State of California
The Resources Agency
DEPARTMENT OF FISH AND GAME

FINAL DRAFT
Hatchery and Genetic Management Plan
American River Fall-Run Chinook Salmon Program

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Final Draft
Hatchery and Genetics Management Plan
American River Fall-Run Chinook Salmon Program

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

Senior Biologist Fisheries (Retired Annuitant) Nimbus Fish Hatchery, North Central Region, 2001 Nimbus Road, Rancho Cordova, CA 95670

Fish and Wildlife Scientific Aid, Nimbus Fish Hatchery, North Central Region, 2001 Nimbus Road, Rancho Cordova, CA 95670
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<th>Hatchery Program</th>
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<td>California Department of Fish and Game under contract with the United States Bureau of Reclamation</td>
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List of Abbreviations

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
CVSPWTC 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. 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) to meet production objectives (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 National Marine Fisheries Service (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 Hatchery and Genetic Management Plan (HGMP) for NFH fall-run Chinook salmon program describes hatchery operations and addresses impacts on anadromous salmon and steelhead 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.**

Chinook salmon *Oncorhyncus tshawytscha* (Walbaum 1792) fall-run

ESA status: Species of Concern

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 for NFH is approximately $1.7 million and includes $210,000 for temporary help personnel.

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<td>Fish and Wildlife Technician A/B</td>
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<td>Office Technician –Typing</td>
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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). The regional mark processing center code is 6FCSAAMN NBFH for NFH and 6FCSAAMN for the American River.

NFH office location:
Longitude 121.225.4000 W, Latitude 38.633.6000 N

NFH office address:
Nimbus Fish Hatchery
California Department of Fish and Game, North Central Region
2001 Nimbus Road
Rancho Cordova, CA 95670
Figure 1-1 Location of Nimbus Fish Hatchery on the lower American River.
1.6 Type of program

The Chinook salmon program is an artificial production program.

1.7 Purpose (Goal) of program

The goal of NFH is to mitigate for American River Chinook salmon spawning habitat eliminated by construction of Nimbus Dam. This is accomplished through the trapping, artificial spawning, rearing, and release of Chinook salmon. Mitigation goals are for an annual egg take of 8 million fall-run Chinook salmon eggs and a release of 4 million smolts that are 60 per pound or larger.

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 was needed. 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 Corps’ 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 than 3 million acres of farmland are annually irrigated by water provided by the CVP; it also provides 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 Folsom the north to City of 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 such as NFH-spawned or NFH-raised fish (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” (16 U.S.C. § 1532 (16) (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. 58,613, 58,618 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. 58,613, 58,618 1991) (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.

Chinook salmon reared at NFH are considered to be part of the Central Valley fall-run ESU. This ESU was listed as a NMFS Species of Concern April 15, 2004.

There is no evidence to indicate that Chinook salmon presently found in the American River are not indigenous, however, anecdotal information suggests that non-indigenous Chinook salmon from other Sacramento River sources may have been introduced into the river after gold mining activities in the 1800’s decimated the salmon run. Yoshiyama et al. (2001) reviewed available information and suggested the American River spring-run was extirpated by construction of Folsom Dam.

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.

Hatchery Goals

The goal of NFH is to mitigate for American River Chinook salmon spawning habitat eliminated by construction of Nimbus Dam. This is accomplished through the trapping, artificial spawning, rearing, and release of Chinook salmon. Fall-run Chinook salmon reared at NFH contribute to major sport and commercial fisheries in the Pacific Ocean, primarily off the California and Oregon coasts. NFH Chinook salmon also supports popular sport fisheries in San Francisco Bay, and the Sacramento and lower American rivers.

Specific numbers of eggs and fish relative to the fall-run Chinook salmon program mitigation goals are:

• Annually take 8 million fall-run Chinook salmon eggs

• Annually release 4 million Chinook salmon smolts that are 60 per pound or larger; and:  

The number of returning adult naturally- and NFH-produced fish fluctuates considerably between years and the dynamics behind those changes are not completely known. Due to the complex salmon life cycle their survival can be affected by a multitude of physical and biological factors. Although not specifically identified as a program goal, the survival of release NFH-produced Chinook salmon smolts to adult fish may be used as a measure of program performance. However, studies necessary to provide this information have not been conducted.
In spite of the lack of specific information, we attempted to estimate the survival of juvenile Chinook salmon released from NFH and returning to the American River based on available release and return information. Unfortunately, data on the in-river harvest, number of adults by age class returning to the hatchery and river, and proportion of hatchery and naturally-produced fish returning to the hatchery are lacking. Nonetheless, we used available information to provide a “best guess” of survival for releases since 1995 (Table 1-1).

In addition to survival, additional performance standards relating to mitigation, harvest, life history characteristics, genetic characteristics, operation of the artificial production program, and socio-economic effectiveness for the NFH Chinook salmon program were developed.
### Table 1-1. Estimated survival rates of Nimbus Fish Hatchery fall-run Chinook salmon for 1994 – 2002 Brood years.

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<td>Adult return year (3 years post release)</td>
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| Number of fingerlings released | 8,430,523 | 4,083,701 | 4,663,756 | 1,253,570 | 0 | 0 | 4,131,750 | 3,475,650 | 0 | 3,944,400 | 17,469,126 | (2,998,335) |
| Number of smolts released | 1,891,600 | 4,030,450 | 3,718,500 | 4,021,864 | 4,598,208 | 3,851,700 | 0 | 576,000 | 3,367,000 | 634,000 | 20,767,272 | (2,668,932) |

| Total juvenile Chinook salmon released | 10,322,123 | 8,114,151 | 8,382,256 | 5,275,434 | 4,598,208 | 3,851,700 | 4,131,750 | 4,051,650 | 3,367,000 | 4,578,400 | 38,236,398 | (5,667,267) |
| Total estimated number of adults spawning in-river | 17,900 | 25,031 | 14,347 | 17,078 | 6,708 | 25,200 | 9,000 | 4,472 | 11,200 | n/a | 130,936 | (14,548) <sup>3</sup> |
| Total number of adults returning to hatchery | 10,369 | 12,890 | 9,226 | 9,230 | 4,024 | 19,942 | 7,439 | 5,107 | 12,703 | n/a | 90,930 | (10,103) <sup>3</sup> |
| Total number of grilse returning to hatchery | 2,866 | 744 | 744 | 3,442 | 511 | 826 | 9,331 | 1,771 | 1,349 | 1,638 | 21,584 | (2,398) <sup>3</sup> |
| Total number of salmon returning | 31,135 | 38,665 | 24,317 | 29,750 | 11,243 | 45,968 | 25,770 | 11,350 | 25,252 | 1,638 | 243,450 | (27,050) <sup>3</sup> |
| Estimated survival rate<sup>1</sup> | 0.30% | 0.48% | 0.29% | 0.56% | 0.24% | 1.19% | 0.62% | 0.28% | 0.75% | incomplete | 0.64% | (0.52%) <sup>3</sup> |

<sup>1</sup> Estimated survival includes contribution of naturally-produced Chinook salmon.

<sup>2</sup> Number in parenthesis is mean.

<sup>3</sup> Total does not include 2007 grilse and adult return numbers.
Performance Standards

1. Mitigation

**Standard 1.1** Program meets mitigation goals.

*Indicator:* Number of fall-run Chinook salmon eggs taken annually meets numbers identified in mitigation agreement (8 million) and provides enough eggs to meet release numbers (4 million smolts) *(Benefit)*

*Indicator:* Number of 60 per pound Chinook salmon smolts reared meets mitigation agreement of 4 million smolts annually *(Benefit).*

2. Harvest

**Standard 2.1:** Provide adult hatchery fall-run Chinook salmon for harvest in such a way that impacts to listed fish populations are kept within acceptable limits and Incidental impacts from angling on listed species will be minimized during the recreational fishery. *(Benefit)*

*Indicator:* Number of hatchery adult fall-run Chinook salmon caught and estimated economic benefit, and number of angler days generated associated with this program. *(Benefit)*

*Indicator:* Estimated number of listed species caught and released during fall-run Chinook salmon fisheries. *(Risk)*

**Standard 2.2:** 25% of all hatchery-produced juvenile fall-run Chinook salmon will be externally adipose fin clipped and coded wire tagged. *(Benefit)*

*Indicator:* Mark rate by mark type for each release group. *(Benefit)*

*Indicator:* Prerelease quality checks indicate a minimum 95 percent retention of identifiable marks. *(Benefit)*

3. Life History Characteristics

**Standard 3.1:** Fall-run Chinook salmon broodstock will be collected in a manner that approximates the distribution in timing, age, and size of hatchery fish returning to Nimbus Fish Hatchery. However, jacks will make up no more than 2 percent of males spawned. *(Benefit)*

*Indicator:* Temporal distribution of fall-run Chinook salmon returns and adults collected. *(Risk - unknown)*

*Indicator:* Age distribution of Nimbus Fish Hatchery adult fall-run Chinook salmon returns and broodstock spawned. *(Benefit)*
**Indicator:** Size at age distribution of Fish Hatchery adult fall-run Chinook salmon returns and broodstock spawned. *(Risk - unknown)*

**Standard 3.2** Releases of adult fall-run Chinook salmon will limit impacts to naturally produced salmonids through control of hatchery release numbers and timing by minimizing spatial and temporal overlap with natural populations. *(Risk)*

**Indicator:** Number of Nimbus Fish Hatchery adult fall-run Chinook salmon released. *(Risk)*

**Indicator:** Dates of Nimbus Fish Hatchery adult fall-run Chinook salmon releases. *(Risk)*

**Indicator:** Location of Nimbus Fish Hatchery adult fall-run Chinook salmon released. *(Risk)*

**Standard 3.3:** All Nimbus Fish Hatchery adult fall-run Chinook salmon will be released as 60 per pound smolts in the Carquinez Straits at locations identified in the HGMP. *(Risk - unknown)*

**Indicator:** Beginning and ending dates of Nimbus Fish Hatchery fall-run Chinook salmon smolt releases. *(Risk - unknown)*

**Indicator:** Size and length frequency of Nimbus Fish Hatchery fall-run Chinook salmon smolts released. *(Risk - unknown)*

**Indicator:** Locations of releases. *(Risk - unknown)*

**Standard 3.4:** Nimbus Fish Hatchery adult fall-run Chinook salmon in excess of production needs will be released at times and locations that reduce impacts to naturally rearing salmonids. Any surplus Nimbus Fish Hatchery adult fall-run Chinook salmon fry or fingerlings may be released into anadromous waters upon approval of the Fisheries Branch Chief, or they may be destroyed. *(Benefit)*

**Indicator:** Location, number, and timing of Nimbus Fish Hatchery adult fall-run Chinook salmon fry and fingerling releases. *(Benefit)*

### 4 – Genetic Characteristics

**Standard 4.1:** Hatchery adult fall-run Chinook salmon spawning naturally in the American River will not exceed standards identified. *(Benefit)*

**Indicator:** Estimated abundance of naturally spawning fall-run Chinook salmon in the American River. *(Benefit)*

**Indicator:** Estimated abundance of naturally spawning fall-run Chinook salmon in the respective basins that are of hatchery origin based on scales, marks or tags. *(Benefit)*
Standard 4.2: Only Nimbus Fish Hatchery adult fall-run Chinook salmon, or adult returns from smolts released for this program, will be used as broodstock for the Nimbus Fish Hatchery adult fall-run Chinook salmon program. (Risk - unknown)

**Indicator:** Location of broodstock collection. (Risk - unknown)

**Indicator:** Returning adult fall-run Chinook salmon that enter the NFH ladder and fish trap are used for broodstock. (Benefit)

Standard 4.3: Nimbus Fish Hatchery adult fall-run Chinook salmon broodstock will be spawned following appropriate mating and spawning protocols. (Benefit)

**Indicator:** Number of males and females spawned. (Benefit)

**Indicator:** Mating follow procedures described for NFH. (Benefit)

5 – Operation of Artificial Production Program

Standard 5.1: The Nimbus Fish Hatchery adult fall-run Chinook salmon program will be operated in compliance with Department and Commission fish health policies and guidelines. (Benefit)

**Indicator:** Number of broodstock sampled and pathogens observed. (Benefit)

**Indicator:** Rearing survival rates, egg to fry and fry to smolt. Results of fish health examinations. (Benefit)

**Indicator:** Number of juveniles sampled and pathogens observed immediately prior to release. (Benefit)

Standard 5.2: Nimbus Fish Hatchery effluent will comply with the conditions and water quality limitations identified in the current NPDES permit. (Benefit)

**Indicator:** Water samples collected and results reported. (Benefit)

**Indicator:** Results within accepted criteria. (Benefit)

Standard 5.3: Nimbus Fish Hatchery water withdrawals will comply with Department and NMFS juvenile screening criteria. (Benefit)

**Indicator:** Screens are not located in areas that require compliance. (Benefit)

Standard 5.4: Nimbus Fish Hatchery Chinook salmon carcass will be disposed of in manners identified in the HGMP and comply with Department and NMFS criteria. (Benefit)
**Indicator:** Number and location of Chinook salmon carcasses distributed. (Benefit)

**Indicator:** Number of carcasses sampled and pathogens observed. (Benefit)

**Standard 5.5:** All fish that enter the Nimbus Fish Hatchery adult trap are handled and released in a manner that minimizes stress, injury, and mortality or any delay in spawning with the exception of fish that are collected as broodstock. **(Risk)**

**Indicator:** Number of fish handled and released alive from the Nimbus Fish Hatchery trap and not broodstock. **(Risk - unknown)**

**Indicator:** Dates of trap operation and frequency of trapped fish not included as broodstock. **Benefit**

**Standard 5.6:** Releases of Nimbus Fish Hatchery fall-run Chinook salmon will limit predation impacts to naturally produced salmonids through control of hatchery release numbers and by minimizing spatial and temporal overlap of wild salmonid juveniles. **(Risk - unknown)**

**Indicator:** Location, dates, and sizes of NFH fall-run Chinook salmon releases. **(Risk - unknown)**

**6 - Socio-Economic Effectiveness**

**Standard 6.1:** Estimated harvest benefits will equal or exceed hatchery production costs for NFH fall-run Chinook salmon. **(Benefit)**

**Indicator:** Annual budget expenditures. **(Benefit)**

**Indicator:** Estimated harvest benefits. **(Benefit)**
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 Salmon, Steelhead Trout, and Anadromous Fisheries Program Act of 1998 has been incorporated into Section 6902 of the Fish and Game Code:

“...The Legislature, for purposes of this chapter, declares 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.

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 the mid-1950’s, the DFG has conducted an annual mark-recapture carcass survey to estimate the fall-run Chinook salmon spawning escapement in the lower American River. Fall-run Chinook spawning in-river are of hatchery and natural origin. The program recovers coded-wire tags from fish reared and tagged at NFH.

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 (CVPIA 1992)

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 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 make 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 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 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. 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 mitigation goals related to fish production:

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° 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° F and created fish rearing problems. 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.

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. Ocean commercial, ocean sport, and inland sport fisheries benefit from Chinook salmon reared and released by NFH.

The Pacific Fisheries Management Council is responsible for the development of annual recommendations for ocean salmon harvest within the United States' Exclusive Economic Zone (water three to 200 miles offshore). The Council's Salmon Fishery Management Plan describes the goals and methods for salmon management. Management tools such as season length, quotas, and bag limits are used to regulate the fishery based on the estimated number of salmon available for harvest. Each year the Council follows a preseason process to develop recommendations for management of the ocean fisheries. Recommendations are implemented by the National Marine Fisheries Service on May 1 of each year.

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.

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 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 (Appendix 5). The biological opinion includes an effects determination and take statements and also objectives that may affect operation of NFH.

2.4.2 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.

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

The 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.

2.4.4 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 Flow Management Standard (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 (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 and 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 can supplement natural populations and production, protect genetic resources and provide for stream nutrient enrichment (Steward and Bjornn 1990; Cuenco et al. 1993). Some biologists feel that properly managed hatchery programs can provide for fisheries as well as supplement numbers of fish that spawn naturally, thus increasing natural production, while acceptably reducing biological risks; others doubt that this is the case (Waples 1999; Bilby et al. 2003).

Einum and Fleming (2001) reviewed the literature dealing with ecological differences between wild and released salmonids. They indicated that hatchery-produced fish may differ from their wild conspecifics because i) fish are highly phenotypically plastic and therefore their phenotypes may be shaped
considerably by the rearing environment (e.g., Wootton 1994, Pakkasmaa 2000) ii) the intensity and direction of selection differs between the two environments, and iii) the use of non-native fish.

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.

Investigations have shown that most of the fall-run Chinook salmon naturally-produced in the lower American River emerge in large numbers in January and continue to emerge through April, and initiate migration from the river shortly after emerging, with emigration peaking in February (Snider and Keenan 1994, Snider and Titus 1995, Snider et al. 1970. NFH-produced Chinook salmon are released downstream in the Carquinez Straits, generally during the month of May, and competition between naturally-produced Chinook salmon would occur as both groups of fish enter the San Pablo Bay Estuary and eventually the Pacific Ocean.

The severity of competition between naturally-produced and hatchery-produced salmon is unknown. Ruggerone et al. (2003) evaluated offshore competition between Asian pink salmon and Bristol Bay (Alaska) sockeye salmon, which intermingle in the North Pacific Ocean and Bering Sea, using the unique biennial abundance cycle of Asian pink salmon from 1955 to 2000. The interaction with odd-year pink salmon led to significantly smaller size at age of adult sockeye salmon, especially among younger female salmon. They concluded this evidence for interspecific competition highlighted the need for multispecies, international management of salmon production, including salmon released from hatcheries into the ocean.

Weber and Faush (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.
In the American River, competition may occur between NFH-produced Chinook salmon and naturally-produced juvenile Chinook salmon, and other native and non-native fish species. The degree of this competition and affect on native species is unknown but expected to be small. Fish released by NFH replace fish that would have been naturally produced above Nimbus Fish Hatchery and are replacement, not additive or supplemental. As such, competition from NFH-produced fish and naturally-produced fish is not anticipated to be greater that that expected under pre-project conditions.

2.5.2 Predation

Although predation is part of salmonid natural ecology, the significance of jeopardy 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 are not known to be highly piscivorous and while in freshwater feed on a variety of food items of which aquatic insects and other invertebrates make up the greatest proportion (1993, Unger 2004, Rundia and Lindely 2007). Additionally, food abundance plays a role in determining what items are consumed and migrating salmonids are available to resident predators for only a specific period during migration. In addition, NFH-produced steelhead and Chinook salmon are released at locations to reduce predation.

2.5.3 Parasitism and disease transfers

Parasites and pathogens may be transmitted between fish, and fish held in hatcheries are more susceptible to this transfer because of the higher densities in which they are held. All pathogens that affect Nimbus hatchery fish are either present in the water source to the hatchery, or are brought into the hatchery with returning adults. Fish below Nimbus dam are also exposed to the same pathogens, whether they are above or below the hatchery. There is substantial documentation of pathogen transfers from wild to hatchery fish, but virtually none for pathogen transfer from hatchery fish to wild fish (personal communication, W.T. Cox, Program Manager, Fish Production and Distribution, CDFG). Hatchery management practices minimize the release of fish infected with pathogens, and transfer of fish to saltwater is also a control measure for any freshwater parasites that may remain when the fish are released.

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.
2.5.5 Interbreeding

The ecological interaction of naturally- and hatchery-produced fish interbreeding to produce intra-specific hybrids is relevant to the management of wild fish. The National Research Council (1996) reviewed the literature regarding Pacific Northwest salmon and hypothesized a variety of possible explanations for observed declines of wild salmonid populations, including the potential adverse effects of production hatcheries.

Fish produced in hatcheries eventually become domesticated. A fundamental distinction of domesticated fish and naturally-produced fish is that they are created by human labor to meet specific requirements and are become adapted, either intentionally or unintentionally to the conditions of continuous care people maintain for them.

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).

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 Chinook salmon spawning habitat and not supplement natural populations.

Genetic examination of Central Valley Chinook salmon populations began in the mid-1990s and historical genetic information is lacking. Williamson and May (2005) suggested that the Central Valley fall Chinook populations demonstrate a lack of genetic diversity. They suggested that lack of genetic distinction and the lack of temporal differences in allele frequencies between NFH and naturally spawning fish indicate that considerable gene flow occurs between fall-run Chinook salmon throughout the Central Valley. Due to the prevalence of off-site release of NFH-reared juveniles and the history of interbasin NFH transfers and stocking within the Central Valley, hatchery practices at NFH and other Central Valley hatcheries have probably contributed to the homogenization of Central Valley fall-run populations. Other contributing factors may include the lack of access to historic spawning areas, limited diversity of remaining spawning and rearing habitats, relatively high harvest rates and differing water temperatures/quality between rivers during escapement.

During the first 10 years of NFH operation, less than 10% of the total in-river Chinook salmon run entered NFH. While the number of salmon trapped at NFH
has varied, it has averaged slightly less than 10,000 fish (range 769 – 20,569) and has demonstrated a slightly increasing trend in the number of fish trapped. Conversely, the in-river run has demonstrated a downward trend during the same period based on the estimated numbers. Overall, the total number of salmon entering the American River demonstrates a general decline since 1955.

The number of NFH-produced salmon in the total in-river run is unknown. It is very likely that naturally-produced and NFH-produced Chinook salmon interbreed in the American River. It is also very likely that this has occurred since the return of the first NFH-produced Chinook salmon to the river. However, the portions of naturally-produced and NFH-produced fish are unknown and as such, it is impossible to determine if interbreeding has resulted in fewer numbers of Chinook salmon returning to the American River.

2.5.6 Strategies to reduce ecological and genetic interactions

Historically, Chinook salmon produced at NFH have been released to maximize contribution to the fisheries and to assure that sufficient numbers of adults return to the stream and hatchery to meet mitigation requirements and egg requirements at NFH. To help reduce ecological interactions between naturally- and NFH-produced fish and improve survival of released fish, various release strategies involving different sized fish have been attempted.

Fry and fingerling Chinook salmon releases have been made at NFH since operation was initiated and have occurred as early as January. In some instances, plantings were made to reduce numbers of fish held in the hatchery. Although some marking experiments were conducted, there has been little analysis of the contribution of these small fish to the spawning population. Fry and fingerling releases were discontinued after the 1987 brood year.

Smolt-sized Chinook salmon are 100 fish per pound or larger, some of which may not be smolting. Release of this size fish began in 1967 at NFH and beginning in the mid-90s, most of these fish have ranged from 50 to 60 fish per pound range and releases have averaged slightly less than 4 million fish per year. After 1997, all production releases were in this size range and nearer the 4 million per year goal.

Yearling-sized Chinook salmon from the 1955 to 1979 brood years were released each year from NFH. Yearling releases were discontinued in 1979, due to the high cost of holding and feeding the fish over the summer, as well as disease and other problems associated with holding juvenile Chinook salmon during periods of higher water temperatures.

Beginning in 1981, NFH began releasing Chinook salmon smolts in the Carquinez Straits at the town of Bencia and the U.S. Maritime Academy.

Weber and Fausch (2003) reviewed the differences reported, designs appropriate for testing different hypotheses about competition, and tests of
competition reported in the literature. They suggested that many studies have provided circumstantial evidence for competition, but the effects of competition were confounded with other variables. They subsequently measured the densities and size distributions of ocean-type juvenile Chinook salmon in two rearing areas in the Sacramento River before, during, and after two large releases of hatchery fish in both 2001 and 2002 (Weber and Fausch 2004). Although hatchery-produced fish were much larger than most wild fish, the mean size of fish captured did not increase appreciably after hatchery releases, even after the release when density increased. Weber and Fausch (2004) reported that these data suggest the strategy of delaying hatchery releases until most hatchery fish were smolting and most wild fish had emigrated was relatively effective in reducing potential interactions in freshwater rearing areas of the stream margin in the upper Sacramento River.

The current practice of releasing NFH-produced Chinook salmon smolts in San Pablo Bay to encourage rapid out migration and reduce competition with naturally-produced salmonids appears to be the best management strategy. Although releases at this location may increase straying there does not appear to be a better release strategy to reduce competition with listed salmonids.
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.
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 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. A 1/8 inch wire mesh screen is located on the 42-inch intake pipe. A 1/16 inch wire mesh traveling water (trash) screen is located on the 60-inch intake pipe. Both intake pipes enter a head box structure located on the southeast side of NFH grounds that allows water to be directed to the raceways, NFH Buildings 1 and 2, holding ponds, and the fish ladder.

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 the effluent from both NFH Buildings will be directed 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).

![Image of NFH facility](image)

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 were 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.
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 to 12 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, Glickman, and Christensen (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.

![Fish trap at the top of the fish ladder facing north.](image)

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°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 gathering tank and into a lift basket contained within the dope tank. A Smith-Root EA-1000A Electroanesthesia System was placed into operation in 2007 and is used to narcotize the fish.

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

Figure 4-8. Concrete holding ponds adjacent to NFH Building 2 facing west.
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). After the fish are electrically narcotized, they are lifted from the gathering 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 Gathering 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 hatchery 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.
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, and capable of holding approximately 1,500 gallons (Figure 4-14). Each tank is 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 jar 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.
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.
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 (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.
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 fish.
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:

Vehicle 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. Vehicle 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

This program propagates fall-run Chinook salmon. Chinook salmon are native to the American River drainage and are often grouped into different races, runs, or stocks depending on lineage, time of entry into freshwater, or the geographical range of the specific stock. The present run of American River Chinook salmon are considered a fall-run stock.

5.1.1 NFH broodstock source

The original broodstock for NFH was obtained from fish that volitionally entered NFH ladder and were trapped. From 1956 through 1988, eggs from both Coleman National Fish Hatchery and Feather River Hatchery were reared and released from NFH into the American River.

The present broodstock is from fish that volitionally entered NFH ladder and are trapped. Neither eggs nor fish from other sources are transferred to NFH.

5.1.2 Supporting Information

Williams (2006) provided a general overview of the history of Chinook salmon runs in the American River. Based on historical anecdotal information, he suggested that the river historically supported both spring and fall runs of Chinook salmon and in addition a late-fall run.

In the first annual report of the NFH, Hinze et al. (1956) reported that the American River supported both spring and fall runs of Chinook salmon but did not provide supporting information. He also reported that the spring run arrived in the vicinity of NFH in May, June, and July, but were not observed after 1956. He speculated that their demise was due to flood conditions in 1950 that destroyed a fish ladder that provided passage over Folsom Dam and access to suitable upstream habitat. This was not the same Folsom Dam described by Clark (1929) that was constructed in 1893 near the town of Folsom. Construction of the present Folsom Dam began in 1948 and a temporary ladder that was in place during construction was operational for only 2 years. After the ladder was destroyed by high stream flows in 1950 it was not replaced.

5.1.3 History

Yoshiyama et al. (2001) described the historical and present distribution of Chinook salmon in the American River while Williams (2001) briefly reviewed the limited historical information relating to Chinook salmon in the American River.

After construction of NFH was complete and operational on October 5, 1955, water was discharged into the fish ladder and within 34 minutes, the first salmon appeared in the ladder (Hinze et al 1956).
Hinze et al. (1956) also reported that the main American River salmon run began in late September, peaking in late October or early November, and tapering off in December. His observation is supported by the first 10 years (1955-1965) of NFH salmon trapping records. He also reported that “a few fish of the spring-run” were observed below Nimbus Dam in the summer of 1955 but NFH records do not indicate any spring-run Chinook salmon were trapped at NFH in the early years of operation.


5.1.4 Annual run size

Chinook salmon run size estimates or counts prior to 1944 are not available for the American River. Anadromous fish runs in river were impacted by early development and mining activity and historical numbers will never be known. However, Yoshiyama et al. (2000) estimated that 161 miles of stream in the American River were historically available to migrating Chinook salmon of which only 28 (17%) miles are available today.

Estimates of the number of Chinook salmon in the American River were reported by the USFWS and DFG (1953) for 7 years during the period 1944 through 1952. During that period, the estimated annual total in-river Chinook salmon run was 26,144 salmon (Table 5-1).
Table 5-1. Number of Chinook salmon estimated in the American River and reported trapped at the Nimbus Fish Hatchery 1944 – present.

<table>
<thead>
<tr>
<th>Year</th>
<th>Estimated in-river adult Chinook salmon below Nimbus Dam</th>
<th>Estimated in-river grilse Chinook salmon below Nimbus Dam</th>
<th>Estimated in-river run below Nimbus Dam</th>
<th>Estimated in-river run above Nimbus Dam</th>
<th>Total estimated Chinook salmon in-river spawning population</th>
<th>Number of adult Chinook salmon trapped at NFH</th>
<th>Number of grilse Chinook salmon trapped at NFH</th>
<th>Total number of Chinook salmon trapped at NFH</th>
<th>Estimated total in-river run Chinook salmon</th>
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</tr>
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1 Estimates from California Department of Fish North Central Region files, Game CalFish Program and Nimbus Fish Hatchery annual reports.
Beginning in 1953, estimates of in-river Chinook salmon spawning escapement have been made by the DFG (Table 5-1). Williams (1995, 2001) summarized several reviews of these escapement estimates and suggested that the data should be "regarded with considerable caution". The estimates do suggest that the in-river run size has varied greatly since 1944; with highest numbers estimated in the mid 70’s and early 2000’s (Figure 5-1). Since 1996, the total estimated annual in-river fall-run Chinook salmon run (adults and grilse), but not including angler harvest, has averaged 74,311 fish with the peak year occurring in 2003 (Table 5-1).

![Graph showing estimated number of fall-run Chinook salmon in the American River, 1944 to present.](image)

**Figure 5-1.** Estimated number of fall-run Chinook salmon in the American River, 1944 to present.
We reviewed and summarized NFH daily fish counts from NFH annual reports and found discrepancies in some reported numbers. For the purpose of this report, we used the daily fish counts and noted discrepancies where they occurred. Since operation began in 1955, NFH personnel reported trapping totals of 423,784 adult and 103,526 grilse Chinook salmon (Figure 5-2, Table 5-1 and Appendix 6).

During the period 1955 through 1996, NFH trapped an annual average of 7,924 adult and 1,961 grilse Chinook salmon. Since then (1997-2006), NFH has trapped an average of 9,889 adult and 2,314 grilse Chinook salmon annually (Table 5-1).

The size criteria for grilse salmon has changed during NFH operations; since 1973, salmon 60 cm (23.6 inch) or smaller in length have been classified as grilse in NFH annual reports, however, in 1972, the length was 23.9 inches in length. No length is given for grilse prior to 1972. NFH personnel have included female grilse in the grilse salmon counts.

We were unable to determine if any relationship existed between the number of grilse Chinook salmon trapped and number of adults returning the first or second following year. However, our analysis was hampered by lack of information that would allow us to separate the number of returning adults by year class.
5.1.5 Run timing

Information on the specific timing of historical salmon runs in the American River is not available. Since construction of Nimbus Dam, the Chinook salmon that enter the American River have been considered fall-run and first appear in the lower American River in early September. Based on Fry’s (1961) description of the Sacramento River salmon runs, the present American River Chinook salmon run should be considered a fall-run stock.

Based on past trapping records, the first Chinook salmon have been trapped at NFH as early as the 2nd to 3rd week of September. The greatest numbers of salmon have been typically trapped the last week of October through the 3rd week of November; and the last fish were trapped during the 2nd week of December through the 1st week of January. In some years, a small number of Chinook salmon were trapped through the month of January. However, the ability to trap Chinook salmon is contingent on the fish weir remaining in place. During some years, the fish weir was removed due to high river flows and fish may not have entered the fish ladder.

More recently, the fish ladder has remained de-watered and no attempt has been made to trap Chinook salmon until river temperatures are at or below 60°F and are expected to remain at that temperature or lower. During the past 10 years of operation, the first Chinook salmon has been trapped after the middle of October (standard week 42).

Spawning is usually initiated at NFH soon after the first Chinook salmon are trapped and spawning may continue as late as December. Chinook salmon spawned in December may have entered the river earlier and remained in the river before entering NFH. Winter or spring-run Chinook salmon that enter the American River presently are most likely stray fish from other Sacramento River tributaries.

To determine if changes had occurred in the time the first Chinook salmon were trapped at NFH, the peak of trapping, and the time the last Chinook salmon was trapped, we analyzed the daily fish counts during the 52 years of operation based on a standard week format. Since Chinook salmon will not enter NFH ladder unless the fish weir is in place (T. West, NFH Hatchery Manager II, personal communication), we also analyzed the dates the fish weir has been installed and the fish ladder open to upstream migrating fish.

Generally, the fish weir has been typically installed during standard week 37 (second week in September). Both NFH and Reclamation workloads determine when the weir support framework is installed in the fall; however, the objective is to have the framework installed and the weir pickets in place on or before September 15.

Prior to 1996, the ladder remained open through about standard week 7 (mid-February), however, during the past 10 years the ladder has remained open through about standard week 14 (first of April) to trap steelhead.
During the first 7 years of NFH operation, the first Chinook salmon was reported trapped prior to standard week 40 (first of October). Subsequently the first Chinook salmon was reported trapped after standard week 42 (mid-October); and more recently after standard week 44 (late-October). Review of the daily fish counts indicates that the standard week the first Chinook salmon has been trapped at NFH has varied but was earlier during the early operation of NFH. However, regression analysis indicates the trend is not statistically significant ($R^2 = 0.4814$, n = 50) (Figure 5-3). Variation in the data suggests that the date the first Chinook salmon are trapped may be related to river water temperatures and operational procedures as opposed to changes in actual run timing.

Historically, the peak (greatest number of fish trapped) of the run varied but generally occurred between week 44 (end of October) and standard week 49 (first of December). During the past 10 years, the peak has occurred during week 47 (mid-November). Regression analysis suggests that since operation of NFH, there is a very slight trend to a later peak by about 2 weeks, however, this trend is not statistically significant ($R^2 = 0.1054$, n = 50) (Figure 5-3).

The standard week the last Chinook salmon has been trapped has also varied since operation of NFH and our analysis suggests that there has been a slight trend to a slightly earlier run termination, especially for the period prior to 1976. Again, the regression analysis suggests this trend is not statistically significant ($R^2 = 0.0309$, n = 50) (Figure 5-3).

Figure 5-3. Time of first Chinook salmon trapped, peak entry and last fish trapped at Nimbus Fish Hatchery, 1955 to present (note – Standard Week 1 starts January 1 but is noted as Standard Week 53, etc. for graphic display).
5.1.6 Past and proposed level of natural fish in broodstock

Chinook salmon from the American River were originally used as broodstock. However, it is also possible that transfers of Chinook salmon from other sources occurred and contributed to the American River run as early as the late 1800’s. At that time salmon runs in the American River were severely impacted by gold mining activities and from 1907 through the 1930’s the opportunity existed to transport eggs and fish from areas in the upper Sacramento River via rail to other parts of the state. There is a possibility that Chinook salmon fry (and possibly juvenile steelhead) were brought and distributed in the American River via the two railroad fish distribution cars that operated at that time. Leitritz (1970) included a photo of “fingerling trout” being unloaded from a railroad car in the City of Folsom on July 13, 1915, most likely for release in the American River drainage. Records are not available on the ultimate distribution of those fish.

In 1942, the Coleman National Fish Hatchery (CNFH) was constructed on Battle Creek, a tributary to the Sacramento River as part of the CVP to compensate for the loss of salmon spawning grounds above Shasta Dam. CNFH replaced the Baird Hatchery (inundated by construction of Shasta Dam), the Battle Creek Hatchery (a little farther downstream on Battle Creek than CNFH), and the Mill Creek Hatchery located near Los Molinos. During the first years of NFH operation eggs from Chinook salmon collected at the CNFH were transferred to NFH for rearing and released in the American River (Table 5-2).

Table 5-2. Non-indigenous Chinook salmon reared and released from Nimbus Fish Hatchery 1955 - 2006.

<table>
<thead>
<tr>
<th>Source of Fish</th>
<th>River</th>
<th>Brood Year</th>
<th>Release Date</th>
<th>Release Location</th>
<th>Number Released</th>
<th>Release Size¹</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
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<td>Coleman National Fish NFH</td>
<td>Battle Creek, Sacramento River</td>
<td>1956</td>
<td>Jan-Feb-57</td>
<td>American River</td>
<td>n/a</td>
<td>fingerling</td>
<td>Late run</td>
</tr>
<tr>
<td>Coleman National Fish NFH</td>
<td>Battle Creek, Sacramento River</td>
<td>1957</td>
<td>Aug-58 - Jan-59</td>
<td>American River</td>
<td>n/a</td>
<td>587</td>
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<tr>
<td>Coleman National Fish NFH</td>
<td>Battle Creek, Sacramento River</td>
<td>1957</td>
<td>Nov-Dec-58, Jan-59</td>
<td>American River</td>
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<td>n/a</td>
<td></td>
</tr>
<tr>
<td>Coleman National Fish NFH</td>
<td>Battle Creek, Sacramento River</td>
<td>1958</td>
<td>Jul-59</td>
<td>American River</td>
<td>334,320</td>
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</tr>
<tr>
<td>Coleman National Fish NFH</td>
<td>Battle Creek, Sacramento River</td>
<td>1959</td>
<td>Jan-59</td>
<td>American River</td>
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<td>fingerling</td>
<td></td>
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<tr>
<td>Coleman National Fish NFH</td>
<td>Battle Creek, Sacramento River</td>
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<td>Jul-59</td>
<td>American River</td>
<td>98,790</td>
<td>67</td>
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<tr>
<td>Coleman National Fish NFH</td>
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<td>Aug-59</td>
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<td>88</td>
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<tr>
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<tr>
<td>Feather River NFH</td>
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<td>1988</td>
<td>Jan-89</td>
<td>Suisun</td>
<td>815,200</td>
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</table>

¹ Number per pound
Based on the likelihood that mining activities in the late 1800’s had a deleterious impact on American River salmon runs, and because Sacramento River Chinook salmon were transferred to the American River as early as the first part of the 1900’s, the first Chinook salmon that entered NFH may have been from Sacramento and American river stocks. With the subsequent transfers of CNFH (Battle Creek) and FRH fall-run Chinook salmon to NFH, coupled with interbreeding with the indigenous fall-run Chinook salmon, it is very likely that American River fall-run Chinook salmon stock are of a mixed ancestry.

Marked Chinook salmon from other hatcheries have been trapped at NFH (Table 5-4). These adipose marked fish have been included in the broodstock. Beginning in 2007, a portion of all Central Valley hatchery-produced Chinook salmon are scheduled to be marked and tagged. As such, it will not be possible to separate marked hatchery- and naturally-produced salmon during the broodstock collection process and will include both naturally- and hatchery-produced Chinook salmon.
Table 5-3. Number of coded-wire tagged Chinook salmon recovered during NFH
trapping.

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<tr>
<th>Year</th>
<th>CNFH</th>
<th>FRH</th>
<th>MokRH</th>
<th>MRH</th>
<th>NFH</th>
<th>Tehema-Colusa</th>
<th>TRH</th>
<th>WSFH</th>
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<td>995</td>
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</tbody>
</table>

1 CNFH = Coleman National Fish Hatchery, FRH = Feather River Hatchery, MokFH = Mokelumne Fish Hatchery, MRH = Merced Fish Hatchery. NFH = Nimbus Fish Hatchery, TRH = Trinity Fish Hatchery, WSH = Warm Springs Fish Hatchery, TNP = Tiburon Net Pen.
2 Total does not agree with total reported in NFH annual report.
5.1.7 Genetic or ecological differences

A number of individuals have studied the genetic differences in Central Valley Chinook salmon recently,

Yoshiyama et al. (2000) reported that fall-run Chinook salmon stocks in the San Joaquin River basin and Sacramento-San Joaquin Delta tributaries showed various changes but altogether constitute only a minor portion (now 4%) of the total Central Valley spawning escapements. The three other Chinook salmon runs (winter, spring, and late-fall) have shown much more pronounced reductions in recent decades.

Banks et al (2000) assessed genetic diversity within and among the four runs (winter, spring, fall, and late fall) of Central Valley Chinook salmon and examined forty-one population samples comprising naturally spawning and hatchery stocks collected from 1991 through 1997. They determined that most adult samples have random-mating equilibrium proportions of single and multilocus genotypes and temporal and spatial genetic heterogeneity is minimal among samples within subpopulations.

Chinook salmon diversity and stock structure in the California Central Valley were reviewed by Hedgecock et al. (2001) and Williams (2001) reviewed information on the genetic diversity of Central Valley Chinook salmon but focused on differentiating the runs based on the season of freshwater return.

Williamson and May (2005) reported that the Central Valley fall Chinook populations demonstrate a lack of genetic diversity as a result of off-site release of NFH-reared juveniles and the history of interbasin hatchery transfers and stocking within the Central Valley.

5.1.8 Age structure, fish size, fecundity, sex ratio

Age structure – The age structure of the adult Chinook salmon returning to NFH is unknown. Grilse comprised 22% of the Chinook salmon trapped during the period 1955 through 1995, and 30% of the run during the past ten years 1996 - 2006. The majority of the fish trapped during the past ten years appear to be age 2 and 3.

Fish size – Hinze et al. (1956) reported that adult fish averaged 14 pounds, and grilse averaged 2.5 lbs during the first year of operation of NFH. Information on the current size of fish is not available.

Fecundity – Based on the total number of eggs and taken and the number of females spawned, Williams (2001) reported that the fecundity of Chinook salmon spawned at NFH has been declining. However, he based this conclusion on the number of fish spawned and number of eggs taken. This is not a true estimate of fecundity but rather an estimate of the average number of eggs taken from female fish during artificial spawning. Fecundity is the total number of eggs
produced by a female fish. There are a number of reasons why the number of eggs per female may have changed at NFH including changes in how the female fish are euthanized (no anesthesia versus anesthesia resulting in a loss of eggs prior to spawning), spawning methods (stripping the ovarian membrane versus taking only loose eggs), and a decline in the number of larger older age fish in the spawning population due to increased ocean sport and commercial harvest. At NFH, spawning methods have changed with changes in management. The period from 1997 to present has shown the largest reduction in the number of eggs taken per female spawned since operations began in 1955. This period also coincides with the tenure of the present NFH manager and implementation of several different spawning practices. As such, it is not possible to draw conclusions regarding fecundity based on the number of eggs taken during the artificial spawning.

**Sex ratio** – During the first 41 years of NFH operations, female adult Chinook salmon out numbered males 1.13 females to 1 male. During the past ten years, the ratio has changed and there have been more males than females (0.85 females to 1 male). Nonetheless, the ratio has been variable and does not appear to demonstrate any trends (Figure 5-4)

![Figure 5-4. Number of female and male Chinook salmon trapped at Nimbus Fish Hatchery, 1955 to present.](image)

### 5.1.9 Reasons for choosing broodstock

The fall-run Chinook salmon broodstock originated from American River stocks and from non-indigenous Chinook salmon stocks that were transferred to NFH during the period of 1956 through 1959. Although Chinook salmon that entered
NFH from the river were included as broodstock, due to the low number of fish trapped, additional eggs from other Sacramento River Chinook salmon stocks were transferred to NFH to help meet NFH mitigation goals.

No historical documents identify specific reasons as to why a specific stock was chosen for NFH, but in general, those stocks with an abundance of eggs and with similar characteristics were usually selected. All the non-indigenous Chinook salmon transferred to NFH were from the Sacramento River system.
6. BROODSTOCK COLLECTION

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

NFH collects adult fall-run Chinook salmon from the American River.

6.2 Collection or sampling design

Chinook salmon are directed into the fish ladder by the fish weir. If the weir is not installed, salmon rarely enter the fish ladder and will continue to migrate upstream to the base of Nimbus Dam. Only fish that volitionally enter NFH are used as broodstock.

The fish weir is installed during the month of September and the fish ladder is opened after river temperatures are at or below 60°F and are expected to remain at that temperature or lower. This occurs generally about six weeks after the fish weir is installed in late October. The fish ladder remains open to fish through approximately the first of April for the collection of steelhead broodstock. The weir will remain in place throughout the Chinook salmon run but is removed when flow releases exceed or are anticipated to exceed 5,000 cfs. The fish ladder remains open throughout the Chinook salmon run.

During the period the fish ladder and trap are operational, all Chinook salmon that enter the adult gathering tank are anesthetized and examined for marks, sorted by sex, and the degree of sexual maturity determined. Fish are sorted and examined a minimum of two days each week during the run. Ripe female and male salmon are retained for artificial spawning while unripe fish are returned to the adult holding ponds via the stainless steel return tubes.

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 Chinook salmon annually trapped or spawned. However, mitigation goals are for an annual egg take of 8 million fall-run Chinook salmon eggs and a release of 4 million smolts that are 60 per pound or larger.

6.3.2 Broodstock collection levels

During the past 10 years, NFH has trapped an average of 10,181 Chinook salmon (5,499 males and 4,682 females) annually. Based on the number of female Chinook spawned and eggs collected, we estimate that approximately 1,600 to 2,000 female Chinook salmon and a commensurate number of male Chinook salmon must be spawned annually to produce NFH mitigation requirement for an annual egg take of 8 million fall-run Chinook salmon eggs and a subsequent release of 4 million smolts 60 per pound or larger. Artificially spawning continues throughout the salmon run to ensure that eggs are collected.
to represent the entire spawning run. Once the total Chinook salmon egg take reaches approximately 2.5 million eggs, NFH personnel review the season’s trapping records and makes general observations of the number of Chinook salmon in the river both from NFH grounds and from aerial surveys of the river. Based on that information, a determination is made for how many adult Chinook salmon should be retained in the adult holding ponds.

6.4 Disposition of hatchery-origin fish collected in surplus of brood stock needs

All Chinook salmon trapped at NFH are euthanized and either spawned or not spawned. No fish are returned to the river. Fish that are not sexually mature are retained in the adult holding ponds. All adult Chinook salmon in excess to those needed for spawning are euthanized and process as described in Section 6.8.

6.5 Adult fish transportation and holding methods

No adult Chinook salmon are transported to or from NFH. All adult Chinook salmon trapped but not spawned are retained in one of the adult holding ponds described in Section 4.1.5, or euthanized if the egg allotment needs have been met and eggs are on hand to represent the natural run.

6.6 Fish health maintenance and sanitation procedures

No chemicals or therapeutics are used during the spawning process. All equipment used during spawning activities is routinely washed with clean, fresh water. Once the eggs have been fertilized 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 a wide variety of bacteria, viruses, fungi, protozoa, and yeasts.

6.7 Disposition of carcasses

All Chinook salmon carcasses and eggs are retained by NFH. Carcasses suitable for human consumption are turned over to the California Emergency Food Link who contracts with a fish company to process the carcasses. Carcasses not suitable for human consumption are turned over to an animal processing/rendering company.

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

NFH broodstock collection program targets fall-run Chinook salmon that enter NFH broodstock collection system. There are 12 species fish species in California 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). Of these, Chinook salmon, Winter-run; Chinook salmon, California coastal; Chinook salmon, Spring-run; Steelhead, Northern California; Steelhead, Central California Coast; Steelhead, South/Central California Coast; and Steelhead, Central Valley could be anticipated to enter into NFH broodstock collection system. Since none of the listed natural-produced fish possess any distinguishable marks, tags, or morphological characteristics, it is not possible to identify any of these as listed natural fish.

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.

<table>
<thead>
<tr>
<th>Common name, ESU</th>
<th>Scientific name</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chinook salmon, Winter-run</td>
<td>Oncorhynchus tshawytscha</td>
<td>Endangered</td>
</tr>
<tr>
<td>Chinook salmon, California coastal</td>
<td>Oncorhynchus tshawytscha</td>
<td>Threatened</td>
</tr>
<tr>
<td>Chinook salmon, Spring-run</td>
<td>Oncorhynchus tshawytscha</td>
<td>Threatened</td>
</tr>
<tr>
<td>Coho salmon, Central California Coast</td>
<td>Oncorhynchus kisutch</td>
<td>Endangered</td>
</tr>
<tr>
<td>Coho salmon, So. Oregon/No. California</td>
<td>Oncorhynchus kisutch</td>
<td>Threatened</td>
</tr>
<tr>
<td>Steelhead, Northern California</td>
<td>Oncorhynchus mykiss</td>
<td>Threatened</td>
</tr>
<tr>
<td>Steelhead, Central California Coast</td>
<td>Oncorhynchus mykiss</td>
<td>Threatened</td>
</tr>
<tr>
<td>Steelhead, South/Central California Coast</td>
<td>Oncorhynchus mykiss</td>
<td>Threatened</td>
</tr>
<tr>
<td>Steelhead, Southern California</td>
<td>Oncorhynchus mykiss</td>
<td>Endangered</td>
</tr>
<tr>
<td>Steelhead, Central Valley</td>
<td>Oncorhynchus mykiss</td>
<td>Threatened</td>
</tr>
<tr>
<td>Delta smelt</td>
<td>Hypomesus transpacificus</td>
<td>Threatened</td>
</tr>
<tr>
<td>Sacramento splittail</td>
<td>Pogonichthys macrolepidotus</td>
<td>Depleted</td>
</tr>
</tbody>
</table>

However, some of the listed natural fish demonstrate specific freshwater entry timing. These include spring-run Chinook salmon and Central Valley steelhead which are the most likely to stray into the American River. Since the fish ladder is not operated during the time that spring-run Chinook salmon would enter the collection system, it is anticipated that current operations minimize adverse effects to listed natural fish.
7. MATING

7.1 Selection method

In 1998, NFH and DFG Fish Pathology personnel reviewed the mating protocols for Chinook salmon with Dr. Bernie May, Geneticist, University of California Davis. Based on Dr. May’s recommendations, no effort is made to select fish for spawning from the fish that enter the gathering tank except for those characteristics that identify sexually mature fish. Mating is accomplished using one female and one male.

Prior to 2007, adipose fin marked Chinook salmon, indicating they are not NFH origin fish and were not included in NFH spawning population. However, starting with the 2007 BY Chinook salmon, 25% of the juvenile Chinook salmon released will be adipose fin marked. As such, it will not be possible to differentiate NFH origin fish from other stocks beginning in 2008.

7.2 Males

No attempt is made to select males for spawning except that only males that demonstrate free flowing sperm are used. One grilse Chinook salmon out of 100 males is included to ensure representation in the broodstock.

7.3 Egg collection and fertilization

During the adult fish sorting process, only Chinook salmon that expel free flowing eggs, demonstrating they are sexually mature and ready to spawn, are euthanized and spawned. Prior to spawning, adult female Chinook salmon are euthanized with a pneumatic knife inserted into the spinal cord immediately posterior to the head. Males are euthanized with a single forceful blow to the head.

The incision method described by Leitritz and Lewis (1976) is used to collect Chinook salmon eggs. The ventral wall of the abdominal cavity of each female Chinook salmon is slit open with a Wyoming Knife and the eggs allowed to freely flow into a metal spawning pan. The eggs from a single female Chinook salmon are fertilized with the milt from a single male fish randomly selected from the storing table. The sperm is expressed in to the pan with eggs by stroking the male fish’s vent area.

Approximately eight 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 eggs. The salt solution holds the albumen from broken eggs in solution, keeps the egg micropyle from becoming clogged, and prevents agglutination of the sperm.
After eggs are fertilized they are washed in fresh water and drained in a colander. The eggs are placed in a bucket with fresh water and transferred to hatching jars or incubators.

All eggs taken and fertilized on a single day are identified as an egg lot and assigned a lot number, starting with the number 1. An attempt is made to retain representative egg lots to mimic the natural spawning period of fall-run Chinook salmon from the American River. Eggs in excess of NFH need are disposed of through freezing and rendering.

7.4 Cryopreserved gametes

No Chinook salmon 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

No listed natural fish are spawned at NFH and it is suspected that the majority of Chinook salmon spawned are of NFH origin. Since 1972, adipose marked Chinook salmon from other Central Valley fish hatcheries and Warm Springs Hatchery (Russian River, Sonoma County) have been trapped at NFH and are not included in the spawning population.

Starting in 2007, 25% of the hatchery-produced Chinook salmon from Central Valley fish hatchery will be adipose fin marked and CWT’ed. However, it will still not be possible to differentiate all NFH-produced Chinook salmon from other stocks including listed natural fish prior to spawning.

To mimic the number and timing of Chinook salmon spawning during the artificial spawning process, hatchery personnel attempt to take eggs from fish throughout the spawning run. To help improve this procedure, we estimated the minimum number of females Chinook salmon that were needed during a standard week was based on the average number of fish trapped during the past 10 years of operation. The number of females was normalized for a 10 week spawning period and graphically presented (Figure 7-1).
Figure 7-1. Graphic presentation of the minimum number of female Chinook salmon 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).
8. INCUBATION AND REARING

8.1 Incubation

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). Typically, the incubation period for Chinook salmon eggs is about 50 days at a water temperature of 50\(^\circ\) F. and is comparable to eggs incubated at NFH (personal communication, T. West, Hatchery Manager II, NFH).

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

Total number of fish spawned and number of eggs taken is summarized in NFH annual reports. During the year period 1996 to 2005, a total of 126,276,714 Chinook salmon eggs were taken from 27,785 female Chinook salmon for an average of 4,545 eggs per female. These eggs resulted in total of 101,107,544 eyed eggs for a 10-year average survival rate to the eyed stage of 80%.

8.1.2 Cause for, and disposition of surplus egg takes.

Surplus eggs are no intentionally taken at NFH. However, as part of efforts to mimic the natural run and spawning period of Chinook salmon, some lots of eggs may not be needed to the mitigation requirements of NFH. Egg lots subsequently determined not necessary to help meet mitigation requirements are disposed of through a rendering company.

8.1.3 Loading densities applied during incubation.

All eggs are incubated in NFH-modified commercial Eagar hatching jars or NFH-constructed PVC egg hatching jars. The maximum loading density for Chinook salmon is 800 ounces of eggs per hatching jar.

Hatching jars are not be used for smaller experimental 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 nearly all the alevins have 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**

Fresh water is circulated through the hatching jars through a hose attached to the bottom of the hatching jar, 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 (gallons per minute). Water temperatures during the incubation period for Chinook salmon eggs is dependent on American River water temperatures and can vary from 48°- 58° F.

8.1.5 **Ponding (raceways)**

Chinook salmon alevins remain in the deep tanks until they reach a size of 250 to 300 per pound, at which time they are moved to the raceways. Juvenile Chinook salmon remain in the raceways until they are released.

8.1.6 **Fish health maintenance and monitoring**

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

During the egg incubation period, eggs are stirred two times a day and after hatching, the alevins are stirred up to 8 times daily to prevent suffocation. Dead eggs and alevins are removed daily from each of the deep tanks by NFH personnel to minimize fungal growth and transmission. The deep tanks, screens, and overflow sections are cleaned daily by using separate, long-handled scrub brushes. Salt is added to each tank on a weekly basis after the fry absorb the yolk sac and begin feeding. The salt treatment is continued once the fish are in the raceways, until the fish are released.

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

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 and as such, incubation losses in American River Chinook salmon do not result in any adverse genetic or ecological effects. Efforts are made by hatchery personnel to reduce incubation losses through the application of standard and most appropriate hatchery practices including using NFH-modified commercial Eagar hatching jars or NFH-
constructed PVC egg hatching jars that result in improved survival during incubation (personnel communication, T. West, Fish Hatchery Manager II).

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 fingerling: During the 10-year period 1996 to 2005, a total of a total of 101,107,544 eyed eggs produced 52,206,748 fingerlings and advanced fingerlings for an estimated survival rate of 52%.

8.2.2 Density and loading criteria (goals and actual levels)

Deep tanks are 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 Chinook salmon 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 and flow rate, each raceway is capable of holding between 900,000-950,000 fry and fingerlings.

8.2.3 Fish rearing conditions

Once Chinook salmon fry start to become free swimming and feeding, the depth of the water in each of the deep tank is increased, at the discretion of the Hatchery Manager, from 10 inches to 27 inches to prevent overcrowding. Fry remain in the deep tanks until they reach 250-300 to the pound, at which time they are transported to raceways for the remainder of their 6 month rearing period. Juvenile salmon remain the concrete raceways until they are released.

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

Data on fish size is routinely collected by NFH personnel to help adjust feed size and amount during rearing. However, this information is not included in the annual reports or summarized annually.
8.2.5 Monthly fish growth rate and energy reserve data (average program performance), if available.

Typical growth rates for juvenile salmon based on historical NFH annual records were projected (Figure 8-1).

![Chinook salmon growth rate graph](image)

Figure 8-1. Projected growth rate of Chinook salmon 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).

Once the Chinook salmon alevins have absorbed their yolk sac, they are placed on a semi-moist food, BioVita Crum #0, #1, #2, 1.2 mm, and 1.5 mm, manufactured by Bio-Oregon Incorporated for the remainder of the 6 months rearing period. Fry are fed up to 12 times per day. The ideal amount of food per fish is 3% of their total body weight. 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. The amount of food fed through the rearing period is dependent on their body weight and fish appetite, i.e., they are given as much as they will eat without wasting food.

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. In addition, specific protocols for biosecurity at NFH have been provided by the DFG Fish Health Laboratory (Appendix 1)
Routine cleaning of the 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 27 inches to increase the amount of water in each tank. Daily cleaning of the tank is performed by NFH personal. The fry and fingerlings are moved into the raceways once they reach 250-300 per pound to provide additional space.

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 fishes body and loosening of the scales are used as 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 4 million fall-run Chinook salmon smolts at 60 per pound or larger.

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

Chinook salmon - Juvenile Chinook salmon produced at NFH are released in the Carquinez Straits, downstream from the Carquinez Bridge. The first priority release site is a south shore access point near the City of Crockett at latitude 38.05761 and longitude -122.2457, using an offshore net pen release system described in section 9.6. The second priority site is the ConocoPhillips deepwater pier that extends 0.34 miles into the Carquinez Straits from Davis Point at latitude 38.05664 longitude -122.26145. Access to both sites is controlled by ConocoPhillips and trespass permission is usually granted to the Department to release fish from Central Valley hatcheries. Problems sometimes prevent using the net pen release operation and necessitate releasing the fish directly into the water using the second priority release site from the deepwater pier at Davis Point. If access to the deepwater pier is not available, fish are released directly into the straits from the hauling tank at the first priority release site.
9.3 Actual numbers and sizes of fish released by age class through the program

Since 1985, NFH has released approximately 149 million juvenile Chinook salmon in the American, Sacramento, and Cosumnes rivers, San Francisco Bay, and other locations including several tributaries to the Sacramento River in Placer County (Table 9-1). A summary of dates and number and size of fish released during the period 1955 through 2007 is provided in Appendix 11.
<table>
<thead>
<tr>
<th>Release year</th>
<th>Broodyear</th>
<th>American River</th>
<th>Sacramento River</th>
<th>San Francisco Bay</th>
<th>Other anadromous waters</th>
<th>Non-anadromous waters</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td>1984</td>
<td>5,272,100</td>
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<td>1986</td>
<td>1985</td>
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<td>5,290,290</td>
<td></td>
<td></td>
<td></td>
<td>5,294,890</td>
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<td>1987</td>
<td>1986</td>
<td>1,685,480</td>
<td>4,681,725</td>
<td>216,000</td>
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<td>6,583,205</td>
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<td>1987</td>
<td>410,710</td>
<td>5,331,360</td>
<td></td>
<td></td>
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<td>5,742,070</td>
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<td>1988</td>
<td>5,240,390</td>
<td>366,700</td>
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<td>5,607,090</td>
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<td>1989</td>
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<td>438,140</td>
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<td>10,142,990</td>
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<td>8,795,300</td>
<td>638,000</td>
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<td>5,733,951</td>
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<td>646,440</td>
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<td></td>
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<td>9,209,896</td>
<td>310,800</td>
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<td>9,520,696</td>
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<td>1,253,570</td>
<td>3,970,450</td>
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<td>142,200</td>
<td>101,856</td>
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<td>4,578,400</td>
<td>115,066</td>
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<td>2005</td>
<td>3,002,600</td>
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<td>2007</td>
<td>2006</td>
<td>5,045,900</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5,045,900</td>
</tr>
</tbody>
</table>

Totals: 7,631,691 81,576,973 52,938,154 7,182,487 216,922 149,546,227

Table 9-1. Number of juvenile Chinook salmon released from Nimbus Fish Hatchery, 1985 - present (data from DFG Hatchery Information System).
9.4 Actual dates of release and description of release protocols

Juvenile Chinook salmon are released as soon as they average 60 per pound. Depending on water temperatures and growth rates, the release period is generally from mid-May through mid-June but fish are not held at NFH past June 30th.

9.5 Fish transportation procedures

Juvenile Chinook salmon are transported to the release site using 2,800-gallon fish transporting tanks. In addition to fresh water from the HFH water system, up to 1,000 pounds of ice and 150 pounds of kiln dried salt is added to the tank with a maximum of 2,300 pounds of fish per 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

Since 1996, efforts have been made to release as many juvenile Chinook salmon as possible using a net pen release system at the release site. The purpose is to reduce predation by allowing the transported fish the opportunity to acclimate prior to release. Fish are transferred from the fish hauling tank into one of three net pens that are hung from a floating framework via an 80 ft long 12 inch diameter plastic pipe. The floating framework and nets are towed with a power boat away from the shore towards the center of the straits and the net pen opened and the fish allowed to escape.

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

Prior to 2007, juvenile Chinook salmon were not routinely marked to identify NFH adult fish. Various groups of fish have been fin-marked and coded-wire tagged (CWT) as part of various experiments and studies during the operation of NFH. As such, it has not been possible to differentiate between naturally-produce and unmarked hatchery-produced Chinook salmon.

Starting with the 2007 BY Chinook salmon in the spring of 2007, 25% of all juvenile Chinook salmon produced at NFH will be marked with an adipose fin removed and CWT’ed.

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

If approved by the DFG Fisheries Branch Chief, 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.
9.9 Fish health certification procedures applied pre-release.

Hatchery management practices (including early detection and treatment of sick fish) minimize the release of fish infected with pathogens. A random sampling of fish is assessed for general health prior to release, and transfer of fish to saltwater is also a control measure for any freshwater parasites that may remain when the fish are released.

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

It is possible that NFH rearing ponds may become flooded due to high flow releases from Nimbus Dam; or the water system may become disrupted while juvenile Chinook salmon are being reared. If the water system is disrupted, it is possible to provide a temporary alternative water source.

In June 2007, a temporary system was installed due to a leak in one of the main water supply lines. Rental equipment that included four 10-inch intake pipes were installed into head box attached to four diesel water pumps with a maximum total capacity of 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. This temporary system was capable of furnishing water to the raceways although a system that could provide water to the raceways, hatchery buildings, and fish ladder has not been evaluated or tested.

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.

If immediate release is required, juvenile Chinook salmon 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.

In the event that it becomes necessary to immediately release all the juvenile fish 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.
9.11 Measures applied to minimize the likelihood for adverse genetic and ecological effects to listed fish resulting from fish releases

The present strategy is to release all juvenile Chinook salmon in the Carquinez Straits. This release site was selected to:

1. Minimize in-river competition with naturally-produced fish and;
2. Improve survival of NFH-produced fish.

Releases of juvenile Chinook salmon made approximately 105 miles downstream from NFH may increase straying of NFH-produced fish resulting in fewer fish returning to NFH. However, this release site has not impaired the ability of NFH to meet mitigation requirement for egg take. Downstream release may result in increase straying of NFH-produced Chinook salmon to other Central Valley streams. However, since Central Valley fall-run Chinook salmon have been shown to be genetically similar, adverse genetic effects from NFH-produced fish to other Central Valley Chinook salmon populations due to straying is expected to be minimal. Ecological effects of NFH-produced adult Chinook salmon migrating and associating with naturally-produced Chinook salmon in other streams is unknown but expected to be minimal.

Ecological effects to listed salmon populations or other fish species in the Sacramento-San Joaquin river system are unknown but expected to be minimal. Central Valley Chinook salmon populations are presently smaller compared to historical estimates and should pose reduced ecological effects.

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 anesthetic, 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 Chinook salmon have been taken or are projected to be taken at NFH.

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 (CNFH and FRH) 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.


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 listed fish.

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

Broodstock collection –

1. The fish weir support framework will be 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 remains in place throughout the Chinook salmon run but is removed when flow releases exceed or are anticipated to exceed 5,000 cfs. (current status)

2. The fish ladder will be opened after American River temperatures are at or below 60°F and are expected to remain at that temperature or lower and remain open throughout the Chinook salmon run. (current status)

3. During the period the fish ladder and trap are operational, all Chinook salmon that enter the adult gathering tank are anesthetized and examined for marks, sorted by sex, and the degree of sexual maturity determined. Fish are sorted and examined a minimum of 2 days each week during the run. Ripe female and male salmon are retained for artificial spawning while unripe fish are returned to the adult holding ponds via the stainless steel return tubes. (current status)

Mating -

4. Chinook salmon with the adipose fin removed (marked) will not be used as broodstock. However, starting with the 2007 BY Chinook salmon, 25% of the juvenile Chinook salmon released were adipose fin marked and starting in 2008, both fin-marked and un-marked fish will be used as broodstock.

5. Males that demonstrate free flowing sperm will be randomly selected for spawning from fish trapped. (current status)

6. Female Chinook salmon that expel free flowing eggs demonstrating they are sexually mature and ready to spawn will be euthanized and spawned. (current status)

7. All mating and paring of fish will be done randomly and fish will not be selected for any morphological characteristics. (current status)

8. One jack or jill Chinook salmon is included in the spawning process for every 100 adult Chinook salmon spawned to ensure representation in the broodstock. (current status)

9. If enough sexually mature female fish are trapped, the number of fish spawned and eggs taken will mimic the historical spawning period. (current status)
10. Surplus eggs will not be intentionally taken. However, as part of efforts to mimic the natural run and spawning period of American River fall-run chinook salmon, eggs may become surplus to the mitigation requirements of NFH. (current status)

11. Eggs determined unnecessary to help meet mitigation requirements will be disposed of through a rendering company. (current status)

12. The incision method described by Leitritz and Lewis (1976) will continue to be used collect Chinook salmon eggs. (current status)

13. Current egg handling and processing protocols and procedures will be used.

Incubation and Rearing

14. Eggs will be incubated in NFH-modified commercial Eagar hatching jars or NFH-constructed PVC egg hatching jars at a maximum loading density of 800 ounces of eggs per hatching jar. (current status)

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

16. Eggs incubated in the vertical trays and hatching jars remain until nearly all the alevins have buttoned-up. When the majority of eggs have hatched, all the remaining eggs and alevins are carefully poured into the deep tanks. (current status)

17. Chinook salmon alevins remain in the deep tanks until they reach a size of 250 and 300 per pound, at which time they are moved to the raceways. (current status)

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

19. During the incubation period, the eggs may be stirred two times per day, while alevins may be stirred up to eight times daily to prevent suffocation. (current status)

20. Dead eggs and alevins will be removed daily from each of the deep tanks (current status)

21. The deep tanks, screens, and overflow sections will be cleaned daily. Salt to produce an estimated 3% concentration will be added to each tank on a
weekly basis beginning once the fry have buttoned-up and began feeding, and will continue until they are released. (current status)

Release Procedures

22. All juvenile Chinook salmon produced at NFH will be released in the Carquinez Straits downstream from the Carquinez Bridge based on the following priority. (current status)
   
   A. South shore access point (ConcoPhillips Shore Terminal) near the City of Crockett at latitude 38.057.61 and longitude -122.24.57
   
   B. ConocoPhillips deepwater pier that extends 0.34 miles into the Carquinez Straits from Davis Point at latitude 38.056.64 longitude -122.261.45.
   
   C. NFH personnel will continually seek other sites that provide safe access for transportation equipment and access within 3 meters to the water within the Carquinez Straits and San Francisco Bay areas.

23. If possible, all Chinook salmon smolts will be released via an offshore net pen acclimation system or similar process that reduces smolt predation. (current status)

24. Juvenile Chinook salmon will be released as soon as they average 60 per pound. (current status)

25. Chinook salmon will be transported to the release site using suitable sized fish transporting tanks. In addition to fresh water from the NFH water system, up to 1,000 pounds of ice and 150 pounds of kiln dried salt (to produce an estimated 3% salt concentration) will be added to the tank (2,500 gallon capacity) to help reduce stress with a maximum of 2,300 pounds of fish per load. (current status)

26. 25% of all juvenile Chinook salmon produced at NFH will be marked with an adipose fin clip and CWT’ed. This percentage may change as recommended and approved by Department Fishery Managers. (current status)

27. Upon approval by DFG Fisheries Branch Chief, surplus fish may be stocked in waters where they do not and will not conflict with existing management goals or policies. These locations may include anadromous and inland waters. (current status)

28. A random sampling of fish is assessed for general health prior to release. It is the Department’s policy not to release diseased fish. (current status)
12. ATTACHMENTS AND CITATIONS

Citations


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


(CDFG) California Department of Fish and Game. 1993


Clark, G.H. 1929. Sacramento-San Joaquin Salmon (*Oncorhynchus tshawytscha*) Fishery of California. California Department of Fish and Game Fish Bulletin No. 17. 73 p.


(USFWS) United States Fish and Wildlife Service, and (DFG) California Department of Fish and Game. 1953. A plan for the protection and maintenance of salmon and steelhead in the American River, California, together with recommendations for action. Final Report prepared for DFG, Sacramento, CA.


