to the raceways. (current status)

15. Fish health will be routinely monitored by the Department's Fish Health Laboratory personnel. If deemed necessary, emergency fish health inspections can be conducted and any treatment or drugs prescribed by the Department's Fish Pathologist/Veterinarian. (current status)

16. During the incubation period, the eggs may be stirred 2 times per day, while alevins can stirred up to eight times daily to prevent suffocation. Dead eggs and alevins will be removed daily from each of the deep tanks by NFH personnel. (current status)

17. Deep tanks, screens, and overflow sections will be cleaned daily (current status)

18. Salt will be added to each tank on a weekly basis to produce a 0.01 to 0.2 percent salt solution once the fry have buttoned-up and began feeding, and will continue until they are released. (current status)

Release

19. Juvenile steelhead will be released in the Sacramento River at the Garcia Bend Boat Ramp (river mile 49 located approximately 10.5 miles downstream from the confluence of the American River). (current status)

20. Juvenile steelhead will be released at a yearling size and during the period January through March. (current status)

21. NFH personnel will attempt to rear juvenile steelhead to a size of 4 per pound prior to release. (current status)

22. When possible, releases of NFH-produced steelhead should coincide with flow releases >30,000 cfs at Verona in the Sacramento River (USGS gage 11425500 SACRAMENTO R A VERONA CA) to encourage out migration.

23. Regardless of size, juvenile steelhead will be release prior to March 30th. (current status)

24. Juvenile steelhead will be transported to the release site using a suitable sized transporting tank. In addition to fresh water from the hatchery water system, approximately 50 pounds of kiln dried salt will be added to the tank with a maximum 2,300 pounds of fish per load to produce a 0.1 percent solution (1,000 ppm) (current status)

25. All of NFH-produced juvenile steelhead will be marked with an adipose-fin mark denoting a hatchery-produced fish. (current status)

26. If approved by Department fishery managers and fish pathologist, surplus fish may be stocked in waters where they do not and will not conflict with existing management goals or policies. These locations have in the past included anadromous and inland waters. (current status)

27. All juvenile steelhead will be certified to be disease-free by Department Fish Pathologist prior to release. (current status)

12. ATTACHMENTS AND CITATIONS

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