United States Department of the Interior

FISH AND WILDLIFE SERVICE

TAKE PRIDE IN AMERICA

Coleman National Fish Hatchery Complex
24411 Coleman Fish Hatchery Road
Anderson, CA 96007
Phone: 530.365.8622 FAX 530.365.0913

July 27, 2011

Dear Interested Party:

Enclosed please find the U.S. Fish and Wildlife Service's (Service) biological assessment evaluating effects of the facilities, operations, and fish propagation programs at the Coleman National Fish Hatchery Complex, including the Coleman National Fish Hatchery and Livingston Stone National Fish Hatchery, on listed Central Valley Steelhead, Central Valley Spring Chinook Salmon, Sacramento River Winter Chinook Salmon, Southern Resident Killer Whale, and the Southern Distinct Population Segment of North American Green Sturgeon and their critical habitats. This biological assessment was submitted to the National Marine Fisheries Service on July 27, 2011 pursuant to an authorization for incidental take of listed species under section 7(a)(2) of the federal Endangered Species Act.

The biological assessment is a single, comprehensive source of information which considers effects of hatchery facilities and operations at the scale of Evolutionarily Significant Units or Distinct Population Segments. As the Service recognizes the importance of integrating hatchery operations with restoration of natural salmonid populations in Battle Creek (especially in light of ongoing restoration activities within the watershed), effects are also considered on the scale of extant populations within the Battle Creek watershed, where the hatchery is located.

Within this biological assessment, the Service identifies that incidental take of listed anadromous salmonids will occur during the course of conducting fish propagation activities at the Coleman NFH Complex, and requests allowances for incidental take, as required under section 7(a)(2) of the Endangered Species Act. The National Marine Fisheries Service will use the biological assessment, and other relevant information, to generate a biological opinion assessing whether the proposed fish propagation activities will impart deleterious genetic or ecological effects to listed species under their jurisdiction.

To obtain additional copies of the Coleman NFH Complex biological assessment, or for further discussion on information contained in this document, please contact myself or Kevin Niemela of the Hatchery Evaluation and Monitoring Program at the Red Bluff Fish and Wildlife Office (530) 527-3043.

Sincerely,

Scott Hamelberg
Project Leader
Coleman National Fish Hatchery Complex

Enclosure (1)

Biological Assessment of Artificial Propagation at Coleman National Fish Hatchery and Livingston Stone National Fish Hatchery: program description and incidental take of Chinook salmon and steelhead

Prepared by

U.S. Fish and Wildlife Service
Red Bluff Fish and Wildlife Office
Red Bluff, CA 96080

And

U.S. Fish and Wildlife Service
Coleman National Fish Hatchery Complex
Anderson, CA 96007

July 2011

Biological Assessment of Artificial Propagation at Coleman National Fish Hatchery and Livingston Stone National Fish Hatchery: program description and incidental take of Chinook salmon and steelhead trout

Document Overview

Purpose of the Document: This Biological Assessment (BA) is submitted to fulfill the U.S. fish and Wildlife Services (Service) obligations for consultation under section 7(2)(a) of the federal Endangered Species Act of 1973 (ESA) with the National Marine Fisheries Service (NMFS). This document is intended to provide a single, comprehensive source of information to describe and assess incidental impacts of current or proposed operations of the Coleman and Livingston Stone National Fish Hatcheries (NFH) on ESA-listed Central Valley populations of anadromous salmonids, the southern distinct population segment of North American Green Sturgeon and Southern Resident Killer Whales. The ESA Section 7(2)(a) consultation process is specifically designed to determine if proposed activities are or are not likely to jeopardize the continued existence of listed species or result in the destruction or result in adverse modification of their critical habitats. The assessment presented in this BA focuses on potential impacts of hatchery facilities and operations within the Battle Creek watershed, where the hatchery is located. The Service recognizes the importance of integrating hatchery operations with natural salmonid production in Battle Creek, especially in light of pending restoration activities within the watershed.

Within this assessment, the Service acknowledges that incidental take[1] of ESA-listed species of anadromous salmonids may occur during the course of conducting fish propagation programs at the Coleman and Livingston Stone NFH. In some cases, estimates of incidental take are directly quantified. Quantified estimates of take are produced largely for activities occurring at the hatchery facilities, and are based largely on observations from recent years. In other situations estimates of take can be reasonably assessed only on a qualitative basis. For example, take resulting from interactions of hatchery and natural fishes in the wild occur over a wide range of space and time, and, therefore, cannot be directly observed or measured. Based on our assessment, the Service believes that operations of Coleman and Livingston Stone NFHs are not likely to jeopardize the continued existence of listed (or candidate) species or adverse modification to critical habitat.

Format of Biological Assessment: The format of this BA follows the highly-detailed format of the Hatchery and Genetic Management Plan (HGMP) developed by NMFS. The HGMP template is intended to provide a single source of hatchery information for comprehensive planning purposes, and to satisfy permitting requirements under the ESA. The document is divided into 14 Sections. A brief description of each section is presented below.

Section 1: ***General Program Description***
Section 1 provides a broad overview of Coleman and Livingston Stone NFH programs and operations including: 1) facility locations, 2) types and sizes of artificial propagation programs

[1] "Take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.

conducted at each facility, 3) purpose and justification for the propagation programs, 4) performance standards and indicators developed to assess program benefits and risks, and 5) some measures of current program performance including estimated smolt-to-adult survival rates, fishery (i.e., harvest) contribution rates, and hatchery return rates.

Section 1 is not intended to stand alone; rather, it provides an introduction and overview of several aspects of the hatchery propagation programs that are more thoroughly discussed in other sections of the document. Likewise, the bulleted statements accompanying descriptions of Performance Standards and Performance Indicators (Sections 1.9 and 1.10) are also not meant to stand alone. In the format they are presented they do not defend a hatchery benefit, nor do they refute or concur with a potential risk of hatchery activities. As with the majority of the information presented in Section 1, they are intended to provide the basis for discussions which follow in subsequent sections of the document. It is recommended that the reader review the table of contents, including the list of appendices (Section 13), for other sections that provide detailed descriptions of specific topic areas.

Section 2: *Program Effects on Salmonid Populations*
Section 2 provides description, status, and listing history of Central Valley anadromous salmonid populations potentially impacted (directly or indirectly) by activities associated with the artificial production programs conducted at Coleman and Livingston Stone NFHs. This section also briefly describes the original legislation authorizing the Central Valley Project (CVP) and the mitigation or “Salvage Plan” for the CVP which included the construction of the Coleman NFH. The history of ESA permits held by the Service to conduct artificial propagation activities at Coleman and Livingston Stone NFHs is also discussed in this section. Lastly, Section 2 provides a summary of potential impacts on ESA-listed populations of salmonids resulting from hatchery facilities and proposed activities. Whenever possible, quantified estimates of take have been generated, however, for many activities only a qualitative assessment of impact was possible (Section 2.11). Because Section 2.11 is intended to only summarize estimates of take, subsequent sections of this document and appendices should be referenced for the actual derivation of take estimates or the information supporting the qualitative impact assessments.

Section 3: *Relationship to Other Management Objectives*
In Section 3 we describe the relationship between artificial propagation programs at Coleman and Livingston Stone NFHs and other fishery and habitat management objectives and conservation programs in the Central Valley of California. Current and proposed hatchery operations are discussed in relation to major conservation programs designed to restore and recover anadromous salmonids and their habitats in the Central Valley. In this section we also describe the Coleman NFH Re-evaluation Process with its objectives to assess and refine hatchery facilities and operations, and the relationship between Coleman NFH and the Battle Creek Restoration process. We discuss the roles of the U.S. Bureau of Reclamation (primary funding source) and the U.S. Fish and Wildlife Service (operational responsibilities) relative to responsibilities to mitigate for habitat losses due to the Construction of Shasta Dam. Lastly, in Section 3 we describe harvest objectives for Coleman NFH, and identify contribution rates of the Chinook salmon propagation programs to the ocean (commercial and sport) and the in-river sport fisheries. Furthermore, because harvest of fish from Coleman NFH and adult escapement to Battle Creek are closely linked, a discussion is presented on historical and recent adult

escapement as a result of hatchery operations, and the potential impact of escapement or over-escapement of hatchery-origin adults back to the Battle Creek watershed.

Section 4: ***Hatchery Water Source***
Section 4 provides a description of current hatchery water rights and water usage patterns, and hatchery intake structures and water delivery systems for Coleman and Livingston Stone NFHs. Estimates of entrainment of ESA-listed are presented. Also discussed in Section 4 are: 1) potential impacts of water discharges from the hatchery facilities; 2) potential impacts to instream flow associated with hatchery water diversions, including emergency hatchery water-supply situations; and, 3) the potential for instream flow impacts during times of extremely low water or drought years.

Section 5: ***Facilities***
Section 5 provides a description of physical facilities at Coleman and Livingston Stone NFHs, including schematics of the property and a description of all physical structures at each facility. An assessment of the potential impacts of facility maintenance and on-site construction on critical habitat is provided in this section.

Section 6: ***Broodstock Origin and Identity***
Section 6 presents information regarding the source of broodstock used at Coleman and Livingston Stone NFHs, the history of their use, and the numbers of broodstock proposed to be used annually. Phenotypic and genetic differences between hatchery broodstock and natural adults are discussed. Also discussed in Section 6 are past and proposed future levels of incorporating naturally-produced adults as hatchery broodstock. Lastly, a discussion is presented of risk aversion measures that are being used to minimize the likelihood of negative impacts on naturally produced salmonids.

Section 7: ***Broodstock Collection***
In Section 7 we discuss aspects of broodstock congregation and collection, including descriptions of collection locations, collection timing, and, stocks and numbers targeted. Also discussed are methods to identify runs (phenotypic and genetic criteria) and methods to differentiate hatchery and natural stocks (i.e., mark identification). Because of the importance of the Coleman barrier weir in regards to collecting hatchery broodstock and managing and monitoring passage of salmonids into upper Battle Creek, a large portion of Section 7 is dedicated to the hatchery barrier weir.

Section 8: ***Mating***
In Section 8 we discuss broodstock selection methodologies, spawn timing and spawning schedules, and mating protocols.

Section 9: ***Incubation and Rearing***
Section 9 provides information on current and anticipated incubation and rearing practices at Coleman and Livingston NFHs. Specific data provided include: 1) survival rates over various life stages for all species propagated, 2) initial and final density indices and fork lengths at time of release; and, 3) feed types and expected conversion rates.

Section 10: ***Juvenile Releases***
Section 10 provides a description of juvenile release practices, including marking and tagging rates, release location and timing, and size at release for all species propagated at Coleman and Livingston Stone NFHs. The section also provides comprehensive assessment of impacts resulting from hatchery releases (i.e., predation, competition, displacement, disease transmission) to all stocks of naturally-produced anadromous salmonids.

Section 11: ***Monitoring and evaluation***
We provide in Section 11 a general description of the Hatchery Evaluation Program coordinated out of the Red Bluff Fish and Wildlife Office. Also presented is a discussion of monitoring activities associated with evaluating hatchery performance, and assessing impacts to natural salmonid populations. Data collected during monitoring efforts are used to adaptively manage hatchery programs in order to maximize hatchery benefits and minimize hatchery risks.

Section 12: ***Research***
Section 12 provides information on current research activities conducted in direct association with the hatchery propagation programs.

Section 13: ***Citations, Appendices, and Attachments***
Section 13 provides the list of literature referenced in this document. Also contained in Section 13 are several appendices that include information and analyses that are critical to understanding the impact assessments found within this document, including:

- Derivation of estimates of take at hatchery water Intake 2
- Summary of hatchery spawning
- Genetics and Hatchery Programs
- Collection locations and spawn timing
- Compilation of previous Releases from CNFH

Section 14: ***Certification language and signatures***
Section 14 contains signatures of appropriate officials to certify the primary purpose of the Biological Assessment is to obtain limits from take prohibitions under the Endangered Species Act of 1973.

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List of Abbreviations

Anadromous Fish Restoration Program....AFRP
Anderson-Cottonwood Irrigation District....ACID
Bodega Marine Laboratory....BML
California Bay Delta Authority....CALFED
California Department of Fish and Game....CDFG
California Endangered Species Act....CESA
California-Nevada Fish Health Center....CA-NV FHC
carbon dioxide....CO_2
Central Valley Project....CVP
Central Valley Project Improvement Act....CVPIA
coded-wire tag....CWT
cubic feet per second....cfs
delta smelt....DS
distinct population segment....DPS
Ecosystem Restoration Program....ERP
Federal Endangered Species Act....ESA
Evolutionary Significant Unit....ESU
fall Chinook salmon....FCS
Fish Conservation and Culture Laboratory....FCCL
fork length....FL
gallons per minute....gpm
Glenn-Colusa Irrigation District....GCID
Infectious Hematopoietic Necrosis virus....IHNV
late-fall Chinook salmon....LFCS
millimeter....mm
National Fish Hatchery....NFH
National Marine Fisheries Service....NMFS
Pacific Gas & Electric....PG&E
Pacific States Marine Fisheries Commission....PSMFC
Red Bluff Diversion Dam....RBDD
Red Bluff Fish and Wildlife Office....RBFWO
river mile....RM
standard deviation....SD
steelhead trout....STT
U.S. Bureau of Reclamation....Reclamation
U.S. Fish and Wildlife Service....Service
winter Chinook salmon....WCS

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1 GENERAL PROGRAM DESCRIPTION

1.1 Name of hatchery

Coleman National Fish Hatchery (NFH) Complex, including the Coleman NFH, Anderson, California and Livingston Stone NFH, Shasta Lake, California. Both facilities are operated by the U.S. Fish and Wildlife Service (Service).

1.2 Species and populations under propagation, and ESA/CESA status of associated salmonids

Together, the Coleman NFH and the Livingston Stone NFH propagate three runs of Chinook salmon *Oncorhynchus tshawytscha* as well as steelhead *Oncorhynchus mykiss* and delta smelt *Hypomesus transpacificus*. Central Valley fall and late-fall Chinook and Central Valley steelhead are propagated at Coleman NFH. Sacramento River winter Chinook salmon and delta smelt are propagated at the Livingston Stone NFH.

Sacramento River winter Chinook salmon are listed as endangered under the federal Endangered Species Act (ESA), Central Valley steelhead and Central Valley spring Chinook are threatened, Central Valley fall and late-fall Chinook are not currently listed under the ESA, but they are classified as candidates for listing (Table 1-1). All Chinook salmon propagated at the Coleman and Livingston Stone NFHs are included in their respective Evolutionary Significant Unit (ESU) and Coleman NFH steelhead are included in the distinct population segment of Central Valley steelhead.

Under the California Endangered Species Act (CESA), Sacramento River winter Chinook salmon are listed as endangered, Central Valley spring Chinook are threatened, and Central Valley late-fall Chinook are classified as Species of Concern. Central Valley fall Chinook are not currently listed under CESA.

Delta Smelt are currently listed as threatened under both state and federal ESA's. The delta smelt conservation program at the Livingston Stone NFH is operated as a captive broodstock program. This program is managed as a back-up refugial population, intended to supplement the primary refugial population located at the Fish Conservation and Culture Laboratory (FCCL) at Byron, California. Working in concert, the two delta smelt refugial populations reduce the risk of extirpation of this imperiled species.

The delta smelt propagation program at the Livingston Stone NFH is permitted by a recovery permit issued by the Service under section 10(a)(1)(a) of the ESA (Permit #TE-108507, sub permit CNFHC-2). The effects assessment presented in this document is limited to the potential for disease transfer from delta smelt to listed salmonids, as this is the only aspect of the delta smelt propagation program that could potentially impact listed species under the jurisdiction of the National Marine Fisheries Service (NMFS).

Table 1-1 Federal Endangered Species Act (ESA) and California Endangered Species Act (CESA) status of fish stocks propagated at the Coleman and Livingston Stone National Fish Hatcheries, including natural and hatchery Chinook salmon, steelhead, and delta smelt. The Evolutionarily Significant Unit (ESU) or Distinct Population Segment (DPS) status of the hatchery stock is also indicated.

ESU / DPS *Scientific name*	Hatchery	ESA listing status of natural stock	ESA listing status of hatchery stock	CESA listing status of natural stock
Central Valley Fall Chinook Salmon *Oncorhynchus tshawytscha*	Coleman	Candidate	Part of the ESU/ Not listed	Not Listed
Central Valley Late-fall Chinook salmon *Oncorhynchus tshawytscha*	Coleman	Candidate	Part of the ESU/ Not listed	Species of Concern
Central Valley Steelhead *Oncorhynchus mykiss*	Coleman	Threatened	Part of the DPS/ Not listed	Not Listed
Sacramento River Winter Chinook salmon *Oncorhynchus tshawytscha*	Livingston Stone	Endangered	Part of the ESU / Endangered	Endangered
Central Valley Spring Chinook salmon *Oncorhynchus tshawytscha*	Not Propagated	Threatened	Not Propagated	Threatened
Delta Smelt *Hypomesus transpacificus*	Livingston Stone	Threatened	Part of the DPS / Threatened	Threatened

1.3 Responsible organization and individuals

Primary Contact

Mr. Scott Hamelberg, Project Leader
U.S. Fish and Wildlife Service
Coleman National Fish Hatchery
24411 Coleman Fish Hatchery Road
Anderson, CA 96007
Tel: (530) 365 - 8781
FAX: (530) 365 – 0193
e-mail: scott_hamelberg@fws.gov

Hatchery Evaluation and Permitting Contact

Mr. James G. Smith, Project Leader
U.S. Fish and Wildlife Service
Red Bluff Fish and Wildlife Office
10950 Tyler Road
Red Bluff, CA 96080
Tel: (530) 527 – 3043
FAX: (530) 529 – 0292
e-mail: jim_smith@fws.gov

Additional responsible agencies:
Coleman and Livingston Stone NFH are mitigation features to partially offset habitat and fish losses resulting from the construction of Shasta and Keswick dams, part of the Central Valley Project (CVP). Both facilities are operated by the Service and funded by the U.S. Bureau of Reclamation (Reclamation).

Reclamation Contact
Mr. Brian Person, Area Manager
U.S. Bureau of Reclamation
16349 Shasta Dam Blvd.
Shasta Lake, California 96019
(530) 275-1554

1.4 Funding source, staffing level, and annual hatchery program operational costs
Reclamation provides to the Service an annual budget of approximately $4.75 million for operating and maintaining the Coleman and Livingston Stone NFHs. Funding for the delta smelt conservation program at Livingston Stone NFH is provided through the Service's Fisheries Program. Total staff for both Coleman and Livingston Stone NFH is approximately 25 permanent employees and five to fifteen temporary employees and volunteers. A portion of the annual funding received from the Reclamation is transferred to the Red Bluff Fish and Wildlife Office (FWO) for an additional eight to ten employees who conduct evaluation, monitoring, and research related to hatchery operations. Another portion of the total annual funding from the Reclamation is transferred to the California-Nevada Fish Health Center (CA-NV FHC; co-located at Coleman NFH) to support hatchery operations. Additional funding for construction, facility rehabilitation, research and monitoring, or other projects may also be secured from other sources (e.g., Central Valley Project Improvement Act [CVPIA] and state funding).

1.5 Locations of hatcheries and associated facilities
Coleman and Livingston Stone NFHs are located in the upper Sacramento River basin in the northern Central Valley of northern California (Figure 1-1). Coleman NFH is located on the north bank of Battle Creek, a tributary to the Sacramento River, approximately three miles east of the Sacramento River and twenty miles southeast of the city of Redding. Livingston Stone NFH is located on the west side of the Sacramento River, approximately 0.5 miles below the base of Shasta Dam (Keswick Reservoir). The stock location codes recognized by the Pacific States Marine Fisheries Commission (PSMFC) Regional Mark Processing Center for Coleman and Livingston Stone NFH are 6FCSABAT CNFH and 6FCSASAF LVNH, respectively.

1.6 Type of programs
Fall and late-fall Chinook salmon and steelhead are propagated at the Coleman NFH. Winter Chinook salmon are propagated at the Livingston Stone NFH. The Livingston Stone NFH is also used to house a refugial population of delta smelt.

Fall Chinook Salmon
The fall Chinook salmon propagation program at Coleman NFH is operated as an *integrated-harvest* type program. The goal of the fall Chinook salmon program is mitigation for the purpose of contributing to *harvest* in the Sacramento River sport fishery and sport and

commercial ocean fisheries. Coleman NFH's fall Chinook salmon propagation program is considered to be integrated with naturally spawning fall Chinook salmon in the upper Sacramento River and Battle Creek for the following reasons: 1) founding broodstock for fall Chinook salmon at Coleman NFH were endemic fall Chinook salmon from Battle Creek and the upper Sacramento River; 2) hatchery- and natural-origin fall Chinook share a long and continuous history of integration through commingled spawning at the hatchery and in the river and, 3) hatchery fall Chinook salmon are considered to be substantially similar to natural-origin fall Chinook salmon in regards to morphology, behavior, genetics, and life history characteristics. Although it is the intent of the program to be an *integrated-harvest* type program, the extent to which this occurs cannot be verified. Most hatchery fall Chinook are not marked and therefore, not distinguishable from natural fall Chinook during normal spawning operations.

Late-fall Chinook Salmon

The propagation program for late-fall Chinook at Coleman NFH is operated as an *integrated-harvest* type program. The goal of the late-fall Chinook salmon program is mitigation, which is intended to contribute to *harvest* in the Sacramento River sport fishery and ocean sport and commercial fisheries. Late-fall Chinook salmon at Coleman NFH are considered to be *integrated* with the natural population in the upper Sacramento River because: 1) they share similar ancestry with upper Sacramento River late-fall Chinook; 2) natural-origin adults have been regularly incorporated as hatchery broodstock; 3) hatchery-origin adults stray and spawn naturally with natural-origin late-fall Chinook, primarily in the upper Sacramento River; and, 4) hatchery late-fall Chinook salmon are considered to be substantially similar to natural-origin late-fall Chinook salmon in regards to morphology, behavior, genetics, and life history characteristics. At the existing 100% mark rate, the number and the rate that natural-origin fish are incorporated into the spawning matrix can be quantified, which is an important consideration for an integrated hatchery program.

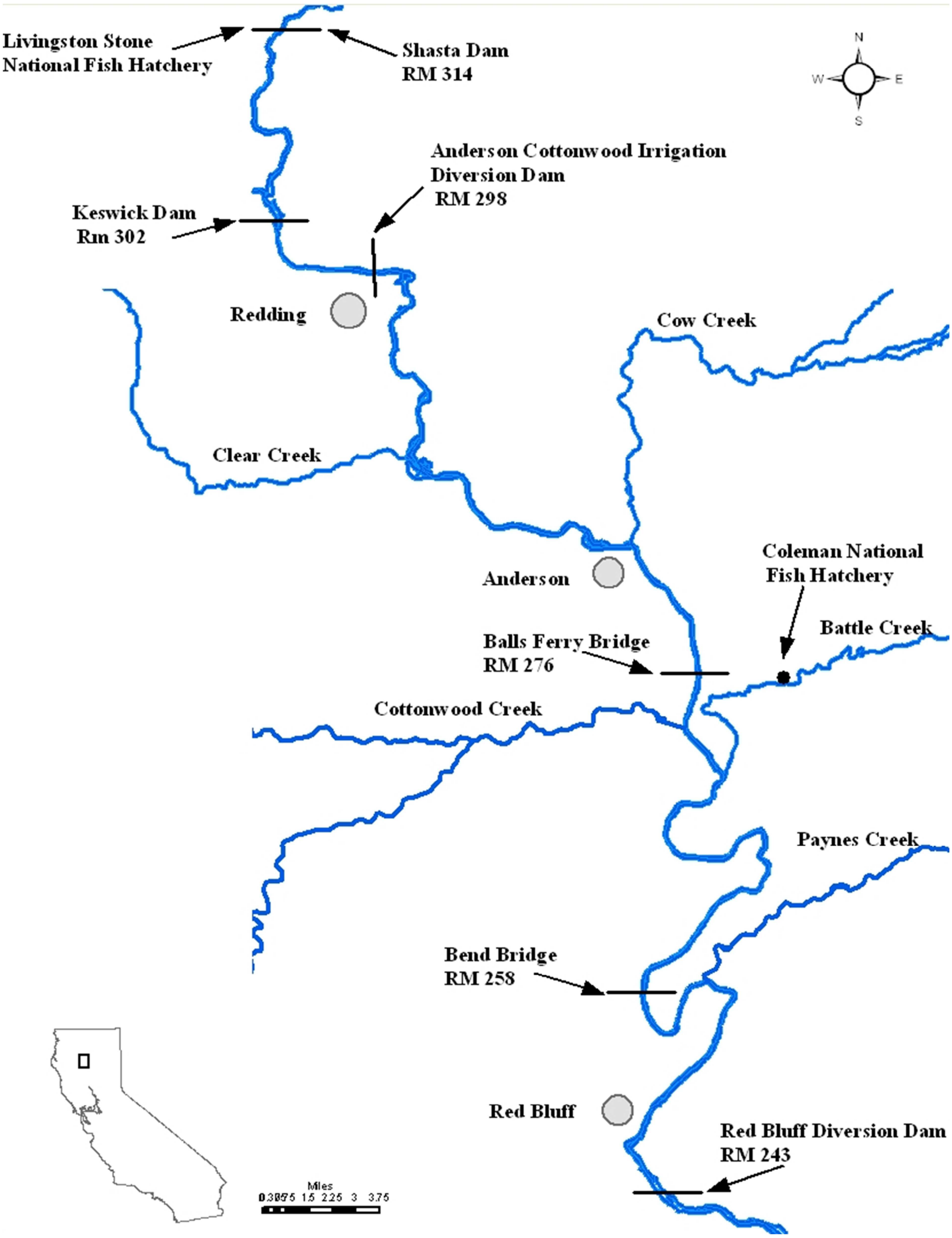

Figure 1-1 Locations of Coleman and Livingston Stone National Fish Hatcheries and other major features in the upper Sacramento River, California.

Winter Chinook Salmon
The Service's artificial propagation program for winter Chinook salmon at Livingston Stone NFH is an *integrated-recovery* type program. That is, hatchery propagated winter Chinook are managed to be *integrated* with the natural population of winter Chinook in the upper Sacramento River, and are intended to provide a demographic boost to aid in the *recovery* of that population. Hatchery-origin winter Chinook are intended to return as adults to the upper Sacramento River, spawn in the wild, and become reproductively and genetically assimilated into the natural population.

Steelhead
The steelhead propagation program at Coleman NFH is currently operated as a segregated-*harvest* type program, with the goal of contributing to sport fishing harvest in the Sacramento River. In the recent past, the Coleman NFH steelhead program was operated as integrated-harvest program and integrated-recovery program, and has a long history of integration of natural-origin broodstock from the Sacramento River (1947-1986) and Battle Creek (1952-2009). However, following the 2008 spawning season the Service temporarily discontinued the spawning of natural origin steelhead collected from Battle Creek until the naturally-spawning population increases to a level that can withstand the removal of fish for use as broodstock. Hatchery steelhead have been marked at 100% rate since 1998, which enables adults to be accurately identified to origin. The ability to identify origin is an important tool for management of both integrated and segregated hatchery programs.

Delta Smelt
The delta smelt propagation program at the Livingston Stone NFH is operated as a *captive broodstock* program. Delta smelt propagation at Livingston Stone NFH functions as a back-up refugial population, providing redundancy to the primary refugial population located at the FCCL at Byron, California. No delta smelt from the Livingston Stone NFH are released.

1.7 Purpose of programs

Fall and Late-fall Chinook Salmon
Construction and operation of Shasta Dam resulted in the loss of approximately 187 miles of salmonid spawning and rearing habitat. The Service produces fall and late-fall Chinook at Coleman NFH to *mitigate* for this loss of habitat and the consequent reduction in salmonid populations. Fall and late-fall Chinook are produced to contribute to harvest in the ocean commercial fishery, ocean sport fishery, and freshwater sport fishery. Another goal of these programs is to provide adequate escapement to the hatchery for broodstock. The Service attempts to achieve these goals while minimizing negative impacts to natural populations. Because Coleman NFH fall and late-fall Chinook are integrated with the natural spawning populations in Battle Creek and the Sacramento River, these hatchery stocks may also be appropriate for future recovery efforts, if needed.

Winter Chinook Salmon
The primary goal of the Service's artificial production program at Livingston Stone NFH is to provide a demographic boost to the natural spawning component of the population in the upper Sacramento River, assisting in the *recovery* of that population.

Steelhead
Since the Coleman NFH steelhead program was founded in 1947, the primary goal has been *mitigation* for fishery losses resulting from the CVP. Steelhead propagated at Coleman NFH are intended to contribute primarily to the sport fishery in the Sacramento River and delta. Another goal of this program is to provide adequate escapement back to the hatchery for broodstock. The Service attempts to achieve these goals while minimizing risks to natural populations.

Because Coleman NFH steelhead have a long history of integration with the natural spawning populations in Battle Creek and the Sacramento River, they may also be considered a "population reserve" to preserve genetic resources for possible future recovery efforts, if needed. The long history of integration of natural origin steelhead adults as broodstock at Coleman NFH has reduced the potential for appreciable divergence from natural populations. The Coleman NFH stock of steelhead was founded from, and has been systematically integrated with, naturally spawning steelhead from the upper Sacramento River and Battle Creek. Natural-origin steelhead collected from the upper Sacramento River were regularly incorporated as hatchery broodstock for 21 brood years between 1947 and 1986. In addition, natural- and hatchery-origin steelhead from Battle Creek have been used as hatchery broodstock from 1952 to 2008. Recently (2009), due to concerns about low abundance of steelhead in Battle Creek, the Service temporarily discontinued the incorporation of natural steelhead for use as broodstock. The Service intends to investigate methods to resume incorporation of natural-origin steelhead in the near future.

Delta Smelt
The goal of the delta smelt propagation program at the Livingston Stone NFH is twofold, including elements of both conservation and research. The primary purpose of the delta smelt program at Livingston Stone NFH is to provide a secondary rearing location for delta smelt broodstock to protect against catastrophic loss of the natural spawning population. A primary genetic refugial population is maintained at the FCCL in Byron, CA and the population component maintained at the Livingston Stone NFH is a mirror image of this population. Together, the FCCL and the Livingston Stone NFH afford added protections which reduce the risks of extirpation of this imperiled species. A secondary purpose of the delta smelt program at the Livingston Stone NFH is to develop expertise and capabilities for culturing this listed species within the Service.

1.8 Justification for the program

Coleman National Fish Hatchery
The Sacramento River in northern California is the only river in the world which has four distinct runs of Chinook salmon (fall, late-fall, winter and spring). The Sacramento River also supports a steelhead population. In 1942, the uppermost drainage was blocked by the construction of Shasta Dam, the keystone of the CVP. Shasta Dam blocked approximately 50% of Chinook salmon and steelhead spawning and rearing habitats (Skinner 1958), although the effects of habitat losses varied substantially for the various species and races. To mitigate for habitat lost upstream of Shasta Dam, the federal government established the Shasta Salvage Plan, which included the construction and operation of a fish hatchery (Moffett 1949; see Black 1999 for a detailed accounting of the development of the Shasta Salvage Plan; also see Section 1.17 and Section 2.2 of this document for additional information on the original authorization of Coleman NFH). Coleman NFH was constructed to partially mitigate for the effects of Shasta Dam.

Construction of the hatchery was completed in 1942 and fish culture operations began in 1943. The hatchery currently propagates three salmonid stocks: fall Chinook salmon, late-fall Chinook salmon, and steelhead. Additionally, prior to the construction of Livingston Stone NFH, Coleman NFH was an integral component of the recovery program for endangered winter Chinook, and pioneered techniques for captive broodstock and supplementation programs. Propagation of winter Chinook was transferred to Livingston Stone NFH in 1997.

Coleman NFH is the principle remaining feature of the original Shasta Salvage Plan, and serves to partially mitigate the negative effects of Shasta Dam on Central Valley salmon populations. Fish produced at the Coleman NFH contribute substantially to the multi-million dollar commercial and recreational fishing industry in California (see also Section 3.5, Relationship of program to harvest objectives) and benefits the region's social, cultural, and economic well-being.

Livingston Stone National Fish Hatchery

Livingston Stone NFH, a substation of Coleman NFH, was constructed by the Reclamation in late-1997. The facility was constructed for the explicit purpose of propagating ESA-listed winter Chinook salmon to assist in the recovery of that population. This program is supported in NMFS's draft Recovery Plan for winter Chinook salmon (NMFS 2009b).

The Service began rearing delta smelt at the Livingston Stone NFH in 2006. Delta smelt are currently listed as threatened, and the abundance of delta smelt in the wild has been at or near record low levels since 2004. The Service has the responsibility for implementing the ESA for the protection and continued existence of delta smelt. Captive propagation of delta smelt at Livingston Stone NFH and the FCCL is conducted to reduce the risks of extinction for this at-risk species (see Section 1.7 above).

<u>History of the Winter Chinook Propagation Program</u>

The Service initially attempted to propagate winter Chinook salmon at Coleman NFH in 1955. This first attempt, as well as subsequent efforts from 1958 through 1967, was largely unsuccessful. From 1978 through 1985, attempts to propagate winter Chinook salmon at Coleman NFH were again met with limited success. High water temperatures at Coleman NFH caused considerable mortality of adult broodstock, eggs, and juveniles.

In 1988, a Cooperative Agreement between the NMFS, Reclamation, Service, and California Department of Fish and Game (CDFG) outlined a 10-point plan to implement actions to improve the status of winter Chinook salmon in the Sacramento River basin. Included in this plan was the development of an artificial propagation program at Coleman NFH, including necessary facilities and operations to meet hatchery production goals. With the population of winter Chinook in severe decline, the Service reinitiated a winter Chinook salmon propagation program at Coleman NFH in 1989. The goal of the winter Chinook hatchery propagation program was to supplement natural spawning in the upper Sacramento River. To improve the likelihood that fish reared at the Coleman NFH would return to the upper Sacramento River and integrate with the naturally spawning population, juvenile winter Chinook were released at the pre-smolt stage in the vicinity of Redding, The first major production group of winter Chinook salmon juveniles (11,582) from the Coleman NFH was released in 1992; however, none of the fish from this release were observed during monitoring efforts in the upper mainstem Sacramento River in 1994, the year the majority of these fish were expected to return. Subsequently, monitoring conducted by the Service's Hatchery Evaluation Program observed that a considerable portion of hatchery-propagated winter Chinook adults were returning to Battle Creek and not assimilating with the natural population in the Sacramento River. These observations suggested that rearing and release strategies intended to imprint hatchery-origin winter Chinook juveniles to the mainstem Sacramento River were ineffective. This situation, combined with evidence of possible hybridization with spring Chinook in the propagation program, resulted in a two year (1996-1997) moratorium on the capture of natural winter Chinook broodstock. Hatchery spawning of winter Chinook adults in 1996 and 1997 was limited to only a small number of adults that were available from the captive broodstock program.

Construction of the Livingston Stone NFH in 1997 and refined genetic methods for broodstock selection ameliorated concerns of straying and hybridization that led to the moratorium, so collection of winter Chinook broodstock was re-initiated in 1998. Juvenile winter Chinook were first released from the Livingston Stone NFH in April 1998.

1.9 List of program performance standards

The following performance standards have been designed to evaluate the benefits and risks of fish propagation at Coleman NFH and Livingston Stone NFH. Performance standards have been classified as either "benefits" or "risks." Performance standards categorized as "benefits" measure the benefits resulting from the artificial propagation program (e.g., contribution to harvest, restoration, conservation/preservation, and/or research). Performance standards categorized as "risks" measure the possible risks the artificial propagation program may pose to natural populations. Performance standards designed to assess benefits (B) are listed first, with performance standards designed to assess risks (R) following. The following abbreviations are used to indicate the specific propagation programs at Coleman NFH and Livingston Stone NFH to which the performance standard applies: FCS - fall Chinook salmon; LFCS - late-fall Chinook salmon; WCS - winter Chinook salmon; STT – steelhead.

Performance Standards to Evaluate Benefits

Benefit Number	Standard / Guideline
B1.	Optimize abundance of anadromous salmonids in Battle Creek by integrating Coleman NFH with the Battle Creek Restoration Project (FCS, LFCS)
B2.	Increase or maintain harvest opportunities for commercial and sport fisheries (FCS, LFCS, STT)
B3.	Assist in the restoration of listed stocks of anadromous salmonids (WCS)
B4.	Maintain stock integrity and conserve genetic and life history diversity (FCS, LFCS, WCS, STT)

B5. Provide fish for experimental purposes (FCS, LFCS, WCS, STT)

B6. Conduct research to monitor and evaluate hatchery operations and practices (FCS, LFCS, WCS, STT)

B7. Improve survival of propagated species/stock using appropriate incubation, rearing, and release strategies (FCS, LFCS, WCS, STT)

B8. Improve survival by preventing disease introduction, spread, or amplification (FCS, LFCS, WCS, STT)

B9. Provide local, state, and regional economic enhancement (FCS, LFCS, STT)

Performance Standards to Evaluate Risks

Risk Number	Standard / Guideline
R1.	Minimize potential negative effects of Coleman NFH on restoration of Battle Creek (FCS, LFCS, STT)
R2.	Minimize potentially harmful interactions between hatchery- and natural-origin stocks (FCS, LFCS, WCS, STT)
R3.	Do not introduce, spread, or amplify pathogens of natural stocks (FCS, LFCS, WCS, STT)
R4.	Reduce the potential for negative genetic effects of artificial propagation programs on natural stocks (FCS, LFCS, WCS, STT)
R5.	Do not exceed carrying capacity of freshwater habitats (FCS, LFCS, WCS, STT)
R6.	Conduct research to evaluate potential effects on natural stocks and adaptively manage hatchery operations and activities (FCS, LFCS, WCS, STT)

1.10 List of program performance indicators, designated by benefits and risks

The following performance indicators can be used to monitor and evaluate the aforementioned benefits and risks of fish propagation at Coleman NFH and Livingston Stone NFH. Also listed with performance indicators are relevant fish culture practices and constraints. Relevant fish culture practices are actions conducted at Coleman NFH and Livingston Stone NFH that attempt to maximize benefits and minimize potential risks of the artificial propagation programs. Constraints limit the ability to achieve or monitor performance standards.

Performance indicators have been separated into two categories: benefits (B) that the hatchery program will provide to the listed species by meeting program objectives; and risks (R) that the hatchery program may pose to listed populations.

Performance Indicators Addressing Benefits

Performance Standard B1: Optimize abundance of anadromous salmonids in Battle Creek by integrating Coleman NFH with Battle Creek restoration efforts (FCS, LFCS, STT).

A major restoration project is underway in the Battle Creek watershed. Because Coleman NFH is located on Battle Creek, fish production at the Coleman NFH is closely linked to the Battle Creek watershed. Restoration of anadromous fish populations and habitats in that watershed must be considered together with facility operations and management at Coleman NFH.

Coleman NFH receives all of its water and nearly all of its broodstock from Battle Creek. Battle Creek also serves as the receiving water for the majority of juvenile salmonids produced at Coleman NFH. Currently, the hatchery likely contributes greater than 90% of the adult salmonids in Battle Creek and even in a fully restored watershed (meeting production goals of the AFRP) returns of hatchery-origin adults will comprise a significant portion of total adult returns to Battle Creek. Because hatchery and natural production of salmonids are linked together so closely in Battle Creek, the Service believes that Battle Creek and Coleman NFH must be managed as a single, complex system in order to achieve optimum benefits from restoration efforts concomitant with fulfilling the mitigation responsibilities of Coleman NFH. The following fish culture operations provide direct benefits to the Battle Creek restoration process while, at the same time, meeting the responsibility of Coleman NFH for mitigating effects of Shasta Dam:

Relevant fish culture practices:

- Management of fish passage and monitoring at the Coleman barrier weir permits controlled passage and monitoring of Chinook salmon and steelhead into the upper Battle Creek watershed. Management of fish passage at the barrier weir allows for segregation and enumeration of runs at that point, thus affording the capability to measure and maximize restoration benefits for “at-risk” priority stocks
- The abundance of fall Chinook salmon adults spawning naturally in Battle Creek is managed through the broodstock collection process at Coleman NFH. Through specific operational strategies of the facility’s barrier weir and fish ladders, fall Chinook in excess of the number required for broodstock may be allowed to stay in the creek to spawn naturally below the barrier weir or may be collected at and culled at the hatchery. Natural-origin late-fall Chinook salmon and steelhead collected at Coleman NFH are passed above the barrier weir to spawn naturally in upper Battle Creek
- Carcasses of returning hatchery-origin adults supply important marine-derived nutrients to the Battle Creek watershed ecosystem as well as the upper Sacramento River

Performance Indicators:

- Continue to monitor numbers of hatchery- and natural-origin adults encountered at the hatchery during spawning operations
- Continue to conduct monitoring at the Coleman barrier weir to enumerate passage of hatchery- and natural-origin adults
- Continue monitoring abundance of fall Chinook salmon in Battle Creek

Other Indirect Indicators and Achievements:

- As part of the Greater Battle Creek Watershed Working Group, assisted in the development of a restoration plan for Battle Creek
- Participating in the development of an adaptive management plan for the Coleman NFH. The hatchery adaptive management plan will provide information necessary to adaptively manage operations at Coleman NFH with the intent to integrate the hatchery with the watershed restoration project
- Completed improvements at the barrier weir and fish ladder at Coleman NFH. Modifications to the existing structure have allowed improved passage to upper Battle Creek for natural origin salmonids and improved control of fish passage into upper Battle Creek by decreasing numbers of hatchery origin salmonids escaping above the barrier weir
- Constructed an ozone water treatment system at Coleman NFH, which alleviates concerns of passing potentially disease-carrying fish into upper Battle Creek, the hatchery water source
- Developed and have largely implemented a long term solution to the hatchery water intake structures. The implemented improvements to two of the station’s three water intake structures provide protection for naturally produced Chinook salmon and steelhead in the upper Battle Creek watershed
- Conducted research of habitat use by ESA-listed winter and spring Chinook salmon in upper Battle Creek (1995 to 2011; Service, Red Bluff Fish and Wildlife Service in progress)

Constraints:

- Incomplete (i.e., <100%) marking of fall Chinook salmon inhibits management strategies that require differentiation of hatchery and natural origin fall Chinook
- Funding is needed to complete the planned improvements to Coleman NFH Intake #2
- Over-escapement of hatchery-origin Chinook salmon presents management difficulties in Battle Creek

Performance Standard B2: Increase or maintain harvest opportunities for commercial and sport fisheries (FCS, LFCS, STT)

With development of the CVP, including construction of the Coleman NFH, the federal government assumed responsibility for mitigating anadromous fishery losses caused by the construction of Shasta Dam. A primary objective of Coleman NFH fall and late-fall Chinook salmon propagation programs is to provide for a viable fisheries while, at the same time, protecting depressed natural populations. Present day harvest of Chinook salmon off the California coast occurs primarily south of Point Arena. Central Valley Chinook stocks comprise an estimated 85-95% of total catch south of Point Arena and a lesser proportion of harvest north of Point Arena. Fall Chinook salmon from brood years 1996-2001 originating at the Coleman NFH contributed an average of 68,000 fish annually to the ocean commercial and sport fishery.

Relevant fish culture practices:

- Fish culture and release practices at Coleman NFH and Livingston Stone NFH are intended to maximize survival of hatchery fish, while minimizing negative effects on natural salmonid stocks in the Sacramento River and Battle Creek

Performance Indicators:
- Estimate contribution (rates and total numbers) of Coleman NFH fall and late-fall Chinook salmon to Pacific Ocean commercial and sport fisheries and the Sacramento River sport fishery. (Note: Harvest estimates for fall and late-fall Chinook salmon are presented in Section 3 of this document)
- Monitor Coleman NFH-origin fall and late-fall Chinook salmon contribution to fisheries as a proportion of the Central Valley Abundance Index (ocean harvest plus river escapement) as reported by Pacific Fishery Management Council (1999)
- Estimate sport harvest of Coleman NFH fall and late-fall Chinook salmon in the Sacramento River
- Monitor ocean contribution rates of hatchery-origin winter Chinook salmon as an index of harvest on natural-origin winter Chinook salmon
- Conduct on-site bio-sampling of returning adults for mark identification and CWT retrieval to develop indices of harvest and escapement

Constraints:
- Propagation of fish at Coleman NFH increases harvest *opportunity*; however, the total number of fish *actually* harvested in the mixed-stock ocean fishery has been restricted to protect ESA listed stocks or depressed stocks
- Over-escapement of hatchery-origin Chinook, caused in part by reduction in harvest opportunities due to more stringent fishing regulations to protect weak stocks, can result in large escapement of fall Chinook to Battle Creek

Performance Standard B3: Assist in the restoration of listed stocks of anadromous salmonids (WCS)

Restoration and recovery of fish and aquatic ecosystems are the highest priorities for the National Fish Hatchery System. Artificial propagation of winter Chinook salmon at Livingston Stone NFH is conducted to supplement the natural population in the Sacramento River. The basis for the winter Chinook supplementation program is that hatchery production can provide a higher survival from egg-to-smolt life stages than occurs in the natural environment. The Service's winter Chinook supplementation program is temporary, and the Service will work with NMFS and the CDFG to develop a strategy, plan, and timeline to phase out the program.

Relevant fish culture practices:
- Rear fish using the water where the fish are intended to imprint in order to facilitate strong homing and promote integration of hatchery fish with the natural population(s) they are intended to supplement
- Developed a hatchery facility designed specifically for supplementing Sacramento River winter Chinook salmon
- Constrain the collection of natural broodstock (maximum of 15% of estimated total run) to lower the demographic and genetic risks to the naturally spawning population
- Develop and use genetic discrimination techniques to effectively identify and spawn only target broodstock
- Use factorial-type mating strategy to maximize effective population size

- Complete (100%) marking of hatchery production

Performance Indicators:
- Continue to conduct field surveys to generate adult run-size estimates and evaluate survival, spawning success, and integration of hatchery propagated winter Chinook salmon with the natural population
- Continue to monitor and evaluate genetic risks of the winter Chinook propagation program to measure potential genetic effects on the natural population
- Conduct a parentage type analysis to confirm reproductive success of the winter Chinook salmon from the propagation program at Livingston Stone NFH

Constraints:
- The feasibility of implementing a grand-parentage analysis for winter Chinook is difficult because of the logistics associated with sampling sufficient numbers of hatchery origin fish, which return at relatively low levels of abundance relative to natural origin fish

Performance Standard B4: Maintain stock integrity and conserve genetic and life history diversity (FCS, LFCS, WCS, STT)

Fish culture practices at Coleman NFH and Livingston Stone NFH are designed to maintain stock integrity, conserve genetic and life history diversity, and reduce divergence from naturally reproducing stocks. Adult broodstock are collected across a range of phenotypic characteristics including: run timing, age, sex ratio, and any other observed traits. Large numbers of broodstock are also spawned (LFCS, FCS, STT). In addition, natural-origin adults are used as hatchery broodstock (LFCS, FCS, WCS). These practices of broodstock selection are believed to help protect the long-term fitness of the hatchery stock and reduce potential risks to natural populations by decreasing divergence between hatchery and natural populations.

Relevant fish culture practices:
- Use locally-collected, natural-origin adults for broodstock (FCS, LFCS, WCS)
- Spawn the number of adults necessary to minimize genetic drift and inbreeding, and conserve genetic variability of the stock (FCS, LFCS, WCS, STT)
- Collect and spawn adults throughout the duration of run/spawn timing, modeling the spawning schedule after a normal (bell-shaped) distribution (FCS, LFCS, WCS, STT)
- Use a paired mating strategy (i.e., 1 male to fertilize 1 female) (FCS, LFCS, STT)
- Use at least two males (if possible) to fertilize a separate portion of eggs from each female. Use males on two but no more than four females (WCS)
- Use phenotype and mark status to effectively identify and spawn only the target population (FCS, LFCS, WCS, STT)
- Incorporate natural-origin fish as hatchery broodstock (FCS, LFCS, WCS)
- Use natal stream water at ambient temperature to reinforce genetic compatibility with local environments and promote homing (FCS, LFCS, WCS, STT)
- Use genetic discrimination techniques to effectively identify target broodstock (WCS)

Performance Indicators:

- At the conclusion of each spawning season, analyze CWT's from spawned fish to verify selection of target broodstock
- Analyze trends in fecundity, return rates, return timing, spawn timing, adult size and age composition, survival for different life stages, and other parameters as surrogates for measures of "fitness" of the hatchery stock

Constraints:

- Current practice of marking less than 100% of hatchery production of fall Chinook does not enable complete differentiation of hatchery- and natural-origin stocks based on mark status and hinders absolute differentiation between different hatchery- and natural-origin fish based on mark status

Performance Standard B5: Provide fish for experimental purposes (FCS, LFCS, WCS, STT)

Investigators from government agencies, academic institutions, and the private sector request fish or fish tissues from fish propagation programs at the Coleman NFH Complex to study a variety of issues, including: Central Valley water management alternatives, bypass efficiencies, monitoring efficiencies, and fish health performance and physiology. In these investigations, fishes propagated at Coleman and Livingston Stone NFHs are often used as surrogates for natural-origin fish, which are generally not available for research purposes. Additionally, Coleman NFH provides fish for educational and outreach purposes, including an annual "Return of the Salmon Festival."

Relevant fish culture practices:

- Spawn and rear fish in a manner that will support the needs of researchers (FCS, LFCS, WCS, STT)
- Mark and CWT experimental fish prior to release (FCS, LFCS, WCS, STT)

Performance Indicators:

- As appropriate for specific experimental design

Constraints:

- The size and configuration of rearing units limits flexibility of lot sizes
- Potential exists for increased interaction with natural-origin fish, including ESA listed and candidate stocks, associated with experimental releases
- Potential exists for reduced contribution of experimental groups

Performance Standard B6: Conduct research to monitor and evaluate hatchery operations and practices (FCS, LFCS, WCS, STT)

Standard and proven fish culture practices are used at Coleman NFH and Livingston Stone NFH to produce fish necessary to accomplish program goals (mitigation, supplementation, and/or conservation/preservation), while reducing the potential for negative effects on natural stocks.

Extensive monitoring and evaluation are conducted on- and off-site in order to adapt and improve standard fish culture methods. Knowledge gained through experimentation and research is used to modify fish culture practices, when appropriate, to better accomplish program goals.

Relevant fish culture practices:

- All existing fish culture practices at Coleman NFH and Livingston Stone NFH

Performance Indicators:

- Evaluate contribution of fall and late-fall Chinook salmon to ocean fisheries
- Continue mark screening and mark/tag recovery efforts on adults returning to the Coleman NFH and Keswick Dam Fish Trap (river mile [RM] 302)
- Continue to collect and analyze information obtained through adult trapping and video monitoring at the Coleman barrier weir in Battle Creek
- Summarize and analyze ocean harvest data (PSMFC)
- Summarize and analyze information collected during Battle Creek and mainstem Sacramento River adult carcass surveys

Other Indicators and Achievements

- The Service will support and participate in the hatchery adaptive management process to integrate the hatchery with the Battle Creek Restoration process
- Developed and implemented a study to examine reproductive success of hatchery-origin steelhead that were released in to upper Battle Creek to spawn naturally

Constraints:

- Lack funding and a basin-wide agreement on a strategy to mark all hatchery-origin fall Chinook salmon
- Environmental conditions (e.g., high flows and turbidity) may hinder field research and monitoring efforts

Performance Standard B7: Improve survival of propagated species/stock using appropriate incubation, rearing, and release strategies (FCS, LFCS, WCS, STT)

The Service will continue to work to improve survival of fish produced at Coleman NFH and Livingston Stone NFH to accomplish the following program objectives: 1) provide harvest opportunity (FCS, LFCS, STT); 2) ensure adequate escapement to the hatchery for broodstock purposes (WCS, FCS, LFC, STT); and, 3) supplement the natural populations (WCS). Fish culture and release practices at Coleman NFH and Livingston Stone NFH are intended to produce a high level of survival of hatchery fish, both before and after release, and reduce negative effects on natural salmonid populations and the Sacramento River watershed.

Relevant fish culture practices:

- Release fish at a time and size to improve survival and minimize potential negative effects on natural stocks in freshwater

- To the extent possible, rear fish at densities favorable for minimizing stress, disease and mortality during all life stages
- Use proper disease prevention and control techniques to maximize survival
- Conduct studies to investigate effects of the following factors on survival: food types; rearing densities; ponding strategies; natural-type rearing elements; size, time, and location of release; and other factors. Apply knowledge gained through investigations to modify hatchery practices, when appropriate, to maximize survival and minimize potential negative effects on natural stocks

<u>Performance Indicators:</u>
- Analyze trends in survival for different life stages at the hatchery
- Analyze trends in rates of ocean harvest, freshwater harvest, and escapement

<u>Constraints:</u>
- Rearing densities at Coleman NFH are dictated largely by the size of the production programs, the availability of rearing space, and the availability of water for hatchery use. Ponding of juvenile fishes at Coleman NFH is generally managed to maximize the use of hatchery rearing space, while maintaining rearing densities suitable for fish culture
- Release locations and timing are chosen to maximize survival while minimizing effects on natural stocks. Therefore, upriver release locations are generally used to minimize stray rates and geographic distribution of hatchery-origin strays (although releasing fish lower in the system would improve overall survival to maturity and contribution of adults). Likewise, timing of releases is adjusted to maintain high rates of contribution and reduce potential effects on natural stocks (see Section 10)

<u>Performance Standard B8:</u> Improve survival by preventing disease introduction, spread, or amplification (FCS, LFCS, WCS, STT)

The primary goal of fish health management programs at Coleman NFH and Livingston Stone NFH is to produce healthy fish that will contribute to program goals of mitigation, supplementation, or conservation and preservation, while minimizing the potential for negative effects on natural stocks. This goal is accomplished, with assistance and technical advice from the Service's CA-NV FHC, using state-of-the art technologies in disease prevention.

Fish culture practices at Coleman NFH and Livingston Stone NFH are designed to produce healthy smolts. Propagation of healthy juveniles will maximize survival and contribution of hatchery fish, both before and after release. The following list details specific projects or activities undertaken at Coleman NFH and Livingston Stone NFH to prevent the introduction, spread, or amplification of fish pathogens from natural populations into all hatchery stocks.

<u>Relevant fish culture practices:</u>
- Maintain sanitary conditions for fish rearing including: 1) disinfecting all equipment (e.g., nets, tanks, rain gear, boots, brooms) with iodophor between uses with different fish/egg lots, 2) disinfecting (with iodophor) the surface of all eggs spawned at the facility, and 3) when practicable, disinfecting outside rearing units between use with a portable ozone sprayer.

- Constructed and operate an ozone water treatment facility to prevent the introduction of pathogens into Coleman NFH through the Battle Creek water supply. In 2005 Reclamation also provided a new 2,000 kv back-up generator and 5,000 gallon diesel fuel tank which provides greater assurance of maintaining water treatment when grid power is lost.
- Monitor output and efficacy of the ozone water treatment system
- Enclosed rearing ponds with fencing and bird netting to minimize predation and risks of disease transmitted by predators
- Prescribe appropriate treatments (prophylactics, therapeutics, or modified fish culture practices) to alleviate disease-contributing factors using approved methods and chemicals
- Conduct applied research leading to improved control of disease epizootics
- Developed and conduct special release strategies to minimize occurrence of disease in hatchery and natural fish
- Developed and execute disease control protocol for marking and tagging of Chinook salmon and steelhead
- Routinely perform examinations of live fish to assess health status and detect problems before they progress into clinical disease or mortality
- Routinely remove dead and moribund fish from rearing containers. In cases of increased mortality, perform necropsies of diseased and dead fish to diagnose the cause of death
- Perform routine examinations of collected broodstock for disease organisms (viral, bacterial and parasites)

Performance Indicators:
- Analyze survival trends for different life stages at the hatcheries
- Examine trends of ocean harvest, freshwater harvest, and hatchery escapement in regards to documented history of disease incidence at Coleman NFH and Livingston Stone NFH
- Examine on-station mortality of Chinook salmon and steelhead as percent of total production

Other Indicators and Achievements
- Conducted a post-release evaluation of hatchery-origin smolts to examine disease progression during emigration through the Sacramento River system
- Conducted a survey for Infectious Hematopoietic Necrosis virus (IHNV) in natural-origin fall Chinook salmon from Battle Creek and the upper Sacramento River

Constraints:
- Power outages or water turbidity may affect the efficacy of the water treatment facility
- Disease organisms may be introduced through other vectors (birds, mammals, visitors)

Performance Standard B9: Provide local, state, and regional economic enhancement (FCS, LFCS, STT)

Local, regional, state, and national economies benefit from increased harvest that results from fish propagation programs at Coleman NFH. The economic value of fish production at Coleman NFH can be estimated by comparing the direct and indirect value of that portion of the commercial and sport fishery attributable to Coleman NFH with the economic cost of fish production programs at the hatchery. Fish culture and release practices at Coleman NFH and

Livingston Stone NFH are designed to improve the survival of hatchery fish, both before and after release, and minimize negative effects on natural salmonid populations and the Sacramento River watershed.

Relevant fish culture practices:
- Release fish at a time and size to improve survival and reduce effects on natural-origin stocks
- To the extent possible, rear fish at densities favorable for minimizing stress, disease, and mortality during all life stages
- Release fish at a location to maximize survival, while reducing straying from the hatchery
- Use disease prevention and control techniques to maximize survival
- Conduct studies to investigate effects of alternative: food types; rearing densities; ponding strategies; natural-type rearing elements; size, time, and location of release; and other factors. Apply knowledge gained through investigations to modify hatchery practices, when appropriate, to maximize survival and minimize potential negative effects on natural stocks

Performance Indicators:
- Estimate direct and indirect economic enhancement of local, state, and regional economies resulting from propagation programs at Coleman NFH by calculating input to local economy and commercial and sport value of the fishery attributable to the hatchery

Constraints:
- Artificial propagation can increase harvest opportunity; however, ocean harvest in a mixed-stock fishery is restricted to protect listed stocks
- Cost/benefit economic analysis provides only a partial valuation of mitigation and restoration/recovery programs for listed stocks

Performance Indicators Addressing Risks

Performance Standard R1: Minimize potential negative effects of Coleman NFH on restoration of Battle Creek (FCS, LFCS, STT)

Relevant fish culture practices:
- Screen water intakes for Coleman NFH to prevent entrainment of fish from Battle Creek upstream of the hatchery
- Water used for fish propagation at Coleman NFH is non-consumptive and returned to the creek immediately downstream of the hatchery
- Operate pollution abatement pond as appropriate to meet the National Pollution Discharge Elimination System water quality discharge criteria
- Manage fish passage at the Coleman barrier weir in a manner compatible with both restoration of Battle Creek and broodstock collection needs at the hatchery. Passage above the barrier weir is blocked and fish are congregated during periods necessary for collection of broodstock for the propagation programs. When broodstock are not being congregated and collected, operation of the barrier weir fish ladder and associated monitoring programs will be coordinated with CDFG and NMFS
- Juvenile release strategies are designed to promote rapid emigration of hatchery origin fish

Performance Indicators:
- Monitor emigration of hatchery releases to document rates of movement
- Monitor quality of water discharged from Coleman NFH to Battle Creek

Other Indicators and Achievements
- As part of the Greater Battle Creek Watershed Working Group, assisted in the development of a Restoration Plan for Battle Creek that integrates operations at Coleman NFH
- Participates in the development and implementation of a hatchery adaptive management plan to integrate the hatchery with the Battle Creek Restoration Project
- Completed modifications to two of three hatchery intake structures to maintain a reliable supply of water to the Coleman NFH while, at the same time, affording protections to natural-origin fish in Battle Creek
- Completed modifications to the Coleman NFH barrier weir and fish ladders. Modifications to the existing structures allow for improved abilities to afford and control fish passage into upper Battle Creek
- Constructed and operate an ozone water treatment facility to prevent the introduction of pathogens into Coleman NFH through the Battle Creek water supply. This action alleviates concerns of releasing fish upstream of the hatchery barrier weir, thereby allowing additional adult passage opportunity into natural spawning habitats

Constraints:
- Funding is currently not available for screening hatchery Intake #2
- Environmental conditions (e.g., high flows) may decrease the effectiveness of the hatchery barrier weir at blocking the upstream migration of hatchery origin salmon and steelhead
- Over-escapement of hatchery-origin Chinook salmon, caused in part by reduction in harvest opportunities, presents management difficulties in Battle Creek
- Operation of the Coleman barrier weir for broodstock collection may block or delay migration of natural-origin adults

Performance Standard R2: Minimize potentially harmful interactions between hatchery- and natural-origin stocks (FCS, LFCS, WCS, STT)

Artificial propagation programs at Coleman NFH and Livingston Stone NFH are designed to achieve program goals of mitigation, augmentation, supplementation, or conservation and preservation, with the additional goal of minimizing the potential for negative effects on natural stocks.

Relevant fish culture practices:
- Propagate only native stocks collected from the upper Sacramento River
- Integrate natural-origin fish into the hatchery mating schemes
- Minimize potential interactions in the freshwater environment by releasing fish at a time, size, physiological condition, and location that promote rapid emigration and minimal straying
- Control upstream passage of natural- and hatchery-origin adult salmon in Battle Creek using the Coleman barrier weir

Performance Indicators:

- Analyze stray rates of fall and late-fall Chinook salmon, comparing groups released at different sizes and at different locations
- Analyze emigration rates and timing of hatchery- and natural-origin Chinook salmon and steelhead

Other Indicators and Achievements

- Terminated the established practice of releasing excess fry

Constraints:

- Environmental conditions limit field monitoring capabilities
- Lack of a Valley-wide total marking program precludes the ability to positively identify and differentiate hatchery and natural origin fall Chinook

Performance Standard R3: Do not introduce, spread, or amplify pathogens of natural stocks (FCS, LFCS, WCS, STT)

The primary goal of fish health management programs at Coleman NFH and Livingston Stone NFH is to produce healthy fish that will contribute to program goals of mitigation, supplementation, or conservation and preservation, while minimizing the potential for negative effects on natural stocks. This goal is accomplished using state-of-the art technologies in disease prevention along with assistance and technical advice from the CA-NV FHC.

Fish culture practices at Coleman NFH and Livingston Stone NFH are designed to produce healthy smolts. Propagation of healthy juveniles will maximize survival and contribution of hatchery fish, both before and after release. It is equally important to minimize potential negative effects that releasing diseased fish may have on natural salmonid populations. The following list details specific projects or activities undertaken at Coleman NFH and Livingston Stone NFH to prevent the introduction, spread, or amplification of fish pathogens from hatchery stocks into natural populations.

Relevant fish culture practices:

- Disinfect the hatchery water supply from Battle Creek with an ozone water treatment facility to prevent the introduction of pathogens to Coleman NFH
- Developed and conduct release strategies to minimize occurrence of disease in hatchery fish and decrease the potential for transmission of diseases to natural fish
- Developed and conduct a disease control protocol for marking and tagging Chinook salmon and steelhead
- Maintain sanitary conditions for fish rearing including: 1) disinfecting all equipment (e.g., nets, tanks, rain gear, boots, brooms) with iodophor between uses with different fish/egg lots, 2) disinfecting (with iodophor) the surface of all eggs spawned at the facility and 3) when practicable, disinfect outside rearing units between use with a portable ozone sprayer
- Prescribe appropriate treatments (prophylactics, therapeutics, or modified fish culture practices) to alleviate disease-contributing factors using approved methods and chemicals

- Conduct applied research through the U. S. Food and Drug Administration Investigational New Animal Drug process to control disease epizootics
- Routinely remove dead and moribund fish from rearing containers. Perform necropsies of diseased and dead fish to diagnose the cause of death
- Perform routine examinations of collected broodstock for disease organisms (bacterial, viral and parasitic)
- Routinely perform examinations of juveniles to assess health status and detect problems before they progress into clinical disease or mortality

Performance Indicators:
- Examine trends of ocean harvest, freshwater harvest, and hatchery escapement in regards to documented history of disease incidence at Coleman NFH and Livingston Stone NFH
- Examine on-station mortality of Chinook salmon and steelhead as proportion of total production

Other Indicators and Achievements
- Conducted an investigation to examine the mode(s) and potential for IHNV transmission between hatchery- and natural-origin Chinook salmon
- Conducted a post-release evaluation of hatchery-origin smolts to examine disease progression during emigration
- Conducted a survey for IHNV in natural-origin fall Chinook salmon from Battle Creek and the upper Sacramento River
- Conducted an assessment of ecological risk of disease transmission to natural stocks

Constraints:
- It is difficult to determine disease prevalence and transmittance between hatchery and natural fish stocks

Performance Standard R4: Reduce the potential for negative genetic effects of artificial propagation programs on natural stocks (FCS, LFCS, WCS, STT)

Fish propagation practices at Coleman NFH and Livingston Stone NFH are conducted so that artificially propagated fish remain genetically similar to natural-origin populations in the upper Sacramento River. Maintaining a high level of genetic similarity between hatchery and natural populations decreases the possibility of hatchery-origin fish having deleterious genetic effects on natural stocks when interbreeding occurs. Hatchery broodstocks are also selected to reduce chances of interbreeding between different stocks (e.g., winter and spring or fall and late-fall). Some fish culture practices that are employed at Coleman and Livingston Stone NFHs to accomplish this task are listed below.

Relevant fish culture practices:
- Use phenotype and mark status to effectively identify and spawn only the target population (fall and late-fall Chinook)
- Manage egg takes to ensure all portions of the run are represented in the spawning distribution

- Use natal stream water to reinforce genetic compatibility with local environments
- Use only native stocks from the upper Sacramento River in propagation programs
- Incorporate natural-origin fish as hatchery broodstock
- Spawn numbers of adults necessary to minimize genetic drift and inbreeding, and to conserve genetic variability of the stock. Large numbers >500 adults (STT, LFS, FCS) and up to 120 (WCS)
- Collect and spawn adults throughout the duration of run/spawn timing, modeling the spawning distribution after a normal, bell-shaped curve
- Use the appropriate mating strategy: a. 1 male to fertilize 1 female (FCS, LFC, STT)
  b. Factorial-type mating; e.g., 1 male to fertilize half eggs from two females (WCS)
- Select broodstock randomly from collected adults. Incorporate jacks into the spawning plan.

<u>Performance Indicators:</u>

- Analyze CWT recoveries of fish spawned at the hatchery to verify selection of target broodstock
- Monitor and analyze trends in fecundity, survival for different life stages, return rates, return timing, spawn timing, adult size and age composition, and other parameters to indicate potentially deleterious changes occurring in the hatchery stock
- Calculate effective population size estimates for releases of juvenile winter Chinook salmon

<u>Other Indicators and Achievements</u>

- Developed genetic discrimination techniques to effectively identify target broodstock (WCS)
- Analyzed broodstock history and the level of incorporation of natural stocks
- Analyzed stray rates of fall and late-fall Chinook salmon, comparing groups released at different sizes and at different locations

<u>Constraints:</u>

- Lack of a Valley-wide total marking program precludes the ability to positively identify and differentiate hatchery- and natural-origin fall Chinook
- Constraints of genetic monitoring (e.g., not “real-time” and expense) inhibit wide-spread use
- Overlap of run/spawn timing of stocks such as winter/spring, spring/fall, and fall/late-fall may lead to hybridization

<u>Performance Standard R5:</u> Do not exceed carrying capacity of freshwater habitats (FCS, LFCS, WCS, STT)

<u>Relevant fish culture practices:</u>

- Release juvenile salmon and steelhead at or near the smolt stage to encourage rapid emigration, thereby reducing the potential for competition with natural-origin juvenile fish in the freshwater environment
- Culling excess fall and late-fall Chinook salmon to reduce competition between hatchery and natural origin fish in spawning areas
- Retaining post-spawn hatchery origin steelhead in the hatchery until after the spawning season is completed reduces competition for spawning with natural-origin steelhead

Performance Indicators:

- Evaluate emigration rates of hatchery-origin juveniles to verify rapid emigration
- Monitor returns of natural- and hatchery-origin adults

Constraints:

- A high level of annual variability in survival rates makes it impossible to accurately predict the number of hatchery fish that will survive to adulthood
- Carrying capacity has not been determined for freshwater environments
- During years of high escapement it may not be possible to remove a sufficient number of hatchery-origin Chinook from Battle Creek to promote optimum spawning success

Performance Standard R6: Conduct research to evaluate potential effects on natural stocks and adaptively manage hatchery operations and activities (FCS, LFCS, WCS, STT)

Monitoring and evaluation are conducted to evaluate potential negative effects to natural salmonids resulting from fish propagation programs at Coleman and Livingston Stone NFH. Knowledge gained through experimentation and research is used to modify fish culture practices, when appropriate, to reduce negative effects on natural populations.

Relevant fish culture practices:

- Existing fish culture practices at Coleman NFH and Livingston Stone NFH
- Control, monitor, and evaluate passage of steelhead and Chinook salmon above the Coleman barrier weir
- Changed release strategy for late-fall Chinook to synchronize releases with high flow events in the Sacramento River. This is intended to encourage rapid emigration from the upper Sacramento River
- Terminated the spawning of natural-origin steelhead from Battle Creek to protect a diminished population

Performance Indicators:

- Monitor straying of fall and late-fall Chinook salmon produced at Coleman NFH
- Conducted monitoring to assess predation by emigrating hatchery origin juvenile late-fall Chinook salmon in the Sacramento River

Other Indicators and Achievements

- Lack of a Valley-wide total marking program precludes the ability to positively identify and differentiate hatchery- and natural-origin fall Chinook
- In 2000, an interagency agreement was reached to extend the duration that salmonids can pass above the Coleman barrier weir into upper Battle Creek
- Investigated mode(s) and potential for IHNV transmission between hatchery- and natural-origin Chinook salmon
- Conducted a survey for IHNV in natural-origin fall Chinook salmon from Battle Creek and the upper Sacramento River

- Conducted a post-release evaluation of hatchery-origin smolts to examine disease progression during emigration
- Conducted research to investigate predation by hatchery origin steelhead and late-fall Chinook salmon emigrating in the Sacramento River
- Conducted a public re-evaluation of Coleman and Livingston Stone NFHs, where potential effects of the artificial propagation programs were assessed. Solicited alternative management strategies that may decrease potential impacts to natural stocks

Constraints:
- Lack of a Valley-wide total marking program precludes the ability to positively identify and differentiate hatchery- and natural-origin fall Chinook
- Environmental conditions (e.g., flows, turbidity) may limit field monitoring capabilities

1.11 Expected size of programs

Proposed Annual Number of Broodstock Spawned

Minimum spawning targets necessary to meet production goals at Coleman NFH are approximately 5,200 fall Chinook, 540 late-fall Chinook, and 400 steelhead, with a male to female ratio of 1:1 (Table 1-2). Typically, the number of adults spawned exceeds these minimum spawning targets, sometimes substantially (e.g., 2-fold), and excess eggs are culled to reduce production. Eggs are culled in a manner to prevent the complete loss of parent pairs and to promote a normal, bell-shaped curve of spawn timing. Spawning of excess adults helps to maintain the genetic diversity and fitness of the hatchery stock and increases the likelihood that the hatcheries production targets are met.

The spawning target for winter Chinook salmon at Livingston Stone NFH depends on the estimated upriver escapement of adults for any given brood year. The broodstock collection target for winter Chinook is 15% of the estimated upriver escapement, up to a maximum of 120 natural-origin winter Chinook broodstock per brood year (i.e., run sizes >800). To maintain genetic diversity, no less than 20 winter Chinook adults will be collected for broodstock regardless of run size (i.e., run sizes <135). To minimize potential negative effects resulting from domestication selection in the hatchery no hatchery-origin winter Chinook will be used as broodstock.

1.12 Proposed annual fish release levels by life stage and location

Coleman NFH releases a total of approximately 13.6 million Chinook salmon and steelhead annually (Table 1-2). Fall Chinook comprise the majority of fish produced. Annual release targets from Coleman NFH are currently largely based on facility capacity and consist of 12 million fall Chinook, 1 million late-fall Chinook, and 600,000 steelhead. Actual production levels may be somewhat higher or lower than production targets because of annual variations in broodstock availability, fecundity levels of available females and/or ultimate on-station survival of eggs/juveniles. However actual production levels shall not exceed release targets by more than 15%. Release targets for winter Chinook at Livingston Stone NFH are variable, depending upon the estimated upriver escapement of adults for any given brood year. Juvenile capacity of the facility is approximately 250,000 pre-smolts. In addition to releases of juvenile salmonids, "reconditioned" post-spawn adult hatchery-origin steelhead are released from the Coleman NFH. All adult hatchery-origin steelhead returning to the hatchery are either spawned or stripped of gametes and placed into a pond for reconditioning prior to release. The number of reconditioned steelhead released depends on survival during the reconditioning process, which is highly variable.

Table 1-2 Annual propagation targets at Coleman and Livingston Stone National Fish Hatcheries are presented, including number of adults spawned, initial egg take, and number of juveniles released. Also shown are target release timing, life stage and size, and release location.

	Spawning		Release				
Stock	Adults (1 ♀ : 1 ♂)	Green Eggs	Production Target	Month	Life Stage	Size	Location
Coleman NFH							
Fall Chinook[a]	5,200	16,650,000	12,000,000	April	Smolt	75 mm. 90 / lb	Battle Creek at Hatchery
Late-fall Chinook[a,b]	540	1,700,000	1,000,000	December - January	Smolt	135 mm. 13/ lb	Battle Creek at Hatchery
Steelhead[a]	400 required 800 targeted[c]	790,000	600,000	January	Smolt	200 mm. 4 / lb	Sacramento River in Bend, CA (RM 258) and Battle Creek at Hatchery
Livingston Stone NFH							
Winter Chinook	up to 120[d]	variable	≤250,000	January-February	Pre-smolt	90 mm. 60 / lb	Sacramento River in Redding, CA (RM 298)

a Targets for number spawned and green eggs are back-calculated from the release targets based on estimated fecundity (eggs/female) and estimated survival through various stages of incubation and rearing (see Section 9). Unusually high mortality of eggs or fry occurring during the spawning season may necessitate increased number spawned and egg take totals to achieve the release target.

b Approximately 140,000 of the late-fall Chinook that are produced are currently released into Battle Creek during December as part of an emigration study to serve as surrogates for spring Chinook.

c. use of 800 adults in spawning matrix is designed to increase effective population size and reduce loss of genetic variation (see Campton et al. 2004)

d Depends on estimated size of winter spawning population. At least 20 but no more than 120 natural-origin winter Chinook will be used as broodstock.

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

Refer to Section 3, "Relationship of Program to Other Management Objectives," of this document for detailed information on ocean contribution of fall, late-fall, and winter Chinook.

Fall Chinook Salmon

Estimated average total contribution of fall Chinook salmon from Coleman NFH was approximately 0.78% (95% CI, 0.31% - 1.46%) of the total number of juveniles released (including fry and smolts) for brood years 1973 through 1995. This is equivalent to approximately 105,000 (95% CI, 69,628 - 139,484) adults annually (Table 1-3). The total estimated contribution includes an average of over 32,000 adults returning to Coleman NFH or spawning naturally in Battle Creek, over 9,000 (95% CI, 4,237 - 14,091) adults harvested annually in the freshwater sport fishery, nearly 60,000 (95% CI, 40,721 - 78,779) adults harvested annually in the ocean commercial fishery, and approximately 6,300 (95% CI, 4,293 - 8,337) adults straying to locations other than Battle Creek.

Late-fall Chinook Salmon

The estimated average rate of total contribution of late-fall Chinook from Coleman NFH was approximately 0.83% (95% CI, 0.08% - 2.38%) of the total number of juveniles released for brood years 1989 through 1995. This is equivalent to approximately 4,000 (95% CI, 1,151 - 7,016) adults annually (Table 1-4). The total contribution includes an average of over 1,500 (95% CI, 0 - 3,030) adults returning to Coleman NFH, and over 2,500 (95% CI, 1,013 - 1,148) adults harvested annually in the ocean commercial and sport fishery.

Winter Chinook Salmon

For brood years 1991 through 1995, the average estimated rate of total contribution per year for winter Chinook salmon from Coleman NFH was approximately 0.72% (95% CI, 0.02% - 3.37%) of the total number of juveniles released (Table 1-5). The total contribution includes an average of approximately 180 (95% CI, 42 - 322) adults returning to the upper Sacramento River, and approximately 40 (95% CI, 2- 82) harvested annually in the ocean commercial and sport fishery.

Steelhead

Escapement of steelhead spawners to Coleman NFH is estimated at 0.32% (95% CI, 0.02% - 0.95%) based on a four-year marking and tagging investigation conducted for brood years 1991-1994 (Service, unpublished data). Numbers of steelhead returning to the hatchery from 2001 through 2010 indicate similar contribution rates (assuming that fish return at age 3). Contribution rates based on hatchery counts averaged 0.33% (95% CI, 0.22%-0.42%) from 2001-2010. These values do not include steelhead harvested in the sport fishery.

Table 1-3. Estimated ocean harvest, freshwater returns and survival to adulthood for Coleman National Fish Hatchery fall Chinook salmon, brood years 1973-1995.

Brood Year	Number Released	Ocean Harvest		Freshwater Returns[a]		Survival to Adult	
		Number	Percent	Number	Percent	Number	Percent
1973	9,386,752	61,857	0.659	19,542	0.208	81,400	0.867
1974	2,497,280	17,126	0.686	13,624	0.546	30,750	1.231
1975	5,580,352	20,119	0.361	12,454	0.223	32,574	0.584
1976	9,791,842	20,512	0.209	16,731	0.171	37,243	0.380
1977	9,626,507	16,999	0.177	16,475	0.171	33,473	0.348
1978	5,704,562	10,889	0.191	18,895	0.331	29,784	0.522
1979	11,687,142	18,500	0.158	22,412	0.192	40,912	0.350
1980	14,494,691	13,642	0.094	19,742	0.136	33,385	0.230
1981	8,991,463	22,870	0.254	30,562	0.340	53,431	0.594
1982	17,035,963	66,389	0.390	38,645	0.227	105,034	0.617
1983	9,986,712	58,461	0.585	35,136	0.352	93,597	0.937
1984	23,424,330	50,739	0.217	41,695	0.178	92,433	0.395
1985	14,613,447	36,374	0.249	64,987	0.445	101,361	0.694
1986	11,802,158	56,849	0.482	41,188	0.349	98,037	0.831
1987	18,152,003	78,111	0.430	27,147	0.150	105,258	0.580
1988	22,172,654	84,301	0.380	23,850	0.108	108,151	0.488
1989	16,866,392	30,966	0.184	26,879	0.159	57,845	0.343
1990	23,372,151	130,217	0.557	43,138	0.185	173,355	0.742
1991	25,302,582	44,850	0.177	73,109	0.289	117,959	0.466
1992	11,916,130	238,217	1.999	103,807	0.871	342,024	2.870
1993	16,660,227	64,544	0.387	108,600	0.652	173,144	1.039
1994	16,178,326	150,932	0.933	128,439	0.794	279,371	1.727
1995	15,967,656	43,567	0.273	140,705	0.881	184,272	1.154
Total	321,211,322	1,337,031	0.416	1,067,762	0.332	2,404,793	0.749
Average	13,965,710	58,132	0.436	46,424	0.346	104,556	0.782
Std	6,060,324	53,241	0.399	38,359	0.240	80,766	0.575

a Freshwater returns include:

1) Returns to Coleman NFH and Battle Creek modified to 90% of Grand Tab tables as per CDFG (1994) and USFWS (1995);
2) In-river harvest values for:
   - -1975-1987 are calculated as 5% of BC escapement as per Cramer (1991);
   - -1988-1990 are calculated as 15% of BC escapement which is an average of Cramer (1991) and PSMFC (1999).
   - -1991-1994 are calculated as 25% of BC escapement as per PSMFC (1999).
   - -1995 is calculated as 25% of BC escapement based on previous years.
3) Freshwater strays for 1975-1987 are taken from Cramer (1991), 1988-1999 estimated by release group and associated stray index (%) by life stage and release site (See Appendix 10C. Stray Rate Analysis in Service 2001b).

Table 1-4. Ocean and freshwater contribution numbers and total contribution percent for late-fall Chinook salmon juveniles released from Coleman National Fish Hatchery (brood years 1989-1995).

Brood Year	Number Released	Contribution		Total Percent Contribution
		Ocean	Fresh Water[a]	
1989	833,807	271	125[b]	0.047
1990	203,387	1,177	508[c]	0.829
1991	289,028	1,679	723[d]	0.831
1992	322,246	2,911	888	1.179
1993	747,585	2,643	1,087	0.499
1994	621,766	4,501	4,927	1.516
1995	775,890	4,885	2,260	0.921
Total	3,793,709	18,067	10,518	0.753
Average	541,958	2,581	1,503	0.832
STD	263,131	1,695	1,651	0.470

a Freshwater returns are returns to Coleman National Fish Hatchery only (i.e., direct coded-wire tag recoveries).
b Estimated at 0.015% generated by one tagged release group.
c No marked groups were released in this brood year. Freshwater contribution value estimated at 0.25% based on brood year 1991 value.
d Estimated at 0.25% from actual contribution from two tagged groups.

Table 1-5. Ocean and freshwater contribution numbers and total contribution percent for winter Chinook salmon juveniles released from Coleman National Fish Hatchery (brood years 1989-1995).

Brood Year[a]	Number Released	Contribution		Total Percent Contribution
		Ocean[b]	Freshwater[c]	
1991	10,866	15	na	0.138
1992	27,383	107	88	0.712
1993	17,034	28	273	1.767
1994	41,412	33	266	0.722
1995	48,154	25	100	0.260
Total	144,849	208	727	0.645
Average	28,970	42	182	0.720
STD	15,776	37	101	0.642

a Following brood year 1995 the Service entered a moratorium on the capture of natural due to problems associates with imprinting and genetic concerns. Collection of natural-origin adults was resumed in 1998 following the construction of the Livingston Stone National Fish Hatchery (see brief history of the program presented below in Section 1.14.
b Expanded recoveries of coded-wire tags from the ocean sport and commercial fishery.
c No inland recoveries of winter Chinook salmon were made in 1994 from brood year 1991. It is assumed any adults originating from this brood year returned to Battle Creek and were not detected. Monitoring efforts in Battle Creek were initiated in 1995 and is reflected for broodyears 1992 - 1995. Freshwater recovery data for broodyears 1992 - 1994 are complete, while the value displayed for 1995 is draft.

1.14 Date programs started

Fall Chinook Salmon

Fall Chinook have been propagated at Battle Creek since 1895. From 1895 to 1942, fall Chinook were propagated at the Battle Creek Egg Taking Station. In 1943, Coleman NFH was completed and fall Chinook have since been propagated at that facility.

Late-fall Chinook Salmon

Late-fall Chinook were formally recognized and managed as distinct from fall Chinook beginning in 1973. However, many years earlier, fish culturists at Coleman NFH recognized differences between these stocks and began propagating them separately (see Appendices 6A on fall and late-fall Chinook broodstock collection locations and 8A on spawn timing at Coleman NFH). Distinctions between these "early" and "late" fall runs were based on observed differences in run/spawn timing and location of broodstock collection. Early-spawning broodstock collected at Battle Creek (i.e., fall Chinook) were spawned separately from late-spawning broodstock collected at the Keswick Dam fish trap (i.e., late-fall Chinook). Propagation of late-fall Chinook salmon at Coleman NFH was completely separated from fall Chinook salmon propagation in 1973.

Winter Chinook Salmon

An initial attempt to hold and propagate winter Chinook salmon at Coleman NFH was made in 1955. In 1955, the Keswick Dam fish trap was operated during the last two weeks in March, and about 200 winter Chinook salmon were transported to Coleman NFH where they were held until mature. The original objectives of the program, as outlined in Azevedo and Parkhurst (1958), were to:

1) save salmon fry that would otherwise be lost to diversion at Anderson-Cottonwood Irrigation District (ACID) Dam;
2) obtain an index of the size of the winter Chinook;
3) learn the migration pattern of the winter Chinook; and,
4) determine the best methods of artificially propagating winter Chinook.

This initial attempt to propagate winter Chinook in 1955, as well as several subsequent efforts from 1958 through 1967, was mostly unsuccessful. Similarly, from 1978 through 1985, additional attempts to propagate winter Chinook salmon at Coleman NFH met with limited success. Stress and high water temperatures at the hatchery resulted in substantial mortality of broodstock, eggs, and juveniles. In 1988, with a decline in the natural winter Chinook salmon population and a petition to list winter Chinook salmon as threatened under the ESA pending, the Service re-committed to developing a propagation program for winter Chinook at Coleman NFH. The goal of the resurrected winter Chinook propagation program at Coleman NFH was to assist in recovery of winter Chinook salmon in the upper Sacramento River.

Winter Chinook salmon were propagated at Coleman NFH from 1989 through 1995. During 1996 and 1997, in response to concerns of hybridization with spring Chinook and failure of juveniles to imprint to the Sacramento River, the Service imposed a moratorium on collecting natural winter Chinook salmon for the propagation program. During these years, hatchery broodstock were limited to a small number of adults from the captive broodstock program. The collection of winter Chinook broodstock from the Sacramento River was re-initiated in 1998, after refined broodstock selection methods and a new rearing facility on the Sacramento River (Livingston Stone NFH) alleviated concerns of hybridization and imprinting.

Steelhead
Steelhead have been propagated at Coleman NFH since 1947.

1.15 Expected duration of program

Fall Chinook Salmon
Coleman NFH's fall Chinook salmon propagation program is considered to be permanent. The primary goal of the fall Chinook propagation program is partial mitigation for fall Chinook spawning and early-rearing habitat permanently lost by the construction of Shasta Dam.

Late-fall Chinook Salmon
Coleman NFH's late-fall Chinook salmon propagation program is considered to be permanent. The primary goal of the late-fall Chinook propagation program is partial mitigation for Shasta Dam which permanently blocked large portions late-fall Chinook spawning and rearing habitat.

Winter Chinook Salmon
Artificial propagation of winter Chinook salmon at Livingston Stone NFH is a temporary measure to assist in the recovery of natural winter Chinook salmon in the upper Sacramento River. Artificial propagation of winter Chinook salmon is expected to cease when the naturally-spawning population of winter Chinook salmon has been recovered, as described in the Public Draft Recovery Plan (NMFS 2009b).

A captive broodstock component of the winter Chinook propagation program was conducted from 1991 to 2007. It was discontinued in 2007 based on the increased abundance of natural origin winter Chinook salmon. Previous guidance from NMFS (1997) had recommended the captive broodstock program be terminated when the run size of the wild population reaches 1,000 per year on a sustained basis. If the abundance level of natural origin winter Chinook salmon again falls to critically low levels, the captive broodstock element of this program could be reconsidered.

Steelhead
Coleman NFH's steelhead propagation program is considered to be permanent. The primary goal of the steelhead propagation program is partial mitigation for Shasta Dam which permanently blocked large portions of steelhead spawning and rearing habitat.

1.16 Watersheds targeted by program

Fall Chinook Salmon
Fall Chinook salmon propagated at Coleman NFH return primarily to Battle Creek (PSMFC Recovery Location code: 6FCSABAT). Additionally, a proportion of hatchery-origin fall Chinook adults stray and spawn with the naturally-spawning fall Chinook salmon.

Late-fall Chinook Salmon
Late-fall Chinook salmon propagated at Coleman NFH return primarily to Battle Creek (PSMFC Recovery Location code: 6FCSABAT). Additionally, a proportion of hatchery-origin late-fall Chinook adults stray and spawn with the natural population in the upper Sacramento River. Most of these fish spawn north of the city of Red Bluff (PSMFC Recovery Location code: 6FCSASAF ABRB).

Winter Chinook Salmon
The winter Chinook salmon propagation program at Livingston Stone NFH is targeted at supplementing the naturally spawning population of winter Chinook salmon in the upper Sacramento River. Natural-origin winter Chinook spawn north of the city of Red Bluff (PSMFC Recovery Location code: 6FCSASAF ABRB).

Steelhead
Steelhead propagated at Coleman NFH return primarily to Battle Creek (PSMFC Recovery Location code: 6FCSABAT). Additionally, a small proportion of hatchery-origin adults stray into the upper Sacramento River and its tributaries (PSMFC Recovery Location code: 6FCSASAF).

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

Since the construction of Shasta Dam, artificial production has been considered an essential component of the strategy to partially mitigate for negative effects on natural Sacramento River salmonid populations. The creation of Shasta Dam on the Sacramento River permanently blocked approximately 187 miles of anadromous fish spawning and rearing habitats, reducing the capacity of that aquatic ecosystem to support Chinook salmon and steelhead by approximately 50%. Barring the removal of Shasta Dam or the creation of additional salmonid spawning habitats above or below Shasta Dam, federal mitigation responsibilities cannot be met without artificial production.

At the time Shasta Dam was being constructed, an investigation was underway to determine the dam's full effects. A report entitled "An investigation of fish salvage problems in relation to Shasta Dam" was released in 1940. This report is also known as "Special Scientific Report Number 10." The report presented three major plans, and a minor fourth plan to salvage salmon runs to the upper Sacramento River. The three main plans were: 1) The Stillwater Plan; 2) The Battle Creek Plan; and 3) The Sacramento River Natural Spawning Plan (Hanson et al. 1940). The final adoption of a plan resulted in the combination of various components of the original plans. The adopted plan (entitled: The Sacramento River, Battle Creek, and Deer Creek Salvage Plan) is called "the Shasta Salvage Plan." A complete description of the evolution of "The Salvage Plan," which justified the construction of Coleman NFH on Battle Creek, is described in detail in Black (1999, also see Section 1.8 and Section 2.2 of this document).

Coleman NFH was created in 1942 to partially mitigate for fishery losses resulting from the isolation of spawning and rearing habitats above the Shasta Dam. Commercial and recreational fisheries serve an important role in the region's social, cultural, and economic well-being. Coleman NFH provides an important tool for augmenting commercial and sportfishing harvest for fall and late-fall Chinook salmon. Coleman and Livingston Stone NFHs also provide important tools necessary to maintain genetic diversity, prevent extinction, and assist in the recovery of declining and imperiled salmonid populations.

While fish hatcheries are an integral component of the current federal mitigation strategy in the upper Sacramento River, they are not the sole remedy for mitigating negative effects on salmonid populations. Restoration of aquatic ecosystems and recovery of at risk species are also priorities for the Service's National Fish Hatchery System. Additional actions to complement hatchery production programs include alignment of hatchery programs with the CVPIA. The Service is continually modifying artificial propagation programs at Coleman and Livingston Stone NFHs, incorporating strategies designed to promote the recovery of healthy naturally spawning populations. During recent years, substantial changes to hatchery facilities and operations have occurred at Coleman NFH to integrate the hatchery with the Battle Creek Restoration Process. Integrating Coleman NFH operations with the Battle Creek Restoration Process is a coordinated strategy that includes habitat restoration (including flow improvements), fish passage improvements, intake screening, and fishery monitoring (see Section 3 for a more complete discussion of the relationship between Coleman NFH and Battle Creek Restoration).

2 PROGRAM EFFECTS ON LISTED POPULATIONS

Together, the Coleman NFH and the Livingston Stone NFH, propagate three runs of Chinook salmon and steelhead. Central Valley fall and late-fall Chinook and Central Valley steelhead are propagated at Coleman NFH. Sacramento River winter Chinook salmon are propagated at the Livingston Stone NFH. All of the hatchery's salmonid stocks are included within the ESU of their respective natural populations. Each of the Chinook salmon stocks at Coleman NFH and Livingston Stone NFH are managed to be integrated with naturally-spawning populations. That is, natural-origin Chinook salmon are incorporated into the hatchery's mating plans for each of the stocks of Chinook salmon. The steelhead program at the Coleman NFH is currently managed as a segregated program. The segregation of the Coleman NFH steelhead program was a recent change implemented due to a paucity of natural-origin broodstock in Battle Creek. The steelhead stock at the Coleman NFH has a long history of integration with natural steelhead in Battle Creek and the Sacramento River, and the Service will investigate options for maintaining integration in the near future. Delta smelt are also propagated at the Livingston Stone NFH. The delta smelt propagation program is managed as a secondary refugial population and does not involve the collection or release of fish to the natural environment.

Fish propagation programs conducted at the Coleman and Livingston Stone NFHs can affect ESA-listed anadromous and marine fish populations and their critical habitats, which are under the jurisdiction of NMFS, including: Sacramento River Winter Chinook, Central Valley Spring Chinook, Central Valley Steelhead, Southern Distinct Population Segment of North American Green Sturgeon, and Southern Resident Killer Whale. The Service's fish propagation programs at the Coleman and Livingston Stone can also affect Central Valley fall and late-fall Chinook salmon, which are currently identified as candidate species. In this chapter we describe the status of anadromous and marine fish populations that may be incidentally or directly affected by fish propagation activities. We provide qualitative and quantitative estimates of take of listed fish populations and assess the effects of take to those populations. Because the effects of fish propagation activities are expected to differ between Battle Creek, where the hatchery is located, and other areas occupied by listed species, we have assessed the effects to these components separately.

2.1 History of listing determinations

Sacramento River Winter Chinook Salmon

Natural- and hatchery-origin winter Chinook salmon from the Sacramento River are included in the Central Valley ESU for the species and are state and federally listed as endangered. NMFS listed these salmon as threatened under the emergency listing procedures for the ESA (16 U.S.C.R. 1531-1543) on August 4, 1989 (54 FR 32085). A proposed rule to add winter Chinook salmon to the list of threatened species beyond expiration of the emergency rule was published by the NMFS on March 20, 1990 (55 FR 10260). Winter Chinook salmon were formally added to the list of federally threatened species by final rule on November 5, 1990 (55 FR 46515), and they were listed as a federally endangered species on January 4, 1994 (59 FR 440). Critical habitat for winter Chinook salmon has been designated from Keswick Dam (RM 302) to the Golden Gate Bridge (58 FR 33212; June 16, 1993). Winter Chinook salmon have been listed as endangered under the CESA since September 22, 1989 (California Code of Regulations, Title XIV, Section 670.5).

Central Valley Spring Chinook Salmon

Central Valley spring Chinook salmon are state and federally listed as a threatened species. On March 9, 1998, the NMFS published a proposed rule to list Central Valley spring Chinook salmon as endangered under the ESA (63 FR 11482). On March 24, 1999, the NMFS extended the final deadline for a listing determination for Central Valley spring Chinook until September 9, 1999 (63 FR 14329). The NMFS published the final rule to declare Central Valley spring Chinook salmon a threatened species on September 16, 1999 (64 FR 50393). Critical habitat for spring Chinook salmon was designated on February 16, 2000 and includes "…all accessible reaches of all rivers" within the range of the Central Valley spring Chinook ESU (65 FR 7764). Central Valley spring Chinook salmon have been listed as threatened under CESA since February 5, 1999 (California Code of Regulations, Title 14, Section 670.5). Central Valley spring Chinook salmon are not currently propagated by the Service or Reclamation.

Central Valley Fall and Late-fall Chinook Salmon

Central Valley fall and late-fall Chinook salmon are currently identified as candidate species under the ESA, and hatchery- and natural-origin stocks for both species are included in their respective Central Valley ESU. On March 9, 1998, NMFS published a proposed rule to list Central Valley fall and late-fall Chinook salmon as threatened under the ESA (63 FR 11482). On March 24, 1999, NMFS deferred a final listing decision for Central Valley fall and late-fall Chinook salmon for six months (63 FR 14329). On September 16, 1999, NMFS published a final decision to not list Central Valley fall and late-fall Chinook salmon as threatened under the ESA, but instead declared them as candidate species (64 FR 50394). As candidate species, the NMFS will closely monitor and reevaluate the status of Central Valley fall and late-fall Chinook salmon as new information becomes available to determine whether listing may be warranted. Central Valley fall and late-fall Chinook salmon are currently not listed under the CESA.

Central Valley Steelhead

Central Valley steelhead are federally listed as a threatened species. On August 9, 1996, the NMFS published a proposed rule to list Central Valley steelhead as endangered under the ESA of 1973 (61 FR 41541). On August 18, 1997, NMFS deferred a final listing decision for Central Valley steelhead for six months, citing substantial scientific disagreements concerning the geographical extent of the Central Valley ESU. On March 19, 1998, the NMFS published a final rule (63 FR 13347) to list California's Central Valley steelhead as threatened under the ESA. Critical habitat has also been established for steelhead (63 FR 7764; February 16, 2000), and includes Battle Creek. Currently, Steelhead are not listed under the CESA.

Southern Distinct Population Segment of North American Green Sturgeon

Green Sturgeon was petitioned for listing under the Endangered Species Act in June 2001. A study of the species' status determined that North American green sturgeon is comprised of two Distinct Population Segments (DPS): the northern DPS and the southern DPS. Both groupings were added to the list of Candidate Species. The Northern DPS of green sturgeon consists of populations north of and including the Eel River. The Southern DPS of Green Sturgeon consists of populations originating from coastal watersheds south of the Eel River and the Central Valley of California. In 2003 the NMFS determined that listing was not warranted (68 FR 4433). However, because of remaining uncertainties about the structure of the population and status of the species, NMFS added both the northern and southern DPS to the list of Species of Concern (69 FR 19975). A subsequent re-evaluation of the two DPSs, in April, 2005, resulted in NMFS proposal to list the southern DPS of green sturgeon. The northern DPS did not warrant listing due to the presence of two spawning populations and continued spawning in other rivers. The Southern DPS of Green Sturgeon was listed as threatened on April 7, 2006 (71 FR 17757), and a proposed 4(d) rule for this DPS was published on May 21, 2009 (74 FR 23822).

Southern Resident Killer Whales
The DPS of Southern Resident killer whale were designated as "depleted" under the Marine Mammal Protection Act (MMPA; May 29, 2003, 68 FR 31980) in May 2003. Depleted status of the MMPA is defined as any case in which (1) the Secretary, after consultation with the Marine Mammal Commission and the Committee of Scientific Advisors on Marine Mammals established under MMPA title II, determines that a species or population stock is below its optimum sustainable population; (2) a State, to which authority for the conservation and management of a species or population stock is transferred under section 109, determines that such species or stock is below its optimum sustainable population; or (3) a species or population stock is listed as an endangered species or a threatened species under the ESA. The Southern Resident killer whales DPS was listed as endangered under the ESA on November 18, 2005 (70 FR 69903). A Recovery Plan for Southern Resident killer whales (NMFS 2008) was published in January 2008.

2.2 List all ESA permits or authorizations in hand for the hatchery program.

Coleman and Livingston Stone National Fish Hatcheries
Legislative authorizations for the Coleman NFH do not identify the hatchery by name but, rather, authorities for the Coleman NFH fall into the realm of "defacto" authorizations. The Coleman NFH is authorized as a mitigation[1] facility for the CVP. Coleman NFH was created to partially compensate for fishery losses resulting from the construction of Shasta Dam. It is the policy of the Service to seek and mitigate losses of fish, wildlife, their habitats and uses thereof from land and water developments. Mitigation policies and objectives of the Service are described in the U.S. Fish and Wildlife Service Mitigation Policy dated January 23, 1981 (46 FR 7644). As part of the overall CVP, Coleman NFH is authorized through the following documents and legislation:

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[1]The Service has adopted the definition of "mitigation", as presented in the National Environmental Policy Act regulations, to include: "(a) avoiding the impact altogether by not taking a certain action or parts of action; (b) minimizing impacts by limiting the degree or magnitude of the action and its implementation; (c) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; (d) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and, (e) compensating for the impact by replacing or providing substitute resources or environments." (40 FR 1508).

The Shasta Dam on the upper Sacramento River was constructed by the United States Government, under authority of the *Reclamation Act of June 17, 1902*. The Shasta Dam and power plant are the principal features of the CVP (16 U.S. C 695d-695j): a series of dams, diversions, and canals constructed for the improvement of Central Valley navigation, flood control, irrigation, salinity control, and electric power generation. The CVP was first established under the authority of the *Emergency Relief Appropriations Act* (Chapter 48, April 8, 1935; 49 Stat. 115). *The First Deficiency Appropriation Act* of 1936 (Chapter 689; June 22; 74 Stat. 1622) formally authorized federal funds for the CVP by name. The CVP was subsequently reauthorized by *The River and Harbor Act* (Chapter 832; August 26, 1937; 50 Stat 844, 850) and the following additional statutes:

Chapter 895; October 17, 1940; 54 Stat. 1198 and 1199
Chapter 690; October 19, 1949; 63 Stat 852
Chapter 1047; September 26, 1950; 64 Stat 1036.

Public Law 83-674 (August 27, 1954; 68 Stat. 879) declared use of CVP water for fish and wildlife as a project purpose in addition to all other previously stated purposes. Public Law 95-616 (November 8, 1978; Stat. 3115) amended the 1954 Act to guarantee the delivery of 3,000 acre- feet of water each fall and 4,000 acre- feet of water each summer to aid salmonid populations. The *Reclamation Projects Authorization and Adjustment Act* of 1992 (Public Law 102-575; October 30, 1992; 106 Stat. 4600), also called the CVPIA, amended the CVP to address the project impacts on fish and wildlife resources including provisions to protect, restore, and enhance fish and wildlife and their habitats.

In 1941, construction of the Shasta Dam permanently blocked salmon and steelhead from accessing their historic principal spawning and rearing areas in the Sacramento, Pit, and McCloud rivers and their tributaries. The federal government assumed responsibility for preserving the runs of migratory salmon and steelhead blocked by the Shasta Dam. Biological investigations of the effects of the Shasta Dam on anadromous fisheries were initiated at the time when dam construction began. Fisheries investigations were financed by the Reclamation, under the supervision of the U.S. Bureau of Fisheries (now U.S. Fish and Wildlife Service), and under the authority of the *Act of March 10, 1934* entitled an "Act to promote the conservation of wildlife, fish, game, and for other purposes." Section 3 of that act authorized the "Bureau of Fisheries to make surveys of the wild-life resources of the public domain, or of any lands owned or leased by the Government, to conduct such investigations as may be necessary for the development of a program for the maintenance of an adequate supply of wild-life in these areas…" The three primary fishery salvage investigations in relation to Shasta Dam were:

1) "An Investigation of Fish-salvage Problems in Relation to Shasta Dam," Special Scientific Report No. 10 by H. Hanson, Bureau of Reclamation, O. Smith and P. Needham, Bureau of Fisheries, 1940.

The authors stated "Responsibility for saving the runs of migratory salmon and steelhead which will be blocked by Shasta Dam has been assumed by the Government…." This report describes three plans which contain components of artificial and natural propagation for salvaging runs of Sacramento River salmon.

2) "Report of the Board of Consultants on the Fish Problems of the Upper Sacramento River," by R. Calkins, W. Durand, and W. Rich, July, 1940.

This report recommended the salvage plan of Hanson, Smith, and Needham with the recommendation of "continuing study of the results of artificial propagation."

3) "Supplementary Report on Investigations of Fish-salvage Problems in Relation to Shasta Dam," Special Scientific Report No. 26 by P. Needham, H. Hanson, and L. Parker, June 1943.

This report updated the position of the status plan recommended by the Board of Consultants and accepted by the Reclamation and outlines the facilities required to carry out this plan, including the construction of the Coleman NFH to partially compensate for the loss of salmon caused by the Shasta Dam.

Additional descriptions of roles and responsibilities of Coleman and Livingston Stone NFHs are contained within the following authorities:

Fish and Wildlife Coordination Act (March 10, 1934; 48 Stat. 401)
Fish and Wildlife Act of 1956 (August 8, 1956; 70 Stat. 1119)
Endangered Species Act of 1973 (December 28, 1973; 87 Stat. 884-903)
Reclamation Projects Authorization and Adjustment Act of 1992 (CVPIA; October 30, 1992; 106 Stat. 4714-4731).

The Reclamation assumed the responsibility for funding the construction and early fish culture operations at the Coleman NFH. Custody and fiscal responsibility of the Coleman NFH were subsequently transferred to the Service upon finding that "salmon runs above Shasta Dam appear to have become established below the dam in numbers equal to the numbers existing before the dam was built" (Memorandum of Agreement dated September 21, 1948). A subsequent audit by the Inspector General in 1991 concluded that mitigation costs associated with fishery damages were reimbursable and could be recovered by Reclamation from project beneficiaries. In that audit, the Coleman NFH was affirmed to be part of the overall CVP. Two years later, on March 19, 1993, an Interagency Agreement between the Bureau of Reclamation and Fish and Wildlife Service resolved that future financial responsibilities for Coleman NFH operations, maintenance, and evaluation were re-assumed by the Reclamation, to be properly allocated among CVP beneficiaries. This agreement superseded all previous agreements made between the Reclamation and the Service regarding the Coleman NFH.

2.3 ESA Permits

Section 7 Permitting History:

Programs:	Artificial propagation of non-listed hatchery-origin fall and late-fall Chinook salmon and steelhead
Current Permit:	Section 7 Biological Opinion covering propagation of non-listed salmonids at Coleman NFH
Issue Date:	February 18, 1999
Expiration Date:	December 31, 1999, the Service is currently operating under an extension of this permit

In accordance with incidental take requirements of the ESA, the Service initially submitted a Section 7(a)(2) Biological Assessment covering effects of artificial production of non-listed stocks at Coleman NFH on endangered winter Chinook salmon in November 1993 (Service 1993). The resultant Biological Opinion issued by NMFS on February 14, 1994, concluded the operation of Coleman NFH for non-listed salmonids "…is not likely to jeopardize the continued existence of winter-run Chinook salmon or result in the destruction or adverse modification of its critical habitat" (NMFS 1994). This Biological Opinion expired on 31 December 1996.

The Service submitted another Biological Assessment in October 1996 (Service 1996a) and was granted non-jeopardy coverage for hatchery programs for an additional two years, through December 31, 1998 (NMFS 1996). At that time, NMFS requested the Service initiate a comprehensive review of all Coleman NFH propagation programs prior to the expiration of that permit (Letter from Hilda Diaz-Soltero, NMFS Regional Director, to Mike Spear, Service Regional Director, dated December 23, 1996). The programmatic review was to re-examine the future role of Coleman NFH in helping to restore declining stocks of salmonids in the Central Valley, given the likelihood that steelhead, spring Chinook, and other Chinook populations in the Central Valley would continue to decline and become listed.

The Service initiated the Coleman NFH Re-evaluation Process during 1998. Due to the large scope of this project, however, substantial work remained when the Service's Biological Opinion was due to expire on December 31, 1998. On October 16, 1998, the Service submitted a project description and impact assessment to NMFS and requested to amend the 1996 Biological Opinion, extending Section 7 coverage for the expected duration of the Coleman NFH Re-evaluation Process. Short-term non-jeopardy coverage for hatchery programs was provided through December 1999 by the NMFS Biological Opinion dated February 18, 1999.

In late 1999, the Service re-initiated Section 7 consultation with NMFS in anticipation of the expiration of the existing Biological Opinion and the recent listing (September 1999) of spring Chinook salmon. A Biological Assessment was submitted to NMFS in June 2001. Later that month, the Service submitted to NMFS several key appendices to the biological assessment for insertion into the final document. This current biological assessment updates the information from the 2001 Biological Assessment, and provides an up-to-date description of hatchery facilities and operations. In October, 2001, NMFS extended the ESA coverage of the 1999 Coleman NFH biological opinion through December 31, 2001. The biological opinion was further extended through March 1, 2002, in order to allow NMFS time to complete their analysis of the effects of the proposed hatchery actions on listed salmonids. During February 2002, the Service sent a letter to inform NMFS of the commitment by the Service to re-initiate formal consultation for operation of Coleman NFH and Livingston Stone NFH upon completion of the Battle Creek Salmon and Steelhead Restoration Project. This action was prompted by concerns of the Greater Battle Creek Watershed Working Group regarding the timing of future section 7 consultations for Coleman NFH with restoration actions in Battle Creek. The Service subsequently initiated Essential Fish Habitat consultation on the facilities and operations of the Coleman NFH and Livingston Stone NFH in July 2003.

Since submittal of the biological assessment in June, 2001, several modifications to the project description have been provided to NMFS to account for proposed changes to operational strategies and program goals. Several modifications associated with the hatchery's steelhead program occurred between 2001 and 2003. In December, 2001, the Service submitted an addendum to the June 2001 Biological Assessment, explaining the intent of the Service to allow passage of adult hatchery steelhead above the Coleman NFH barrier weir in Battle Creek as a population supplementation action. Later that month, the Service submitted to NMFS a description of the proposed protocol for collecting tissue samples from non-marked steelhead at Coleman NFH, to investigate the potential for using the hatchery stock in restoration efforts in Battle Creek. The NMFS responded via letters to Service in January and February of 2002, clarifying the Federal non-listed status of Coleman NFH steelhead, and the need for a scientific basis regarding further hatchery steelhead supplementation in Battle Creek. In April, 2002, the Service requested NMFS' participation in a multi-agency meeting to investigate and recommend a strategy for managing returning steelhead adults in excess of broodstock needs at Coleman NFH, for the 2002-2003 spawning season. Representatives from Service, Reclamation, CDFG, and NMFS met in May, 2002 to discuss potential strategies for managing excess adult Coleman NFH steelhead during the 2002-2003 spawning season. Eleven management alternatives were suggested, and a decision tree was developed to further discuss the alternatives at a planned future meeting. The Service subsequently submitted a letter of justification to NMFS on a proposal to allow passage of surplus hatchery steelhead above the Coleman NFH barrier weir, based on the origin and genetic relationship of the hatchery steelhead to the natural steelhead population in Battle Creek. A consensus decision was reached among the Service, Reclamation, CDFG, and NMFS during September to release adult hatchery steelhead above the Coleman NFH during the 2002-2003 migration and spawning season, and on October 31, 2002, NMFS co-signed a letter of support for this action with the Service, Reclamation, and CDFG. The action of releasing hatchery origin steelhead upstream of the Coleman NFH barrier weir was discontinued by the Service in 2004, upon recommendation of an independent panel assembled by CALFED.

In June, 2005, the Service informed NMFS of the results of planting Coleman NFH steelhead into Keswick Reservoir. Based upon steelhead escapement from the reservoir and their recapture downstream, the Service discontinued the outplanting effort to prevent impact to the natural anadromous steelhead in the upper Sacramento River.

In October, 2003, the Service submitted to NMFS a modification to the 2001 Biological Assessment for the collection of natural steelhead for incorporation as Coleman NFH broodstock. In December 2004, the Service submitted a modification to the collection strategy to also include natural origin late-fall Chinook salmon to be used as broodstock at the Coleman NFH.

The Service also reinitiated consultation for activities associated with the Coleman NFH water intakes. In January, 2005, the Service informed NMFS of a modification to their fish salvage plan for Coleman NFH through an experimental "real-time" fish rescue effort that was conducted in May, June, and August, of 2005. In a letter to NMFS, dated April 7, 2006, the Service provided a revised estimate of incidental take of ESA-listed anadromous salmonids at the Coleman NFH water intakes, precipitated by a forced change in hatchery operations. Damage to the Pacific Gas & Electric (PG&E) Coleman Powerhouse on December 2, 2005, prevented routing of stream flow through the powerhouse and made the hatchery's primary water supply intake (Intake 1) non-functional. Coleman NFH relied on its unscreened backup water supply, Intake 2, until the repairs were completed and Intake 1 made functional again.

In a letter to NMFS, dated December 1, 2008, the Service described a proposed modification to the release strategy for late-fall Chinook. The newly proposed strategy would attempt to time the releases of late-fall Chinook to coincide with high flow and turbidity events, and the peak of smoltification of hatchery late-fall Chinook.

Section 10 Permitting History:

Program:	Artificial propagation, enhancement, and associated monitoring projects for ESA-listed hatchery-origin winter Chinook salmon
Current Permit:	Section 10 Enhancement Permit (No. 1,027) authorizing the winter Chinook salmon propagation and captive broodstock programs, and associated monitoring projects
Issue Date:	January 31, 1997
Expiration Date:	July 31, 2001

The Service's initial permit application, requesting take of ESA-listed winter Chinook salmon under section 10 of the ESA, was submitted to NMFS on July 13, 1990 (Service 1990). Both the winter Chinook salmon captive propagation and captive broodstock programs subsequently received coverage under the section 10 permit # 747, dated August 8, 1991 (NMFS 1991). This permit authorized the Service's directed-take activities of winter Chinook for both scientific and enhancement purposes. Because of the complexity and rapid evolution of these programs, this permit was modified several times over the following six years.

In 1995, the discovery of two problems necessitated significant alterations to the Service's winter Chinook propagation program. Monitoring conducted by the Service's Northern Central Valley Fish and Wildlife Office (now the RBFWO) revealed that adult winter Chinook salmon were returning to Battle Creek and not the mainstem Sacramento River, the intended target of the supplementation program (Service 1996b). Additional data provided genetic evidence suggesting the interbreeding of winter Chinook salmon with spring Chinook salmon in the hatchery population (Hedgecock et al. 1995). In combination, these findings raised questions as to the program's ability to: 1) supplement the natural population in the mainstem Sacramento

River; and, 2) maintain the genetic integrity of the ESA-listed species.

In light of the above findings, and in conjunction with a section 10 permit extension, NMFS imposed a temporary (90-day) moratorium on the capture of adult winter Chinook salmon in the mainstem Sacramento River prior to the 1995-1996 trapping season (i.e., December-August). In a series of meetings held during the week of January 8, 1996, the Service announced that the verification of these findings and analyses of potential solutions would be examined during 1996. However, as the problems were not likely to be resolved early in the year, the Service proposed to extend the moratorium on the capture of adult Sacramento River winter Chinook salmon for the entire year (1996). Following this announcement, the NMFS further extended permit #747 until November 30, 1996.

During October 1996, the Service submitted a section 10 permit application to NMFS, again proposing to extend the moratorium on the capture of natural-origin winter Chinook adults for another year (through 1997), or until concerns about imprinting and genetic identification of broodstock were addressed. NMFS responded with another short-term extension to permit #747 and, shortly thereafter, issued a new ESA section 10 permit (#1,027; 31 January 1997) to completely replace permit #747 (NMFS 1997).

On February 20, 1998 the Service submitted to NMFS a section 10 permit supplement requesting re-authorization of the winter Chinook propagation program, contingent upon implementing a strategy to address concerns regarding imprinting and broodstock selection methods. An addendum to the permit supplement was subsequently submitted to NMFS on June 30, 1998. The addendum provided information on advances made in genetic identification of winter Chinook salmon and the completion of Livingston Stone NFH, built to rear and imprint winter Chinook salmon to the mainstem Sacramento River. The Service's winter Chinook salmon propagation program was fully re-authorized by NMFS on March 13, 1998. In 2003, the Service submitted a request to reauthorize the section 10 permit for the winter Chinook supplementation program.

All information submitted to NMFS (i.e., permit applications and permit supplements) were also provided to CDFG to satisfy CESA permitting requirements. Based on that information, Memoranda of Understandings were developed between CDFG and the Service for the winter Chinook artificial propagation and captive broodstock programs. The Service's winter Chinook salmon propagation program was re-authorized by CDFG on March 11, 1998.

2.4 Description of ESA-listed anadromous and marine fish populations affected by the program

Information presented below summarizes biological information and life history characteristics of ESA-listed and non-listed salmonid populations potentially affected by artificial propagation programs at Coleman and Livingston Stone NFHs. General information is presented on geographic distribution and life history characteristics of natural stocks co-occurring with Chinook salmon and steelhead from Coleman NFH. Greater detail of biological and environmental information can be found for ESA-listed stocks of winter Chinook salmon in NMFS (1997; 2009b), for spring Chinook salmon in CDFG (1998) and Myers et al. (1998), and for steelhead in Busby et al. (1996) and McEwan and Jackson (1996). Additional life history and biological information on ESA-candidate species fall and late-fall Chinook salmon can be found in Myers et al. (1998).

Sacramento River Winter Chinook Salmon

Since the construction of Shasta Dam, spawning habitat for winter Chinook salmon has been limited to the upper Sacramento River, primarily between Shasta Dam and Red Bluff (Hallock and Fisher 1985, NMFS 1997). Migrating winter Chinook salmon generally arrive at RBDD between mid-December and early August. Most migrating winter Chinook adults pass RBDD between January and May, with numbers peaking in March. Winter Chinook spawning occurs from mid-April through mid-August, with most spawning activity occurring in May and June. Hallock and Fisher (1985) estimated age structure of spawning winter Chinook as follows: 25% age-2, 67% age-3, and 8% age-4. However, this study only included three brood years (one generation) of spawning fish. Fisher (1994) later reported that most females mature at age-3 (1% age-2, 91% age-3, and 8% age-4). Information on age structure of more recent brood years are in preparation, using data collected from adults at the Keswick Dam fish trap.

Size and sex ratio data for spawning winter Chinook salmon are available for adults captured during 1998 through 2008 at the Battle Creek barrier weir, RBDD fish trap, and Keswick Dam fish trap (Table 2-1). Adult males ranged between 391 and 1,151 millimeter (mm) fork length (FL), and females ranged between 500 and 960 mm FL. Approximately 2% of female and 35% of male winter Chinook salmon collected were less than 620 mm (Service, RBFWO, unpublished data); this length is roughly associated with age-2 spawners. Male winter Chinook outnumbered females in seven of ten years, with an average male-to-female sex ratio 1.1 to 1. Winter Chinook eggs incubate and hatch in about two months, depending on water temperatures. Juveniles emerge between the end of June and mid-October (Vogel and Marine 1991). Juvenile winter Chinook salmon generally emigrate between August and April, with peak emigration rates in September (Johnson and Martin 1997; Service 2008a). Juvenile winter Chinook salmon enter saltwater at approximately 120 mm FL (Fisher 1994).

Table 2-1. Size ranges, means, and sex ratios of spawning winter Chinook salmon captured at the Coleman NFH barrier weir, Red Bluff Diversion Dam, and Keswick Dam for 1998-20008[a,b].

Return Year	Males				Females				Sex Ratio (♂ to ♀)
		Fork Length (mm)				Fork Length (mm)			
	Number	Min	Max	Mean	Number	Min	Max	Mean	
1998	42	621	833	724	63	523	781	674	0.7 to 1
1999	14	492	772	578	10	610	782	678	1.4 to 1
2000	48	391	958	678	57	673	886	768	0.8 to 1
2001	116	445	1,151	688	89	584	845	737	1.3 to 1
2002	90	450	1,000	693	104	665	828	750	0.9 to 1
2003	114	412	1,000	674	123	538	880	750	0.9 to 1
2004	255	420	935	587	65	640	881	757	3.9 to 1
2005	164	475	1,000	786	212	620	910	779	0.8 to 1
2006	160	490	1,000	829	149	620	900	776	1.1 to 1
2007	79	430	1,000	819	75	680	960	789	1.1 to 1
2008	96	450	930	763	98	500	890	778	1.0 to 1
Overall	1,178	391	1,151	712	1,045	500	960	736	1.1 to 1

a. Source: U.S. Fish and Wildlife Service unpublished data.
b. Winter Chinook salmon were identified through genetic analyses. Genetic analyses for 1998 to 2003 were conducted by Bodega Marine Laboratory, University of California-Davis, Bodega, California. Genetic analyses for 2004 to 2008 were conducted by the Abernathy Fish Technology Center, Service, Longview, Washington.

Central Valley Spring Chinook Salmon
Current spawning habitats for spring Chinook salmon are restricted to the upper Sacramento River (below Keswick Dam), a few larger east-side tributaries (including Mill, Deer, and Butte creeks), Clear Creek, Battle Creek, and a remnant population in Beegum Creek. Migration of adult spring Chinook salmon in the upper Sacramento River begins in late-March. Historical accounts suggest that spring Chinook salmon migration continued until October, peaking July through September. However, recent data for spring Chinook populations in Mill and Deer creeks show adult migrations occurring primarily from March through June, peaking during the month of May (Colleen Harvey-Arrison, CDFG, Red Bluff, pers. comm.). Changes in timing of migration apparently occurred after the construction of Shasta Dam, and indicate possible hybridization with fall Chinook salmon (CDFG 1998). Spring Chinook spawning occurs from mid-August through October and peaks in late September. Data on age and sex ratios of upper Sacramento River spring Chinook spawners are not currently available.

Age at emigration varies; spring Chinook salmon have been captured emigrating as fry, fingerlings, and yearlings (CDFG 1998, Service 2002). Newly-emerged spring Chinook fry begin migrating past RBDD in November. Emigration continues through April, with the largest numbers of juveniles passing RBDD as fry in December and January (Johnson and Martin 1997).

Spring Chinook salmon undergo physiological changes that enable transition to saltwater at about 80 mm FL (Fisher 1994).

Central Valley Steelhead

Life history characteristics for steelhead are highly variable. Adult steelhead pass RBDD throughout the year. Most of the migrating adults arrive between the end of August and the end of November, with peak numbers passing in late September and early October. Spawning occurs between late December and early May, peaking in February (Hallock 1989, Busby et al. 1996).

Hallock (1989) reports age structure of naturally-spawning steelhead as follows: 17% age-2, 41% age-3, 33% age-4, 6% age-5, and 2% age-6. Most steelhead spawn once then die, but repeat spawning does occur, mostly among females. Analysis of scale data indicated 83% were first-time spawners, 14% were second-time spawners, 2% were spawning for the third time, and 1% spawned for the fourth time (Hallock 1989). Sex ratios for naturally-spawning populations of steelhead in the Sacramento River are not available, but overall sex ratio of steelhead along the west coast of the US is thought to be 1 to 1 (Pauley et al. 1986).

Steelhead eggs generally hatch in four to seven weeks, and fry emerge one to two weeks after hatching (Pauley et al. 1986). Juvenile steelhead may emigrate soon after emergence, or spend one to two years in freshwater before their seaward migration. Hallock (1989) reported a small percentage of steelhead rear for three years in freshwater before smolting. Most steelhead fry disperse downstream past the RBDD shortly after emergence from the gravels (Service 2002). Newly-emerged steelhead fry emigrate from the upper Sacramento River in two temporal peaks annually. Steelhead fry (≈50 mm) typically begin to pass RBDD in February and downstream movement continues through August. A second, distinct peak of steelhead fry typically begins to pass RBDD in early-July and continues through November (Johnson and Martin 1997, Service 2002).

Southern DPS of North American Green Sturgeon

Adult green sturgeon begin their upstream spawning migrations into the Central Valley in late February with spawning occurring between March and July (CDFG 2002. Heublin 2006, Heublin *et al.* 2009, Vogel 2008). Kelly *et al.* (2007) indicated that green sturgeon enter the San Francisco Estuary during the spring and remain until autumn. Peak spawning is believed to occur between April and June in deep, turbulent, mainstem channels over large cobble and rocky substrates with crevices and interstices. Sexually mature female green sturgeon are typically 13 to 27 years old and have a total body length (TL) ranging between 145 and 205 cm (Nakamoto *et al*. 1995, Van Eenennaam *et al.* 2006). Male green sturgeon become sexually mature at a younger age and smaller size than females. Typically, male green sturgeon reach sexual maturity between 8 and 18 years of age and have a TL ranging between 120 cm to 185 cm (Nakamoto *et al.* 1995, Van Eenennaam *et al.* 2006). Females broadcast spawn their eggs over this substrate, while the male releases its milt (sperm) into the water column. Fertilization occurs externally in the water column and the fertilized eggs sink into the interstices of the substrate where they develop further (Kynard *et al.* 2005, Heublin *et al.* 2009).

After spawning, the adults hold over in the upper Sacramento River between RBDD and GCID until November (Heublein et al. 2009). Heublein et al. (2006 and 2009) has documented the presence of adults in the Sacramento River during the spring and through the fall into the early winter months. These fish hold in upstream locations prior to their emigration from the system later in the year. Downstream migration appears to be triggered by increased flows, decreasing water temperatures, and occurs rapidly once initiated. Some adults rapidly leave the system following their suspected spawning activity and re-enter the ocean in early summer (Heublin 2006). This behavior has also been observed on the other spawning rivers (Benson *et al. 2007)* but may have been an artifact of the stress of the tagging procedure in that study. The remainder of the adult's life is generally spent in the ocean or near-shore environment (bays and estuaries) without venturing upriver into freshwater.

Green sturgeon larvae hatch from fertilized eggs after approximately 169 hours at a water temperature of 15°C (Van Eenennaam *et al.* 2001, Deng *et al*. 2002), which is similar to the sympatric white sturgeon development rate (176 hours). Van Eenennaam *et al.* (2005) indicated that an optimum range of water temperature for egg development ranged between 14°C and 17°C. Newly hatched green sturgeon are approximately 12.5 to 14.5 mm in length and have a large ovoid yolk sac that supplies nutritional energy until exogenous feeding occurs. At 10 days of age, the yolk sac has become greatly reduced in size and the larvae initiates exogenous feeding through a functional mouth.

Green sturgeon larvae are strongly oriented to the bottom and exhibit nocturnal activity patterns. After 6 days, the larvae exhibit nocturnal swim-up activity (Deng *et al*. 2002) and nocturnal downstream migrational movements (Kynard *et al.* 2005). Juvenile fish continue to exhibit nocturnal behavioral beyond the metamorphosis from larvae to juvenile stages. Kynard *et al*.'s (2005) laboratory studies indicated that juvenile fish continued to migrate downstream at night for the first 6 months of life. When ambient water temperatures reached 8°C, downstream migrational behavior diminished and holding behavior increased. This data suggests that 9 to 10 month old fish would hold over in their natal rivers during the ensuing winter following hatching, but at a location downstream of their spawning grounds.

Southern Resident Killer Whales

The Southern Resident DPS of killer whale consists of three pods, identified as J, K, and L pods, that reside for part of the year in the inland waterways of Washington State and British Columbia. The geographic ranges of Southern and Northern Residents overlap considerably; however, genetic analysis indicates that these social groupings are most likely reproductively isolated from each other (Hoelzel et al. 1998, Barrett-Lennard 2000, Barrett-Lennard and Ellis 2001). Clans are composed of pods with similar vocal dialects. All three pods of the Southern Residents are part of the J clan.

Southern Residents are a long-lived species, with late onset of sexual maturity (review in NMFS 2008). Maximum life span is estimated to be 80-90 years for females and 50-60 years for males (Olesiuk et al. 1990). Females produce a low number of calves over the course of their reproductive life span (an average of 5.3 surviving calves over an average reproductive lifespan of 25 years; Olesiuk *et al*. 2005). Mothers and offspring maintain highly stable social bonds throughout their lives, which is the basis for the matrilineal social structure in the Southern Resident population (Bigg *et al*. 1990, Baird 2000, Ford *et al*. 2000).

Resident whales spend about 50-67 % of the time foraging (Heimlich-Boran 1988, Ford 1989, Morton 1990, Felleman et al. 1991). Resident whales are known to consume 22 species of fish and one species of squid, including salmon, rockfish, herring, lingcod, greenling, and flatfish (Scheffer and Slipp 1948, Ford et al. 1998, Ford and Ellis 2005, Saulitis et al. 2000). Published information of fish predation comes mostly from field observations focused primarily on Northern Residents, which showed that salmon represent over 96% of prey during summer and fall. Chinook salmon are selected preferentially over other species of salmon, presumably because of the species' large size and high fat and energy content. Southern Residents are large mammals with high energy requirements.

The seasonal timing of salmon spawning runs may influence the migratory patterns of Southern Residents to coincide with the congregations of salmon prior to their movement into freshwater. Southern Residents spend considerable time from late spring to early autumn in inland waterways of Washington State and British Columbia (Strait of Georgia, Strait of Juan de Fuca, and Puget Sound; Bigg 1982, Ford *et al*. 2000, Krahn *et al*. 2002). Typically, J, K and L pods are increasingly present in May or June and spend considerable time in the core area of Georgia Basin and Puget Sound until at least September. During this time, pods (particularly K and L) make frequent trips from inland waters to the outer coasts of Washington and southern Vancouver Island, which typically last a few days (Ford *et al*. 2000). Late summer and early fall movements of Southern Residents in the Georgia Basin have remained fairly consistent since the early 1970s, with strong site fidelity shown to the region as a whole; however presence in inland waters in the fall has increased in recent years (NMFS 2008). During early autumn, J pod in particular expands their routine movements into Puget Sound, likely to take advantage of chum and Chinook salmon runs (Osborne 1999). Some sightings in Monterey Bay, California have also coincided with large runs of salmon, with feeding witnessed in 2000 (Black *et al*. 2001). However, when Southern Residents were sighted in Monterey Bay during 2008, salmon runs were expected to be very small. L pod was also seen feeding on unidentified salmon off Westport, Washington, in March 2004 during the spring Chinook salmon run in the Columbia River (Krahn *et al*. 2004). During late fall, winter, and early spring, the ranges and movements of the Southern Residents are less well known. Sightings through the Strait of Juan de Fuca in late fall suggest that activity shifts to the outer coasts of Vancouver Island and Washington (Krahn *et al*. 2002).

2.5 Description of non-listed salmonid populations affected by the program

Fall and late-fall Chinook salmon are not listed under the ESA or CESA at present. Natural populations of these Central Valley stocks are identified as candidates for listing (September 16, 1999, 50 FR 50394).

Central Valley Fall Chinook Salmon

Fall Chinook are the most abundant run of salmon in the Central Valley. Central Valley fall Chinook are supported by a large-scale hatchery programs that produce a total of approximately 32 million juveniles annually. Migrating adult fall Chinook salmon begin passing RBDD in late

July. Their migration continues through late November, with peak numbers arriving in the upper Sacramento River in October. Spawning occurs between October and December, with peak spawning in November (Vogel and Marine 1991). From 1996 to 1999, sex ratios of naturally spawning fall Chinook salmon averaged 0.86 males to each female (range 0.6 to 1 males to 1 female). Fork lengths of females ranged from 450 to 1,070 mm FL, with an average of 800 mm. Fall Chinook males ranged between 350 and 1,130 mm FL, and averaged 812 mm (Snider et al. 1997b, 1998a, 1999a, 2000b).

Juvenile fall Chinook salmon generally emigrate from the upper river as fry. Fall Chinook emigration occurs between the months of December and June, with a peak in January (Johnson and Martin 1997, Martin et al. 2000). Fall Chinook are estimated to be 80 mm FL upon entry to saltwater (Fisher 1994).

Central Valley Late-fall Chinook Salmon
Late-fall Chinook adults begin passing RBDD in late October. Their migration continues through March, with peak numbers arriving in the upper Sacramento River in December and January. Late-fall Chinook spawning occurs between January and April, with peak spawning in February and March (Vogel and Marine 1991).

In the late-fall Chinook upper Sacramento River escapement survey, Snider et al. (1999b) observed adult females ranging from 520 to 1,020 mm FL (mean 821), and males ranging from 340 to 1,050 mm FL (mean 924). The sex ratio of carcasses recovered was 0.5 males for each female. Data collected from late-fall Chinook salmon trapped at Keswick Dam in 1995 and 1996 show a sex ratio of 0.7 males to 1 female (Service RBFWO unpublished data). Age structure of the naturally-spawning population of late-fall Chinook salmon is currently unknown. Juveniles emigrate past RBDD from April through January, with higher numbers in April and May (Johnson and Martin 1997). Late-fall Chinook salmon are about 160 mm FL upon entering saltwater (Fisher 1994).

2.6 ESA-listed and non-listed populations that will be directly affected by the program

Sacramento River Winter Chinook Salmon (Endangered)
The Sacramento River winter Chinook salmon ESU will be directly affected by the propagation program at the Livingston Stone NFH. Hatchery-origin adults are intended to spawn with the natural-origin population of winter Chinook salmon in the upper Sacramento River and integrate into the naturally spawning population.

Central Valley Steelhead (Threatened)
The steelhead propagation program at the Coleman NFH will directly affect the ESU of ESA-listed Central Valley steelhead. Hatchery-origin steelhead are included in the ESU of Central Valley steelhead. Adult hatchery-origin steelhead are collected at the Coleman NFH and spawned as broodstock. Juvenile steelhead are released from the hatchery into the wild. Hatchery-origin steelhead are not intended to spawn naturally, nor are natural-origin steelhead currently being incorporated into the hatchery broodstock.

Central Valley Fall and Late-Fall Chinook Salmon (Candidate Species)
Fall and late-fall Chinook salmon populations will be directly affected by fish propagation programs at Coleman NFH. Fall and late-fall Chinook salmon propagation programs at Coleman NFH are managed to integrate hatchery stocks with the naturally-spawning fish in Battle Creek and the mainstem Sacramento River, respectively. Integration between hatchery and natural stocks is conducted to reduce domestication, inbreeding, and genetic drift in hatchery populations. To integrate hatchery and natural populations of fall Chinook, natural-origin adults are collected in Battle Creek and incorporated as hatchery broodstock. Hatchery-origin fall Chinook adults also spawn with natural-origin fish below the barrier weir in Battle Creek. To integrate hatchery and natural populations of late-fall Chinook, natural-origin adults are collected from the mainstem Sacramento River and used as hatchery broodstock.

2.7 ESA-listed populations that may be <u>incidentally</u> affected by the program.
Sacramento River winter Chinook, Central Valley spring Chinook, the southern Distinct Population Segment (DPS) of North American Green Sturgeon, and Southern Resident killer whale may be incidentally affected by artificial propagation programs at Coleman NFH and Livingston Stone NFH.

2.8 Status of ESA-listed populations affected by the program
Sacramento River Winter Chinook Salmon
Historically, winter Chinook salmon were abundant and comprised of populations in the McCloud, Pit, Little Sacramento, and Calaveras rivers. Most of these populations have been isolated from historic spawning and rearing habitats by the construction of Shasta Dam. Currently, the ESU is mostly confined to the mainstem Sacramento River below Keswick Dam, and a small remnant population may also exist in Battle Creek. Population estimates for winter Chinook salmon were historically derived by counting passage through the fish ladders at the RBDD. Currently, winter Chinook spawner estimates are derived by conducting a carcass survey using mark-and-recapture methods. Based on passage estimates at RBDD, the Sacramento River winter Chinook salmon population reached a low abundance in 1994 when an estimated 189 adults passed above RBDD (Table 2-2). From 1967 through the early 1990s, the Sacramento River winter Chinook salmon population declined at an average rate of 18% per year, or roughly 50% per generation. Since the early 1990s, the winter Chinook salmon population has generally shown signs of increasing abundance. The average spawner abundance for winter Chinook salmon from 2001 - 2008 is 8,693. Recent estimates for spawner replacement ratios are as follows: 1 to 1 (2001-2004), 2.1 to 1 (2002-2005), 2.1 to 1 (2003-2006), 0.3 to 1 (2004-2007), and 0.2 to 1 (2005-2008) (Service RBFWO unpublished data). Estimated number of natural-origin winter Chinook juveniles emigrating past the RBDD on the upper Sacramento River from 2002 to 2006 averaged over 6.8 million, ranging between 3,758,790 and 8,941,241 (Standard Deviation [SD]=2,062,045; Service 2008a).

Newly developed recovery criteria for winter Chinook salmon have been proposed by NMFS (2009b) and included in the draft recovery plan for ESA-listed Central Valley salmonids. The new recovery criteria incorporate four parameters into the assessments of population viability, including: diversity, spatial structure, productivity, and abundance. Recovery scenarios have been developed based on ESU, population, and ecological considerations to identify combinations of populations and population and habitat status levels that meet biological and threat abatement recovery criteria for the species. Considerations for the viability of the winter Chinook ESU depends on the number of populations, their individual status, their spatial arrangement with respect to each other, sources of catastrophic disturbance, and diversity of the populations and their habitats. In general terms, viability of the winter Chinook ESU increases with the number of populations, the viability of those populations, the diversity of the populations, and the diversity of habitats they occupy (Lindley et al. 2007).

Central Valley Spring Chinook Salmon

Spring Chinook salmon were once the predominant run in the Central Valley. Present day abundance of spring Chinook has declined dramatically from historical levels. Commercial harvest data comparing average catch from 1916 through 1949 and 1950 through 1957 showed a 90% reduction in spring Chinook salmon harvest over that time period (Skinner 1958). Dam construction and habitat degradation have eliminated spring Chinook populations from the entire San Joaquin River Basin and from many tributaries to the Sacramento River Basin. Estimated spawner escapement for the Sacramento River basin population of spring Chinook salmon averaged 11,155 over the last 13 years, but yearly estimates ranged widely from just over 3,000 spawners to over 31,000 (Table 2-2). There are only a few isolated, naturally-spawning populations remaining and these all exist at relatively low levels of abundance (typically <1000) (Yoshiyama et al. 1998). Streams that support wild, persistent, and long-term documented populations of spring Chinook salmon are Mill, Deer, and Butte Creeks (CDFG 1998). Other streams that may support weak or non-persistent populations include Battle, Antelope, Cottonwood, Clear, and Big Chico Creeks (CDFG 1998). Spring Chinook salmon may also be present in the Feather River, another tributary to the Sacramento River. The extent of natural spawning by spring Chinook in the mainstem Sacramento River is unknown. Juvenile emigration data collected at the RBDD do not show a discrete emigration of spring Chinook from the upper Sacramento River; rather, most juveniles within the spring Chinook size-class appear to fit better into the leading-tail of fall Chinook distribution (Service 2002). Hybridization with fall Chinook salmon is a primary concern for naturally-spawning spring Chinook salmon in the mainstem Sacramento River and elsewhere, because of similar spawn timing and lack of spatial separation in limited geographic distribution.

Central Valley Steelhead

Run size estimates are not available for the Central Valley steelhead ESU prior to the construction of Shasta Dam. Early salvage investigations associated with the construction of Shasta Dam documented steelhead runs to the upper Sacramento River to be of “negligible” size (Hanson et al. 1940), and it is likely that steelhead populations in the upper Sacramento River had already been depleted considerably at that time. Following construction of Shasta Dam, steelhead abundance in the upper Sacramento River was believed to initially increase appreciably (Azevedo and Parkhurst 1958, Moffett 1949). Between 1953 and 1959, steelhead run-size estimates for the Sacramento River system (above Feather River) ranged from over 14,000 to over 28,000 (Hallock et al. 1961). Hallock et al. (1961) estimated a total run size of 40,000 in the Sacramento River system in the early 1960s. From 1966 through 1993 estimates of steelhead abundance in the upper Sacramento River were conducted by counting passage through the fish ladders at RBDD. Abundance of steelhead in the upper Sacramento River has declined since the

1980s. Average escapement past RBDD for the years 1966 - 1977 (15,000) is more than eight times higher than the average return for the years 1989 - 1993 (1,855), a decline of about 9% per year (Table 2-2).

A reliable estimate of present day steelhead abundance in the upper Sacramento River is not available. Standardized estimates of passage past RBDD ended in 1993 when fish ladder counts were discontinued in mid-September, thereby missing all but the earliest portion of the run. McEwan and Jackson (1996) estimated the current steelhead run size for the Sacramento River system at less than 10,000 adults. However, this should be considered a rough estimate because data are limited. Critical and viable population thresholds have not been determined for Central Valley steelhead.

Table 2-2. Fall, late-fall, winter, and spring Chinook salmon and steelhead spawner population estimates in the Sacramento River, Battle Creek, and Coleman National Fish Hatchery; 1952-2007. Estimates from the Sacramento River include estimated harvests.

	Fall Chinook[a]			Late-fall Chinook[a]		Winter Chinook[a]	Spring Chinook[a]	Steelhead [b]		
Year	Sacramento River above Red Bluff[c]	Battle Creek below Coleman NFH[d]	Coleman NFH	Sacramento River Mainstem	Coleman NFH	Sacramento River Mainstem	Sacramento River system-wide	Sacramento River above Red Bluff	Coleman NFH	Year
1952		4,000	11,000							1952
1953		4,000	12,000							1953
1954		4,000	8,000							1954
1955		16,000	10,000							1955
1956	87,357	13,650	7,458							1956
1957	54,989	2,285	3,045							1957
1958	107,153	14,600	14,643							1958
1959	256,700	19,400	10,833							1959
1960	218,940	14,200	9,605				11,068			1960
1961	140,181	11,700	8,158				4,327			1961
1962	127,837	8,200	4,857				3,642			1962
1963	138,881	12,400	5,114				10,817			1963
1964	142,584	12,000	3,875				8,021			1964
1965	101,876	6,000	3,194				1,788			1965
1966	111,881	2,400	900				427			1966
1967	82,490	2,160	3,050	37,208			476	13,488	1,532	1967
1968	98,429	2,950	3,526	34,733			663	15,771	3,229	1968
1969	115,652	3,200	2,626	38,752			21,378	9,342	4,939	1969
1970	65,142	3,320	3,512	25,310		40,409	7,672	8,423	4,406	1970
1971	53,888	3,285	2,004	16,741		53,089	9,281	7,432	3,742	1971
1972	33,958	2,030	2,882	31,559		35,929	8,844	4,272	1,486	1972

Table 2-2 (cont). Fall, late-fall, winter, and spring Chinook salmon and steelhead spawner population estimates in the Sacramento River, Battle Creek, and Coleman National Fish Hatchery, 1952-2007.

	Fall Chinook[a]			Late-fall Chinook[a]		Winter Chinook[a]	Spring Chinook[a]	Steelhead [b]		
Year	Sacramento River above Red Bluff[c]	Battle Creek below Coleman NFH[d]	Coleman NFH	Sacramento River Mainstem	Coleman NFH	Sacramento River Mainstem	Sacramento River system-wide	Sacramento River above Red Bluff	Coleman NFH	Year
1973	41,129	4,300	3,835	21,781		22,651	11,430	5,772	2,645	1973
1974	47,019	2,294	1,607	6,083		21,389	9,251	4,967	1,834	1974
1975	53,129	2,426	2,431	19,261		22,579	23,578	4,271	1,099	1975
1976	45,753	3,147	2,297	15,908		33,029	25,840	6,328	2,162	1976
1977	16,176	5,604	5,244	9,210	914	16,470	12,730	3,636	2,069	1977
1978	32,235	1,770	1,882	12,479		24,735	8,126	1,697	697	1978
1979	47,758	4,430	8,729	10,284		2,339	3,116	2,469	865	1979
1980	21,961	4,940	9,503	9,093		1,142	12,464	6,811	4,264	1980
1981	29,212	6,933	10,272	6,571	147	22,551	22,105	2,032	1,118	1981
1982	17,966	7,270	19,525	3,981	43	1,272	27,890	1,239	1,275	1982
1983	26,226	5,277	8,756	14,984	105	1,827	7,958	2,369	938	1983
1984	36,965	8,312	21,581	9,638		2,662	9,599	1,406	529	1984
1985	52,120	23,488	16,320	9,999	181	5,131	15,221	2,008	2,084	1985
1986	67,940	18,771	12,481	8,104	197	2,566	25,696	1,032	2,229	1986
1987	76,562	7,993	16,256	16,222	349	2,165	13,888	1,563	1,176	1987
1988	63,998	53,860	13,615	13,165	53	2,857	18,933	783	890	1988
1989	48,968	19,062	11,986	12,807	65	649	12,163		467	1989
1990	32,109	6,453	14,635	7,986	92	411	7,683	702	4,172	1990
1991	20,523	6,558	10,683	8,102	161	177	5,927		1,143	1991
1992	23,914	5,433	7,275	9,787	344	1,203	3,044	2,996	4,429	1992
1993	33,471	11,029	7,587	739	528	378	6,075	553	2,862	1993
1994	44,729	24,274	18,991	291	598	144	6,187		3,387	1994

Table 2-2 (cont). Fall, late-fall, winter, and spring Chinook salmon and steelhead spawner population estimates in the Sacramento River, Battle Creek, and Coleman National Fish Hatchery, 1952-2007.

	Fall Chinook[a]			Late-fall Chinook[a]		Winter Chinook[a]	Spring Chinook[a]	Steelhead [b]		
Year	Sacramento River above Red Bluff[c]	Battle Creek below Coleman NFH[d]	Coleman NFH	Sacramento River Mainstem	Coleman NFH	Sacramento River Mainstem	Sacramento River system-wide	Sacramento River above Red Bluff	Coleman NFH	Year
1995	53,385	56,515	26,677	166	323	1,166	15,238		2,185	1995
1996	71,725	52,409	21,178	48	1,337	1,012	9,082		3,106	1996
1997	98,765	50,744	50,670		4,578	836	5,086		2,529	1997
1998	5,718	53,957	44,351	39,340	3,079	2,903	31,471		1,409	1998
1999	133,365	92,929	26,970	8,683	7,075	3,264	9,835		1,755	1999
2000	87,793	53,447	21,659	8,751	4,194	1,263	9,234		1,976	2000
2001	57,792	100,604	25,082	19,276	3,327	8,120	17,698		2,294	2001
2002	45,523	397,149	66,147	36,004	2,669	7,360	17,409		3,486	2002
2003	66,476	64,764	88,281	5,494	2,797	8,133	17,570		2,688	2003
2004	34,050	23,861	68,232	8,824	5,040	7,784	13,986		1,603	2004
2005[e]	44,950	20,520	142,283	10,601	6,434	15,730	16,117		1,655	2005[e]
2006[e]	46,568	19,493	58,017	18,023	5,111	17,205	10,652		1,276	2006[e]
2007[e]	14,097	9,904	11,778	21,701	3,319	2,488	10,571		1,544	2007[e]

a Source: GrandTab; California Department of Fish and Game, Inland Fisheries Division, Sacramento.
b Source: McEwan, D. and T.A. Jackson. 1996. Steelhead Restoration and Management Plan for California. California Department of Fish and Game, Inland Fisheries Division, Sacramento.
c Sacramento River mainstem above Red Bluff includes adults captured and transferred to Coleman National Fish Hatchery, 1952-1986.
d Battle Creek below Coleman NFH includes estimated number of naturally spawning fall Chinook salmon in Battle Creek above Coleman NFH during the following years: 1958 (100); 1959 (100); 1985 (10,696); 1986 (7,263); 1987 (2,125); 1988 (1,973); and, 1989 (233).
e. Values for 2005-2007 are preliminary.

Southern DPS of North American Green Sturgeon
Green sturgeon are known to range from Baja California to the Bering Sea along the North American continental shelf. In North America, spawning populations of green sturgeon are currently found in only three river systems: the Sacramento and Klamath rivers in California and the Rogue River in southern Oregon. Data from commercial trawl fisheries and tagging studies indicate that the green sturgeon occupy waters within the 110 meter contour (Erickson and Hightower 2007). During the late summer and early fall, subadults and nonspawning adult green sturgeon frequently can be found aggregating in estuaries along the Pacific coast (Emmett *et al.* 1991, Moser and Lindley 2007). Particularly large concentrations of green sturgeon from both the northern and southern populations occur in the Columbia River estuary, Willapa Bay, Grays Harbor and Winchester Bay, with smaller aggregations in Humboldt Bay, Tillamook Bay, Nehalem Bay, and San Francisco and San Pablo bays (Emmett *et al* 1991, Moyle *et al.* 1992, and Beamesderfer *et al.* 2007). Data indicate that North American green sturgeon migrate considerable distances up the Pacific Coast into other estuaries, particularly the Columbia River estuary. This information also agrees with the results of previous green sturgeon tagging studies (CDFG 2002), where CDFG tagged a total of 233 green sturgeon in the San Pablo Bay estuary between 1954 and 2001. A total of 17 tagged fish were recovered: 3 in the Sacramento-San Joaquin Estuary, 2 in the Pacific Ocean off of California, and 12 from commercial fisheries off of the Oregon and Washington coasts. Eight of the 12 commercial fisheries recoveries were in the Columbia River estuary (CDFG 2002).

Abundance of the Southern DPS of green sturgeon is described in the NMFS status reviews (Adams *et al*. 2002, NMFS 2005). Limited information of population abundance comes from incidental captures of North American green sturgeon while monitoring white sturgeon during the CDFG's sturgeon tagging program (CDFG 2002). By comparing ratios of white sturgeon to green sturgeon captures, CDFG provides estimates of adult and sub-adult North American green sturgeon abundance. Estimated abundance between 1954 and 2001 ranged from 175 fish in 1993 to more than 8,421 in 2001, and averaged 1,509 fish per year. Unfortunately, there are many biases and errors associated with these estimates, and CDFG does not consider these estimates reliable because they are based on small sample sizes, intermittent reporting, and are drawn from inferences made from incidental catches while monitoring catch of white sturgeon.

Larval and juvenile sturgeon have been caught in traps at two sites in the upper Sacramento River: the RBDD (RM 342) and the GCID pumping plant (RM 205, CDFG 2002). Salmonid monitoring efforts at RBDD and GCID on the upper Sacramento River have captured between 0 and 2,068 larvae and juvenile green sturgeon per year (Adams *et al*. 2002). Larvae captured at the RBDD site are typically only a few days to a few weeks old, with lengths ranging from 24 to 31 mm. This body length is equivalent to 15 to 28 days post hatch as determined by Deng *et al.* (2002). Recent data indicate that very little production took place in 2007 and 2008 (13 and 3 larval green sturgeon captured in the RST monitoring sites at RBDD, respectively; Poytress 2008, Poytress *et al*. 2009).

Collections of juvenile green sturgeon at the John E. Skinner Fish Collection Facility between 1968 and 2006 can be used to make inferences on the abundance of the Southern DPS of green sturgeon. The average number of Southern DPS of green sturgeon entrained per year at the State

Facility prior to 1986 was 732. From 1986 to 2006, the average per year was 47 (April 5, 2005, 70 FR 17386). For the Harvey O. Banks Pumping Plant, the average number prior to 1986 was 889; from 1986 to 2001 the average was 32 (April 5, 2005, 70 FR 17386). In light of the increased exports, particularly during the previous 10 years, it is clear that the abundance of the Southern DPS of green sturgeon is declining.

Southern Resident Killer Whales
The historical abundance of Southern Residents is estimated from 140 to 200 whales. The minimum estimate (≈140) is the number of whales killed or removed for public display in the 1960s and 1970s added to the remaining population at the time of the captures. The maximum estimate (≈200) is based on a recent genetic analysis of microsatellite DNA (May 29, 2003, 68 FR 31980). At present, the Southern Resident population has declined to essentially the same size that was estimated during the early 1960s, when it was likely depleted (figure 4-13 in Olesiuk *et al*. 1990). Since censuses began in 1974, J and K pods steadily increased; however, the population suffered an almost 20 percent decline from 1996-2001, largely driven by lower survival rates in L pod. There were increases in the overall population from 2002-2007, however, the population declined in 2008 with 85 Southern Residents counted, 25 in J pod, 19 in K pod and 41 in L pod. Two additional whales have been reported missing since the 2008 census count.

2.9 Status of unlisted salmonid populations affected by the program

Central Valley Fall Chinook Salmon
Fall Chinook are the most abundant salmon run in the Central Valley, being supported largely by several large-scale hatcheries. Recent estimates indicate that hatcheries contribute the majority of the spawning escapement of Central Valley fall Chinook. Abundance of the Central Valley fall Chinook ESU was relatively high through 2005, perhaps near historical levels during some years (Table 2-2). However, the abundance of Central Valley fall Chinook collapsed in 2007, resulting in the closure or severe restrictions to ocean and inland fisheries for through 2010. Forecasts of fall Chinook abundance based on the return of age-2 males (Jacks) predict a rebounding of fall Chinook abundance for the 2011 return year.

Central Valley Late-fall Chinook Salmon
Abundance estimates of late-fall Chinook salmon are depressed from historic levels (Table 2-2) but have been stable relative to the dramatic fluctuations of abundance observed for Central Valley fall Chinook. In the late-1960s about 35,000 late-fall Chinook salmon annually migrated past the RBDD. Passage estimates from 1987-1992 averaged about 11,000 annually. Between 1992 and 1998, estimates of abundance of late-fall Chinook salmon migrating past RBDD were not reliable because of changes to the operation of the dam. However, carcass mark-and-recapture surveys for late-fall Chinook were initiated by CDFG in 1998. From 1998 through 2004, an average of 17,726 late-fall Chinook were estimated to return to the upper Sacramento River (GrandTab, http://www.calfish.org/IndependentDatasets/CDFGRedBluff/tabid/126/Default.aspx, CDFG).

2.10 Status of salmonid populations in Battle Creek

Fall Chinook have always comprised the largest population in Battle Creek; however, late-fall, winter, and spring Chinook salmon and steelhead are also native to the Battle Creek watershed. Early accounts by fisheries investigators report that Battle Creek was perhaps the most important tributary for salmon production in the Sacramento River (Rutter 1904). The unique hydrology and geology of the natural Battle Creek watershed ensures a reliable supply of cool water required for adult holding and spawning and year-round rearing of juveniles.

The unique hydrological characteristics that made Battle Creek such a productive stream for salmonid populations also led to the early development of Battle Creek for hydroelectric power generation and hatchery propagation. For over 100 years, naturally producing salmonid populations in Battle Creek have been affected by hydropower and hatchery activities. Clark (1928) reported that spring Chinook salmon were nearly extirpated in Battle Creek by 1928 as a result of water diversions and dams related to power generation. Hatchery propagation has occurred in Battle Creek since 1895. The peak of hatchery propagation in Battle Creek occurred in 1904 when 50 million eggs were collected from an estimated 10,000 female fall Chinook salmon at the Battle Creek Egg Taking Station (Clark 1928).

Remnant populations of naturally producing late-fall and spring Chinook salmon and steelhead exist in Battle Creek. Winter Chinook are occasionally observed in Battle Creek but do not support a viable population.

Central Valley Fall Chinook Salmon

Trends of abundance for natural-origin fall Chinook salmon are very different for Battle Creek and the upper Sacramento River (Figure 2-1). From 1956 to 1976 the majority (80 - 90%) of fall Chinook salmon migrating above RBDD spawned naturally in the mainstem Sacramento River. The remaining 10 to 20% of the fall Chinook salmon migrating past RBDD returned to Battle Creek and the Coleman NFH. Since 1977 the portion of fall Chinook salmon returning to Battle Creek relative to the mainstem Sacramento River has increased. This is attributed to substantially increased escapement to Battle Creek and decreased numbers of natural-origin fall Chinook returning to the mainstem Sacramento River. From 1995 through 1999, the abundance of naturally-spawning fall Chinook salmon in the mainstem Sacramento River averaged 46,444, whereas, an average of 95,831 fall Chinook annually entered Battle Creek. An estimated 84% of fall Chinook salmon that migrated above Red Bluff in 1998 entered Battle Creek.

Adult fall Chinook salmon returning to Battle Creek are primarily of hatchery-origin, but Battle Creek does support natural spawning of fall Chinook of mixed-origin, resulting from both hatchery and natural-production. Artificial propagation has been a major influence on fall Chinook salmon in Battle Creek since the creation of the Battle Creek Egg Taking Station in the late-1890s. Broodstock for the Battle Creek Egg Taking Station were primarily natural-origin fall Chinook salmon. Coleman NFH was created in 1942. Both hatchery- and natural-origin fall Chinook salmon have always been used as broodstock at the Coleman NFH. Integration between hatchery and natural-origin fish occurs within the hatchery and through natural spawning in Battle Creek. Most fall Chinook adults entering Battle Creek originate from production at Coleman NFH. Long-term, continuous, and extensive integration between hatchery and natural fall Chinook populations resulted in a genetically homogeneous population of mixed (i.e., hatchery and natural) ancestry.

Central Valley Late-fall Chinook Salmon
Information is scarce regarding the abundance of naturally spawning late-fall Chinook salmon in Battle Creek. Generally, late-fall Chinook are considered to spawn in the mainstem Sacramento River. However, some natural-origin (unmarked) and phenotypic late-fall Chinook do migrate into Battle Creek and are collected at Coleman NFH. From 2003-2008, the annual recovery of unmarked late-fall Chinook at Coleman NFH has averaged 51 (range: 16 – 109, SD = 32.9). Some of the unmarked late-fall Chinook may actually be hatchery-origin fish that regenerated adipose fins or were inadvertently missed during the marking process. The number of late-fall Chinook salmon spawning naturally below the Coleman NFH barrier weir is unknown, but is presumed to be small.

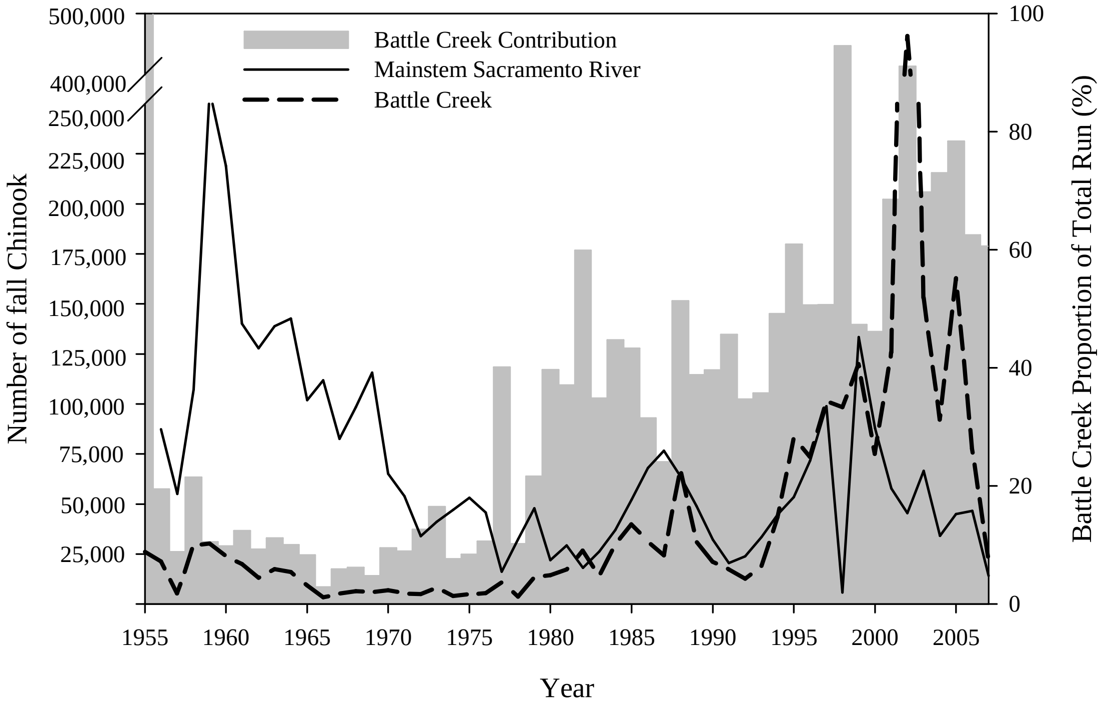

Figure 2-1. Estimated numbers of adult fall Chinook salmon returning to Coleman National Fish Hatchery and lower Battle Creek, and estimates of fall Chinook salmon returning to the mainstem Sacramento River for 1952-2008. Also shown is the proportion of the total run of fall Chinook salmon returning to Battle Creek.

Sacramento River Winter Chinook Salmon
The importance of Battle Creek as historical habitat for winter Chinook is uncertain. Direct information is inadequate to conclusively determine the abundance or constancy of winter Chinook in Battle Creek prior to the dramatic alterations of the watershed that occurred during the early 1900s. Scattered records do exist, however, to show that both juvenile and adult winter Chinook inhabited the tributary at least occasionally. Rutter (1904) reported the capture of

newly emerged salmon fry in Battle Creek during September and October, suggesting that winter Chinook had spawned successfully in the tributary. Needham et al. (1941) observed salmon spawning in Battle Creek during May and June: a timeframe characteristic of winter Chinook. In 1958, Coleman NFH trapping efforts resulted in over 300 winter Chinook captured from Battle Creek (USFWS 1963). These observations, along with the presence of suitable habitat features including, most notably, a constant supply of cool spring-fed water support the inference that Battle Creek provided habitats at least occasionally suitable for winter Chinook. Lindley et al. (2007) theorized on the historical population structure of winter Chinook salmon based on historical distribution, geography, hydrography, ecology, population genetics, life history, and trends in abundance. The authors postulated that Battle Creek was one of four independent populations comprising the historical Sacramento River winter Chinook salmon ESU, with the others being the Little Sacramento, Pit-Fall-Hat, and the McCloud.

Winter Chinook were largely eliminated from Battle Creek early in the twentieth century as a result of hydropower dams that blocked suitable spawning and rearing habitats (Yoshiyama et al. 1998). Restoration actions planned and underway for Battle Creek are focused on establishing and improving the status of federally listed salmonids, including winter Chinook, by restoring adequate stream flows and improving passage through the migration corridor.

A conservation hatchery program for winter Chinook salmon was initiated at the Coleman NFH in 1988. Winter Chinook originating at the Coleman NFH did not assimilate, however, into the natural population in the upper Sacramento River as intended (USFWS 1996). Monitoring in Battle Creek in the mid-90s estimated approximately 200 hatchery-origin winter Chinook salmon were returning to that watershed. To remediate the situation, hatchery operations were moved in 1998 to the newly constructed Livingston Stone NFH on the upper Sacramento River, and subsequent to the relocation of the hatchery propagation program, returns of winter Chinook to Battle Creek declined to near zero within a couple years. Since that time, winter Chinook salmon have been observed in only two years (2002 and 2006). In 2002, three adults were estimated to pass upstream of the barrier weir at the Coleman NFH, and in 2006, five adults (one natural-origin and four hatchery-origin fish) were observed at the Coleman NFH barrier weir. These fish in these years are likely strays from principal spawning areas of the upper Sacramento River. No other recent observations of winter Chinook salmon have been made in Battle Creek and Winter Chinook salmon do not currently inhabit Battle Creek as a self-sustaining population.

Central Valley Spring Chinook Salmon

Historic run-size estimates for spring Chinook salmon in Battle Creek are incomplete. Available estimates begin in 1943 with the initiation of the spring Chinook salmon propagation program at Coleman NFH. Data presented in Fry (1961) are rounded estimates based on Service counts. These data suggest less than 500 spring Chinook were counted annually between 1943 through 1945, as well as in 1948 and 1949. In all other years (1946, 1947, and 1950-1956), the estimate ranged between 1,000 and 2,000 (Fry 1961). No population estimates were performed from 1956 to 1994. Population estimates for spring Chinook salmon in Battle Creek since 1995, when available, have averaged 78 (range: 34-144; SD = 35.9; Service 1996b, 1998, 2007d).

Adult spring Chinook salmon are believed to migrate into Battle Creek primarily during April, May, and June, similar to migration patterns in Mill and Deer Creeks. However, historic migration timing for spring Chinook salmon extends into November and overlaps considerably with fall Chinook salmon. Monitoring conducted at the upstream ladder of the Coleman barrier weir, in 2000, showed infrequent passage of adult Chinook salmon through mid-July (Service, RBFWO, unpublished data). Thereafter, Chinook salmon migration past the Coleman barrier weir ceased from mid-July to mid-August. Water temperatures in lower Battle Creek typically exceed the temperature suitability range of Chinook salmon during these months. Adult Chinook salmon were again observed at the Coleman barrier weir after mid-August, 2000. However, considering the larger number of fish encountered at that time, it is likely those fish were early-arriving fall Chinook salmon. Spring Chinook salmon entering Battle Creek at that time of year would not be distinguished from early-arriving fall Chinook salmon.

Central Valley Steelhead
Historically, steelhead are believed to inhabit nearly all tributaries of the Sacramento River, including Battle Creek. However, historic steelhead run-size estimates do not exist for Battle Creek. Circumstantial evidence suggests that the steelhead run in Battle Creek was relatively small prior to the propagation of that species at the Coleman NFH. When the Coleman NFH steelhead program was initiated in 1947, founding broodstock were collected from the Sacramento River at the Keswick Dam fish trap and transported to the hatchery. An on-site captive rearing program was used to supply broodstock for three years until returns of hatchery-origin steelhead were sufficient to meet spawning goals.

The vast majority of all steelhead migrating into Battle Creek do so during the period of broodstock collection at Coleman NFH. Typically, about 60% of steelhead collected at Coleman NFH enter the hatchery ponds prior to January 1 (Service, Coleman NFH unpublished data) and nearly all have arrived at the hatchery by late-February. A small number of steelhead migrate into Battle Creek from March through April.

The existing population of steelhead returning to Battle Creek is a mixture of hatchery- and natural-origin adults. Since the early-1950s, artificial propagation has had a major influence on steelhead in Battle Creek. Because hatchery- and natural-origin steelhead were not differentiable based on appearance, both have been used as broodstock at Coleman NFH. In addition to integrating hatchery and natural populations as hatchery broodstock, considerable integration has also occurred through natural spawning in Battle Creek. Spawning records from 1953 through 1995 at Coleman NFH indicate frequent releases of adults above the Coleman barrier weir (Service, Coleman NFH unpublished data). Between 1996 and 2001, over 1,000 steelhead per year were passed upstream of the Coleman NFH barrier weir to spawn naturally in upper Battle Creek[3] (Figure 2-2); the origin of steelhead released upstream of the barrier weir was uncertain, however, the vast majority of those fish were presumed to have originated at the Coleman NFH. Between 1999 and 2001, were passed upstream of the Coleman barrier weir to spawn naturally.

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[3]This action was originally executed at the request of the CDFG in 1995 at the Coleman NFH Annual Production/Coordination Meeting. The request followed the development of an interim flow agreement with PG&E to increase instream flows in the Battle Creek watershed.

Until 2001, reliable information regarding the size of the naturally spawning steelhead population in Battle Creek was unavailable. Prior to brood year 1997, nearly all hatchery-origin steelhead from Coleman NFH were unmarked, so returning hatchery-origin adults could not be differentiated from natural-origin steelhead. A complete (i.e., 100%) mass mark was instituted at Coleman NFH beginning in 1998. As a result of the mass marking program, essentially all hatchery-origin steelhead returning to Battle Creek after 2000 have been identifiable by a clipped adipose fin. During hatchery broodstock collection activities from 2005 through 2009, an average of 228 unmarked steelhead returned to Coleman NFH. These likely represent a naturally produced run in Battle Creek. All steelhead collected at Coleman NFH are counted and identified to origin (i.e., hatchery or natural) to monitor and evaluate recovery of the natural population in Battle Creek.

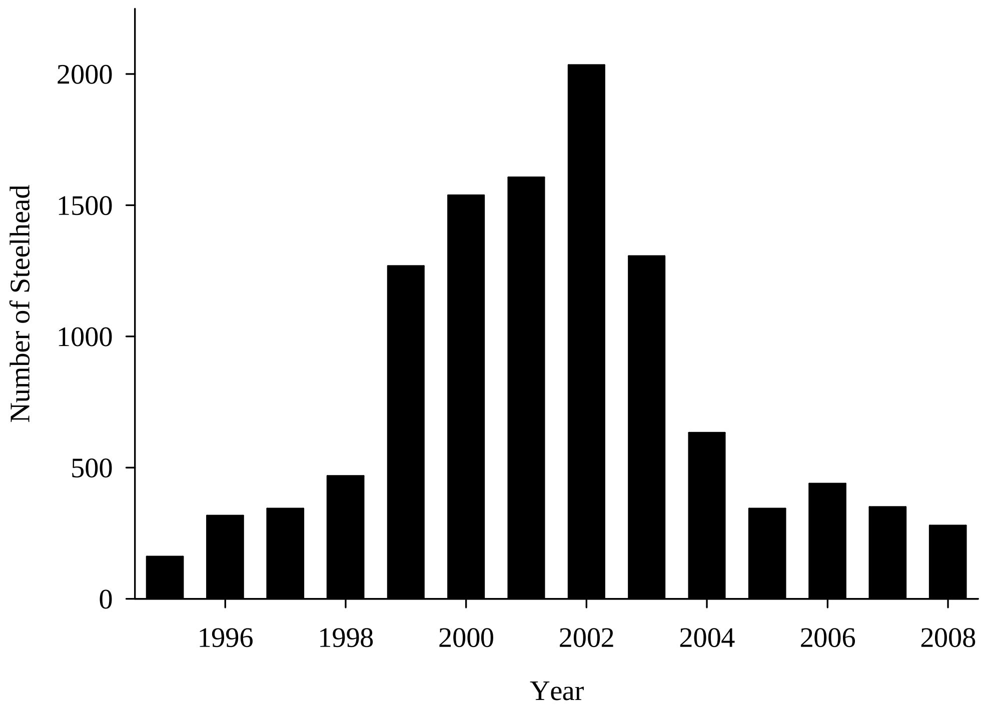

Figure 2-2. Numbers of returning steelhead adults intentionally passed upstream of the Coleman National Fish Hatchery barrier weir from 1995 through 2008.

2.11 Description of hatchery activities that may lead to the take of listed populations, the likelihood of occurrence, and an assessment of the effects of the take

Risk Assessment Framework

The primary goal of an impact analysis is to assess the likelihood for an action or group of actions to adversely affect a listed *population*, thus jeopardizing the future existence of the population. This assessment of jeopardy or "risk" is based on the concept of population viability. Population viability is defined as the probability that a population can continue to perpetuate itself, and is a function of the population's current abundance and fitness as well as its environment.

We have assessed activities associated with artificial production programs at the Coleman NFH Complex with regard to their potential impacts to the viability of populations of Central Valley salmonids, green sturgeon, and killer whale. To accomplish this, we first determined the likelihood that an individual fish or group of fish would incur negative impacts when exposed directly to the activity, or as a consequence of the activity. Secondly, when our assessments indicated that a hatchery activity was likely to impact individual listed fish, we considered potential impacts at the population level by evaluating factors such as: the severity of impact (e.g., short-term migration delay, injury, or death); the number of individuals to be impacted; and, population status. For example, although an impact may be high on an individual (e.g., high potential for mortality if exposed directly to a hatchery activity), if limited numbers of individuals may be impacted, the overall impact at the population level could be “moderate” or “low”. Population-level impacts of hatchery operations were characterized as: No impact, Low Impact, Moderate Impact, and High Impact. Definitions of these impacts were adopted from Bonneville Power Administration (1997).

No Impact: Activity will not affect fish abundance

Low Impact: Activity may result in small changes of abundance, but would remain within expected year-to-year variability of the affected species and would not affect population viability.

Moderate Impact: Action is likely to produce a moderate change in abundance similar in magnitude to changes in abundance witnessed during atypical conditions (i.e., drought). Should conditions or impacts persist, population viability may be affected.

High Impact: Likely to cause large immediate changes in abundance such as a catastrophic natural event.

Impact Assessment: Effects on Salmonid Populations
Activities associated with fish propagation at the Coleman NFH Complex have the potential to result in direct and incidental take of ESA-listed species of anadromous salmonids, or destroy or alter critical habitats. Hatchery operations that may negatively impact listed and candidate stocks of anadromous salmonids or their critical habitats can be classified into four main categories: 1) facility maintenance and on-site construction; 2) on-site fish production operations; 3) interactions following fish releases; and, 4) impacts associated with contributing or returning adults. These four main categories have been separated into specific program activities to identify certain aspects of hatchery operations that may result in take of listed salmonids:

1) Facility maintenance and on-site construction
   - Grounds Maintenance
   - On-site Construction
2) On-site fish production operations
   - Hatchery Water Diversions

- Water Discharge
- Broodstock Collection (fish ladders, weirs, and traps)
- Broodstock Maintenance and Selection
- Broodstock Mating
- Juvenile Incubation and Rearing

3) Effects of fish releases
   - Competition/Displacement
   - Predation
   - Altered Migration of Juveniles
   - Disease Transmission
   - Increased Straying (particularly with off-site releases)
4) Impacts associated with contributing or returning adults
   - Harvest
   - (Over) Escapement
   - Decoying

Each of hatchery propagation programs at Coleman and Livingston Stone NFHs were evaluated for their incidental effects on ESA-listed species and adverse modification of critical habitats. Take was estimated quantitatively whenever sufficient data were available to calculate reliable estimates. For example, quantitative estimates of take were generated for specific hatchery activities such as broodstock congregation and collection from the Sacramento River and Battle Creek. Take resulting from broodstock congregation and collection in Battle Creek could result in migration delay, blockage, or unintentional lethal take. Broodstock collection at the fish traps at Keswick Dam could result in take by capture, handle, transport, tissue sample, or unintentional mortality of ESA-listed species. Estimates of take resulting from activities related to broodstock collection can be directly estimated by enumerating the adults captured during broodstock collection activities during recent years. Quantitative estimates of take were also calculated for water diversions from Battle Creek. Take resulting from hatchery water diversions on Battle Creek may occur as entrainment of juvenile salmonids, potentially causing mortality. Quantitative estimates of take related to hatchery water diversions can be reasonably estimated by analyzing the amount and timing of diversions through the hatchery's unscreened back-up water intake. Quantitative estimates of unintentional take resulting from artificial propagation programs at Coleman and Livingston Stone NFHs are summarized in Table 2-3. More detailed explanations regarding the derivation of these take estimates are explained in the appropriate sections of this document.

Some of the effects of hatchery propagation programs do not permit quantitative estimates of take because data were not available or because the magnitude of potential impacts are immeasurable and largely speculative. This inability to explicitly quantify estimates of take is a consequence of the complex biology of salmon and steelhead and the multitude ecological interactions that simultaneously affect organisms in the natural environment. When available data did not enable calculation of a quantitative estimate of take, impacts of the hatchery propagation programs were assessed qualitatively. For example, data are not available to quantitatively assess with reasonable certainty the impacts to listed salmonid populations resulting from inter-specific and intra-specific competition caused by releases of juvenile hatchery-origin salmonids. While we know that competitive interactions between hatchery and natural fishes can occur in the natural environment, calculating a reliable estimate of take resulting from competitive interactions is fraught with uncertainties. In situations where we could not develop reliable quantitative estimates of take we assessed impacts using a qualitative assessment of impacts. Qualitative assessments of impacts drew upon information such as: life history, habitat preferences, food resources, spatial and temporal occurrence, and details related specifically to artificial propagation programs at Coleman and Livingston Stone NFHs. A summary of the qualitative estimates of take resulting from artificial propagation programs at Coleman and Livingston Stone NFHs is presented in Table 2-4. Derivation of these qualitative impact assessments are presented in the appropriate sections of this document.

Based on our qualitative and quantitative assessments of impacts resulting from artificial propagation programs at Coleman and Livingston Stone NFHs, we have assessed the likelihood that hatchery facilities and operations will adversely affect anadromous salmonid populations and jeopardize the future existence of those populations. In the accompanying biological opinion, the Service determined that the anticipated level of take and impacts resulting from hatchery facilities and operations is not likely to result in jeopardy or destruction or adverse modification of critical habitats for Sacramento River Winter Chinook, Central Valley Spring Chinook, Central Valley Steelhead, Southern DPS of North American Green Sturgeon, or Southern Resident Killer Whale.

Impact Assessment: Effects on Southern DPS North American Green Sturgeon
The proposed fish propagation activities at the Coleman NFH Complex are not expected to result in direct or incidental take of the Southern DPS of North American Green Sturgeon. Substantive differences of life history and habitats between green sturgeon and salmonids propagated at the Coleman NFH Complex make interactions between these species unlikely to occur. The range of green sturgeon does not extend into Battle Creek and, therefore, there will be no effects of these propagation programs on the species' critical habitat.

Impact Assessment: Effects on Southern Resident Killer Whale
The proposed fish propagation activities at the Coleman NFH Complex are not expected to result in direct or incidental take of the DPS of Southern Resident Killer Whale, nor are they expected to destroy or alter the species' critical habitat. Conversely, implementation of the proposed project would be expected to benefit killer whale by increasing the abundance of salmonids, a primary food resource for Southern Resident killer whale. Hatchery production of fall- and late-fall Chinook salmon are likely a major source of forage for the Southern Residents and these stocks increase the likelihood for Southern Residents to sustain the current ocean abundance. Without hatchery production, in absence of the historic spawning habitat for Chinook salmon, Southern Residents would need to expend additional energy to locate and capture available prey. Such a scenario would be expected to decrease the resiliency of Southern Resident killer whale to stochastic events, and further reduce the viability of the DPS.

Table 2-3. Projected levels and types of incidental take of listed salmonids resulting from artificial propagation programs at Coleman and Livingston Stone National Fish Hatcheries. Take of adults in indicated by "A" and juveniles by "J". Where a fish may be affected by more than one type of take it is included in the category that would have the greatest impact; such that the total number of potentially affected individuals of each species can be estimated by the sum of each column.

	Affected Stock		
	Winter Chinook	Spring Chinook	Steelhead
Battle Creek			
Entrainment (J)	0	243	6
Capture, handle, tissue sample, mark-tag, hold, release (A)	4	0	466
Unintentional lethal take (A)	2	11 [a]	5
Sacramento River			
Capture, handle, transport, tissue sample, mark-tag, hold, and release (A)	173 [b]	140	102
Intentional lethal take (A)	0	20 [c]	0
Unintentional lethal take (A)	2	2	2
TOTAL	181	416	581

a. Estimates of unintentional lethal take of spring Chinook salmon from Battle Creek are based on recoveries of coded-wire tags at the Coleman NFH from spring Chinook salmon originating at the Feather River Hatchery.

b. Estimates of take of winter Chinook salmon from the Sacramento River are for fishes incidentally trapped while collecting for late-fall Chinook broodstock a the Keswick Dam fish trap. Winter Chinook collected during trapping for the winter Chinook broodstock collection period (i.e., March through July) are covered under the Service's Section 10 permit and are not included in this table.

c. Estimates of intentional lethal take of spring Chinook from the Sacramento River are based on recoveries of coded-wire tags from spring Chinook originating at the Feather River Hatchery and collected at the Keswick fish trap while trapping for winter Chinook broodstock (i.e., March through July). Spring Chinook from the Feather River Hatchery are identified by a clipped adipose fin, phenotype, and a genetic run determination. Spring Chinook from the Feather River Hatchery are culled to reduce impacts to the natural population in the upper Sacramento River.

Table 2-4. Qualitative summary of population-level impacts associated with fish production activities conducted at Coleman and Livingston Stone National Fish Hatcheries that may result in direct or indirect take of ESA-listed and non-listed species, or destruction or alteration of critical habitat. Impact assessment is based on discussions, data, and analyses presented in this document and represent the U.S. Fish and Wildlife Service's evaluation of available information. Complete discussions of these activities and impacts can be found in the specified sections of this document.

General Category	Activity	Species Impacted	Assessment of Population-level Impact	Sections in Document
Facility Maintenance and On-site Construction	Grounds Maintenance and Site Disturbances at Coleman NFH	Fall Chinook Late-fall Chinook Winter Chinook Spring Chinook Steelhead	none to low none to low none to low none to low none to low	5.1 for description
	Grounds Maintenance and Site Disturbances at Livingston Stone NFH	Fall Chinook Late-fall Chinook Winter Chinook Spring Chinook Steelhead	none none none none none	5.2 for description. The hatchery is not located within designated critical habitat.
On-site fish production operations	Water Intake and Use at Coleman NFH	Fall Chinook Late-fall Chinook Winter Chinook Spring Chinook Steelhead	See Table 4-3 for quantitative assessment of take for all stocks.	4.1 for description of Intakes 4.4, and Appendix 4A for derivation and estimates of take 4.5 for a discussion of effects on critical habitat.
	Water Intake and Use at Livingston Stone NFH	Fall Chinook Late-fall Chinook Winter Chinook Spring Chinook Steelhead	none none none none none	4.2 for description of water source 4.4 for impact assessment

Table 2-4 (cont.). Qualitative summary of population-level impacts associated with fish production activities conducted at Coleman and Livingston Stone National Fish Hatcheries that may result in direct or indirect take of ESA-listed and non-listed species, or destruction or alteration of critical habitat.

General Category	Activity	Species Impacted	Assessment of Population-level Impact	Sections in Document
On-site fish production operations (cont.)	Water Discharge at Coleman NFH	Fall Chinook Late-fall Chinook Winter Chinook Spring Chinook Steelhead	none to low none to low none to low none to low none to low	4.1 for description of water treatment facility and water discharge, and 4.4 for impact assessment
	Water Discharge at Livingston Stone NFH	Fall Chinook Late-fall Chinook Winter Chinook Spring Chinook Steelhead	none to low none to low none to low none to low none to low	4.2 for description of water discharge and 4.4 impact assessment
	Broodstock Congregation and Collection at Battle Creek	Winter Chinook Spring Chinook Steelhead	See Table 7-12 for quantitative assessment.	7.2 and 7.3 for description of congregation and collection of broodstock 7.10 for discussion of derivation and Table 7-12 for estimate of take
	Broodstock Congregation and Collection at Sacramento River	Winter Chinook Spring Chinook Steelhead	See Table 7-14 for quantitative assessment.	7.2 and 7.3 for description of congregation and collection of broodstock 7.10 for discussion of derivation and Table 7-14 for estimate of take of ESA-listed stocks

Table 2-4 (cont.). Qualitative summary of population-level impacts associated with fish production activities conducted at Coleman and Livingston Stone National Fish Hatcheries that may result in direct or indirect take of ESA-listed and non-listed species, or destruction or alteration of critical habitat.

General Category	Activity	Species Impacted	Assessment of Population-level Impact	Sections in Document
On-site fish production operations (cont.)	Broodstock Selection, Mating and Genetic Implications	Fall Chinook	low	6.1 and 6.5 for broodstock origin and incorporation of natural adults
		Late-fall Chinook	low	
		Winter Chinook	low	6.6 for discussion of genetic or ecological differences
		Spring Chinook	low	
		Steelhead	low	Appendix 6D for discussion of genetic risks 7.4 for identification of broodstock 6.8 and 7.9 for discussion of risks and risk aversion methods.
	Incubation and Rearing	Fall Chinook	none	9.1 for description of incubation and
		Late-fall Chinook	none	9.2 for description of rearing
		Winter Chinook	none	No impacts are expected from on-site incubation and rearing. Impacts associated with water use and discharge, and juvenile releases are covered in Sections 4 and 10 respectively.
		Spring Chinook	none	
		Steelhead	none	
Juvenile Releases	Fall Chinook	Fall Chinook	none to low	10.8 and 10.12 for a discussion of effects on natural populations
		Late-fall Chinook	none to low	
		Winter Chinook	none to low	Table 10-9 for a summary of qualitative assessment.
		Spring Chinook	none to low	
		Steelhead	none to low	Appendix 10D in Service 2001b for analysis of straying

Table 2-4 (cont.). Qualitative summary of population-level impacts associated with fish production activities conducted at Coleman and Livingston Stone National Fish Hatcheries that may result in direct or indirect take of ESA-listed and non-listed species, or destruction or alteration of critical habitat.

General Category	Activity	Species Impacted	Assessment of Population-level Impact	Sections in Document
Juvenile Releases (cont.)	Late-fall Chinook	Fall Chinook Late-fall Chinook Winter Chinook Spring Chinook Steelhead	low to moderate low low low low	10.9 and 10.12 for a discussion of effects on natural populations Table 10-11 for a summary of qualitative assessment. Appendix 10D in Service 2001b for analysis of straying
	Winter Chinook	Fall Chinook Late-fall Chinook Winter Chinook Spring Chinook Steelhead	none none none none none	10.10 and 10.12 for a discussion of effects on natural populations Table 10-13 for a summary of qualitative assessment. Appendix 10D in Service 2001b for analysis of straying
	Steelhead	Fall Chinook Late-fall Chinook Winter Chinook Spring Chinook Steelhead	none to moderate none to low none to low none to low none to low	10.11 and 10.12 for a discussion of effects on natural populations Table 10-14 for a summary of qualitative assessment.
Adult Contribution	Harvest	Fall Chinook Late-fall Chinook Winter Chinook Spring Chinook Steelhead	unknown unknown unknown unknown Unknown, likely low	3.5 for discussion of Chinook contribution to harvest 3.8 for discussion of relationship between harvest and escapement Data on Steelhead harvest are lacking.

Table 2-4 (cont.). Qualitative summary of population-level impacts associated with fish production activities conducted at Coleman and Livingston Stone National Fish Hatcheries that may result in direct or indirect take of ESA-listed and non-listed species, or destruction or alteration of critical habitat.

General Category	Activity	Species Impacted	Assessment of Population-level Impact	Sections in Document
Adult Contribution (cont.)	Escapement	Fall Chinook	low	3.6 for discussion of escapement to Battle Creek and 3.7 for impacts of hatchery (over) escapement 3.8 for discussion of relationship between harvest and escapement
		Late-fall Chinook	low	
		Winter Chinook	low	
		Spring Chinook	low	
		Steelhead	low	
	Straying	Fall Chinook	low	Section 10.12 and Appendix 10C in Service 2001b for analysis of stray rates and associated impacts
		Late-fall Chinook	low to medium	
		Winter Chinook	low	
		Spring Chinook	low	
		Steelhead	low	
	Decoying	Fall Chinook	low	2.10 for a brief discussion in relation to hatchery-origin fall Chinook
		Late-fall Chinook	none to low	
		Winter Chinook	none to low	
		Spring Chinook	none to low	
		Steelhead	none to low	Minimal risk of decoying is expected from returns of hatchery-origin late-fall or winter Chinook salmon or steelhead because numbers of returning adults are low (usually < 5,000).

3 RELATIONSHIP OF PROGRAM TO OTHER MANAGEMENT OBJECTIVES

In Section 3 we describe the relationship between artificial propagation programs at the Coleman NFH Complex and other fishery and habitat management objectives and conservation programs in the Central Valley of California. Current and proposed hatchery operations are discussed in relation to major conservation programs designed to restore and recover anadromous salmonids and their habitats in the Central Valley. We discuss the roles of the Reclamation (primary funding source) and the Service (operational responsibilities) relative to responsibilities to mitigate for habitat losses due to the construction of Shasta Dam. Lastly, we describe harvest objectives for fishes propagated at the Coleman NFH, and identify contribution rates of the Chinook salmon propagation programs to the ocean (commercial and sport) and the in-river sport fisheries. Furthermore, because harvest of fish from Coleman NFH and escapement of salmon to Battle Creek are closely linked, a discussion is presented on historical and recent adult escapement as a result of hatchery operations, and the potential impact of escapement or over-escapement of hatchery-origin adults back to the Battle Creek watershed.

3.1 Existing cooperative agreements, memoranda of understanding, memoranda of agreement, or other management plans or court orders under which the program operates

The following bullets highlight the Interagency Agreement between the Service and the Reclamation for the operation and funding responsibilities of Coleman NFH. A more detailed description is presented following the bulleted list.

- The Reclamation built Coleman NFH in 1942 to partially mitigate for fishery damage resulting from habitat losses due to the construction of Shasta and Keswick Dams on the upper Sacramento River. Through a 1948 Memorandum of Agreement with the Reclamation, the Service assumed complete responsibility for operations and maintenance at the Coleman NFH beginning in 1950.

- A GAO audit conducted in 1989/1990 (GAO 1991) determined that funding responsibility should be returned to Reclamation.

- A 1993 Interagency Agreement between the Service and the Reclamation addressed funding and operation of the Coleman NFH as a feature of the CVP (Attachment 3-1). Consistent with the audit findings, this agreement stipulates that the Service will continue to operate, maintain and evaluate the facility for the salvage, protection, and preservation of fish which spawned in the upper Sacramento River Basin prior to the construction of Shasta and Keswick dams, while the Reclamation will (re)assume all financial responsibility for the facility and arrange for recovery costs from project beneficiaries in accordance with Federal reclamation law.

- The CVPIA (Title XXXIV of the Act of October 30, 1992, Public Law No. 102-575) authorized the rehabilitation of the Coleman NFH through the execution of the 1987 Coleman NFH Station Development Plan (Service 1987).

- A 2008 Amendment of the 1993 Interagency Agreement between the Service and the Reclamation established general principles and described the responsibilities of both agencies concerning the custody and responsibility for Livingston Stone NFH, which is an extension of and is being funded as part of the Coleman NFH (Attachment 3-2).

3.2 History of the current Interagency Agreement

The Reclamation constructed the CVP to serve a variety of purposes such as irrigation, electrical power generation, and flood control. The two project dams, however, adversely affected fishery resources in the Sacramento River system. The Keswick Dam constructed between 1940 and 1951, and the Shasta Dam constructed between 1938 and 1944 became impassable barriers to salmonids migrating upstream. Together, the two dams permanently denied access to 187 miles of anadromous fish (salmon and steelhead) habitat.

The Coleman NFH was constructed to mitigate for a portion of the effects caused by Shasta Dam. Until 1950, the Reclamation transferred appropriate funds to the Service for the operation of the hatchery. Beginning with fiscal year 1950, through a 1948 Memorandum of Agreement, the Service assumed complete responsibility for the operations and maintenance of the hatchery, and for requesting the appropriate funds for operation and maintenance of the facility.

In 1985, after a comprehensive review of its national fishery resources program, the Service developed a Statement of Responsibilities and Role, which detailed four areas of responsibility, including seeking and providing for mitigation of important fishery resource losses caused by federal water-related development. As part of this responsibility, the Service was required to pursue recovery of costs related to hatcheries that had been constructed and operated to mitigate for federal water projects. Nationwide, nine hatcheries built by the Reclamation and funded and operated by the Service were identified in the document. California's Coleman NFH is one of these. Previous changes in federal law had also stipulated that California's water project beneficiaries were to be held responsible by the developing agency (e.g., the Reclamation) for the costs of constructing, operating, and maintaining measures to prevent or compensate for fisheries damages. This requirement was in accord with the government's user pay policy to seek equitable ways to reduce the federal deficit.

An audit conducted between April 1989 and June 1990, found that Service funding of artificial propagation activities at Coleman NFH between the years of 1950 and 1989 was largely inappropriate, and that 73% of the expended funds should have been recovered from CVP beneficiaries. The audit recommended that funding from the Reclamation should have been continuous since the 1948 memorandum of agreement. The audit also noted that the CVP authorization supported this finding, as did also the cost recovery language contained in pertinent legislation including the Reclamation Acts of 1902 and 1939 (amended). These acts, particularly the Act of August 4, 1939, provided specific authority for the Secretary of the Interior to enter into contracts to sell water and power at rates covering an appropriate share of the annual operating and fixed costs of the project facilities. The Coleman NFH is considered part of the overall CVP. The audit resulted in the development of the existing 1993 *Interagency Agreement between U.S. Fish and Wildlife Service and Bureau of Reclamation* concerning the funding and operation of the Coleman NFH as a feature of the CVP (Attachment 3-1).

The existing 1993 Interagency Agreement (Attachment 3-1) along with the subsequent amendment in 2008 (Attachment 3-2) now supersedes all previous agreements between the Service and the Reclamation pertaining to the operation and funding of Coleman NFH and Livingston Stone NFH. The agreement stipulates that the Service will continue to operate, maintain and evaluate the facility for the salvage, protection, and preservation of fish which spawned in the upper Sacramento River Basin prior to the construction of Shasta and Keswick dams, while the Reclamation will reassume all financial responsibility for the facility and arrange for recovery costs from project beneficiaries in accordance with Federal reclamation law.

3.3 Integration of artificial propagation programs at Coleman NFH with conservation initiatives developed to conserve and restore anadromous fish resources and their habitats

Several programs are in place to restore and recover anadromous salmonids and their habitats in the Central Valley, including: the CVPIA and associated AFRP, and previously the CALFED ERP. These programs are designed to address the complex biological, economic, social, and technological issues necessary to restore populations of naturally reproducing anadromous salmonids and their Central Valley habitats. Goals specific to the Battle Creek watershed, including the Battle Creek Restoration Program, have also been developed and are in alignment with the valley-wide restoration programs. Following is a discussion of the relationships between artificial propagation programs conducted at Coleman NFH and the CVPIA, AFRP, CALFED, and the Battle Creek Restoration Program.

The Central Valley Project Improvement Act

Program Overview - The CVPIA of October 1992 (Public Law 102-575, Title 34) is intended to remedy habitat and other problems associated with the Reclamation's CVP. The CVPIA amends the authority of the CVP to include fish and wildlife protection, restoration, and mitigation as equal priorities with other CVP functions such as navigation, flood control, irrigation, and municipal water supply. The CVPIA has two key features to benefit anadromous salmonids: Firstly, Section 3406(b)(1) of the CVPIA directs the Department of the Interior to "develop...and implement a program which makes all reasonable efforts to ensure that, by the year 2002, *natural production* of anadromous fishes in Central Valley rivers and streams will be sustainable, on a long-term basis, at levels not less than twice the average levels attained during the period of 1967 - 1991...." [emphasis added]. Secondly, Section 3406(b)(2) authorizes the use of 800,000 acre- feet of CVP water rights for fish, wildlife, and habitat restoration purposes. The Central Valley Project Restoration Fund was established to contribute to the goals of the CVPIA. The CVPIA provides the Secretary of the Interior the authority to use the fund to carry out the habitat restoration, improvement, and acquisition (from willing sellers) provisions necessary to fulfill the requirements of the CVPIA. For a complete description of the CVPIA refer to the following documents:

1) Service and Reclamation. 1999. Central Valley Project Improvement Act: Final Programmatic Environmental Impact Statement. Sacramento, California. October 1999.

2) Service and Reclamation. 2001. Record of Decision: Central Valley Project Improvement Act: Final Programmatic Environmental Impact Statement. Sacramento, California.

Implementation of the CVPIA at Coleman NFH - Rehabilitation of the Coleman NFH (a mitigation feature of the CVP) was authorized through the CVPIA by implementing the Station Development Plan (Service 1987). Since 1998, approximately $30 million have been expended to renovate the hatchery facilities. Completed and ongoing modifications to hatchery facilities include: 1) construction of an ozone water treatment plant and water filtration system; 2) modifications to the hatchery's barrier weir and associated fish ladders; and 3) screening/modification of the hatchery's primary water intakes. These modifications will help to integrate artificial propagation activities at Coleman NFH with the restoration of natural salmonid populations in the Battle Creek watershed as follows:

1) The water treatment plant at Coleman NFH (constructed between 1993 and 2002) is capable of sand filtering 45,000 gallons/minute (gpm) and treating with ozone 30,000 gpm of fish production water. Water treatment capabilities of the new system alleviate concerns of passing potentially disease-carrying fish into upper Battle Creek, where the hatchery obtains its water. Lower incidence of infection or disease on-station will also reduce the potential for transmission of disease to natural populations (either through effluent discharge or following the release of hatchery juveniles).

2) Although, the hatchery was able to adequately utilize the barrier weir and associated fish ladder for broodstock collection, significant modifications to the infrastructure were designed and implemented in 2007 and 2008 to improve management abilities for upstream migrating fish. The infrastructure consists of a barrier weir and fish ladders leading from below the barrier weir into the hatchery and upstream. All three of these components were re-engineered to improve the capabilities of managing fish passage and monitoring. Controlled passage and monitoring of Chinook salmon and steelhead into the upper Battle Creek watershed allows for segregation and enumeration of runs at that point, thus affording the capability to measure and maximize restoration benefits for priority stocks of ESA-listed species.

3) In 2009 and 2010, the hatchery's primary water intake structures were modified to afford increased protections for naturally produced fishes and increased operational flexibility at the hatchery (see Section 4 for complete description on the modifications).

The Anadromous Fish Restoration Program
Program Overview - The AFRP was developed by the Secretary of the Department of the Interior to accomplish the fish population restoration goals identified in the CVPIA. Within the AFRP, watersheds have been prioritized for restoration actions based on a combination of biological and non-biological factors. Specific numeric population recovery goals have been determined for each watershed or watershed portion, including the Sacramento River and Battle Creek. Because the Secretary does not have direct authority to implement restoration actions in all streams, implementation of the AFRP relies heavily upon cooperation through partnerships, including state and federal agencies, watershed workgroups, conservation groups, water districts,

and property owners. For a complete description of the AFRP refer to the following documents or URL.

1) Service. 2001a. Final restoration plan for the Anadromous Fish Restoration Program. Sacramento, California.
2) Service. 1995. Working paper on restoration needs: habitat restoration actions to double natural production of anadromous fish in the Central Valley of California. Volumes 1-3. Prepared for the Service under the direction of the Anadromous Fish Restoration Program Core Group, Stockton, California. May 1995.
3) AFRP website http://www.delta.dfg.ca.gov/afrp

A total of 172 actions and 117 evaluations are identified in the AFRP that, when implemented, are intended to increase anadromous fish populations throughout the Central Valley to twice the average levels from 1967 through 1991 as specified by the CVPIA (Service 2001a).

Implementation of the AFRP at the Coleman NFH - Several actions and evaluations identified in the AFRP pertain directly to hatchery facilities and operations that could limit natural production of anadromous fish. Specific actions and evaluations and corresponding changes that have been implemented at Coleman NFH to help bring the hatchery into alignment with the AFRP are identified below:

Evaluation 1) Evaluate the potential to modify hatchery procedures to benefit native stocks of salmonids.

Numerous activities at Coleman NFH have been modified to benefit Central Valley anadromous fish populations. Notable changes at Coleman NFH include: discontinuing releases of fall Chinook fry (1998), and extending the range of time allowed for passage into upper Battle Creek through the upstream ladder at the Coleman barrier weir (i.e. from May through July to March through July).

Evaluation 2) Evaluation of the impacts of hatchery juvenile release practices on natural stocks.

Hatchery release practices at Coleman NFH have been continually monitored, evaluated, and adapted to minimize negative impacts to natural salmonid populations. A summary of impacts resulting from the release of hatchery-origin juveniles is included in this document (see section 10). Weber and Fausch (2004 and 2005) assessed competition between hatchery- and natural-origin Chinook salmon residing in the upper Sacramento River. They concluded that the strategy of delaying fall Chinook salmon release from early April until mid-April was effective at reducing potential interactions in stream margin rearing areas. They also determined hatchery-origin fish prompted few natural-origin fish to emigrate. Hatchery-origin fish were not likely to utilize the stream margins as much as the naturally produced fish due to their advanced state of smoltification. However, when hatchery- and natural-origin fish did co-occur, natural-origin fish experienced a negative growth effect due to the presence of or competition with hatchery-origin fish. This study assessed the potential for interactions within habitats in the margins of the upper Sacramento River but did not investigate interactions within the river delta or ocean environments.

Evaluation 3) Evaluate and implement specific spawning protocols and genetic evaluation programs to maintain genetic diversity in natural and hatchery stocks.

The winter Chinook salmon propagation at Livingston Stone NFH utilizes the latest research and technology in genetic monitoring. Other Coleman NFH propagation programs incorporate protocols to minimize genetic risks associated with artificial production programs (See Sections 6, 7, and 8, for descriptions of broodstock source(s), selection, and mating protocols. See Appendix 6D for a discussion of potential genetic impacts.

Evaluation 4) Evaluate disease transfer between hatchery and natural fish stocks.

Numerous field and laboratory experiments to evaluate disease transfer between hatchery and natural stocks have been conducted by the Service's CA-NV FHC (see Section 10). Additionally, the completion of the ozone water treatment facility has greatly reduced the potential for disease transmission to natural stocks by reducing the incidence of disease within the hatchery.

The CALFED Bay-Delta Program
Program Overview - The CALFED Bay-Delta Program, also known as CALFED, is department within the government of California, administered under the California Resources Agency. The department acts as consortium, coordinating the activities and interests of the state government of California and the U.S. federal government to focus on interrelated water problems in the state's Sacramento-San Joaquin River Delta. CALFED's priorities for the Sacramento-San Joaquin River Delta include:

- **Improve Ecosystem Quality**. Improve and increase aquatic and terrestrial habitats and improve ecological functions in the Bay-Delta system to support sustainable populations of diverse and valuable plant and animal species.
- **Improve Water Supply Reliability**. Reduce the mismatch between Bay-Delta system water supplies and current and projected beneficial uses that depend on the Bay-Delta system ecosystems.
- **Improve Water Quality**. Provide good water quality for all beneficial uses.
- **Improve Levee System Integrity**. Reduce the risk to land use and associated economic activities, water supply, infrastructure, and ecosystem from catastrophic failure of Delta levees.

A major element of the CALFED program is the ERP. The ERP is designed to improve and increase aquatic and terrestrial habitats and improve ecological functions to support sustainable populations of diverse and valuable plant and animal species. Major elements of the ERP are directed at recovering endangered species, eliminating the need for additional listings on the ESA, and providing increased abundance of valuable sport and commercial fisheries. Benefits of the ERP will be achieved by working with local conservancies and watershed groups to restore the ecological processes associated with stream flow, stream channels, watersheds, and floodplains. Refer to the following documents for a thorough description of the CALFED Program and the ERP:

1) CALFED. 1998. CALFED Bay-Delta Program. Sacramento, California.
2) CALFED. 2000. CALFED Bay-Delta Program: Final Programmatic Environmental Impact Statement. Sacramento, California.
3) CALFED. 1999. CALFED Bay-Delta Program: Strategic Plan for Ecosystem Restoration. Sacramento, California.

The CALFED ERP presents restoration actions specific to the Battle Creek watershed and to Coleman NFH. These are:

- Improving fish passage facilities at Coleman NFH; and
- Improving hatchery management and release practices to protect genetic integrity of natural populations.

Implementation of CALFED ERP at Coleman NFH - Hatchery facilities and fish culture activities at the Coleman NFH are designed to integrate with natural salmonid populations in Battle Creek. Working toward this goal, and in alignment with the specific restoration goals identified in the CALFED ERP, CALFED was the primary source of funding to modify the Coleman NFH barrier weir and fish ladders. The modifications were completed to improve fish passage management capability at that site including: 1) improve the fish blocking capabilities of the barrier weir, 2) improve attraction and fish passage through the upstream fish ladder, and 3) improve monitoring and management of passage into upper Battle Creek. Improved management of fish passage at the hatchery barrier weir will allow segregation of the various runs of Chinook salmon at that location. The ability to segregate the runs of Chinook salmon at the Coleman barrier weir will enable fishery managers to permit upstream passage for natural-origin spring, winter and late-fall Chinook and steelhead whereas hatchery-origin fish can be better restricted to the section of Battle Creek below the hatchery weir. The genetic integrity of naturally spawning salmonid populations in Battle Creek and elsewhere is further protected through implementation of refined protocols for broodstock selection, spawning, and juvenile release that are developed to reduce genetic risks to natural populations.

The Battle Creek Restoration Project
Program Overview – In 1999, an agreement was reached between resource agencies, other stakeholders, and cooperators to restore approximately 42 miles of high-quality salmonid spawning and rearing habitats in the Battle Creek watershed. Restoration of the Battle Creek watershed is designed primarily to benefit ESA-listed priority species (winter and spring Chinook salmon and steelhead), but will also benefit naturally-spawning fall and late-fall Chinook salmon.

The intent to restore the Battle Creek watershed for naturally-producing salmonids, while integrating artificial propagation activities at the Coleman NFH, was formally advanced in a Service position paper (Wayne S. White, April 3, 1998; Attachment 3-3). Through implementation of the AFRP, the Service has been a leader in planning, coordinating, and monitoring for the restoration project.

Alignment between the Battle Creek Restoration Program and Coleman NFH

Because of its location on Battle Creek, facility operations at Coleman NFH are intimately linked to the Battle Creek watershed through two major operational requirements: 1) Battle Creek serves as the hatchery's sole water source; and, 2) Coleman NFH operates a barrier weir on Battle Creek to facilitate seasonal congregation and collection of broodstock. Facilities at Coleman NFH are being adjusted, when necessary, to align the hatchery with the restoration of natural salmonid populations in Battle Creek. Many of the restoration changes that have been completed or are underway at the hatchery are in direct alignment with actions described in the 1995 AFRP Working Paper and the Final AFRP plan (see AFRP references and Table 3-1). These changes, including modification of the hatchery's barrier weir and fish ladders, improvements to hatchery two primary water intakes, and construction of an ozone treatment plant are expected to directly benefit naturally producing anadromous salmonid populations in the Battle Creek watershed.

Coleman NFH Adaptive Management Plan

The Service is committed to integrating operations at the Coleman NFH with the Battle Creek Restoration Program in a manner that promotes the successful restoration of anadromous salmonids in Battle Creek. To foster the successful restoration of anadromous salmonids in Battle Creek concomitant to the production of salmon and steelhead at the Coleman NFH an adaptive management process will be developed and implemented. Reclamation will facilitate the development of the Coleman NFH adaptive management plan in a process that will be inclusive of responsible agencies and interested stakeholders. The Coleman NFH adaptive management plan will acknowledge, identify, study, and evaluate uncertainties regarding the operation of a large scale fish hatchery in a watershed being restored for natural salmonid populations. The goal of the Coleman NFH adaptive management plan will be to inform decision making processes to ensure that hatchery activities are compatible with the objectives of the Restoration Project in addition to goals and objectives of the Coleman NFH.

The Coleman NFH adaptive management plan will be developed and organized in a manner similar to the Battle Creek Restoration Project adaptive management plan, including goals, objectives, conceptual models, scientific uncertainties, approaches to monitoring and data assessment, specifications of focused studies, description of decision-making process, funding prioritization, and all other elements of formal adaptive management. Adaptive management operating procedures will be well coordinated with those of the Battle Creek Restoration Project adaptive management plan. Results of monitoring and evaluation will be evaluated against goals and objectives of the restoration project and the hatchery. Improved understanding resulting from this formal adaptive management program may result in the development of alternative management strategies to better achieve goals and objectives of both Coleman NFH and the Restoration Project. Together, the Restoration Project adaptive management plan and the Coleman NFH adaptive management plan will form a cooperative framework for adaptive management in Battle Creek.

3.4 Direct effects of artificial propagation programs at Coleman and Livingston Stone NFHs on the restoration and recovery of listed species

Sacramento River Winter Chinook Salmon

The Service's winter Chinook supplementation program previously conducted at the Coleman NFH and currently conducted at the Livingston Stone NFH fulfill an important role in fishery conservation and recovery for endangered winter Chinook salmon. A propagation program to supplement the endangered winter Chinook salmon originated at Coleman NFH and is now conducted at Livingston Stone NFH. The Livingston Stone NFH was constructed for the explicit purpose of propagating endangered winter Chinook salmon to assist in the recovery of that species. Hatchery-origin winter Chinook salmon are intended to return as adults to the upper Sacramento River, spawn in the wild, and become reproductively and genetically assimilated into the natural population. In addition to the winter Chinook propagation program, a captive broodstock program for winter Chinook salmon was previously conducted by the Livingston Stone NFH, the University of California's Bodega Marine Laboratory, and the Steinhart Aquarium operated by the California Academy of Science. The goal of the winter Chinook salmon captive propagation program was to provide short-term security against extinction for the at-risk population while environmental factors that lead to population decline were corrected. Both the winter Chinook artificial propagation program and captive broodstock program are part of the NMFS draft recovery plan for this endangered species (NMFS 1997; 2009b). Due to increased abundance levels of winter Chinook salmon, the captive broodstock program was phased out after brood year 2006. If abundance levels of winter Chinook salmon again decline and remain below a critical threshold (e.g., 1,000 individuals), the captive broodstock program could again be considered.

Table 3-1 Specific actions of the Anadromous Fish Restoration Program associated with hatchery operations or Battle Creek restoration. Items in bold are specific to the Coleman NFH

Action	Status
Continue to allow passage of adult spring and winter Chinook salmon and steelhead above the Coleman NFH barrier weir.	Beginning in 2000, the upstream ladder in the Coleman NFH barrier weir was opened longer to allow an additional two months of access upstream of the hatchery. From 2001-2004 the ladder was open from March 1st to September 1st. From 2004-2010, the ladder was open from March 1st to August 1st. Further in 2007 and 2008 the barrier weir and associated fish ladders underwent significant modification to improve fish passage management capability at this site
Allow passage of fall, late-fall and passage of steelhead following development of disease-safe water supply for Coleman NFH	Construction of an ozone water treatment plant at Coleman NFH began in 1993 and concluded in 2002. Passage of additional steelhead since 1996. Passage of fall and late-fall Chinook contingent on restoration of priority species.
Screen CNFH intakes to prevent entrainment of juvenile Chinook salmon and steelhead.	In 2009 and 2010, the hatchery's primary water intake structures (intake #1 and #3) were modified to afford natural fish protection and increased operational flexibility (see Section 4 for complete description on the modifications).
Negotiate agreements to increase flows past PG&E hydropower diversions, and construct fish screens and fish ladders at PG&E facilities.	Ongoing/underway consistent with Battle Creek Restoration Project (see Section 4).
Construct barrier racks at Gover Diversion dam	Seasonal racks installed by CDFG in Battle Creek prevent adult fall Chinook from being entrained downstream into the Gover Diversion (stream mile 5.4).
Screen Orwick Diversion	Between 2006 and 2008 a properly functioning fish screen was completed with two phases of AFRP funds and technical assistance. A bypass pipe and head gate water control structure are now in place. (AFRP Action 4).
Screen tailrace of PG&E's Coleman Powerhouse tailrace	In 2004, PG&E funded construction of a picket weir to prevent adult salmonids from entering the tailrace. (AFRP Action 5)

3.5 Relationship of program to harvest objectives

Harvest rates and numbers are estimated for contribution to the ocean commercial and sport fishery and the freshwater sport fishery. Spawning escapement is considered in regards to returns of adults to the hatchery facilities, natural spawning near the hatchery facilities, and straying of adults to non-natal locations.

Ocean harvest

Ocean harvest of Chinook salmon originating at the Coleman NFH was estimated by expanding recovery data of CWT fish released from the hatchery as juveniles. Recovery data, expanded for port sampling effort, was downloaded from the website (http://www.rmpc.org) of the RMPC. Coded-wire tag recovery data were then expanded further to account for unmarked fish within each release group. Ocean harvest rates were generated for all CWT release groups by dividing the number of expanded ocean recoveries by the number of marked juveniles in each release group and multiplying that value by 100.

Fall Chinook are spawned at the Coleman NFH in October and November and late-fall Chinook are spawned in December, January, and February. Brood year refers to the year when the majority of the fish were spawned. For example, fall Chinook spawned at the Coleman NFH during October and November of 2001 would be assigned a brood year of 2001. Late-fall Chinook salmon that were spawned from December 2001 through February 2002 would be assigned a brood year of 2002. Harvest year refers to the year when fish were harvested, which typically occurs from March through November. Age of the fish at the time of harvest was calculated by subtracting brood year from harvest year. Thus, a brood year 2001 fall Chinook harvested in 2003 would be classified as age-2. Note that age designations developed using this methodology are influenced by the specific stock of fish. For example, the actual age a brood year 2001 fall Chinook harvested in the ocean fishery during 2003 could range from approximately 17 to 25 months. Conversely, a brood year 2002 late-fall Chinook salmon harvested in 2003, which could have been spawned only a couple of months after the aforementioned fall Chinook, would be classified as age-1. The actual age of these fish would range from approximately 14 to 22 months from spawn date to harvest.

Ocean contribution was estimated for fall, late-fall, and winter Chinook salmon. For fall Chinook salmon, we focus on brood years 1996 through 2001 because, during these years, mark rates were relatively high compared to other years and fish were representatively marked (i.e. fish from each rearing pond received a CWT). Fall Chinook production at Coleman NFH were not marked or tagged from brood year 2002 through brood year 2005; therefore, ocean harvest data are not available. Also, harvest of unmarked fall Chinook fry released prior to 1999 are not accounted for. Fall Chinook salmon fry generally contribute to the ocean salmon fisheries at a low rate and the release groups that were unaccounted for are unlikely to significantly change the results presented in this section. Ocean harvest data presented for late-fall and winter Chinook salmon are for brood years 1996 through 2001 and 1992 through 2002, respectively. Both late-fall and winter Chinook were marked and CWT at a rate of 100% during these periods.

Ocean contribution was previously estimated for both fall and late-fall Chinook salmon, brood years 1989 through 1995 in the Service's biological assessment of Coleman and Livingston Stone NFHs (Service 2001b). Estimates of late-fall Chinook ocean harvest presented in this report are negligibly different from those presented in the Service's 2001 Biological Assessment

(Service 2001b). Minor differences in harvest estimates are due to corrections and updates to harvest data from the RMPC website.

Harvest of Chinook salmon off the coast of California have declined from historic levels due to decreases in many stocks and increased protections provided for ESA-listed stocks. Since 1991, management objectives and allocation of harvest have required substantially lower ocean harvest rates on Klamath River fall Chinook. Since Central Valley salmon intermingle in the ocean with Klamath River salmon stocks, harvest restrictions intended to protect Klamath River fall Chinook have frequently limited commercial seasons that would normally also target Central Valley stocks including salmon from Coleman NFH. Beginning in 1996, ocean fisheries were further constrained to protect Sacramento River winter Chinook salmon. In 1999, coastal California Chinook stocks south of the Klamath River were listed as threatened under the ESA. Ocean harvest has also been affected during the last decade as a result of fishery restrictions off the Washington and Oregon coasts. From the U.S.-Canada border to Cape Falcon, OR, ocean fisheries are managed to protect depressed Columbia River fall Chinook salmon and Washington coastal and Puget Sound natural coho salmon stocks, and to meet ESA requirements for Snake River fall Chinook salmon. Finally, in 2008, the Ocean salmon commercial and recreational fisheries were closed off the coast of Oregon and California as a result of the extremely low abundance of Central Valley fall Chinook. It is important to consider management changes such as these when looking at trends in ocean harvest. For a more detailed description of ocean salmon regulations and fisheries effort refer to the Pacific Fishery Management Council's Review of Ocean Salmon Fisheries reports (http://www.pcouncil.org).

Ocean Contribution by Brood Year

Fall Chinook Salmon

During brood years 1996 through 2001, fall Chinook salmon originating at the Coleman NFH contributed an average of 59,151 fish annually to the ocean salmon fishery. This equates to an average ocean harvest (contribution) rate for Coleman NFH fall Chinook salmon of 0.50% (Table 3-2). The contribution rates observed for brood years 1996 through 2001 were heavily weighted upwards by one brood year (i.e. 1999). Fall Chinook salmon were harvested predominately at age 3 (83.50%; Table 3-2). Fall Chinook harvested at Age-2, age-4, age-5 and age-6 comprised 3.62%, 12.67%, 0.16% and 0.05% of the average ocean catch, respectively.

Coleman NFH Fall Chinook in the Ocean Troll Fishery

Numbers of Coleman NFH fall Chinook harvested in the ocean troll (commercial) fisheries of Washington, Oregon, and California ranged from 19,894 (2001) to 99,185 (2002), and averaged 45,158 annually (Table 3-3) from 2000 through 2004. It should be noted that 2004 values are slightly underestimated due to the absence of harvest data for age-2 fish. Age-2 fish represented between 2.1% and 11.7% and averaged 5.0% of the Coleman NFH fall Chinook that were harvested annually between 2000 and 2003. Fall Chinook from Coleman NFH represented between 4.0% and 13.1% of the combined troll fisheries off of Washington, Oregon, and California (Table 3-3). Harvest of Coleman NFH fall Chinook was highest off the coast of California, averaging 31,295 and ranging from 9,606 to 70,391 annually (Table 3-3). Coleman NFH fall Chinook represented between 4.9% and 18.0% of the total California troll fishery. During all but one year (2000), numbers of fall Chinook landed was greatest in San Francisco area ports (Point Arena to Pigeon Point).

Table 3-2 Estimated ocean contribution for fall Chinook salmon from Coleman National Fish Hatchery (NFH), by brood year, based on the number of salmon released.

Brood Year	Release Number	Contribution						
		Total	Percent	Age 2	Age 3	Age 4	Age 5	Age 6
1996	11,190,852	43,446	0.388	2,139	37,471	3,683	154	0
1997	12,775,200	38,424	0.301	1,244	34,328	2,661	87	103
1998	12,552,950	31,505	0.251	1,073	23,138	7,247	46	0
1999	11,897,670	158,349	1.331	3,444	131,439	23,354	112	0
2000	12,664,585	39,205	0.310	2,965	31,093	5,067	81	0
2001	11,318,028	43,979	0.389	1,987	39,012	2,980	0	0
Average	12,066,548	59,151	0.495	2,142	49,414	7,499	96	26
SD	700,295	48,803	0.413	932	40,577	7,947	40	52
		Age Structure		3.62%	83.50%	12.67%	0.16%	0.05%

Coleman NFH Fall Chinook in the Recreational Ocean Fishery

An average of 16,204 Coleman NFH fall Chinook were harvested annually (Table 3-3) in the Washington, Oregon, and California recreational ocean fisheries from 2000 through 2004. It should be noted that 2004 values are slightly underestimated due to the absence of harvest data for age-2 fish. Age-2 fish represented between 2.1% and 11.7% and averaged 5.0% of the Coleman NFH fall Chinook that were harvested annually between 2000 and 2003. Annual harvest of Coleman NFH fall Chinook ranged from 8,979 (2001) to 41,843 in (2002), and represented between 2.6% and 15.4% of the combined Washington, Oregon, and California recreational ocean fisheries (Table 3-3). Harvest of Coleman NFH fall Chinook was highest off the coast of California, averaging 13,955 and ranging from 7,699 to 35,752 annually (Table 3-3). Coleman NFH fall Chinook represented between 3.9% and 19.6% of the total California recreational ocean fishery. Numbers of Coleman NFH fall Chinook landed was greatest in the San Francisco (Point Arena to Pigeon Point) and Monterey (Pigeon Point to the California-Mexico Border) area ports.

Table 3-3 Percentage of Coleman National Fish Hatchery (NFH) fall Chinook salmon caught in the West Coast troll and recreational ocean fisheries. Harvest and effort data were obtained from the Review of 2006 Ocean Salmon Fisheries report (Pacific Fishery Management Council 2007).

		Ocean Troll				Recreational			
Harvest Year	Region	Effort Days Fished	Coleman Fall Chinook	Total Harvest	% of Harvest	Effort Angler Trips	Coleman Fall Chinook	Total Harvest	% of Harvest
2000	Washington	563	0	17,907	0.0%	48,919	61	8,478	0.7%
	Oregon	7,480	3,287	135,903	2.4%	78,563	786	25,460	3.1%
	California Total	20,453	25,481	480,352	5.3%	208,473	9,070	185,851	4.9%
	Klamath Mgt. Zone, CA	142	26	2,027	1.3%	14,420	650	13,474	4.8%
	Fort Bragg	1,079	77	30,773	0.3%	25,554	948	25,942	3.7%
	San Francisco	11,131	10,258	250,368	4.1%	83,712	2,139	64,653	3.3%
	Monterey	8,101	15,120	197,184	7.7%	84,787	5,334	81,782	6.5%
	Total (WA, OR, and CA)	**28,496**	**28,768**	**634,162**	**4.5%**	**335,955**	**9,918**	**219,789**	**4.5%**
2001	Washington	1,280	230	50,072	0.5%	126,402	36	22,974	0.2%
	Oregon	11,148	10,058	274,963	3.7%	120,461	1,243	27,200	4.6%
	California Total	13,841	9,606	193,086	5.0%	165,135	7,699	98,783	7.8%
	Klamath Mgt. Zone, CA	315	177	5,523	3.2%	24,693	645	12,824	5.0%
	Fort Bragg	816	676	14,993	4.5%	30,798	2,285	26,064	8.8%
	San Francisco	8,951	6,572	136,630	4.8%	71,490	3,656	39,856	9.2%
	Monterey	3,759	2,181	35,940	6.1%	38,154	1,114	20,039	5.6%
	Total (WA, OR, and CA)	**26,269**	**19,894**	**518,121**	**3.8%**	**411,998**	**8,979**	**148,957**	**6.0%**
2002	Washington	1,564	719	93,665	0.8%	95,167	798	57,821	1.4%
	Oregon	11,701	28,075	304,189	9.2%	107,641	5,294	47,480	11.1%
	California Total	17,395	70,391	391,655	18.0%	210,052	35,752	182,044	19.6%
	Klamath Mgt. Zone, CA	597	920	13,467	6.8%	21,543	2,512	16,131	15.6%
	Fort Bragg	2,124	11,529	65,336	17.6%	31,802	5,400	31,202	17.3%
	San Francisco	9,145	40,353	242,872	16.6%	88,784	15,304	87,008	17.6%
	Monterey	5,529	17,589	69,980	25.1%	67,923	12,536	47,703	26.3%
	Total (WA, OR, and CA)	**30,660**	**99,185**	**789,509**	**12.6%**	**412,860**	**41,843**	**287,345**	**14.6%**

Table 3-3 (cont.) Percentage of Coleman National Fish Hatchery (NFH) fall Chinook salmon caught in the West Coast troll and recreational ocean fisheries. Harvest and effort data were obtained from the Review of 2006 Ocean Salmon Fisheries report (Pacific Fishery Management Council 2007).

		Ocean Troll				Recreational			
Harvest Year	Region	Effort Days Fished	Coleman Fall Chinook	Total Harvest	% of Harvest	Effort Angler Trips	Coleman Fall Chinook	Total Harvest	% of Harvest
2003	Washington	1,914	461	91,374	0.5%	124,867	476	34,183	1.4%
	Oregon	12,418	16,871	329,678	5.1%	144,423	1,539	40,654	3.8%
	California Total	15,915	26,722	491,894	5.4%	134,627	8,646	94,674	9.1%
	Klamath Mgt. Zone, CA	105	0	4,044	0.0%	15,777	439	8,752	5.0%
	Fort Bragg	6,296	11,512	248,875	4.6%	23,709	1,350	16,180	8.3%
	San Francisco	6,770	11,821	202,876	5.8%	66,616	5,243	56,616	9.3%
	Monterey	2,744	3,390	36,099	9.4%	28,525	1,613	13,126	12.3%
	Total (WA, OR, and CA)	**30,247**	**44,055**	**912,946**	**4.8%**	**403,917**	**10,660**	**169,511**	**6.3%**
2004[1]	Washington	1,812	797	85,107	0.9%	112,704	219	24,907	0.9%
	Oregon	13,204	8,820	252,709	3.5%	145,702	790	56,433	1.4%
	California Total	21,506	24,274	502,110	4.8%	218,743	8,609	221,114	3.9%
	Klamath Mgt. Zone, CA	297	381	31,915	1.2%	25,597	840	22,844	3.7%
	Fort Bragg	5,584	2,701	107,259	2.5%	30,573	1,131	23,205	4.9%
	San Francisco	10,856	14,470	298,229	4.9%	106,078	3,000	130,220	2.3%
	Monterey	4,769	6,722	64,707	10.4%	56,495	3,638	44,845	8.1%
	Total (WA, OR, and CA)	**36,522**	**33,891**	**839,926**	**4.0%**	**477,149**	**9,618**	**302,454**	**3.2%**

[1] Brood year 2002 Coleman NFH fall Chinook production was not marked (adipose-fin clipped and coded-wire tagged). Therefore, we were unable to generate estimates of age-2 fish that were harvested in 2004. Age-2 fish represented between 2.1% and 11.7% and averaged 5.0% of the Coleman NFH fall Chinook that were harvested annually between 2000 and 2003.

Late-fall Chinook Salmon

The ocean fishery contribution for late-fall Chinook salmon from brood years 1992 through 2002 averaged 0.52%, with approximately 4,475 fish harvested annually in ocean commercial and sport fisheries (Table 3-4). Greater than half (51.59%) of the late-fall Chinook were harvested at age 2. Late-fall Chinook harvested at Age -1, Age-3, age-4, and age-5 comprised 1.13%, 45.68%, 1.54% and 0.06% of the ocean catch, respectively.

Table 3-4 Estimated ocean contribution for late-fall Chinook salmon from Coleman National Fish Hatchery (NFH), by brood year, based on the number of salmon released.

Brood Year	Release Number	Contribution						
		Total	Percent	Age 1	Age 2	Age 3	Age 4	Age 5
1992	338,279	2,940	0.869	12	1,781	1,114	29	4
1993	757,688	2,700	0.356	4	1,242	1,412	41	0
1994	632,867	4,656	0.736	19	2,371	2,236	29	0
1995	930,963	5,888	0.632	22	4,829	949	88	0
1996	1,083,109	8,170	0.754	340	1,081	6,538	205	5
1997	1,138,224	3,393	0.298	41	2,066	1,278	8	0
1998	1,146,676	3,218	0.281	79	1,459	1,631	35	14
1999	1,122,421	4,965	0.442	23	2,220	2,606	109	7
2000	826,450	2,264	0.274	15	1,009	1,160	81	0
2001	1,067,105	4,758	0.446	0	1,904	2,728	125	0
2002	1,008,895	6,279	0.622	0	5,435	835	8	0
Average	913,880	4,475	0.519	51	2,309	2,044	69	3
SD	255,299	1,800	0.213	99	1,473	1,627	60	5
		Age Structure		1.13%	51.59%	45.68%	1.54%	0.06%

Winter Chinook Salmon

An average of 149 winter Chinook salmon from Coleman NFH were harvested in ocean commercial and sport fisheries from 1991 to 2003 (Table 3-5). The overall ocean harvest rate for Coleman NFH winter Chinook salmon was approximately 0.14%. Age composition of ocean-caught winter Chinook was 0.4% age-1, 91.2% age-2, 7.5% age-3, 0.5% age-4, and 0.4% age-5 (Table 3-5).

Table 3-5 Estimated ocean harvest of winter Chinook salmon from Coleman NFH Complex, listed by brood year. Harvest rates are based on the number of salmon released.

Brood Year	Release Number	Harvest						
		Total	Percent	Age 1	Age 2	Age 3	Age 4	Age 5
1991	11,153	16	0.14	0	13	3	0	0
1992	26,433	98	0.37	0	98	0	0	0
1993	18,723	37	0.19	0	25	5	0	7
1994	43,346	36	0.08	0	9	27	0	0
1995	51,267	24	0.05	0	21	0	3	0
1996	4,718	0	0	0	0	0	0	0
1997	21,271	0	0	0	0	0	0	0
1998	153,908	157	0.1	8	137	5	7	0
1999	30,840	58	0.19	0	55	3	0	0
2000	166,207	83	0.05	0	77	5	0	0
2001	252,685	49	0.02	0	44	5	0	0
2002	233,612	910	0.39	0	843	67	0	0
2003	218,517	467	0.21	0	443	25	0	0
Average	92,822	149	0.14	1	136	11	1	1
SD	96,657	260	0.13	2	243	19	2	2
		Age Structure		0.4%	0.40%	91.20%	7.50%	0.50%

Freshwater harvest

Fall and Late-fall Chinook Salmon

Freshwater harvest was estimated for fall and late-fall Chinook salmon by apportioning Sacramento River creel survey harvest estimates (CDFG unpublished data) based on the estimated abundance of Coleman NFH produced salmon to the total salmon escapement within each creel survey reach (Table 3-6; Grand Tab, CDFG, Red Bluff, CA). Chinook harvested from July through October in the CDFG creel survey sections 2-7 were considered to be fall Chinook. Chinook harvested from July through September in CDFG creel survey section 1 were considered to be fall Chinook. Chinook harvested after October were considered to be late-fall Chinook.

Table 3-6 Allocation of Coleman NFH Chinook Salmon to Sacramento River, California Creel Survey estimates.

Creel Survey Section	Creel Survey Section Description	Allocation to Coleman NFH
1	Carquinez Bridge to Rio Vista Bridge	Coleman NFH Escapement/Total Central Valley Escapement
2	Rio Vista Bridge to mouth of the American River	Coleman NFH Escapement /Total Sacramento River Escapement
3	Mouth of American River to Knights Landing (HWY 113 bridge)	Coleman NFH Escapement /Total Escapement Above Sacramento
4	Knights Landing to Colusa (River Road bridge)	Coleman NFH Escapement/Escapement Above Princeton Ferry
5	Colusa to Hamilton City (Hwy 32 bridge)	"
6	Hamilton City to Red Bluff Diversion Dam	"
7	Red Bluff Diversion Dam to Deschutes Road bridge in Anderson	Coleman NFH Escapement/Escapement Above the Red Bluff Diversion Dam
8	Deschutes Road bridge to ACID dam in Redding	"

We estimate that a total of 96,400 Coleman NFH fall Chinook salmon and 8,677 late-fall Chinook salmon was harvested in the Sacramento River sport fishery from 1998 to 2002 (Table 3-7). During that time period, over 400,000 hours were spent angling (Table 3-7). Average freshwater harvest of fall Chinook salmon was approximately 19,280 per year with the low of 14,340 in 1998 and a high of 24,509 in 2002 (Table 3-7). Average freshwater harvest of late-fall Chinook salmon was approximately 1,735 per year with the low of 1,034 in 2002 and a high of 2,408 in 2000 (Table 3-7).

Table 3-7 Numbers of Coleman NFH Fall and Late-fall Chinook salmon harvested and hours spent angling in the freshwater recreational fishery, 1998 through 2002.

	Fall Chinook		Late-fall Chinook	
	Number Harvested	Angler Hours	Number Harvested	Angler Hours
1998	14,340	444,634	1,745	18,420
1999	19,673	282,069	1,741	31,785
2000	19,094	194,545	2,408	47,412
2001	18,784	362,788	1,749	34,106
2002	24,509	719,441	1,034	25,020
Average	19,280	400,695	1,735	31,348

Steelhead
Freshwater angling and harvest was estimated using information from the California Steelhead Fishing Report-Restoration Card report (Jackson 2007). All steelhead released from the Coleman NFH hatchery since 1998 have been adipose-fin clipped. All fin-clipped steelhead caught upstream of the confluence of the Feather River were assumed to be of Coleman NFH origin. From 2003-2005, an average of approximately 900 angler trips resulted in approximately 350 steelhead being caught in the freshwater recreational fishery annually. Of the steelhead caught, approximately 26% were harvested and the rest were released (Jackson 2007).

3.6 Escapement to Battle Creek

The number of hatchery-origin fall Chinook salmon from Coleman NFH escaping to the spawning grounds showed an increasing trend and exceeded broodstock requirements at the hatchery through much of the 1990s and early 2000s. Spawner escapement of fall Chinook salmon to Battle Creek from 1953 through 1991, including AFRP baseline period 1967 - 1991, averaged approximately 17,000 adults (Figure 3-1). From 1994 to 2006, substantially more fall Chinook salmon returned to Battle Creek, with an estimated average escapement of approximately 128,000. However, the abundance of fall Chinook in Battle Creek has been much reduced since 2007, with escapement levels below 22,000.

Escapement of fall Chinook salmon to Coleman NFH has generally exceeded broodstock collection requirements since the late-1970s (Figure 3-1). However, in 2007 and 2008 the numbers of fall Chinook that returned to Battle Creek were sufficient to achieve broodstock collection targets and also to allow for some natural spawning, but were not considered to be over-escapement. Spawner requirements at current production levels at Coleman NFH are approximately 6,400 adults (generally 60% male and 40% female). To obtain the required number of broodstock over 8,000 adult fall Chinook must be collected. Collection of adults in addition to spawner requirements is conducted to buffer for gender inequity and pre-spawn mortality (>5%), and to obtain sufficient numbers of spawners at the tails of the spawning distribution to form a normal, bell-shaped spawning distribution.

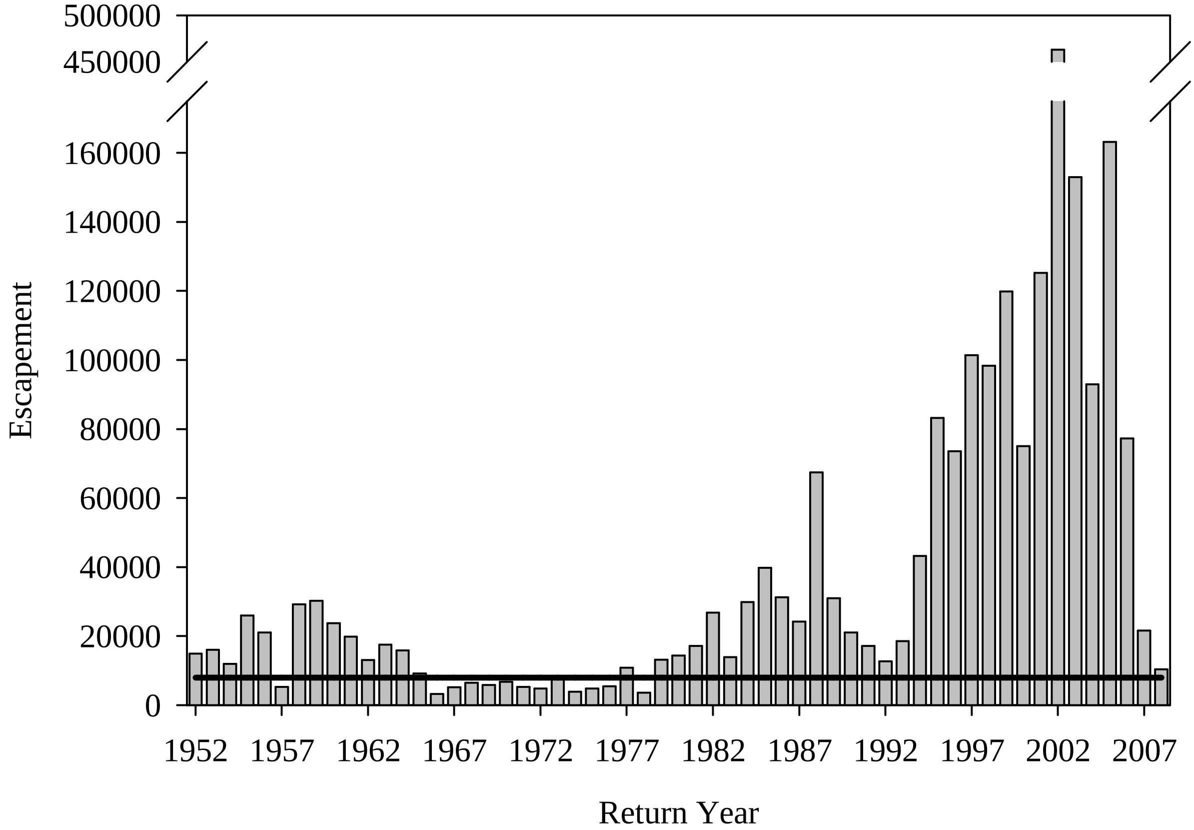

Figure 3-1 Escapement of fall Chinook salmon to Battle Creek from 1952-2008 (source California Department of Fish and Game GrandTab). Escapement includes both adults taken into Coleman National Fish Hatchery and adults spawning naturally in Battle Creek. Heavy black lines denotes broodstock collection requirement (approximately 8,000) for fall Chinook salmon at Coleman National Fish Hatchery.

3.7 Impacts of hatchery-origin salmonid (over) escapement on Battle Creek Restoration

Fall Chinook Salmon

Escapement of large numbers of fall Chinook salmon to Battle Creek during some years could impact naturally-producing salmonids. Potential impacts are: 1) spatial limitations of spawning habitat, causing increased competition for redd sites or redd superimposition; 2) disease transmission; 3) negative effects to emigrating juveniles caused by hatchery-origin fall Chinook salmon; or, 4) genetic concerns related to hatchery-natural interbreeding.

Spatial Limitations of Spawning Habitat and Genetic Concerns

The Service culls adult fall Chinook salmon at Coleman NFH during years of substantial over-escapement to Battle Creek. This practice is conducted to reduce the frequency of redd superimposition and to decrease the level of stress resulting from competition for redd sites. This practice is believed to benefit conditions favoring successful reproduction of natural spawners downstream of the barrier weir. Until a fishery management plan is developed for

Battle Creek the Service will continue to remove fall Chinook from Battle Creek when abundance exceeds the carrying capacity of the creek.

Disease Transmission
There is no evidence of disease transmission from adult carcasses to natural-origin Chinook salmon in Battle Creek. In an investigation of naturally-produced fall Chinook fry collected from Battle Creek, no IHNV was detected despite their close proximity to IHNV-infected adult carcasses (Foott 1996b). Furthermore, no IHNV-infected juveniles of natural-origin have been collected from the Sacramento River despite close association with IHNV-infected carcasses (S. Foott, pers. comm.). The practice of culling fall Chinook salmon at Coleman NFH during years of substantial over-escapement is believed to reduce the potential for disease transmission to juvenile salmonids in Battle Creek.

Negative Effects on Emigrating Juveniles
Natural-origin juvenile salmonids emigrating during the months of October through November could be negatively affected as they emigrate through large congregations of hatchery-origin fall Chinook salmon in lower Battle Creek. Negative impacts could occur as stress, alteration of migratory patterns, or predation.

While it is possible that juvenile salmonids are negatively impacted as they emigrate through large congregations of adults, no data are available to either support or refute this speculation. Monitoring of juvenile emigration patterns in Battle Creek from 1998 through 2000 has shown that few salmonids emigrate from Battle Creek during the fall Chinook spawning season (see Appendix 10D in Service 2001b for timing and estimated passage of emigrating juvenile salmonids). A temporal difference between spawning and emigration is believed to reduce potential impacts. Continued and increased monitoring of juvenile emigration patterns in conjunction with adult abundance estimates will be necessary to determine the existence and degree of impact.

Late-fall Chinook Salmon
Numbers of late-fall Chinook salmon collected at Coleman NFH ranged between 1,300 and 6,300 adults from 1996 to 2007. To accomplish production goals, less than 1,000 adults are required for broodstock. The number of late-fall Chinook spawning naturally in Battle Creek downstream of the Coleman NFH barrier weir is unknown, but is presumed to be small, as most late-fall adults are thought to enter into the hatchery. This level of late-fall Chinook salmon escapement is not believed to constitute a risk emigrating juvenile salmonids.

Steelhead
The Service believes that the majority of hatchery-origin steelhead enter the Coleman NFH during the period of broodstock collection. Hatchery-origin steelhead are either spawned or, when numbers of hatchery-origin steelhead exceed broodstock collection requirements, stripped of eggs. After spawning or stripping steelhead are placed in holding ponds at the hatchery, where they are detained for “reconditioning” until March when they are released into Battle Creek. Most steelhead kelts migrate rapidly downstream following release. Current escapement numbers and adult release practices for steelhead should not constitute a risk to naturally-producing salmonids.

3.8 Relationship of harvest and escapement

Impacts of Mixed-stock Fisheries

Mixed stock fisheries present complex problems for fishery regulatory agencies (e.g., setting appropriate fishing regulations and harvest levels) and hatchery production programs (determining production levels). Hatchery-origin stocks can generally sustain substantially higher rates of harvest as compared to natural populations. This occurs because mortality associated with spawning and rearing is substantially reduced in hatcheries compared to natural environments. A result of these differences is that relatively fewer adults are required to produce a sustainable rate of hatchery recruitment as compared to natural recruitment, and, therefore, the hatchery stock can generally sustain substantially higher exploitation rates. When fishing effort is set at a level compatible with the more-productive component of the population overfishing of the less-productive component is a likely outcome. Alternatively, fishing regulations are sometimes implemented to protect the weak stocks of a mixed-stock fishery. For example, restrictions of commercial fishing seasons off the California coast were implemented in the mid-1990s to protect imperiled stocks of Sacramento River winter and Klamath River fall Chinook salmon. An unintended consequence of restricting fishing effort to protect weak stocks can be underutilization of the more-productive hatchery stocks, leading to a substantial surplus of adults returning to the hatchery. These situations describe what is commonly referred as the mixed-stock fishery dilemma.

4 HATCHERY WATER SOURCE

4.1 Coleman National Fish Hatchery

Water Rights
The Service holds Battle Creek water rights for up to 122 cubic feet per second (cfs) to conduct fish propagation activities at Coleman NFH). Coleman NFH water rights were obtained by appropriation.

As a result of a water intakes modification project (see *water intakes* Section below), in March of 2008 the Service submitted a Water Right Change Petition to the State of California Water Resources Control Board. The water right change petition specifically requested that all previous diversions and uses remain in place but that diversion of the entire water right (122 cfs) could be diverted at the Intake 1 site. Approval was granted in January 2010.

Water Diversion and use of water diversion Intakes
Battle Creek is the source of water for all fish culture activities at the Coleman NFH. Three water intake structures and associated conveyance facilities are used to deliver water to the hatchery (Figure 4-1). The water delivery system at Coleman NFH is highly complex and has numerous piping interconnections between facilities. Water from all three intakes can be shunted to the ozone water treatment facility (see *water treatment facility* section below) or sent directly to various fish rearing areas at the Coleman NFH.

The Reclamation, Northern California Area Office, and the Service recently modified the Coleman NFH water intakes and conveyance systems. These modifications allow the Service to meet criteria for fish screening required by the NMFS and the CDFG. Aside from providing juvenile fish protection, the modifications also offer the operational redundancy needed to ensure stable and reliable water deliveries within the confines of Coleman NFH's existing water rights (122 cfs). These modifications were deemed necessary to ensure that hatchery water supply facilities are compatible with the multi-agency effort associated with the Battle Creek Salmon and Steelhead Restoration Project to restore runs of salmonids to 42 miles of Battle Creek. A brief description of the Coleman NFH water intakes, water delivery system, and fish protection measures are presented below and a complete description can be found in *Coleman National Fish Hatchery Water Intakes Rehabilitation Project Action Specific Implementation Plan* (Reclamation 2007).

The primary water intake for the Coleman NFH is designated as Intake 1. Intake 1 was constructed in 1942 and is located in the tailrace of the PG&E's Coleman Powerhouse. Water in the PG&E Coleman Powerhouse tailrace originates from an area of upper Battle Creek that is currently considered inaccessible to anadromous fish. Intake 1 is also inaccessible to anadromous salmonids from the downstream direction by a juvenile fish barrier and an adult salmonid exclusion weir. In the near future, full implementation of the Battle Creek Salmon and Steelhead Restoration Project will result in all PG&E hydroelectric project water diversions being fully screened at the point of diversion and anadromous fishes will be afforded unrestricted access throughout the restoration project area. Water taken through Intake 1 is conveyed to the hatchery via a 46-inch diameter pipe which daylights into an open canal. Water in the PG&E

powerhouse tailrace not diverted to the hatchery empties into Battle Creek approximately 1.6 miles upstream of the hatchery property.

Anticipating implementation of the restoration project, the Service recently (2009) expanded the capacity of the hatchery's Intake 1 to provide improved efficiency and operational flexibility. As the water available in the PG&E Coleman Powerhouse Tailrace is considered anadromous fish free, an independent fish screen is not necessary at the Intake 1 site. Modification instead consists of an adjacent intake orifice at the Intake 1 site which feeds a new 36 inch pipeline. The new 36 inch pipeline at the Intake 1 site, ties into the new Intake 3. This expansion of Intake 1 allows the hatchery to use more of the water from the PG&E Coleman powerhouse tailrace (i.e., water that has already been diverted through the PG&E hydroelectric system project), thereby reducing the need for additional diversions directly from the creek.

Coleman NFH's Intake 3 is located approximately 1.2 miles upstream of the hatchery. This intake structure was rebuilt in 2009, and now features a state-of-the-art fish screen that has been designed and constructed to meet juvenile fish protection criteria of the NMFS and the CDFG. Water directly diverted from Battle Creek through the fish screen, or delivered to this site via Intake 1 (see above) is conveyed to the hatchery through 4,600 feet of 48-inch diameter pipeline.

Coleman NFH Intake 2 is located on the south bank of Battle Creek, in close proximity to Intake 1. Intake 2 is not screened and is used only as an emergency backup to intakes one and three. The design of Intake 2 prevents diversion of water simultaneous with Intake 1. During normal Coleman NFH operations, water is diverted from either Intake 1 or a combination of Intake 1 and Intake 3. Occasionally, however, situations arise with the PG&E hydropower facilities causing either a planned (e.g., annual maintenance) or unplanned (e.g., failure of PG&E powerhouse or water delivery system infrastructure) interruption in flow through the powerhouse. Under these circumstances, the PG&E Coleman Powerhouse tailrace empties, and no water is available for Intake 1. When Intake 1 is not available, Intake 2 automatically begins diverting water (Intake 3 may also be used), thus maintaining adequate water supply for fish culture at the Coleman NFH.

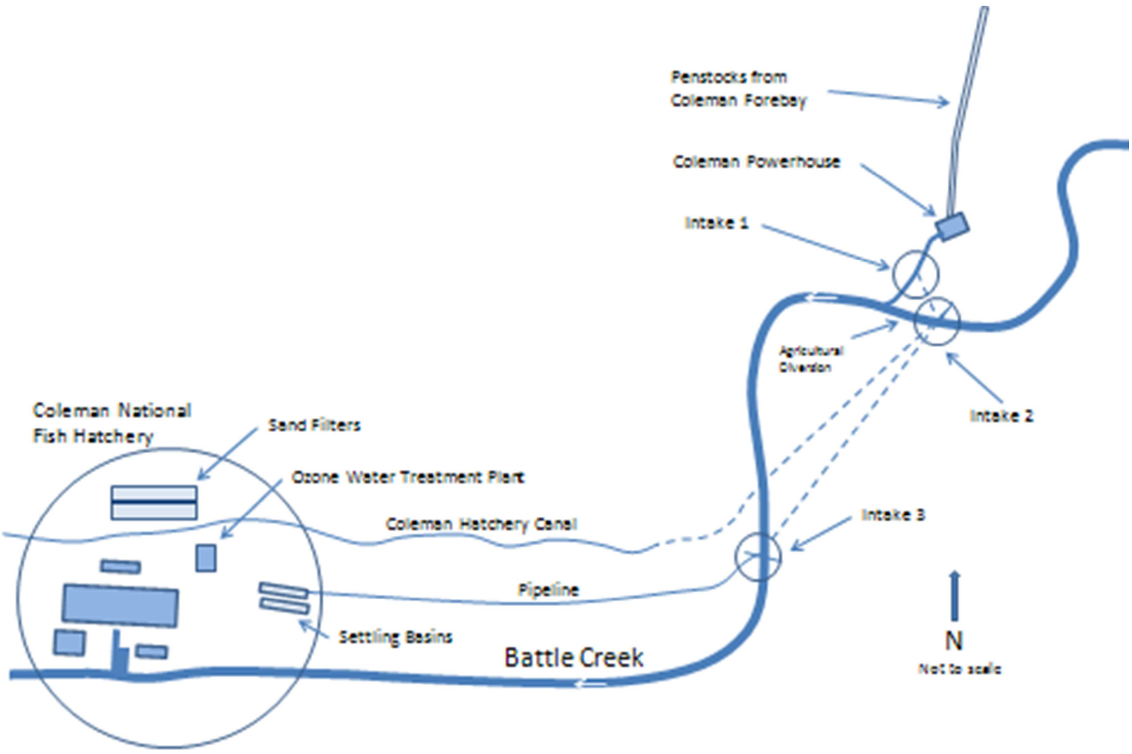

Figure 4-1. Existing water diversion and delivery system at Coleman National Fish Hatchery, Battle Creek, California.

Water Treatment Facility

Disease and sediment problems associated with the water supply had confounded fish culture at Coleman NFH since its inception. High sediment loads, generally associated with high flow events in Battle Creek, have caused mortality of juvenile and adult salmonids at the hatchery. Likewise, recurrent disease outbreaks possibly associated with the hatchery water supply resulted in increased mortality of juveniles (Foott and Williamson 1997). More than ten significant pathogens have been detected in salmonids at Coleman NFH (Foott 1996a).

To reduce sediment in the hatchery water supply and to alleviate recurrent disease problems, a water treatment facility capable of filtering 45,000 gpm and ozonating 30,000 gpm was constructed at Coleman NFH. Construction of the facility began in 1993. Although ozone production capability reached full capacity in 2000, construction and final build out did not conclude until 2002. Several documents thoroughly discuss the justification, selection, and construction of the ozone water treatment facility at Coleman NFH (Service 1986, 1987, 1989, 1997a, 1997b). Operation of the ozone water treatment facility has substantially reduced the occurrence of disease in hatchery production and the potential for disease transmission to naturally-produced stocks. Since brood year 1999, juvenile salmonids propagated at the Coleman NFH have been reared and released with no incidence of IHNV.

The water delivery system and water treatment plant at Coleman NFH are equipped with numerous alarms to alert hatchery staff in the event of power outages or low water supply. On-station housing and an automated dialer system increases the likelihood that hatchery staff will respond in a timely manner to emergencies occurring during non-business hours.

Water Discharge
Water use at the Coleman NFH is non-consumptive. All water diverted from Battle Creek is returned to the creek through an overflow channel, the fish ladder, a wastewater ditch, or the outfall of the pollution abatement pond. The total distance over which water is diverted is 1.2 miles (from Intake 3) to 1.6 miles (from Intakes 1 and 2). The facility discharges an average of 40.8 million gallons/day. Approximately 3.3 million gallons/day of hatchery wastewater is diverted through the pollution abatement pond prior to discharge into Battle Creek. The pollution abatement pond is used primarily to reduce the discharge of solids (i.e., fish fecal material, unconsumed food, algae, and silt) associated with cleaning the raceways and filtering the incoming water prior to passage through the ozone water treatment plant.

Water discharged from the Coleman NFH is regulated by National Pollution Discharge Elimination System permit (Attachment 4-1) issued by the California Regional Water Quality Control Board. As a provision of this permit, the Service conducts monthly sampling of total suspended solids, pH, dissolved oxygen, turbidity, and temperature in both supply- and receiving-waters in Battle Creek. The permit also covers chemicals used for fish health maintenance and treatment at the hatchery (e.g., formalin, antibiotics).

4.2 Livingston Stone National Fish Hatchery

Water Intake
The water supply for Livingston Stone NFH is provided by a pipe tapped directly into the penstocks of Shasta Dam. To ensure water reliability in the event one or more penstocks are not delivering water, the facility has the option to draw off of alternate penstocks[2]. Water is delivered from the penstocks to two gas equilibration columns atop an 18,000-gallon head tank. This head tank supplies the entire facility through a PVC manifold system. Total flow available to the facility is approximately 3,000 gpm.

The water delivery system at the Livingston Stone NFH is completely automated (computer controlled electronic valves), but manual overrides are built into the system. In the event of a power outage, an energy-dependent solenoid will trip thus allowing free flow (i.e., approximately 5,000 gpm) to the head tank. Although the head tank will overflow in this situation, the water supply to the rearing facility will be uninterrupted and fish production will not be at risk. Furthermore, since Shasta Dam is the primary electricity generating facility in Northern California, electrical grids at the facility are generally restored first, and power outages are expected to be short.

Water quality at Livingston Stone NFH is favorable for propagating winter Chinook salmon (United States Department of the Interior 1997). Suitable water temperature is achieved through

[2] The facility is currently plumbed into three penstocks and in the future may be plumbed into four for improved reliability of water supply.

operation of the Temperature Control Device at Shasta Dam. Turbidity is low because most suspended solids fall out in Shasta Lake (reservoir) prior to use at the Livingston Stone NFH. Disease concerns are minimal because it is unlikely that pathogens would be transmitted from Shasta Lake into Livingston Stone NFH for the following reasons: 1) Shasta Dam prevents upstream migration of anadromous salmonids into the hatchery water supply; and, 2) the water used at Livingston Stone NFH is taken from 270 feet below the crest of Shasta Dam, a depth where fish and pathogens are expected to be absent.

Water Discharge
Water used for winter Chinook production at Livingston Stone NFH is returned to Keswick Reservoir just below Shasta Dam, upstream of the limit of anadromous fishes migrations. Water discharged from the Livingston Stone NFH is regulated by a National Pollution Discharge Elimination System permit issued by the California Regional California Regional Water Quality Control Board (Attachment 4-2).

Recently, the Service has begun rearing delta smelt at the Livingston Stone NFH. The delta smelt program at the Livingston Stone NFH is operated as a back-up to the refugial population housed at the FCCL in Byron, California. The primary purpose of this project is to maintain a portion of the captive delta smelt population at a second location to protect against loss of the entire population due to a catastrophic occurrence, such as dewatering or disease epidemic. Hatchery effluent associated with the delta smelt tanks is disinfected with a double ultraviolet flow-through treatment system.

4.3 Fish salvage efforts associated with Coleman NFH water diversions

Fish salvage efforts
Prior to the recent water intake modifications, the Service conducted periodic salvage to rescue fishes entrained in the hatchery's water delivery system. Fish salvage was conducted by a variety of methods including seining, dip nets, cast nets, and electroshocking. Salvage efforts were developed in consultation with NMFS and were conducted in both the Coleman NFH water delivery canal (to rescue fishes diverted through unscreened Intake 2) and the settling basins (to rescue fishes diverted through Intake 3). With the functioning fish screen now in place at Intake 3, annual fish salvage efforts in the sand settling basins will no longer be necessary. The new fish screen at Intake 3 was installed in late 2009. Zero salmonids were observed during salvage of the settling basins in 2010, indicating that the new screen structure was protecting emigrating salmonids from entrainment.

Salvage efforts continue to be occasionally necessary to rescue fishes entrained during the operation of the hatchery's emergency back-up Intake (Intake 2). Recent efforts demonstrated that a fyke net salvage operation conducted in the Coleman NFH canal could be used to successfully execute real-time salvage of entrained fishes (see Whitton et al. 2007). For example, an extended outage at PG&E's Coleman Powerhouse from February through March 2010 resulted in the need to operate Intake #2 for an extended period. A fyke weir was installed in March and successful operation of the fyke weir for real time salvage was accomplished (Service 2010). Coleman NFH retains on-hand all components of a complete fyke weir including pontoons, live box, nets, and fyke panels. This equipment will be maintained and be readily accessible for rapid deployment into the Coleman Canal when: 1) extended periods of operation of emergency Intake 2 is required/expected, and 3) the time period coincides with expected substantial salmonid outmigration.

Operation of Intake 2 may not warrant real-time salvage efforts at times when outmigration of juvenile salmonids is either not expected or anticipated to be minimal. For example, the primary water intake for the Coleman NFH was disabled from July 22 to Sept 22, 2010 due to a failure at the PG&E's Coleman Powerhouse. This inability to supply water to the hatchery through the primary intake necessitated use of the hatchery's unscreened back-up Intake #2. During this time period, however, salvage efforts were not implemented in the hatchery canal. Through consultation with NMFS, and using data from the Service's juvenile salmonid monitoring program in Battle Creek, the Service showed that the timing of the event coincided with a period when few salmonids are expected to emigrate from Battle Creek.

4.4 Take of ESA-listed and non-listed salmonids resulting from hatchery water withdrawal and discharge

Coleman NFH-water diversion

Existing water diversions for Coleman NFH may result in take of juvenile ESA-listed and non-listed salmonids from Battle Creek. The primary intake for Coleman NFH is located in the tailrace of the Coleman powerhouse. Intake 1 is located in an area inaccessible to anadromous salmonids. Intake 3 has been modified to meet NMFS' fish screening criteria; therefore, take of salmonids is also not expected to occur at that location. Water diversion at back-up Intake 2 may entrain juvenile salmonids because this intake is unscreened. Funding for design and construction of the screening of Intake 2 have not been secured, and no timeline has been established for completion of this action.

We estimated entrainment of juvenile salmonids at the Coleman NFH Intake 2 based on the assumptions that entrainment is related to the following factors: 1) the proportion of Battle Creek flow diverted into the hatchery; 2) the magnitude and timing of diversions at Intake 2; and, 3) the magnitude and timing of salmonid emigrations in Battle Creek past Intake 2. Explanation of these assumptions is presented below:

1) *Proportion of Battle Creek flow diverted at Coleman NFH*

   The amount of water diverted into Coleman NFH varies throughout the year, depending on the water demands for fish culture activities associated with various cycles of collecting, spawning, and rearing three stocks of anadromous salmonids (Figure 4-2). Total water use at the hatchery is highest from October through early-March (generally >100 cfs) when broodstock collection, spawning, egg incubation, and rearing all occur simultaneously. Lowest water use at Coleman NFH occurs in May (54 cfs) following the release of most of the fall Chinook. Total diversion through the Coleman NFH intakes also includes 13 cfs that is delivered to downstream water users without being used at the hatchery (Sverdrup and Tetra Tech/KCM, Inc. 1999). A detailed analysis of hatchery water requirements at Coleman NFH, broken down by species and rearing unit, is presented by Reclamation (2007).

   Average monthly flow in Battle Creek ranges from a low of 260 cfs during September to a high of 742 cfs during January (Figure 4-2; USGS website: http://waterdata.usgs.gov). High base flows in Battle Creek create a year-round connection to the Sacramento River. During a portion of the summer (i.e. July), however, elevated water temperature in the lower most section of Battle Creek are generally considered to preclude salmonid movement into or out of the tributary. Winter flows in Battle Creek are influenced greatly by winter storm events, with high flow events generally occurring between January and March.

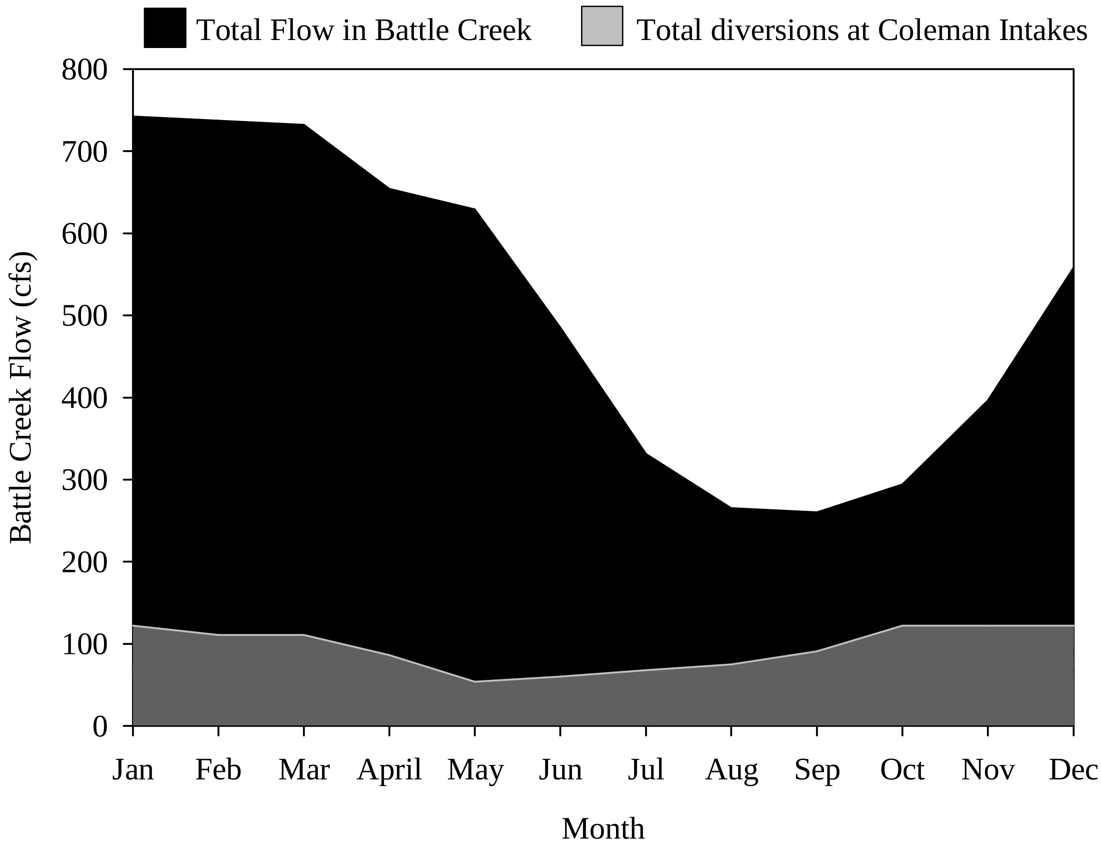

Figure 4-2 Annual hydrograph for Battle Creek and expected diversions at Coleman National Fish Hatchery intakes. Total diversions at Coleman National Fish Hatchery intakes includes approximately 13 cfs delivered to downstream water users. Monthly flow averages are based on data for Battle Creek from 1961 through 2008.

2) *The magnitude and timing of diversions at Intake 2*
Intakes 1 and 3 are the primary intakes for Coleman NFH. The full water right for the Coleman NFH is 122 cfs. As per the recent water right modifications, the entire water right may be diverted at Intake 1. When water cannot be fully or partly supplied through Intake 1, water will be diverted at Intakes 2 and/or 3.

Planned and unplanned diversions through Intake 2 are occasionally required for routine maintenance and emergency situations that interrupt water supply to Intake 1. The normal operating condition of the Coleman powerhouse involves discharge of flow from the Coleman Powerhouse forebay, through the penstocks and turbine, and into the tailrace where the hatchery's Intake 1 is located. Occasionally, water is blocked from the Coleman powerhouse to perform maintenance or repairs of the PG&E canals and turbine. Planned maintenance activities are typically scheduled during May and June, to correspond with decreased water needs at Coleman NFH. However, the timing of unplanned events such as turbine trip or canal failure cannot be anticipated. When sufficient water is not available at Intakes 1 and 3 because of maintenance or emergency situations, Intake 2 on Battle Creek will be used to divert water to supply the hatchery.

Until 2005, the average amount of time that Coleman NFH has been dependent upon emergency Intake 2 was approximately 412 hours per year. However, several major mechanical or structural break-downs to the hydropower system occurred in 2006 and 2010, which disabled the use of the hatchery's primary intake and resulted in extended use of intakes two and three. Specifically during 2006, intakes two and three were used to supply water to the hatchery facility for a total of approximately 270 days. As a result of these specific outages, the long term average operation of Intake 2 has increased from 17.2 days per year (as presented in the Service's 2001 Biological Assessment) to approximately 40 days per year (considering the recent 20 years of record) or approximately 57 days per year (considering the recent 10 years of record).

To estimate future entrainment of salmonids, the Service assumed the unscreened Intake 2 of the Coleman NFH would be used an average of 412 hours annually. This estimate is consistent with that used in the 2001 Biological Assessment. Extended outages of PG&E infrastructure of the magnitude witnessed in 2006 and 2010 are unusual, and should not be expected to reflect future conditions. Based on the amount of work and retrofitting that has recently occurred at PG&E's Coleman Powerhouse extended breakdowns are expected to now be reduced.

We further assumed that Intake 2 will be used only when Intake 1 is inoperable; and that half of the hours of operation for Intake 2 (206 hours) will occur during May and June (as part of scheduled PG&E maintenance) and the remaining 206 hours will occur as randomly timed emergency events. To estimate take of juvenile salmonids at Intake 2 during emergency events, we apportioned the hours equally from July through April. **The Service commits that any major outages at the PG&E powerhouse that requires the extended use of Intake 2 will result in the reinitiation of consultation as has been the continuing practice of the Service.**

3) *The magnitude and timing of juvenile salmonid emigrations past the Coleman NFH intake structures.*

We estimated the magnitude and timing of juvenile salmonid emigrations from Battle Creek using monitoring data from 2004-2010. Data from December 2009 through July 2010 were selected for take estimate derivation for spring Chinook salmon as the greatest number of juveniles were estimated during that time. During that time, 96,533 juvenile spring-run Chinook are estimated to have emigrated from Battle Creek, with the greatest number emigrating in December and January. Likewise during that same time period, 5,112 juvenile steelhead/rainbow trout emigrated annually from Battle Creek. We assume that emigrations of ESA-listed Central Valley spring-run Chinook salmon and Central Valley steelhead will follow similar seasonal patterns (i.e., monthly percentages) as observed during these years. Winter Chinook salmon do not currently inhabit Battle Creek; therefore, emigrations of juveniles are not anticipated.

Based on best available information, and given the above considerations, we estimate total take of ESA-listed and non-listed salmonids at the Coleman NFH Intake 2 will be 243 spring Chinook and 6 steelhead. No take of winter Chinook has been estimated to occur as a result of diversions through Intake 2 (Table 4-1). Take will occur as entrainment. Derivation of these estimates is shown in Appendix 4A.

Table 4-1. Estimated salmonid take resulting from entrainment from Battle Creek into the Coleman National Fish Hatchery water delivery system. Numerical take estimates do not include fishes salvaged from the hatchery's water supply system (i.e., actual lethal take will likely be less as some of these fish will be rescued during salvage operations. Take for rescued fishes will be decreased to handling and delay of emigration).

	Species		
Type of Take	Winter Chinook	Spring Chinook	Steelhead
Unintentional lethal take[a]	0	243	6
% of estimated outmigrants	0	0.25	0.11

[a] Juvenile take through Intake 2 will occur as entrainment.

Our estimates of take resulting from water diversions at Coleman NFH do not account for salvage of fishes from the hatchery's water supply system. Salvage of fishes from the hatchery's canal will reduce the severity of take for entrained fishes, such that, for example, the effect on salvaged fishes will change from mortality to handling, sampling, and release. Previous attempts at salvaging entrained juveniles from the hatchery's canal or settling basin have been successful at collecting some entrained fishes by seining and electro-shocking; however, the efficacy of these efforts in regards to the total number of fishes entrained is unknown.

Real-time fish salvage efforts will be mobilized if the diversion at Intake 2 is expected to be of duration sufficient to enable the mobilization of salvage efforts and if the timing of operations of Intake 2 occurs during a time of year associated with emigrations of ESA-listed salmonids from Battle Creek (see *Fish Salvage* Section above). As in the past, consultation documentation will be forwarded to the National Oceanic and Atmospheric Administration describing any such event and the planned action associated with the event.

Coleman NFH—Water Discharge
Negative impacts to naturally producing salmonid populations and their habitats associated with water discharge from Coleman NFH are considered to be minimal (none to low) for two reasons. First, the determination by the California Regional Water Quality Control Board indicates that discharge should not adversely affect beneficial uses of surface or ground water. Specifically, in issuing the National Pollution Discharge Elimination System permit, the California Regional Water Quality Control Board concluded that discharge at the Coleman NFH is considered minor, and existing wastewater treatment technology (such as the settling pond) is capable of consistently reducing hatchery wastewater constituents to concentrations which are below the level at which the beneficial uses of surface and/or ground water are adversely affected. Beneficial uses include preservation and enhancement of fish, wildlife, and other aquatic resources. Second, the operation of the ozone water treatment plant reduces the risk of disease outbreaks at Coleman NFH (e.g., no IHNV since the plant came online in 1999) with a concomitant decrease in risk of transmitting disease(s) to naturally-produced juveniles in Battle Creek.

Livingston Stone NFH—Water Diversion
The Service anticipates no take of ESA-listed or non-listed salmonids through Livingston Stone NFH water intakes. Livingston Stone NFH obtains its water through the penstocks of Shasta Dam. Because the dam prevents upstream migration of salmonids and water is withdrawn from Shasta Lake at a depth of 270 feet below crest elevation, take of salmonids is not expected during hatchery water withdrawals.

Livingston Stone NFH – Water Discharge
Hatchery effluent associated with the delta smelt program at the Livingston Stone NFH is disinfected with a double ultraviolet flow-through treatment system prior to discharge into Keswick reservoir. Negative impacts to naturally producing salmonid populations and their habitats associated are not expected to result from the discharge of water from the Livingstone Stone NFH. The findings of the National Pollution Discharge Elimination (NPDE) permit issued by the California Regional Water Quality Control Board for Livingston Stone NFH concluded that discharge at the Livingston Stone NFH is considered minor, and existing wastewater treatment technology is capable of consistently reducing hatchery wastewater constituents to concentrations which are below the level at which the beneficial uses of surface and/or ground water are adversely affected. Beneficial uses include preservation and enhancement of fish, wildlife, and other aquatic resources. Monthly water supply and effluent monitoring at the Livingston Stone NFH includes parameters similar to those measured at Coleman NFH.

4.5 Effects of water diversions for Coleman NFH on Battle Creek salmonid habitats after proposed restoration

Current minimum flow agreements for Battle Creek, which will continue after implementation of the Battle Creek Restoration Project, call for 35 cfs and 40 cfs from the Eagle Canyon and Inskip dams, respectively (Memoranda of Understanding among the NMFS, Service, CDFG, Reclamation, and PG&E dated June 10, 1999). These flows reflect an effort to balance power production needs with fish habitat requirements at various life-stages, and take into consideration water quality (e.g., temperature) and habitat availability. Stream flows reallocated under the Battle Creek Restoration Project are designed to satisfy the life history requirements (e.g., upstream migration, spawning, egg incubation, rearing, and emigration) of priority species within restored stream reaches.

Ward and Keir (1999) recommended minimum flows between 45 and 112 cfs for the mainstem of Battle Creek after full restoration (Table 4-2). The mainstem reach, which extends from the Coleman barrier weir upstream to the confluence of North and South Forks, encompasses an area affected by hydropower diversions and also includes the 1.2 to 1.6 miles of salmonid habitat below the Coleman Powerhouse which are affected by Coleman NFH water diversions. Although the section of Battle Creek that is affected by hatchery water withdrawals was not included in the original studies completed by Thomas R. Payne and Associates (Thomas R. Payne and Associates 1998a through 1998d), a Biological Team developed by the Greater Battle Creek Watershed Working Group extended flow recommendations to this section based on habitat similarities to the upstream reach that was investigated.

Battle Creek flows and water requirements for Coleman NFH vary depending on time of year and activities associated with fish propagation (Table 4-3). Monthly water requirements for Coleman NFH range between and 54 and 122 cfs, including 13 cfs delivered to downstream users without being used in the hatchery. Hatchery water needs will not change as a result of the intake modification project or as a result of Battle Creek restoration efforts. Water use at Coleman NFH is non-consumptive, so all water diverted for hatchery propagation efforts (except for the approximately 13 cfs that must be delivered to downstream users) is returned to Battle Creek at the hatchery site.

Potential impacts from hatchery water withdrawals vary throughout the year. Impacts to salmonid habitats caused by hatchery water withdrawals are likely greatest during late-summer and fall months when water requirements for Coleman NFH comprise the largest proportion of flow in Battle Creek (e.g., August through November; Table 4-3). Although hatchery water demands are higher in December and January, flows in Battle Creek during those months are higher as well, which reduces the relative effects of hatchery water withdrawals (Table 4-3). To illustrate potential effects of hatchery water withdrawals from Battle Creek, we analyzed hatchery water requirements and minimum releases for August (after restoration). The 2001 Biological Assessment contains a map and schematic of water flow through sections of Battle Creek and its diversions; Figure 4-3, Section 4, Page 4-20 (Service 2001b). We consider August to be the most critical month for determining the impacts of hatchery water withdrawals because the lowest "low average monthly flow" occurs and is coupled with moderate hatchery water demands. Regardless, similar analyses for any month can be made using information from Table 4-3 (this report) and Figure 4-3 (Service 2001b).

Minimum releases from Eagle Canyon and Inskip Dams will be 35 cfs and 40 cfs, respectively (Memoranda of Understanding among NMFS, Service, CDFG, Reclamation, and PG&E dated June 10, 1999). Based on these minimum releases, additional accretions (approximately 5 to 10 cfs) from small feeder streams (Thomas R. Payne and Associates 1998a), and average monthly flow in Battle Creek, mainstem flows upstream of the Coleman Powerhouse tailrace would be approximately 80 cfs and hydropower diversions would be approximately 176 cfs during August. Coleman NFH water requirements are approximately 75 cfs in August, so 101 cfs would be returned to Battle Creek at the Coleman tailrace. Therefore, even during low flow months like August, flows in the hatchery affected stretch of Battle Creek will usually be higher than flows in the section of Battle Creek just upstream of the hatchery's intakes. If the minimum releases established to protect fish habitats in the mainstem section of Battle Creek are effective, impacts to fish habitat or passage associated with Coleman NFH water diversions should be minimal or non-existent since flows in this section of Battle Creek will be higher than the established minimum flows above the Coleman NFH water diversions. In fact, during August the majority of Battle Creek's natural flow (≈72%) will usually be present in the 1.6 miles affected by hatchery withdrawals.

While Battle Creek flows are sufficient to supply Coleman NFH's water requirements and to maintain recommended minimum flows during normal water conditions (Table 4-3), this will not always be the case. Situations that would alter normal flow patterns fall into two categories: equipment failures/emergencies (e.g., associated with hydropower diversions or facilities) and environmental conditions (primarily drought).

Emergency Situations

Occasionally, emergency situations arise with hydropower facilities causing an unplanned interruption in water flow from the Coleman tailrace. Under these circumstances, the Coleman tailrace empties, and no water is available for Intake 1 or returned to Battle Creek. When Intake 1 is not available Intake 2 automatically opens (Intake 3 may also be used), supplying Coleman NFH with water for hatchery operations. When this happens, water from the Coleman Canal overfills the Coleman forebay (this takes approximately 45 minutes to 1 hour) and eventually spills over the side of the canal and flows down the hillside into Battle Creek.

Depending on time of year, Coleman NFH water requirements, and hydropower diversions, interruptions of flow through the Coleman tailrace could reduce flow in the 1.6 mile stretch of Battle Creek below the hatchery water intakes below the recommended minimum flow (see Table 4-3 for recommended minimum flows). Risks to salmonids in Battle Creek resulting from a failure to achieve recommended minimum flow are believed to be low. Several factors help to ameliorate the affects of this type of situation. Firstly, water within the penstocks and Coleman Powerhouse would continue to drain through the tailrace, so the Coleman tailrace would not drain immediately. Secondly, the Coleman forebay fills and overflows relatively quickly (usually less than 1 hour) and the location of the forebay ensures that overflow water returns to Battle Creek above the hatchery intakes. This means that water withdrawals from hatchery diversions should not decrease Battle Creek flows below the recommended levels for long (probably less than an hour). Thirdly, because water in Battle Creek is flowing, and because the minimum instream flow would be unaffected upstream of the hatchery intakes, a localized reduction of flow in the hatchery affected section should not result in detrimental increases in water temperatures. Lastly, hatchery intakes cannot divert all of the water in Battle Creek, even at low flows, because of design constraints. Therefore, the hatchery affected section should not be completely dewatered and a migration corridor should remain open.

Drought

Drought conditions could also cause hatchery water withdrawals to lower flow in the hatchery-affected section of Battle Creek below recommended minimum flows (see Table 4-3 for recommended minimum flows). Between October 1961 and March 2011, average daily flows in Battle Creek were less than total water requirements (Coleman NFH water requirements plus minimum recommended flows by month) 3.0% of the time (547 days out of 17,943 days on record; USGS historic flow records). Most of the days where Battle Creek flow did not meet total water requirements in the 1.6 mile reach affected by hatchery diversions occurred in December (216 days) and January (114 days), when water requirements at Coleman NFH are greatest, followed by October (102 days) and September (50 days).

We also examined the flow data for number of days and distribution of days where not only the recommended minimum flow values would not be met in the 1.6 mile reach affected by the hatchery diversion, but flows would also result in a weighted usable area[3] of less than 95% (Table 4-2). As steelhead are the only listed species that may successfully spawn in this reach or use this reach for juvenile rearing, data are only presented for this species.

For October 1961 through March 2011, flow in the hatchery-affected reach failed to meet the flow necessary for the 95% weighted usable area approximately 0.9% of the time; 167 out of 17,943 days on record. Days with mean flows that were less than that necessary to maintain 95% weighted usable area were limited to December (94 days), October (28 days), January (33 days) and February (12 days). Times when flows were less than 95% weighted usable area were largely consistent with known drought years (late-1970s, late-1980s, and early-1990s).

The results of these analyses demonstrate that during extreme drought conditions, water withdrawals from hatchery diversions could decrease flow in the 1.6 mile hatchery affected reach of Battle Creek below the recommended minimum levels and, at times, below the 95% weighted usable area level. During these situations, additional operational modifications would likely need to be considered for the Coleman NFH. For example, water from hatchery raceways could be reused in the adult holding ponds from October through February. This operational change would reduce Coleman NFH water requirements by approximately 22 cfs. Based on the flow data from 1961 through 2011, this change would result in a failure to meet the 95% weighted usable area only 0.3% of the time, equating to a 67 % reduction of impact (i.e., 0.9% reduced to 0.3%). Additional operational scenarios will likely be developed to further minimize impacts.

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[3]Weighted usable area is defined as the wetted area of a stream weighted by its suitability for use by species and lifestage (see Stalnaker et al. {1995} for a general discussion of weighted usable area, see Thomas R. Payne and Associates {1998a, 1998b, 1998c, 1998d} and Ward and Kier {1999} for specific information about generating estimated minimum flows for Battle Creek).

Table 4-2 Flows providing maximum weighted usable area (WUA[a]) for different species and life stages for the mainstem reach of Battle Creek (from the Coleman barrier weir to approximately 10 miles upstream). Flows are from the Battle Creek Working Group Technical Committee (reported in Ward and Keir {1999}) and are based primarily on four studies of Battle Creek completed by Thomas R. Payne and Associates (Thomas R. Payne and Associates 1998a through 1998d). Blank cells indicate life stage was not present or habitat was not used at this time. May 95% of total WUA flows higher to cover some late possible late spawning of steelhead and October and November 95% of total WUA flows adapted to reflect only steelhead rearing.

	Recommended Monthly Minimum Flow (cfs)											
Species and habitat	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Steelhead spawning	136	136	136	136	136							136
Steelhead rearing	76	76	76	76	76	76	76	76	76	76	76	76
95% of total WUA	112	112	112	112	112	45	45	45	45	45	45	112

a Weighted usable area is defined as the wetted area of a stream weighted by its suitability for use by species and life stage (see Stalnaker et al. {1995} for a general discussion of WUA, see Thomas R. Payne and Associates {1998a, 1998b, 1998c, 1998d} and Ward and Kier {1999} for specific information about generating these estimated minimum flows).

Table 4-3 Average monthly discharge for Battle Creek (BC), recommended minimum flows after Battle Creek restoration, monthly water requirements for Coleman National Fish, and average flows in excess of minimum flows and Coleman NFH water requirements.

	Water Flow (CFS)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average monthly flows for BC[a]	742	737	732	654	629	485	331	265	260	294	396	558
Recommended minimum flow[b]	137	137	137	136[d]	136[d]	80	80	80	80	80	80	137
Coleman NFH water requirement[c]	122	111	111	86	54[e]	60	68	75	91	122	122	122
Average flow in excess of minimum recommended flows and Coleman NFH water requirements	486	489	484	432	439	345	183	110	89	92	194	299

a Average monthly flows for Battle Creek were taken from USGS (http://waterdata.usgs.gov; gauging station 11376550) and are based on data from 1961 through 2008.

b Minimum flows are based on agreed upon minimum releases from hydropower facilities after Battle Creek restoration (Memoranda of Understanding among NMFS, Reclamation, Service, CDFG, and PG&E dated June 10, 1999) and estimated accretions (≈5 cfs) from small tributaries. Implementation of the minimum releases is pending (anticipated start date late 2001 or early 2002).

c Coleman NFH water requirements (value displayed is the greater of either 2007-2009 averages or previously reported monthly values). Values include approximately 13 cfs delivered to downstream water users without being used at the hatchery.

d Recommended minimum flow for BC in April and May estimated at 107 and 80 respectively. Data for analysis incremented to 136 to accommodate late steelhead spawning as noted as required in Table 4-2.

e Amount of water use in May has been increased from about 34 cfs to 54 cfs as a result of the requirement to truck fall Chinook salmon to the Delta. For on-site releases, fall Chinook salmon are generally released at about 90/lb (about 3 inches) in April. Release into the net pens in the delta require, however, that the fish be about 60/lb (3.5 inches). This requires about an additional month of growth and because of the increased size of the fish they require more space and water.

5 FACILITIES

5.1 Coleman National Fish Hatchery

Property

Coleman NFH covers approximately 75 acres of land owned by the Service. An additional 63 acres of land are in perpetual easements for pipelines and access. Legal description of the lands, easements and water rights owned by the U.S. government are as follows (Luken et al. 1981):

- Two parcels of land in Section One, Township Twenty-nine North, Range Three West, Mount Diablo Base, and Meridian, and described in Land Purchase Control 149r-1079 dated September 25, 1942, as (a) 55.28 acres more or less by purchase, (b) 7.45 acres more or less by perpetual easement.
- Perpetual easement of the one parcel of land located in Section Two, Township Twenty-Nine North, Range Three West, containing 3.14 acres more or less, described in Land Purchase Contract 149r-1193.
- Perpetual easements in five parcels of land located in Section Thirty-one, Township Thirty North, Range Two West and one parcel in Section Two, Township Twenty-nine North, Range Three West, Mount Diablo Base and Meridian, totaling an aggregate of 93.4 acres, described in Land Purchase Contract 149r-1070.
    - On September 5, 1957, a quitclaim deed was filed in Redding, California under Document No. 9318, Book O.R. 543, page 144, covering tracts 9R, Parcel A, 6R Parcel B, 5R-3 Parcel C and 8R Parcel D. There was a road right-of-way transferred to Shasta County. This easement is involved in the two items immediately above.
- Perpetual easement of a strip of land 200 feet in width containing an area of 11.8 acres of land in Section One, Township Twenty-nine North, Range Three West, Mount Diablo Base and Meridian, described in Land Purchase Contract 149r-1530.
- Twenty and thirteen hundredths (20.13) acres adjoining existing Service property on the west and located in Township 29 North, Range Three West, Mount Diablo Base and Meridian.

Physical Structures

Facilities at Coleman NFH include: the main hatchery building containing incubation stacks and trays and early-rearing tanks; administration building; feed storage building; garage, warehouse and storage buildings; spawning building; shop; electrical sub-station and generator buildings; ozone water treatment plant and associated structures; and three residences. Additionally, the Service's CA-NV FHC uses three buildings located on the hatchery grounds. Other structures for fish propagation include: twenty-eight 15-feet by 150-feet concrete raceways; thirty 8-feet by 80-feet concrete raceways; a pollution abatement pond, and facilities for congregating, collecting, holding, and spawning broodstock (Figure 5-1).

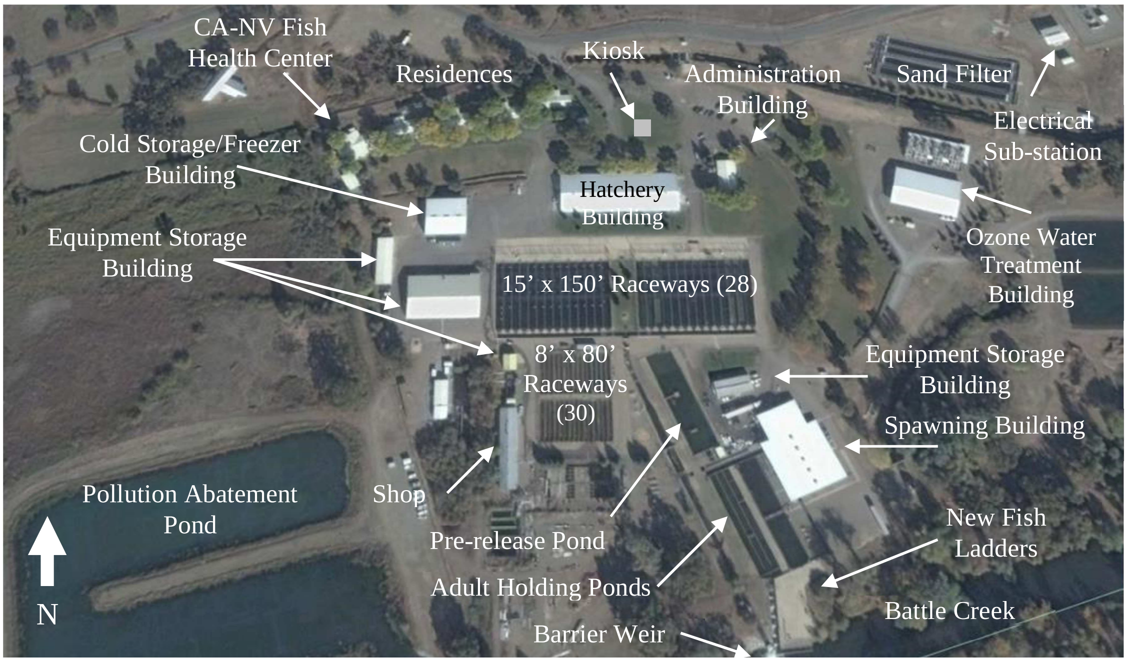

Figure 5-1 Physical layout of hatchery facilities at Coleman National Fish Hatchery.

Broodstock Collection Facilities

Broodstock congregation and collection facilities at Coleman NFH consist of a barrier weir and a fish ladder. The Coleman NFH barrier weir and fish ladder are located approximately six miles up from Battle Creek’s confluence with the Sacramento River. The weir is permanent and extends across the full width of Battle Creek (approximately 90 feet). The primary purpose of the barrier weir is to congregate salmonids and divert them into the hatchery adult collection and holding ponds. The Service, working cooperatively with Reclamation, completed modifications to the Coleman NFH barrier weir and fish ladder, in October 2008. The modifications to the barrier weir are intended to provide the capability of blocking fish migration up Battle Creek at flows up to 800 cubic feet per second (cfs), and allow selective passage management at least equal to that provided by proposed ladders planned for upstream dams at flows up to 3,000 cfs, the flow at which the stream overflows its banks. The proposed actions were consistent with the Service’s 2001 Final Restoration Plan for the AFRP, CALFED, and supported by the Battle Creek Salmon and Steelhead Restoration Working Group. Project activities included the modification of the existing barrier weir by adding a 2-foot-wide, lipped crest cap and an overshot gate, which is intended to block the passage of upstream migrating salmonids at flows up to 800 cfs. A new fish ladder was constructed containing two forks, one leading directly to the existing Coleman NFH adult holding ponds and the other providing access to Battle Creek upstream of the barrier weir. Additional modifications were included to enable lamprey (*Lampetra* spp.) to migrate through the fish ladder. A monitoring vault and viewing window is also included to support monitoring of fish passing above the hatchery.

In addition to broodstock collection in Battle Creek, natural-origin late-fall Chinook may be collected at the Keswick Dam fish trap located on the Sacramento River (see Section 6.5 for a more complete discussion). A description of the Keswick Dam fish trap is provided below under the Livingston Stone NFH broodstock collection facilities (Section 5.2).

Adult Holding and Spawning Facilities
Adult holding and spawning facilities at Coleman NFH consist of five holding ponds of various configurations and a fully-mechanized facility for crowding, sorting, and spawning collected adults. Upon ascending the hatchery adult collection ladder and lower part of Pond 2, salmonids enter Pond 3, which measures 200 feet x 36 feet (volume = 30,600 cfs). From Pond 3, collected fish are routed into the spawning building using crowders. The spawning building includes a spawning and sorting facility, and encloses two additional holding ponds (Ponds 4 and 5) measuring 81 feet-6 inches x 41 feet each (23,390 cubic feet). During spawning operations, a hydraulic lift located in the spawning building raises fish into a carbon dioxide (CO_2) anaesthetization tank. Non-target fish can be returned immediately to Battle Creek by sliding them through a tube that enters Battle Creek upstream of the hatchery barrier weir. Pond 2 measures 188 feet x 12 feet (4,800 cubic feet), and is used to hold natural-origin late-fall Chinook collected at the Keswick Dam fish trap and transferred to the Coleman NFH for use as broodstock. Pond 1, or the pre-release pond, which is 201-feet x 60-feet (approx. 25,000 cubic feet) is used to hold post spawn steelhead during the recondition of those fish. Pond 1 has concrete sides and a gravel bottom.

Incubation and Indoor Rearing Facilities
Egg incubation facilities are located in the Hatchery Building. Incubation units consist of 178 sixteen-tray vertical fiberglass incubators (Heath Incubation Trays). The top tray of each incubation stack is not used to limit the exposure of incubating eggs to light and silt. Also located in the Hatchery Building are sixty-seven 16-feet x 3-feet 4-inch fiberglass tanks used for early-rearing of steelhead.

Outdoor Rearing Facilities
Outdoor rearing units include twenty-eight 15-feet x 150-feet raceways, thirty 8-feet x 80-feet raceways. The raceways are constructed of concrete. The 15-feet x 150-feet raceways are approximately 4 feet deep at the front end and 4 feet 9 inches deep at the lower end (approx.. 5,600 cubic feet). The 8-feet x 80-feet raceways hold approximately 1,148 cubic feet of water. Both banks of raceways are enclosed with a wire fence and covered with wire mesh to reduce predation.

Fish Transportation Equipment
Coleman NFH has two trucks that are used to transport fish; a 2002 Freightliner (tank capacity of 2,000 gallon) and a 1998 Freightliner (tank capacity of 1,500 gallon). Coleman NFH uses the distribution trucks for transporting steelhead to the Sacramento River at Bend Bridge (RM 258) and for transporting a portion of the fall Chinook to the San Pablo Bay. Occasionally, the trucks are also used to transport Chinook salmon and steelhead for various research projects.

Water Treatment Facilities
The Coleman NFH uses a water treatment facility capable of filtering 45,000 gpm and ozonating 30,000 gpm to reduce sediment in the hatchery water supply and to alleviate recurrent disease problems. Operation of the ozone water treatment facility has substantially lessened the occurrence of disease in hatchery production, which in turn reduces the risks for transmitting disease to naturally-produced stocks. Several documents thoroughly discuss the justification,

selection, and construction of the ozone water treatment facility at Coleman NFH (Service 1986, 1987, 1989, 1997a, 1997b).

Operational Difficulties or Disasters That Led to Significant Fish Mortality

Battle Creek is the water source for Coleman NFH. Occasionally, the hatchery water supply is laden with heavy silt loads associated with high-flow events in Battle Creek. In addition, Battle Creek has been identified as the source of about thirteen anadromous fish disease-causing organisms. Disease and high sediment loads have caused mortality of eggs, juveniles, and broodstock at Coleman NFH. Power outages and failure of back-up generators have also resulted in losses of eggs and fish.

Back-up Systems and Risk Aversion Measures to Minimize the Likelihood for the Take of Fish Resulting from Equipment Failure, Water Loss, Flooding, Disease Transmission, or Other Events That Could Lead to Injury or Mortality

A state-of-the-art water filtration and ozone disinfection system (see Section 4) at the Coleman NFH has reduced the likelihood of fish loss due to heavy silt loads or disease transmission. The Coleman NFH is equipped with a highly sophisticated computer control system which monitors water flow and the ozone water treatment plant. The system, called Metasys Extended architecture, provides a graphical interface which provides pressure and temperature readings for all of the equipment. This system monitors about 1,100 control points every 70 seconds. When system problems are detected with water delivery, ozone generation, or other equipment, sirens and flashing lights will alert on station personnel to the problem, and the automatic dialer will alert staff through their home phones. Many problems are immediately automatically remedied by the system. For example, if a pump fails, the system will turn on a back-up pump, if levels of water get to low in the sumps, the system will open valves to let in more water. A back-up power generator capable of powering the entire facility reduces the risks of system disruption and fish loss in the event that the main project power is lost or disrupted. Further, separate back-up power Uninterruptable Power Supply system and actuator can operate an 18 inch raw water line from the main water canal to the tank house to provide water to all areas of the tank house in an extreme emergency. This system of monitoring, alarms, and built in redundancy minimizes the likelihood of fish loss due to equipment failure or disruption of the hatchery water or power supply. On-site residences further reduce response time in the event of an emergency.

Impacts of Facility Maintenance and On-site Construction on Listed Stocks or Critical Habitat

Impacts to naturally producing salmonid populations and their habitats associated with grounds maintenance or site disturbance at Coleman NFH are considered to be low. Current maintenance operations do not require disturbance of previously undisturbed areas, and will not result in the loss of or degradation of salmonid habitats. New construction projects comply with National Environmental Policy Act requirements, and are addressed in separate Environmental Assessments, Environmental Impact Statements, Environmental Impact Reports, and other environmental compliance prior to initiating construction.

5.2 Livingston Stone National Fish Hatchery

Property

Construction of the Livingston Stone NFH, a substation of Coleman NFH, was completed in 1998. The Livingston Stone NFH is constructed on a 0.4 acre Reclamation-owned site approximately 0.5 miles below Shasta Dam and upstream of Keswick Dam. It is adjacent to the Sacramento River (west side), and outside the flood plain.

Broodstock Collection Facilities
Adult winter Chinook salmon broodstock are collected from the Sacramento River at fish trap located at the Keswick Dam.

<u>Keswick Dam Fish Trap</u> - The Keswick Dam fish trap and associated structures are located in the center of the dam between the powerhouse and the spillway. Broodstock collection facilities consist of a twelve-step fish ladder, a brail-lift, and a 1,000-gallon fish-tank elevator.

Salmon and steelhead are attracted to the Keswick Dam fish ladder with a 340 cfs jet pump that supplies water to the trap and fish ladder. Additional flow for attracting fish is supplied through diffusers within the ladder floor. The fish ladder is approximately 170- feet long by 38- feet wide, and contains weirs which create pools. The top of the ladder leads to a fyke weir. After passing through the fyke weir, adult fish are contained in a large fiberglass brail enclosure. When the brail is raised, fish are directed into a 1,000-gallon elevator which transports them up the face of the dam to a fish distribution vehicle.

Several modifications to the Keswick Dam fish trap and associated structures occurred prior to 2001 and resulted in improved operation and maintenance of the structure and are described in Service 2001b. Since 2001, modifications to these structures have consisted of installation of cameras and placement of an automatic gate allowing the trap to be operated only during daylight hours to monitor and reduce otter predation, and replacement of the hoist motor and brake system.

Fish Transportation Equipment
Adults collected in the fish trap at Keswick Dam are transported to Livingston Stone NFH in a fish distribution vehicle carrying an aerated 250-gallon insulated transport tank, or one of the two larger distribution vehicles from Coleman NFH. These larger vehicles are used for: 1) distribution of juvenile winter Chinook salmon, 2) transfer of winter Chinook juveniles to long-term, off-site rearing facilities (e.g., captive broodstock program), and 3) transportation of adult Chinook salmon from broodstock collection locations and back to the upper Sacramento River.

Broodstock Holding Facilities
Following transport to Livingston Stone NFH, fish are placed in a 20-foot circular quarantine tank while awaiting the results of genetic analyses. Adult salmon genetically identified as winter Chinook salmon are transferred into the other 20-foot circular holding tank. The holding tanks are connected to a carbon filter for removal of malachite green following prophylactic and therapeutic antifungal treatments of broodstock.

Spawning, Incubation, and Rearing Facilities
The Livingston Stone NFH spawning and rearing building is a 2,700-square feet insulated steel building containing egg and fry incubation units, sixty 30-inch diameter circular tanks for early-rearing, a 100 square-feet walk-in freezer, and an office (Figure 5-2). The incubation building also contains a large 120 gpm chiller and a 75 kilowatt back-up generator is being added outside

the building. Twenty-four 3-feet x 16-feet rectangular tanks are used for early-rearing and ten 12-feet diameter circular tanks (reduced from twenty tanks in 2007 to accommodate a construction of a building for rearing delta smelt), are used for some juvenile rearing and can also be used for captive broodstock holding and rearing.

Facilities for propagation of delta smelt
A 1,400 square feet metal building contains a jar incubation system and thirty 110-liter tanks and twenty one 400-liter tanks which will be used for rearing delta smelt (Figure 5-2). The building has a main area and two wings. Two additional 1,000-liter tanks are located outside of this building and will also be used for rearing delta smelt, and three additional 1,000 liter tanks will be added outside to hold post-spawn delta smelt adults. The infrastructure for the delta smelt rearing is highly complex and also consists of various chillers, heat pumps, water pumps for recirculation systems, and back-up generators.

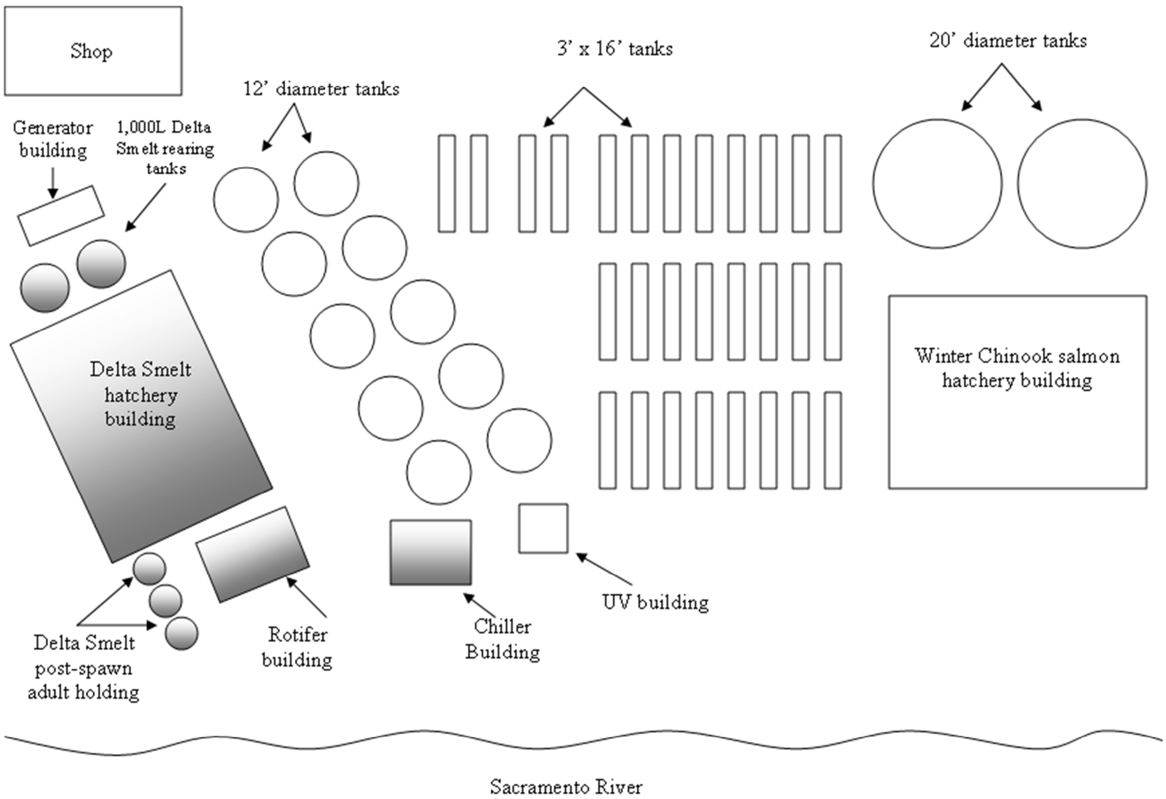

Figure 5-2 Physical layout of hatchery facilities at Livingston Stone National Fish Hatchery.

Back-up Systems and Risk Aversion Measures That Will Be Applied to Minimize the Likelihood for the Take of Listed Natural Fish That May Result from Equipment Failure, Water Loss, Flooding, Disease Transmission, or Other Events That Could Lead to Injury or Mortality
The water delivery system for Livingston Stone NFH is equipped with a low-water alarm and a telephone call out system. In the event of an emergency (e.g., power outage), the penstock supplying Livingston Stone NFH defaults to open. This causes an overflow but ensures continued water supply to the juvenile salmon. The facility has water supply valves from three of the five Shasta Dam penstocks (penstocks 2, 3, and 4). Water supply capability from penstock

5 is currently being sought. Acquisition and installation of a 75 kilowatt back-up generator and fuel tank has recently been completed. The infrastructure for the delta smelt rearing consists of various chillers, heat pumps, water pumps for recirculation systems, and back-up generators. The back-up power generation system reduces the risk of fish/egg loss associated with power outages. Effluent from delta smelt rearing chambers is treated with an ultra-violet disinfection process, which has built-in redundancy in the event of equipment failure.

Impacts of Facility Maintenance and On-site Construction on Listed Stocks or Critical Habitat
Livingston NFH is situated upstream of Keswick Dam and all critical habitat for anadromous salmonids. Maintenance operations at the Livingston Stone NFH do not affect critical habitat for salmonids. New construction projects at the Livingston Stone NFH are addressed in Environmental Assessments, Environmental Impact Statements, Environmental Impact Reports, and other assessment documents before initiating construction.

6 BROODSTOCK ORIGIN AND IDENTITY

6.1 Source

Fall Chinook Salmon
Fall Chinook salmon broodstock are selected from natural- and hatchery-origin adults collected at Coleman NFH on Battle Creek.

Late-fall Chinook Salmon
Late-fall Chinook salmon broodstock are selected from hatchery-origin adults returning to Coleman NFH on Battle Creek and natural-origin adults captured at the Keswick Dam fish trap.

Winter Chinook Salmon
Broodstock for the winter Chinook supplementation program are obtained from the mainstem Sacramento River using the fish trap at the Keswick Dam. Only natural-origin adults are used as broodstock.

Steelhead
Steelhead broodstock are selected from adults collected at Coleman NFH on Battle Creek. The Service currently spawns only hatchery- origin steelhead at Coleman NFH. The incorporation of natural-origin steelhead into the hatchery broodstock was discontinued after the 2008 spawning season due to the low run size of natural-origin steelhead in Battle Creek. It is the desire of the Service to operate the Coleman NFH steelhead program as an integrated program, and the Service will investigate additional options to collect natural-origin steelhead broodstock.

6.2 History

Fall Chinook Salmon
From 1895 to 1944, an egg taking Station was operated on Battle Creek. The source of fall Chinook broodstock for the Battle Creek Egg Taking Station was the indigenous population of fall Chinook salmon in Battle Creek. A series of weirs, called “racks” were seasonally installed in Battle Creek to block the migration of adult fall Chinook salmon and hatchery broodstock were obtained by seining them from congregations downstream of the racks. Broodstock collections for the Battle Creek Egg Taking Station were occasionally supplemented by seining adults from the mainstem Sacramento River.

Following construction of the Coleman NFH in 1942, adult fall Chinook salmon were collected using seasonally installed weirs in Battle Creek and the mainstem Sacramento River and the Keswick Dam fish trap. The weir on the Sacramento River at Balls Ferry was abandoned after 1945 because of recurrent washouts during high flow events. In 1950, a permanent barrier weir was constructed on Battle Creek at the site of Coleman NFH and the seasonally installed weirs were subsequently phased out of operation. From 1950 through 1986, fall Chinook broodstock were collected at the barrier weir in Battle Creek and from the Sacramento River at the Keswick Dam fish trap. Since 1987, fall Chinook broodstock have been obtained exclusively at the hatchery on Battle Creek. A complete accounting of sources for fall Chinook broodstock is in Appendix 6A.

Late-fall Chinook Salmon
Founding broodstock for Coleman NFH late-fall Chinook salmon were collected at the Keswick Dam fish trap in the early 1950s. However, hatchery records do not formally recognize late-fall Chinook salmon as a completely separate run from fall Chinook salmon until 1973. Prior to 1973, fall and late-fall Chinook salmon were partially-segregated at Coleman NFH; separation between the "early fall run" and "late fall run" was based on location of adult collection and spawn timing. The early segment of the fall run was typically spawned beginning about October 1 from adults collected at Battle Creek. The late segment of the fall run was spawned after about November 15, from adults collected at the Keswick Dam fish trap. Spawning of the combined-run extended from early-October through late-March (see Appendix 8A).

Since 1973, late-fall Chinook have been recognized as distinctly separate stock from fall Chinook salmon at Coleman NFH. From 1973 to 1982, hatchery late-fall Chinook broodstock were obtained exclusively from the Keswick Dam fish trap. Beginning in 1982, returns of hatchery-origin late-fall Chinook to Battle Creek were also used as hatchery broodstock. From 1982 through 1996, collections of late-fall Chinook salmon broodstock at the Keswick Dam fish trap were gradually phased-out in favor of volitional returns to the hatchery. From 1997 to 2002, hatchery broodstock were collected only from Battle Creek. Since 2003, the Service has reinitiated the process of collecting a portion of the late-fall Chinook broodstock at the Keswick Dam fish trap. This is conducted to maintain a genetically integrated hatchery stock and reduce effects of domestication.

Winter Chinook Salmon
The winter Chinook propagation program was initiated at Coleman NFH in 1988 and relocated to Livingston Stone NFH in 1997 to improve integration with the naturally reproducing population in the upper Sacramento River. The winter Chinook supplementation program obtains broodstock from the Sacramento River at the Keswick Dam fish trap. Prior to 2007, winter Chinook broodstock were also occasionally collected at the RBDD, however, this practice was discontinued because of the ineffectiveness of those efforts. Winter Chinook broodstock are completely of natural-origin. A maximum of 10% hatchery-origin adults were used as broodstock through 2009. Beginning in 2010 only natural-origin winter Chinook have been used as broodstock to further reduce the effects of domestication selection.

Steelhead
Steelhead have been propagated at Coleman NFH since 1947. Founding broodstock were collected from the Sacramento River at the Keswick Dam fish trap. From this initial propagation effort, more than 11,000 fingerlings were released and an additional 500 juveniles were retained as captive broodstock. Steelhead spawning at the Coleman NFH from 1949 through 1951 was limited to captive broodstock. The captive broodstock program for steelhead was terminated in 1952. From 1952 through 1986 steelhead were collected from both Battle Creek and the Sacramento River at the Keswick Dam fish trap. From 1987 to 2008, steelhead broodstock were collected only at Battle Creek, using both hatchery- and natural-origin adults. Since 2009 steelhead broodstock have consisted of only hatchery-origin fish collected from Battle Creek. In the future, the Service will investigate alternative strategies to reincorporate natural-origin adults into the hatchery's broodstock. A compilation of historical sources for steelhead and rainbow trout broodstock at the Coleman NFH is presented in Appendix 6B.

6.3 Transfers from other hatcheries

Fall Chinook Salmon

Current policy at Coleman NFH prohibits receipt of egg transfers from other hatcheries. Hatchery records, however, indicate receipt of eggs from various locations of California and, in one instance, from out of state (see Appendix 6A). Most transfers of fall Chinook eggs to Coleman NFH originated from state-operated hatcheries in the Central Valley. For example, eyed eggs were brought in from Nimbus Hatchery on the American River in 1958, `60, `61, `64, `65, `68, `72, and `74-`79. Additionally, eyed eggs were transferred to Coleman NFH from the Feather River Fish Hatchery in 1974, `77, and `83. A few transfers of fall Chinook eggs to Coleman NFH originated from outside of the Central Valley basin, including eggs received from: Klamath River (1958); Fall Creek Hatchery (1960); and Mad River Hatchery (1970). In all years, collection of eggs from locally-obtained broodstock far exceeded the number of eggs transferred into the Coleman NFH. There have been no transfers of fall Chinook salmon into Coleman NFH since 1983.

Late-fall Chinook Salmon

Late-fall Chinook salmon are propagated only at Coleman NFH. There have been no transfers of late-fall Chinook salmon into Coleman NFH from other hatcheries.

Winter Chinook Salmon

Winter Chinook salmon have been propagated only at Coleman NFH (formerly) and Livingston Stone NFH (currently). There have been no transfers of winter Chinook salmon into Coleman or Livingston Stone NFHs.

Steelhead

Steelhead eggs were transferred to Coleman NFH from various other locations prior to 1990, mostly from State-operated hatcheries in the Central Valley. Eyed eggs were received from Nimbus Hatchery on the American River in 1972, `75, `76, `77, and `84. A shipment of eyed eggs was also received from the Feather River Hatchery in 1989. The only transfer of steelhead eggs originating from outside the Central Valley Basin was received from the Mad River Fish Hatchery in 1978.

In addition to steelhead, several strains of non-migratory rainbow trout were propagated at Coleman NFH from 1950-1978. The goal of the “catchable trout program” at Coleman NFH was to supply non-anadromous rainbow trout for put-and-take fisheries in Shasta and Whiskeytown lakes and at local military bases. Steelhead and rainbow trout were generally spawned separately at the Coleman NFH: however, during the early 1960s nearly 250,000 Gerrard strain rainbow trout (Kamloops) were apparently released into anadromous waters of the Sacramento River. A complete compilation of historical sources for steelhead broodstock at Coleman NFH is located in Appendix 6B.

6.4 Annual size

Fall Chinook Salmon

The numbers of fall Chinook salmon spawned at the Battle Creek Egg Taking Station and Coleman NFH since 1909 are shown in Appendix 6A. Broodstock sizes range from a low of 679 in 1936 to 16,564 in 1984. Current and projected future broodstock requirements for Coleman NFH call for a minimum of approximately 2,500 pairs of mixed natural- and hatchery-origin fall

Chinook salmon. Actual numbers of fall Chinook spawned will likely be higher than this minimum broodstock requirement in order to ensure production goals are achieved. In the event that excess eggs are collected they will be culled prior to hatch.

Late-fall Chinook Salmon
Hatchery production of late-fall Chinook peaked in 1981 when nearly 1,500 (814 female / 684 male) adults were spawned at Coleman NFH producing over 3.5 million eggs. Following that year, production of late-fall Chinook at Coleman NFH decreased. A production target of one million late-fall Chinook was eventually adopted to balance competing needs for space and water with the hatchery steelhead propagation program. To achieve the current production target of one million late-fall Chinook smolts, the annual broodstock requirement is approximately 270 spawning pairs. The number of late-fall Chinook actually spawned is generally increased to maintain within-population genetic diversity and reduce the potentially deleterious effects of inbreeding. Excess eggs are culled prior to hatch.

Winter Chinook Salmon
The collection target for winter Chinook salmon broodstock is 15% of the estimated run-size, with a maximum of 120 naturally-produced adults. Monthly collection targets are determined based on the percentages of historic run timing past the RBDD. A minimum of 20 winter Chinook adults will be targeted for capture during any year regardless of run size (e.g., run size <133).

Steelhead
The number of steelhead spawned annually at Coleman NFH has varied considerably, depending on the availability of adults and fluctuating production goals. Maximum production occurred in 1965 when nearly 1,500 female steelhead were spawned at Coleman NFH. Following that year, production of steelhead decreased at Coleman NFH. A production target of 600,000 smolts was eventually adopted to balance the competing needs for rearing space and water with the late-fall Chinook salmon propagation program. The number of steelhead broodstock necessary to achieve the current production target of 600,000 smolts is approximately 200 spawning pairs annually. Actual numbers spawned will be increased to maintain within-population genetic diversity and reduce the potentially deleterious effects of inbreeding. Excess eggs are culled prior to hatch.

6.5 Past and proposed level of natural fish in broodstock

Fall Chinook Salmon
Past Levels of Natural Fall Chinook Broodstock
From the early-1940s through the early-1970s, the Keswick Dam fish trap regularly contributed greater than half, and as much as 75% (1957), of the fall Chinook broodstock spawned at Coleman NFH. At that time, fall Chinook collected at the Keswick Dam fish trap on the Sacramento River were considered to be primarily of natural-origin. During the drought years of 1976 and 1977, all fall Chinook broodstock for Coleman NFH were collected at the RBDD. During those years, natural-origin fish likely contributed a large proportion of collected adults.

The practice of obtaining fall Chinook broodstock from the Sacramento River was phased out beginning in 1977. During 1985 and 1986, only one or two percent of the total fall Chinook spawned at Coleman NFH were captured at the Keswick Dam fish trap. Fall Chinook broodstock have been collected exclusively from Battle Creek since 1987.

Future Levels of Natural Fall Chinook as Broodstock

All fall Chinook broodstock used at Coleman NFH since 1987 have been collected from Battle Creek. Fall Chinook salmon in Battle Creek are comprised of adults originating from both hatchery and natural production. Actual physical counts of natural-origin fall Chinook incorporated as hatchery broodstock are not available because hatchery- and natural-origin fall Chinook are not visually distinguishable. However, marking data provide evidence of the numbers of natural-origin fall Chinook that have entered the hatchery collection ponds during the recent past. Juvenile fall Chinook salmon at Coleman NFH were marked at a rate of 8% from 1995 to 1999. Hatchery returns of marked adults during 1998 and 1999 were 4.8% and 6.3%, respectively. The inequality of mark rates applied to juveniles produced at the hatchery compared to the mark rates observed for adults returning to the hatchery likely results from the dilution of marked (hatchery-origin) fall Chinook salmon by unmarked (naturally-produced) adults entering the hatchery ponds. We estimate, by standardizing the return of marked fish at 8%, that approximately 3,725 and 2,060 naturally-produced fall Chinook salmon entered Coleman NFH during 1998 and 1999, respectively. These estimates of naturally-produced fall Chinook collected at Coleman NFH equate to 8.4% (1998) and 7.6% (1999) of the total adults collected at the hatchery and are in close agreement with previous estimates of approximately 10% natural-origin fall Chinook adults in Battle Creek. Improved estimates of the proportion of hatchery and natural fall Chinook in Battle Creek were possible beginning in 2010, when the age-3 fish returned from the first year of the constant fractional marking program (25% mark-tag rate). An estimated 13% of the fall Chinook collected at the Coleman NFH in 2009 was of natural-origin.

Late-fall Chinook Salmon

Past Levels of Natural Late-fall Chinook as Broodstock

From the early 1950s through 1982, late-fall Chinook broodstock were obtained from the Sacramento River at the Keswick Dam fish trap. Late-fall adults collected at the Keswick Dam fish trap are considered to be primarily natural-origin. Beginning in 1982, returns of hatchery-origin late-fall adults to Battle Creek were used as hatchery broodstock. From 1982 through 1989, collections of late-fall Chinook broodstock at the Keswick Dam fish trap were phased-out in favor of volitional returns to the hatchery on Battle Creek. From 1997 through 2001, only hatchery-origin late-fall Chinook collected at the hatchery on Battle Creek were spawned at Coleman NFH (Table 6-1). Beginning in late 2002 (return year 2003), the Service re-initiated periodic collections of natural-origin late-fall Chinook salmon from the Keswick Dam fish trap. Naturally produced late-fall Chinook salmon were incorporated as hatchery broodstock to reduce the deleterious genetic impacts that may occur to isolated hatchery stocks (i.e., domestication and genetic divergence).

Within the 2001 Biological Assessment (Service 2001b), the Service proposed a strategy to collect and spawn natural origin late-fall Chinook at a rate of approximately 25% (n = 135) of the annual spawning target (n = 540) per year during every-other generation. This strategy was an attempt to balance the need to incorporate natural origin adults into the hatchery spawning matrix, reduce risks associated with removing fish from the natural spawning population, and reduce expenses associated with trapping and transporting these fish to the Coleman NFH.

However, after attempting to implement this broodstock collection strategy over two spawning seasons (i.e. 2002 and 2003), the Service was not successful at collecting and spawning the targeted number of natural origin late-fall Chinook. During the 2002 and 2003 spawning seasons only 32 and 42, respectively, natural origin late-fall Chinook were spawned at the Coleman NFH. During both years the number of natural origin broodstock spawned at the Coleman NFH was substantially less than the target of 135. Reasons for the shortfall on collections of natural origin late-fall Chinook broodstock include the following: (1) an inability to trap adequate numbers of fish, (2) the Service's preference to collect only ripe fish in effort to reduce prespawn mortality, and (3) occasionally high river flows that preclude operation of the fish trap at the Keswick Dam. The rate of incorporation of natural origin fish (5.7%) during 2003 fell substantially short of the desired 25% incorporation rate in each of those years.

As a result of not achieving the desired broodstock collection targets for natural origin late-fall Chinook for two consecutive years, the Service modified the collection strategy in 2004. Instead of collecting and spawning 25% natural-origin adults at the Coleman NFH per year during every-other generation, the Service at that time began to target a rate of 10-15% natural origin broodstock (n = 54–81) on an annual basis. The Service considered this broodstock collection strategy to be more achievable than that previously proposed and, at the same time, successful implementation of this strategy would enable the Service to provide genetic input by natural origin fish at a level equivalent to the collection targets identified in the Service's 2001 Biological Assessment of the Coleman and Livingston Stone National Fish Hatcheries (Service 2001b). Between 2003 and 2007, 1.1%-12.4% of the late-fall Chinook released from the Coleman NFH were progeny of natural-origin Chinook. Spawning of natural-origin late-fall Chinook was temporarily discontinued at the Coleman NFH in 2008 because construction at the Coleman NFH barrier weir made it difficult to access the fish holding ponds. Collection of natural-origin late-fall Chinook broodstock resumed in return year 2009.

<u>Future Levels of Natural Late-fall Chinook as Broodstock</u>
The Service will target a rate of 10-15% natural origin broodstock (n = 54–81) on an annual basis. This cycle of infusing 10-15% natural-origin broodstock every year will benefit the hatchery stock by decreasing domestication effects and reduce the potential for genetic divergence between hatchery and natural stocks.

Winter Chinook Salmon
Natural-origin salmon have comprised the >90% of winter Chinook broodstock through 2009. Beginning in 2010, only natural-origin broodstock will be spawned at the Livingston Stone NFH.

Table 6-1. Number of late-fall Chinook salmon collected from Battle Creek and the Sacramento River at the Keswick Dam fish trap, for return years 1988 - 2008. Beginning with return year 2003, eggs collected from natural-origin fish are not culled; therefore, the percentage of natural-origin broodstock is obtained by dividing the number of fish collected at the Keswick Dam fish trap by the number of broodstock required to meet egg collection targets (i.e. 540).

Return Year	Number of late-fall Chinook collected		Percent natural-origin broodstock
	Battle Creek	Keswick Dam Fish Trap	
1988	53	411	88
1989	65	817	93
1990	92	100	52
1991	161	118	42
1992	344	388	49
1993	528	375	42
1994	598	154	20
1995	492	224	31
1996	1,337	48	3
1997	4,578	0	0
1998	3,069	0	0
1999	7,075	0	0
2000	4,194	0	0
2001	2,359	0	0
2002	2,709	0	0
2003	3,053	32[a]	5.7
2004	5,099	42	7.8
2005	6,460	33[b]	5.9
2006	14,772	6[c]	1.1
2007	5,243	67[d]	12.4
2008	6,374	0[e]	0

a. One male died prior to spawning.

b. One male not completely "ripe" and was not used for spawning.

c. One female died prior to spawning.

d. Two females and one male died prior to spawning.

e. late-fall broodstock were not collected at the Keswick Dam due to construction activities in the adult holding ponds at the Coleman NFH

Steelhead

<u>Past Levels of Natural Steelhead as Broodstock</u>

Natural-origin steelhead have been regularly incorporated as broodstock at Coleman NFH. From the late-1940s through the mid-1980s, substantial numbers of natural-origin adults from Keswick Dam were collected and spawned at Coleman NFH (see Appendix 6B). Steelhead collected at the Keswick Dam fish trap are mostly of natural-origin. Since 1986, collection of steelhead broodstock has occurred exclusively at Battle Creek. The rate that natural-origin steelhead were incorporated as hatchery broodstock prior to 2002 cannot be determined because hatchery steelhead were not consistently marked. A 100% marking (adipose fin clip) program for steelhead was instituted at Coleman NFH for brood year 1998. Since 2002, all adult hatchery-origin steelhead in Battle Creek have been identifiable by an adipose fin-clip.

Beginning in return year 2002-2003, the Service began spawning known numbers of natural-origin steelhead at the Coleman NFH. The annual spawning target for natural-origin steelhead was 10% of the total broodstock (i.e. n = 40). This effort, however, was not completely successful because the broodstock collection strategy employed during that season was designed to select only adults that were "ripe" (e.g., ready to spawn) at the time when they were initially handled. This strategy of retaining only ripe natural-origin steelhead was intended to reduce potential impacts to natural-origin steelhead; because unripe steelhead were not retained the potential for pre-spawning mortality was greatly reduced. However, the vast majority of steelhead collected at the Coleman NFH during return year 2002-2003 were not sexually mature at the time of capture and, as a result, the Service did not achieve the goal of incorporating 10% natural-origin adults into the spawning matrix. Furthermore, the natural-origin steelhead that were spawned at the hatchery were not representative of the range of migration timing. Of the 427 natural-origin steelhead collected at the hatchery, only twelve were ripe and incorporated as hatchery broodstock; all of these were encountered during the latter half of the spawning season (Table 6-2).

The Service changed the broodstock collection strategy for natural-origin steelhead beginning in brood year 2004 to accommodate the retention of unripe fish. Unripe steelhead were retained at the hatchery until they reached sexual maturity and then spawned (Service 2003c). Retaining natural-origin fish at the hatchery did result in increased numbers of natural-origin fish being spawned; however, annual spawning targets were not achieved (Table 6-2).

Table 6-2 Number of natural-origin steelhead collected and spawned at Coleman NFH during return years 2003-2008. These fish are categorized as returned (total number into the hatchery), retained (number of fish held for spawning), or spawned (the number of fish actually spawned).

Return Year	Number of natural-origin steelhead		
	Returned	Retained	Spawned
2003	427	0	12
2004	225	45	38
2005	312	43	37
2006	282	34	25
2007	164	37	28
2008	184	33	23

Beginning in 2008-2009, the Service suspended use of natural-origin steelhead as broodstock due to the small population size of natural-origin fish returning to Battle Creek. Particularly concerning was the decrease of larger-sized fish (>18 inches), which are believed to contain primarily anadromous fish. The number of larger-sized natural-origin steelhead returning to Battle Creek decreased in abundance from 427 in 2003 to 184 in 2008 during the October through May collection sampling periods (Table 6-2).

Future Levels of Natural Steelhead as Broodstock

The Service would like for natural origin steelhead to comprise approximately 10 –20 % of the total effective number of steelhead spawned at the Coleman NFH, on an annual basis, to reduce the effects of domestication and to reduce genetic divergence between hatchery and natural stocks. The rate of 10-20% natural-origin steelhead broodstock was chosen to balance the objectives of decreasing the potential for genetic divergence, maintaining fitness of the hatchery stock, and reducing the effects of removing a portion of the natural steelhead run in Battle Creek. However, in response to the small population size of steelhead returning to Battle Creek, the Service has temporarily suspended collection of natural-origin steelhead as broodstock. In the future, the Service will investigate alternatives for incorporation of natural-origin steelhead broodstock.

6.6 Genetic or ecological differences

Fall Chinook Salmon

This stock is considered to be genetically similar to the remaining endemic stock of fall Chinook salmon in Battle Creek and the upper Sacramento River. This similarity results from: 1) a long history of fall Chinook hatchery propagation in Battle Creek; 2) indigenous fall Chinook salmon used as founding broodstock; and 3) continuous and substantial genetic exchange between natural- and Coleman NFH-propagated stocks. Considered together, naturally-produced fall Chinook salmon and fall Chinook propagated at Coleman NFH comprise one homogeneous population containing mixed ancestry of hatchery and natural lineage.

Late-fall Chinook Salmon

Coleman NFH late-fall Chinook salmon are considered to be genetically similar to late-fall Chinook salmon in the upper Sacramento River. This similarity exists because founding broodstock were collected from the Sacramento River; and natural-origin late-fall Chinook have been regularly used as hatchery broodstock. Considered together, naturally-produced late-fall Chinook salmon in the Sacramento River and late-fall Chinook at Coleman NFH comprise one homogeneous population containing mixed ancestry of hatchery and natural lineage.

Winter Chinook Salmon

The winter Chinook salmon supplementation program at Livingston Stone NFH is designed to reduce the potential for genetic divergence of the hatchery fish from the natural origin fish and to manage the hatchery- and natural-origin fish as one population. Indigenous winter Chinook salmon are the only source of hatchery broodstock. Naturally spawning winter Chinook are collected at the Keswick Dam fish trap, the migration terminus of the upper Sacramento River. Selection of winter Chinook broodstock is accomplished by screening all collected adults using several diagnostic criteria developed to reliably discriminate winter Chinook salmon. To be selected as hatchery broodstock, adult salmon must satisfy both phenotypic criteria (run/spawn timing, collection location, and physical appearance) and genetic criteria (based on seven loci that provide effective discrimination of winter Chinook plus another marker GHpsi to identify gender; see Appendix 6C for more information). In combination, the genetic and phenotypic criteria enable accurate and precise identification of winter Chinook salmon for use in the winter Chinook salmon artificial propagation program at Livingston Stone NFH.

Steelhead

Coleman NFH steelhead are included in the ESU of Central Valley steelhead based largely on genetic similarities to local populations. Coleman NFH steelhead were derived from the endemic stock of steelhead in the upper Sacramento River and hatchery and natural stocks have experienced substantial genetic interchange throughout the almost 70 -year history of the propagation program. Sampled steelhead populations from the Central Valley form a small, coherent, and distinctly identifiable genetic grouping when compared to other steelhead populations in California and the West Coast (NMFS 1996).

Nielsen et al. (2003) examined population structure of Central Valley steelhead populations using 11 microsatellite loci and found no significant differences in allelic frequencies between steelhead from Coleman NFH and the mainstem Sacramento River. Further analyses of additional samples from the mainstem Sacramento River and Battle Creek revealed significantly different allelic frequencies at some loci, suggesting some degree of genetic separation within these rivers (Service unpublished data, Figure 6.1). This could be due to hatchery-origin steelhead making a greater genetic contribution to early-returning (October – December) than to later returning (March – May) natural-origin steelhead. Natural-origin steelhead in Battle Creek appear to exhibit a cline in genetic distances, with early-returning fish more similar genetically to the Coleman NFH adults and late-returning natural-origin steelhead more similar genetically to adults collected from the mainstem Sacramento River. More recently, a genetic pedigree analysis conducted of Battle Creek steelhead showed hatchery steelhead exhibit decreased reproductive fitness compared to natural steelhead; however, it has not been conclusively determined that the observed differences in reproductive success resulted from genetic versus environmental factors.

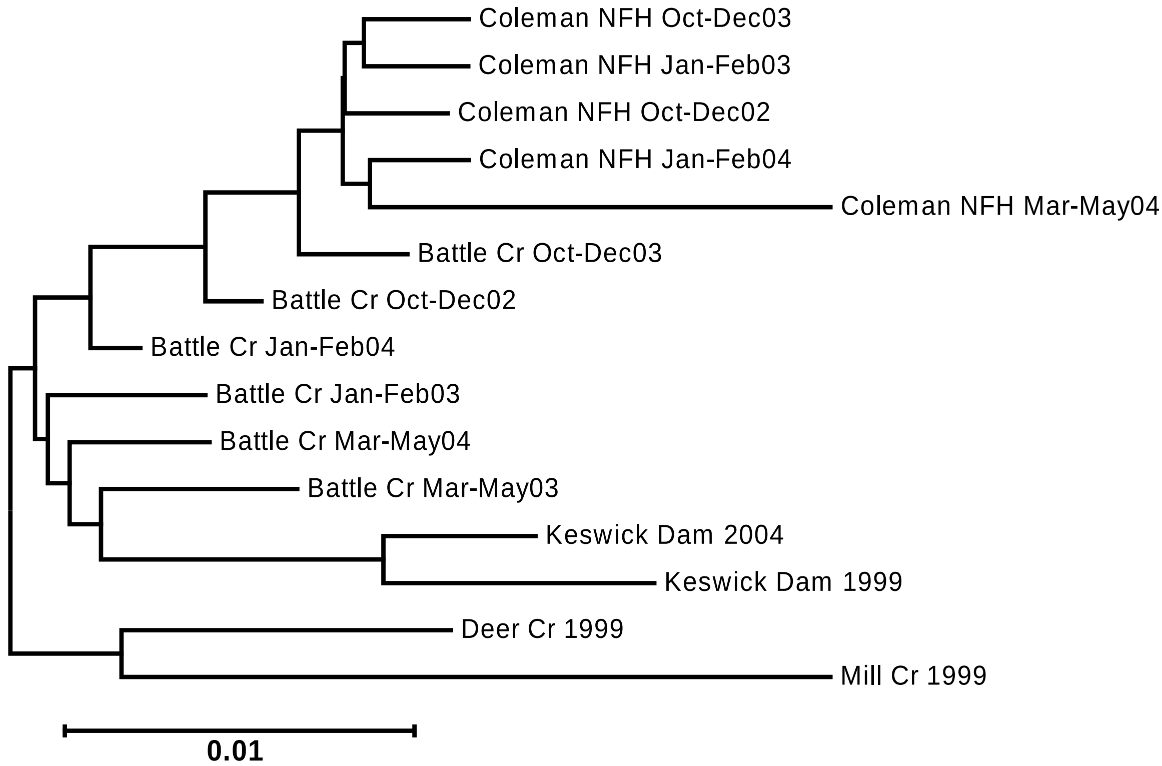

Figure 6.1 Unrooted Neighbor-Joining tree (Service, unpublished data). Branches with bootstrap probabilities are provided.

6.7 Reasons for choosing broodstock

Broodstocks for salmon and steelhead propagation programs at the Coleman and Livingston Stone NFHs are collected from local populations in Battle Creek and the upper Sacramento River. Hatchery stocks were founded from local natural populations and systematic incorporation of natural adults as broodstock is intended to reduce risks to natural populations. See below for a more complete description of broodstock selection by stock.

Fall Chinook Salmon

Founding broodstock for fall Chinook salmon at Coleman NFH were obtained from the Sacramento River and Battle Creek. Adult fall Chinook broodstock were regularly collected at the Sacramento River until 1986. Since 1987, fall Chinook broodstock have been collected only at the hatchery on Battle Creek. Fall Chinook salmon in Battle Creek are comprised of both hatchery- and natural-origin fish.

Fall Chinook broodstock at Coleman NFH are randomly selected from the total number of ripe adults ≥650 mm FL collected at the hatchery on Battle Creek. Jacks (males <650 mm FL; approximately age-2) are incorporated at a rate of up to 5% the total number spawned.

Late-fall Chinook Salmon

Founding broodstock for late-fall Chinook salmon were selected from the indigenous population in the upper Sacramento River. Selection criteria applied to founding broodstock were based on location of capture, run timing and phenotypic characteristics indicative of naturally spawning late-fall Chinook salmon in the Sacramento River.

Broodstock selection criteria presently used for late-fall Chinook salmon at Coleman NFH include run timing, phenotypic criteria, and hatchery mark status. All late-fall Chinook produced at Coleman NFH are marked with an adipose fin-clip and CWT. Unmarked (natural-origin) adults in Battle Creek are not used as hatchery broodstock because they exist at a low level of abundance. Unmarked adult late-fall Chinook collected at the Coleman NFH are released during the initial sorting process to spawn naturally in upper Battle Creek.

Beginning in 2002, natural-origin late-fall Chinook from the Sacramento River were used as hatchery broodstock (Table 6-1). Natural-origin late-fall Chinook were collected at the Keswick Dam fish trap, and were differentiated from early-arriving winter Chinook salmon based on phenotypic criteria including degree of ripeness and coloration.

To verify that phenotype was an accurate way to identify late-fall Chinook at the Keswick Dam fish trap, fin tissue samples were collected from natural-origin late-fall Chinook salmon used as broodstock during 2003 through 2007. Fin tissue samples from 112 late-fall Chinook salmon (32 in 2003, 42 in 2004, 33 in 2005, and 5 in 2007) were analyzed at the suite of seven microsatellite markers that are used to identify winter Chinook broodstock. All fish transferred to Coleman NFH from 2003 through 2005 were analyzed and 5 fish from 2007 that had questionable phenotypes were also analyzed. A run call of either winter or non-winter was assigned. Non-winter fish were assumed to be late-fall Chinook salmon because only winter and late-fall Chinook are likely to be captured in the Keswick Dam fish trap while trapping for late-fall broodstock. Of the 112 samples that were analyzed, 111 were identified as non-winter and one fish was not assigned a run because it was missing genotypes at many of the loci used in the run assignment and, therefore, was not within acceptable bounds of risk of misdiagnosis. Based on these data, run calls based on phenotype appear to be effectively screening late-fall Chinook for spawning at the Coleman NFH.

Late-fall Chinook broodstock at Coleman NFH and the Keswick Dam fish trap are randomly selected from the total number of ripe adults ≥650 mm FL collected. Jacks (males <650 mm FL; approximately age-2) are incorporated as broodstock at a rate of 5% of the number spawned.

Winter Chinook Salmon
Selection of winter Chinook broodstock is accomplished by screening collected adults using several diagnostic criteria developed to reliably discriminate winter Chinook salmon from non-target stocks. To be selected as winter Chinook broodstock at Livingston Stone NFH, an adult salmon must satisfy phenotypic criteria (run and spawn timing, location of capture, physical appearance indicators) and genetic criteria (based on seven loci that provide a high-level of discrimination). In combination, the phenotypic and genetic criteria used to select winter Chinook broodstock provide an accurate and precise discriminatory tool.

Steelhead
For various reasons, larger sized steelhead have been selectively spawned at Coleman NFH for many years. In the early 1950s, larger adults were preferentially selected for spawning because hatchery-origin steelhead were thought to be too small, and larger steelhead were desired for the

Sacramento River sport fishery. Beginning in 1986, exclusive selection for larger (≥554 mm) steelhead broodstock was instituted to breed out characteristics of non-anadromy believed to exist from speculated crosses between steelhead and non-anadromous rainbow trout (Service 1979). Scale analysis conducted at that time suggested that steelhead shorts (<554 mm) may have actually been non-anadromous river-trout, and an aggressive broodstock selection program was implemented to breed out the non-anadromous trait.

In the mid-1990s, after nearly a decade of excluding smaller sized steelhead from spawning at Coleman NFH, shorter steelhead continued to be abundant in the returning hatchery population. At that time the Service began to re-examine (using scale analysis, CWT returns, and growth rates) the practice of length-based broodstock selection. Throughout this examination, several inconsistencies were noted with the theory of non-anadromy for steelhead shorts: 1) length-at-age data suggested that growth rates of steelhead shorts were substantially greater than those typical of resident trout in the upper Sacramento River (unpublished data, CDFG, Redding, CA); 2) research showed that returning hatchery-origin steelhead at Coleman NFH were not smaller than indigenous steelhead populations existing prior to hatchery influences (Hallock 1989); and through otolith micro-chemistry, it was determined that steelhead shorts returning to Coleman NFH are predominantly anadromous (unpublished data, Service, Red Bluff, CA). With this new information, steelhead shorts were re-incorporated as broodstock in 1999.

Since 1999, steelhead of all lengths ≥406 mm (16 inches) have been included in the spawning matrix at the Coleman NFH. Steelhead ≥454 mm continue to be enumerated separately from longs, but they are incorporated into the spawning matrix at their rate of return. *Oncorhynchus mykiss* <406 mm are excluded from hatchery spawning because research has shown that they are non-anadromous rainbow trout. An investigation is currently underway using otolith microchemistry that is expected to provide more information on the life history of steelhead returning to the Coleman NFH. Results of this research will be used to determine the age at maturity and length of freshwater and ocean residency in hatchery- and naturally-produced steelhead returning to Battle Creek, California.

6.8 Risk aversion measures to minimize the likelihood of negative impacts on naturally-produced salmonids

Several measures are taken to reduce the likelihood of negative impacts to naturally produced salmonids resulting from broodstock collection activities at Coleman and Livingston Stone NFHs. Spawning of natural origin broodstock to achieve a high level of integration between hatchery- and natural-origin fall Chinook salmon will in itself reduce the risks of genetic divergence and domestication, and is intended to reduce the potential for negative genetic impacts to natural populations (see Appendix 6D for a more complete discussion of genetic risks to natural populations associated with hatchery propagation efforts). Broodstock collection and selection methods are designed to prevent the use of non-target fish as hatchery broodstock, reducing the risk of hybridization between stocks. In addition, genetic variability will be maintained by collecting and spawning adults throughout the duration of natural run/spawn timing. Specifics for each stock are discussed below.

Natural Fall Chinook Salmon

The large number of fall Chinook broodstock used at Coleman NFH (approx. 5,000) greatly reduces the potential for genetic drift within the hatchery. Furthermore, because of the large number of fall Chinook salmon spawned at the hatchery, it is unlikely that there has been a substantial loss of heterozygosity (Ryman and Ståhl 1980). In instances where allele frequency instability between years in hatcheries has been noted (i.e., loss of heterozygosity), it was attributed to the use of an effective number of parents of less than 50, even though the actual number of returning adults may have been much higher (Waples and Teel 1990). Maximization of the effective number is critical, as high levels of inbreeding depression and loss of genetic variability can be experienced within populations of small effective population size (Hard et al. 1992). The rate of inbreeding per generation is proportional to the inverse of two times the effective number (Ryman and Ståhl 1980) and is substantially greater at a lower effective number (Figure 6-2). However, opinions regarding an acceptable minimum value of the effective number are varied (Tave 1986, Waples and Teel 1990, Simon 1991).

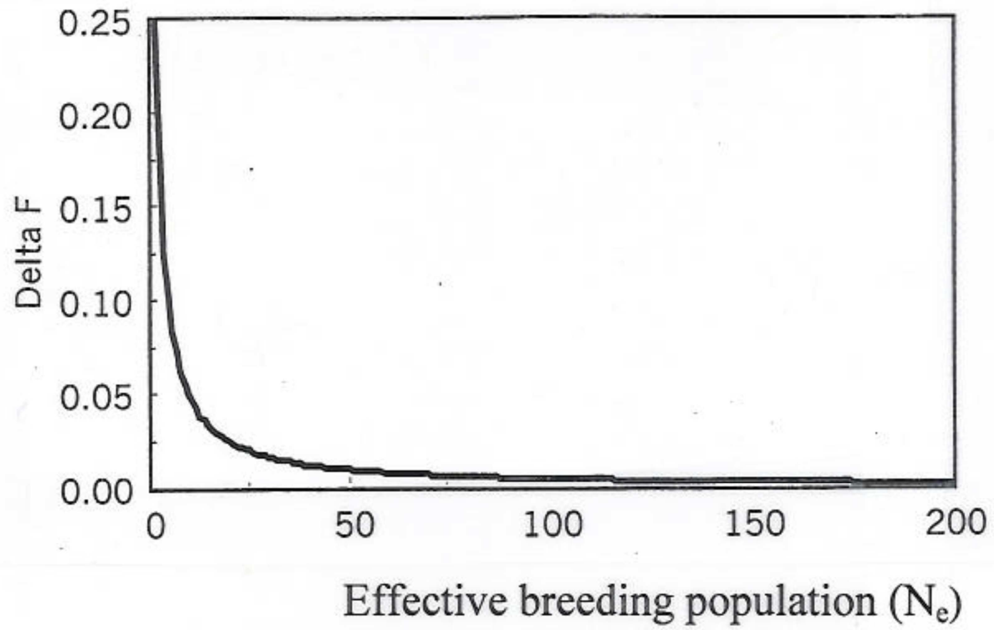

Figure 6-2 Increase of breeding per generation (Delta F) as a function of the number of effective parents (N_e; from Ryman and Ståhl 1980).

Natural Late-fall Chinook Salmon
Coleman NFH late-fall Chinook are considered to be genetically similar to natural-origin late-fall Chinook in the upper Sacramento River. Coleman NFH late-fall Chinook salmon were selected from the indigenous population of late-fall Chinook in the upper Sacramento River. Founding broodstock were selected based on location of capture, run timing, and phenotypic characteristics indicative of naturally spawning late-fall Chinook salmon in the Sacramento River. Similar to fall Chinook, the large number of late-fall Chinook broodstock used at Coleman NFH (a minimum of approximately 540 annually) will serve to reduce risk of genetic drift and maintain heterozygosity in the hatchery (Figure 6-2). Broodstock collection and selection strategies are in place to exclude non-target adults from the late-fall Chinook spawning process. Hatchery spawning of late-fall Chinook salmon extends through the duration of natural spawn timing.

Natural-origin late-fall Chinook salmon have been regularly incorporated as hatchery-broodstock. Incorporation of natural-origin adults is conducted to reduce genetic risks including loss of diversity among populations, domestication, and divergence between hatchery and natural stocks, which, in turn serves to limit risks to naturally produced salmonids (see Appendix 6D for discussion of genetic impacts to the natural population).

Natural Winter Chinook Salmon

The winter Chinook supplementation program was developed to reduce the risk of extinction and support recovery of the ESA-listed stock. Winter Chinook are collected and spawned throughout the duration of run/spawn timing to maintain variability. Risk aversion measures such as phenotypic and genetic selection criteria are briefly explained in Sections 7-4 and 7-9. For additional description see Service (1996a and 1998), University of California-Davis (2001), and Du et. al (1993). A factorial-type spawning scheme is used to increase the effective population size of hatchery winter Chinook.

Natural Spring Chinook Salmon

Unmarked Chinook salmon are currently afforded passage past the Coleman barrier weir from December through July, a period encompassing the known migration timing of Spring Chinook. Migration of spring Chinook into natal Central Valley streams occurs from mid-February through July, with the peak occurring May (CDFG 1998). Migration of spring Chinook into Battle Creek is not likely after July because high water temperatures inhibit salmon migrations until after the water temperature begins to cool. Due to adult migration timing, environmental constraints, and fish ladder operation, the probability of encountering spring Chinook salmon during fall Chinook salmon broodstock collection is considered to be low, as is the likelihood of hybridization with fall Chinook salmon in the Coleman NFH.

Steelhead

The likelihood of genetic drift will be kept low by using a large number of steelhead broodstock (approximately 800). Variability of run/spawn timing is maintained by spawning steelhead throughout the distribution of natural spawn timing. Steelhead will be spawned from the entire size distribution of returning adults to reduce the likelihood of negative genetic effects including directional selection and inbreeding. Due to the current low abundance of natural-origin steelhead in Battle Creek, the Service has temporarily discontinued the collection and incorporation of natural origin steelhead into the hatchery spawning matrix.

7 BROODSTOCK COLLECTION

7.1 Life-history stage to be collected

Fall, late-fall, and winter Chinook salmon and steelhead broodstock are collected for propagation programs at Coleman NFH and Livingston Stone NFHs. Fall Chinook, late-fall Chinook, and steelhead are collected from Battle Creek. Late-fall Chinook salmon are also collected from the Sacramento River at the Keswick Dam fish trap. Winter Chinook salmon for the program at Livingston Stone NFH are collected from the Sacramento River at the Keswick Dam fish trap.

7.2 Congregation and collection of broodstock

Fall and Late-fall Chinook Salmon and Steelhead in Battle Creek

The Coleman NFH barrier weir and its associated fish ladders are located approximately 5.8 miles upstream from Battle Creek's confluence with the Sacramento River. The weir is permanent, and extends across the full width of Battle Creek (approximately 90 feet). The weir and associated fish ladders provide fish passage management capability at that site. Specifically when broodstock collection activities are underway at the hatchery, the weir is designed to congregate fish below the structure and divert them into the fish ladder that connects the creek to the hatchery's adult holding ponds. This method of broodstock collection is believed to provide a representative sample of all salmon and steelhead attempting to migrate upstream of the hatchery. Fishes that do not enter the hatchery holding ponds will either remain in lower Battle Creek and spawn naturally or travel downstream to the Sacramento River. Non-salmonid fishes are seldom captured in the hatchery holding ponds due to a "step" in the upper section of the fish ladder that prevents their passage.

In the event that an emergency situation prohibits broodstock collections in Battle Creek, the adult fish trap at the Keswick Dam could also be used to collect Chinook salmon and steelhead from the Sacramento River. Historically, the Coleman NFH stocks of late-fall Chinook and steelhead were founded from adults captured at the Keswick Dam fish trap, and collections of adults from that location were a regular part of hatchery operations for many years. The adult fish trap at RBDD was used for collecting all fall Chinook broodstock during the drought years of 1978 and 1979 when fall Chinook were blocked at the RBDD to prevent them from entering habitats that were considered to be unfavorable for spawning. However, barring a catastrophic occurrence in Battle Creek, the Service does not currently propose to operate the traps at Keswick Dam or RBDD for collecting fall Chinook salmon or steelhead for broodstock.

Escapement Upstream of the Barrier Weir

In 2008, the barrier weir and fish ladders at the Coleman NFH were modified by adding a lipped crest cap, an overshot gate, and new fish ladders. One of the goals of these modifications was to provide improved capabilities of managing fish movement upstream of the hatchery. Blocking the undesired passage of fall Chinook salmon is a priority, as it is believed that escapement of fall Chinook upstream of the hatchery could impact ESA-listed spring Chinook salmon spawning upstream of the hatchery. The modified weir was designed to block passage at flows up to 800 cfs. Prior to recent construction of the lipped crest cap on the barrier weir, salmonids were capable of ascending past the weir during flows at or above 350 cfs. Historic flow data from Battle Creek suggests that creek flow will remain below 800 cfs for about 98% of the time that fall Chinook salmon are present below the weir. Further, that window of time where flows would most likely be exceed 800 cfs generally occurs very late in the fall Chinook salmon migration window when far fewer fish are actually likely to be present.

The Service recently investigated the effectiveness of the modified barrier weir at preventing salmonids from escaping into upper Battle Creek (Null et al. 2011). The investigation used a video camera array; the views from which capture the full width of the barrier. The cameras captured video images of both successful and unsuccessful passage attempts as fish challenged the weir during the migration timing of fall Chinook in 2008 (partial season) and 2009. No fish were observed escaping past the weir in 2008. A total of five fish were documented to have escaped over the weir in 2009. Species of the fish escaping past the weir could not be determined with certainty, however, based on size and morphology three of the fish were likely steelhead/rainbow trout and two were likely salmon. Four of the five fish escaping past the weir jumped over the overshot gate and one fish, likely a rainbow trout, jumped over the weir's new lipped crest cap. Escapement past the barrier weir occurred during September and October, when creek flows were within criteria that passage should have been precluded (min flow 163 cfs and max flow 331 cfs from Sept 1, 2009 to Nov 1, 2009). Observed escapement past the weir in 2009 represents less than 0.002% of the estimated 9,000 fall Chinook salmon in Battle Creek. Structural modifications to the overshot are currently being pursued to rectify this deficiency.

Timing of Broodstock Collection at the Barrier Weir

Salmon and steelhead enter the hatchery's adult collection ponds from October through February (Figure 7-1). The fish ladder leading from Battle Creek into the hatchery's adult collection ponds is opened intermittently during this period, depending on broodstock needs at the hatchery and salmon abundance below the weir. Collection of fall Chinook begins two or three days before the initial spawn date in early-October and continues through the final spawn date in mid- to late-November. Late-fall Chinook are collected from mid-December through February. Collection of steelhead occurs concurrently with collection of fall and late-fall Chinook salmon, beginning in October and continuing through February.

Between collections of fall and late-fall Chinook salmon (approximately four weeks between Thanksgiving and Christmas), the fish ladder into the hatchery is generally kept closed but is opened infrequently to collect fishes from Battle Creek. Hatchery-origin fall and late-fall Chinook salmon collected during this time are culled. This practice promotes separation of spawn timing between hatchery stocks of fall and late-fall Chinook salmon, which reduces the risk of hybridization between these stocks (Hankin 1991). Natural-origin late-fall Chinook and steelhead are passed upstream of the barrier weir to spawn in upper Battle Creek. Hatchery and natural origin late-fall Chinook salmon and steelhead are differentiated based on the presence or absence of the adipose-fin (hatchery-origin fish are 100% marked with an adipose-fin clip prior to release from the hatchery). Hatchery-origin steelhead collected during this time are retained as potential broodstock.

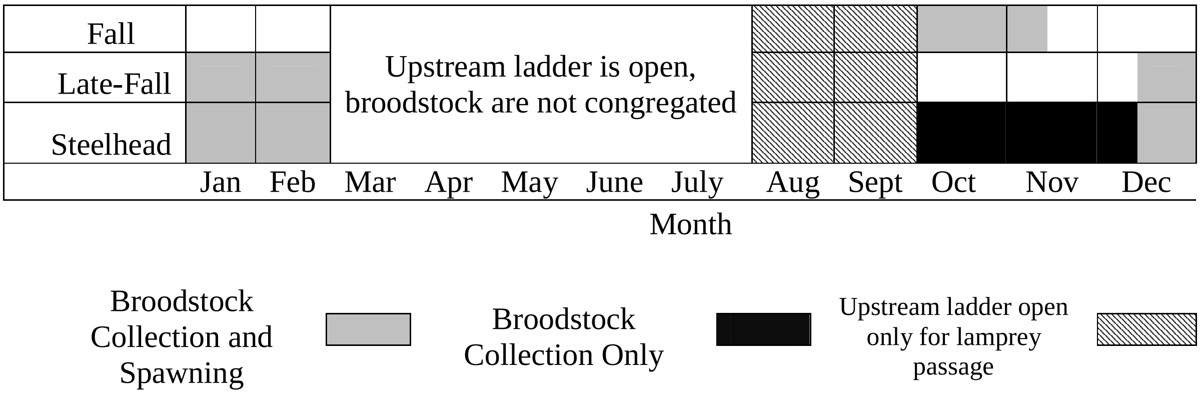

Figure 7-1 Operational purpose of the fish ladder at Coleman National Fish Hatchery. The upstream ladder is opened for salmonid passage from March 1 through July 31.

Additional Functions of the Barrier Weir

Additional functions of the Coleman NFH barrier weir include managing and monitoring passage of adult salmonids into upper Battle Creek. Historically, the Coleman NFH barrier weir has been used to restrict and monitor upstream passage of adult salmonids, outside of the time of broodstock collection, in order to accomplish the following objectives:

1) reduce the potential for hybridization between co-occurring, naturally-reproducing runs of Chinook salmon in upper Battle Creek (e.g. fall and spring Chinook);
2) reduce the risk of IHNV being shed into the Coleman NFH water supply.

Function of the Upstream Fish Ladder

Operation of the upstream fish ladder at the Coleman barrier weir outside the window of time associated with broodstock congregation and collection has been based on multi-agency decisions related to fishery management in Battle Creek. Specifically, the Coleman NFH barrier weir was closed beginning on or about July 1 from 1995 through 1999 to block the upstream passage of early arriving fall Chinook salmon. From 2000 through 2002 the barrier weir was closed on September 1, and beginning in since 2003 the barrier weir has been closed on or around August 1 (Figure 7-2). This period of passage is intended to accommodate the primary migration timing of spring Chinook salmon. It also encompasses a portion of the migrations of winter Chinook salmon, steelhead, pacific lamprey, and non-anadromous fishes.

Anadromous fish spawning and rearing habitat upstream of the Coleman NFH barrier weir contains designated critical habitat for steelhead and spring Chinook salmon, and potentially restorable habitats for ESA-listed winter Chinook salmon. All of these stocks are primary target species/runs for the Battle Creek Restoration Project. Restoration of the Battle Creek watershed requires that target stocks of salmon and steelhead be afforded the opportunity to access the upper reaches of Battle Creek. Currently, fall Chinook are being restricted to that portion of Battle Creek downstream of the Coleman NFH barrier weir because of their potential impacts to listed species.

Future operations of the Coleman NFH barrier weir will be adapted to integrate hatchery operations with restoration activities in Battle Creek. Current plans are to block the upstream ladder from August 1 through February to prevent fall Chinook from accessing spring Chinook spawning habitats in upper Battle Creek (during August) and to meet the hatchery's broodstock requirements (starting in September). Operation of the upstream fish ladder outside of this time frame can be flexible to meet the objectives of the salmon management in Battle Creek. For example, the current operational strategy of the barrier weir calls for the upstream ladder to be closed on or about August 1, a month prior to the hatchery's need to block passage of fall Chinook broodstock. This operational scheme was adopted upon agreement between the Service, CDFG, and NMFS to prevent superimposition and hybridization of fall Chinook on spring Chinook. Current operations of the Coleman NFH barrier weir are shown graphically in Figure 7-2.

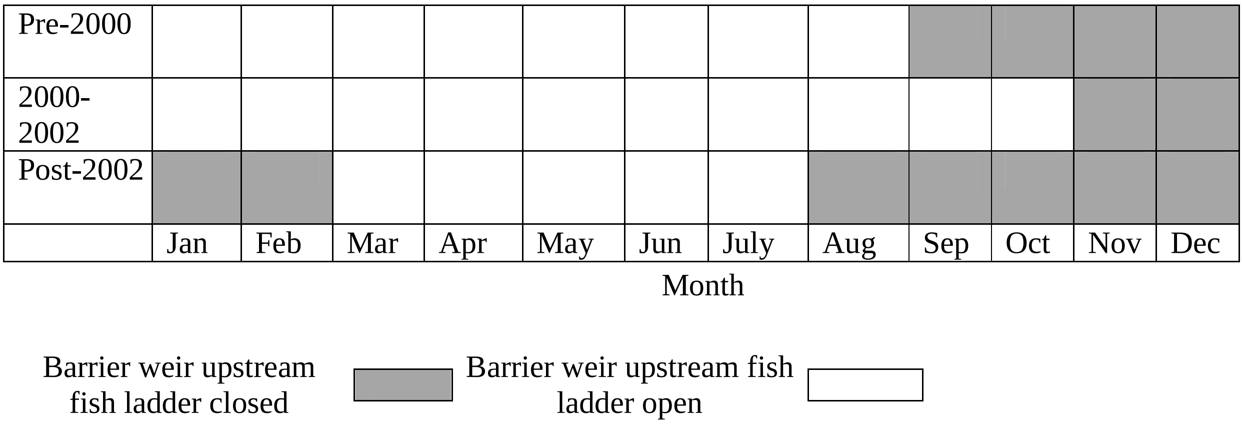

Figure 7-2 Timing of barrier weir fish ladder operations at the Coleman NFH since 2000.

Winter and Late-fall Chinook Salmon from the Sacramento River
Winter Chinook salmon broodstock are collected from the upper Sacramento River. Broodstock are collected from late-December through July using the fish trap at Keswick Dam. Collection of late-fall Chinook broodstock extends from late-December through mid-February and collection of winter Chinook broodstock extends from mid-February and into July. The fish trapping facilities are located in the center of the dam, between the powerhouse and the spillway. The trapping facilities consist of a twelve-step upstream fish ladder, a brail-lift, and a 1,000 gallon elevator. The fish ladder is approximately 170 feet long and 38 feet wide. Weirs spaced every 13 feet 7 inches create pools in the ladder. Fish approaching Keswick Dam are attracted to the fish ladder by means of a 340 cfs jet pump supplying water to the trap and fish ladder. Additional attraction is supplied through water diffusers in the ladder floor. The top of the ladder leads to a fyke weir. After passing through the fyke weir, adult salmonids are contained in a large fiberglass brail enclosure. When the trap brail is raised, trapped fish are directed into a 1,000-gallon fish tank elevator which transports them up the face of the dam. The fish tank elevator is then emptied into a vehicle equipped with a distribution tank and transported to Livingston Stone NFH. The design of the Keswick Dam fish trap allows fish collected at that site to remain in water at all times.

Beginning in 2002, the Service re-initiated periodic collection of natural-origin late-fall Chinook salmon from the upper Sacramento River for spawning at Coleman NFH. Late-fall Chinook salmon are collected using the Keswick Dam fish trap, in the same manner as winter Chinook salmon. Another fish trap located in the east fish ladder at RBDD has also been used for capturing winter Chinook salmon. Use of this trapping facility was discontinued after the 2007 trapping season because of the ineffectiveness of those efforts. Future collection of winter Chinook broodstock at that facility is unlikely due to implementation of the RBDD fish passage improvement project (http://recovery.doi.gov/press/wp-content/uploads/2010/08/red-bluff-factsheet-072210.pdf), which will alleviate the need to operate the dam and thereby render the fish trap inoperable.

The ACID Dam, located three miles downstream from Keswick Dam, is installed from May to October. The Service is currently pursuing construction of a trap in the fish ladder on the east side of the Sacramento River. The ACID Dam is located in the center of the winter Chinook primary spawning area. Construction of a fish trap at ACID Dam will provide an additional site for collection of winter Chinook broodstock.

Timing of Broodstock Collection
Collection of late-fall and winter Chinook salmon at the Keswick Dam fish trap is conducted to sample throughout the timing of migration (Figure 7-3). Collection of late-fall Chinook at the Keswick Dam fish trap begins in December and continues through mid-February. Collection of winter Chinook salmon at the Keswick Dam fish trap begins in mid-February and continues into July.

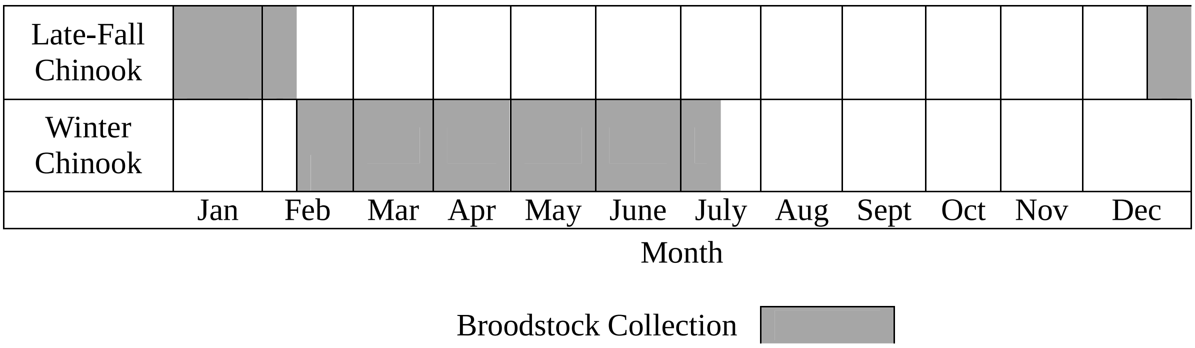

Figure 7-3 Broodstock collection timing for late-fall and winter Chinook salmon at the Keswick Dam fish trap on the Sacramento River.

7.3 Broodstock transportation and holding methods
Fall Chinook Salmon
<u>Transportation</u>
Fall Chinook broodstock are collected at Coleman NFH and do not require transport. Fish collected at the Coleman NFH are directed from the creek into adult holding ponds via the barrier weir and fish ladder.

<u>Holding and Sorting</u>
Fall Chinook collected in the hatchery pond are first handled during a process called sorting. After exiting the fish ladder and entering the hatchery adult holding pond, the fish are guided into the spawning building using several mechanical/powered crowders. Once congregated (in the cross channel) inside the spawning building, operation of a series of valves allows fish to volitionally enter a lift tower. A hydraulically driven brail located in the lift tower raises and guides fish into a CO_2 anaesthetization tank. Upon being anaesthetized, fall Chinook salmon are phenotypically sorted into one of three categories: 1) ripe fish to be spawned, 2) fish to be culled

(excessed), or 3) unripe fish to be held for possible spawning at a later date. Fall Chinook salmon that are needed for broodstock and are ready to be spawned at the time of sorting are spawned that same day. Excess salmon are culled immediately. Unripe fish may be relocated into one of two additional holding ponds if the availability of future broodstock is uncertain. This practice is most likely to occur with fall Chinook late in the spawning season.

The duration that fall Chinook are retained in the hatchery ponds prior to sorting varies from one to seven days, depending on when fish enter the hatchery ponds relative to the schedule of hatchery spawning. Generally, fall Chinook salmon are initially sorted within one or two days after collection in the holding ponds. Pre-spawning mortality for fall Chinook is highly variable, ranging between 0.7% and 24.8% (mean 7.3%) for return years 2001 through 2008. Although pre-spawn mortality of fall Chinook in the holding ponds is generally low, substantially increased prespawn mortality occurred in 2007 and 2008. The higher pre-spawn mortality that occurred in 2007 and 2008 was a result of additional handling and extended holding that occurred during those years. Due to the extremely low numbers of fall Chinook returning, few fish were excessed and attempts were made to maximize the number of fish spawned. Since not all fish were ripe at the time when they were initially collected, many fish were returned to the hatchery broodstock collection pond for maturation. This "recycling" of handled fish dramatically increases the rate of prespawn mortality. During a typical year, when numbers of fish returning is not a concern, these fish would have been excessed during the initial sort.

Late-fall Chinook Salmon

Transportation

Adult late-fall Chinook salmon collected at the Keswick Dam Fish trap require transport to Coleman NFH. In 2002, the Service began collecting natural-origin late-fall Chinook salmon at the Keswick Dam fish trap for use in the spawning matrix at Coleman NFH. This is done in attempt to reduce genetic divergence of hatchery late-fall Chinook salmon from natural-origin late-fall Chinook salmon. Hatchery-origin late-fall Chinook salmon broodstock (which make up the bulk of the broodstock collected for the program), are collected directly from Battle Creek, and do not require transport.

Upon removal from the Keswick Dam fish trap, all target and non-target fish are transported in the 2,000 gallon insulated fish hauling trucks to Livingston Stone NFH; which is in close proximity to the Keswick Dam fish trap. At Livingston Stone NFH, baffles are added inside the tank and CO_2 is infused to anaesthetize all fish. Species identification and other phenotypic characteristics are used to sort target fully mature/ready to spawn natural-origin late-fall Chinook salmon from non-target fishes (e.g., steelhead; winter or spring Chinook, depending on time of year; and hatchery-origin or natural-origin late-fall Chinook salmon that are not fully mature). Hatchery-origin (adipose fin-clipped) Chinook salmon are sacrificed for recovery of the CWT.

Late-fall Chinook broodstock are transported to Coleman NFH in one truck, while non-target fish are transported to Redding, CA for release into the upper Sacramento River. If the ACID Dam has not been installed and water levels are low, non-target fishes are relocated to the Posse Grounds (RM 298) boat ramp. After the ACID Dam is installed for the year, all fish are relocated to the boat ramp at Caldwell Park (RM 299). Salt, artificial slime, and ice may be added to transport water at standard rates to reduce stress during transport.

Estimated time to transport late-fall Chinook salmon from Keswick Dam to Coleman NFH varies depending on the number and types of fish initially captured in the Keswick Dam Fish trap: ranging from two to four hours. Transport from Keswick Dam to Livingston Stone NFH is less than one hour. Sorting of fish may take up to two hours. Transport of late-fall Chinook salmon from Livingston Stone NFH to Coleman NFH is less than one hour.

<u>Holding and Sorting</u>
Late-fall Chinook salmon collected from Battle Creek may reside in the hatchery holding ponds one to seven days before initial sorting. Hatchery-origin late-fall Chinook salmon collected from Battle Creek are sorted into three categories: 1) ripe fish to be spawned, 2) fish to be excessed, or 3) unripe fish to be held for possible spawning at a later date. Unripe hatchery-origin late-fall Chinook salmon are frequently held for spawning at a later date. This helps to ensure there will be enough broodstock available to meet spawning goals at the end of the season. Total pre-spawning mortality of hatchery origin late-fall Chinook (including fish sorted and held for spawning at a later date) ranged between 13.2% and 42.3% (mean 29.5%) for return years 2001 through 2008. High mortality levels in hatchery origin late-fall Chinook are likely due to the fact that excessing late-fall Chinook salmon adults is infrequently done resulting in fish undergoing multiple handling events possibly coupled with a longer initial holding time in adult collection ponds.

Natural-origin late-fall Chinook salmon from Battle Creek are identified at the initial sorting process and placed into a sorting tube that diverts them directly to Battle Creek above the barrier weir. Mortality of natural-origin (intact adipose fin) Chinook may occur during the late-fall Chinook broodstock collection period. These fish are observed dead in the adult holding pond *prior* to any handling or sorting event. From 2002 through 2008, pre-spawning mortality of unmarked Chinook occurring during the collection of late-fall Chinook broodstock has ranged from 0 to 66 fish per year (0-54%; Table 7-1).

Natural origin late-fall Chinook salmon captured at the Keswick Dam fish trap will be transported to Coleman NFH where they will be held until spawned (typically one day). Duration of time in the holding ponds depends on the time when the fish are placed into the ponds relative to the schedule of hatchery spawning. The sorting procedure for late-fall Chinook salmon is similar to that described previously for fall Chinook salmon. Since 2002, pre-spawn mortality of natural-origin late-fall Chinook salmon collected at the Keswick Dam fish trap has ranged from 0 to 3 fish (0-4.29%) per year

Table 7-1 Total count and pre-spawn mortalities of natural-origin late-fall Chinook salmon observed during late-fall Chinook broodstock collection (late-December through February) at the Keswick Dam fish trap and Coleman National Fish Hatchery, return years 2002-2008.

Return Year	Coleman National Fish Hatchery		Keswick Dam Fish Trap	
	Count	Mortality	Count	Mortality
2002	216	0	0	0
2003	57	0	32	1
2004	41	1	42	0
2005	26	0	32	0
2006	117	66	5	1
2007	88	16	70	3
2008	29	10	0	0

Winter Chinook Salmon

Transportation

Winter Chinook salmon are collected at the Keswick Dam fish trap. Adults collected in the fish traps at Keswick Dam are transported to Livingston Stone NFH in a fish distribution vehicle carrying an aerated 250-gallon insulated transport tank. Salt, artificial slime, and ice may be added to transport water at standard rates to reduce stress during transport. A more detailed description of fish transportation and sorting for fishes collected at the Keswick Dam fish trap can be found in the previous section on late-fall Chinook salmon transportation.

Holding and Sorting

Upon arrival at Livingston Stone NFH, phenotypic winter Chinook salmon collected from the Keswick Dam fish trap are anaesthetized using CO_2. Length, gender, and visible marks are recorded for each fish and a tissue sample is collected for genetic run identification. A color-coded and alphanumeric floy tag is attached to the salmon just anterior to the dorsal fin for individual identification. Winter Chinook needed for broodstock are retained while fish in excess of broodstock requirements are returned to the Sacramento River. Tissue samples are collected from all fish returned to the river for run discrimination analysis.

Phenotypic winter Chinook salmon adults that are retained for candidate broodstock are placed into a 20-foot diameter circular holding quarantine tank and tissue samples are sent for “rapid-response” genetic analysis and run determination (see Appendix 6C). Adult salmon subsequently genetically confirmed as winter Chinook salmon are then transferred into a second 20-foot diameter circular adult holding tank. Hatchery-origin (adipose fin-clipped) Chinook salmon identified as “non-winter” are sacrificed for recovery of the CWT. Natural-origin Chinook salmon identified as “non-winter” are relocated to the Sacramento River. Hatchery and natural winter Chinook salmon not held for spawning are relocated to the Sacramento River. Releases into the Sacramento River occur at one of two sites in Redding, CA, depending on water level; the boat ramp at Posse Grounds is used when the ACID dam is not installed and the boat ramp at Caldwell Park is used when the ACID dam is installed. Observed pre-spawn mortality associated with the operation of Keswick Dam fish trap averaged 8% between 2000 and 2008 (Table 7-2).

Table 7-2 Total collected and pre-spawn mortalities of winter Chinook salmon collected at the Keswick Dam fish trap during winter Chinook broodstock collection (March 1 through July), return years 2000-2008.

Return Year	Number of Mortalities			Total number collected	% Mortality
	Male	Female	Total		
2000	6	4	10	78	12.82%
2001	4	2	6	97	6.19%
2002	6	2	8	88	9.09%
2003	5	2	7	78	8.97%
2004	8	4	12	73	16.44%
2005	9	5	14	95	14.74%
2006	0	0	0	89	0.00%
2007	1	1	2	44	4.55%
2008	0	0	0	93	0.00%
Average	4	2	7	82	8.03%

Steelhead

Transportation

No transport of steelhead broodstock occurs as all adult steelhead broodstock are collected from Battle Creek and spawned on-site at the Coleman NFH.

Holding and Sorting

Steelhead collected from Battle Creek may reside in the hatchery holding ponds for one to seven days before initial sorting. Steelhead generally arrive at the hatchery prior to being ready to spawn and in good physical condition. Pre-sorting mortality of steelhead averaged 2.7% (range 1.3 to 3.7%) from 2003 through 2008.

Methods of sorting steelhead are similar to those used for fall and late-fall Chinook salmon and have already been described previously in the section on fall Chinook salmon. Steelhead are sorted into three categories: 1) ripe and ready to spawn, 2) natural-origin fish to be released into Battle Creek above the barrier weir, or 3) unripe fish to be retained for spawning at a later date. Currently, unmarked (natural-origin) steelhead are not retained for spawning at Coleman NFH; however, the Service will investigate strategies to reinitiate collection of natural-origin steelhead in the future.

Steelhead from Battle Creek are typically unripe when they enter the hatchery. Consequently, steelhead broodstock are separated from Chinook salmon and detained in the hatchery while they mature. This practice is called “banking.” Banking is conducted by placing all hatchery-origin steelhead collected from early-October through mid-December in an adult holding pond; these fish are spawned during about the first half of egg takes. Hatchery-origin steelhead entering the hatchery after mid-December are placed into a separate holding pond; these fish will be spawned generally during the second half of egg takes. Banking is conducted to ensure that steelhead broodstock are spawned from a broad spectrum of run timing and helps to ensure that an adequate number of broodstock are available to meet the hatchery’s egg-take goals. With the current practice of “banking” steelhead broodstock, it is not possible to calculate the duration that any individual steelhead may be detained in the hatchery collection ponds. For example, any steelhead spawned any day during the month of January may have been collected as early as October or as late as mid-November. From 2003 to 2008, “banked” steelhead mortality ranged from 4.7% to 20.4% (average = 12.4%).

7.4 Identifying target populations and hatchery vs. natural-origin fish

During broodstock collection at Coleman NFH and Keswick and RBDD fish traps, as many as five different runs of salmonids may be migrating at any one time. Consequently, non-target runs may be collected in conjunction with hatchery broodstocks. In addition, both hatchery- and natural-origin fish may be captured while collecting broodstock, which, depending on the stock being propagated, may also need to be distinguished. Identification and disposition of the different runs encountered during collection of broodstock is described below:

Target Population: Fall Chinook Salmon collected from Battle Creek

Both marked and unmarked fall Chinook salmon are collected at Coleman NFH and used as hatchery broodstock. While marked fish are known to be of hatchery-origin, unmarked adults returning to Battle Creek and collected at Coleman NFH cannot be distinguished to origin and may either be of hatchery- or natural-origin. Only a portion of fall Chinook salmon juveniles released from Coleman NFH are currently marked (adipose fin-clip and CWT) and thus can be identified to origin. Unmarked fish are a mixture of unmarked hatchery fish or the result of natural production occurring primarily in lower Battle Creek. Expansion of mark rate data would suggest, however, that the majority of unmarked fall Chinook salmon in Battle Creek are of hatchery-origin.

Identification and disposition of non-target salmonids encountered during collection of fall Chinook broodstock are described below:

Hatchery-origin Late-fall Chinook Salmon

The upstream migration timing of adult late-fall Chinook salmon can overlap with that of adult fall Chinook salmon and therefore both may enter the hatchery ponds during the collection of fall Chinook salmon broodstock. During some years, early-arriving late-fall Chinook salmon may comprise a substantial portion of adults collected at the end of the fall Chinook spawning season (Figure 7-4). However, these early arriving late-fall Chinook salmon are generally phenotypically distinguishable from fall Chinook salmon in that they are bright in color, have little evidence of fungus, and overall muscle tone is very firm. Further, mark status is used to assist in decreasing potential for hybridization. Since 2007 (brood year 2006), fall Chinook salmon smolts released from Coleman NFH have been marked with an adipose fin-clip and CWT at a rate of 25%. Late-fall Chinook originating at Coleman NFH have been 100% marked and tagged since 1992[4]. Therefore, to reduce potential for incorporating early arriving late-fall Chinook salmon into the fall Chinook salmon spawning matrix, no marked fish are spawned during the fall Chinook spawning season after about the first week of November.

[4] In 1998, approximately 125,000 unmarked late-fall Chinook juveniles were placed in the hatchery pollution abatement pond. Evidence suggests that substantial numbers of these fish (est. 50,000) exited the pond through a spillway and entered Battle Creek.

The effectiveness of using physical marks and phenotypic characteristics in minimizing potential for hybridization has been verified through recoveries of CWTs. Heads are collected from all hatchery-origin (i.e., adipose fin-clipped) salmon encountered during the fall Chinook spawning process for ultimate recovery of the CWT. As verified through CWT recovery, nearly all late-fall adults have been excluded from the fall Chinook spawning process. Specifically, between 1996 and 2008, only four hatchery-origin late-fall Chinook salmon were spawned during the fall Chinook period; one each in 1999, 2002, 2003, and 2008.

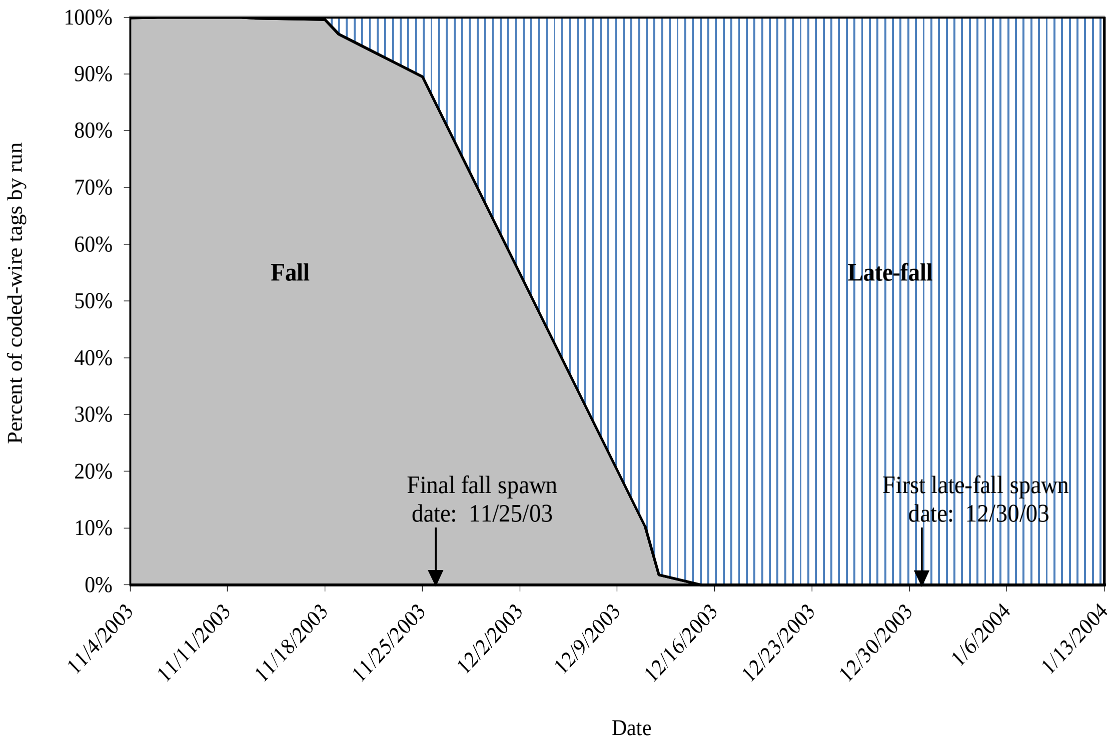

Figure 7-4 Transition from fall to late-fall migrations of adult Chinook salmon at Coleman National Fish Hatchery, Battle Creek, California. Data are from coded-wire tag recoveries from November 2003 through January 2004 and represent typical proportions by return.

Natural-origin Late-fall Chinook Salmon

Natural-origin (i.e., unmarked) late-fall Chinook salmon encountered during the fall Chinook spawning process are identified and separated from fall Chinook salmon on the basis of physical appearance. Broodstock selection criteria in effect during the end of fall Chinook spawn timing (e.g., late-November) select *against* traits characteristic of early-arriving late-fall Chinook adults (e.g., bright, firm, and unripe). Phenotypic natural-origin late-fall Chinook salmon encountered during the end of fall Chinook spawning (i.e., fish that are unmarked, bright, firm, and unripe) will be passed upstream of the Coleman NFH barrier weir. Based on demonstrated effectiveness to not use hatchery-origin late-fall Chinook salmon in the fall Chinook salmon spawning matrix, assumption of successful ability to exclude natural-origin late-fall Chinook salmon using same phenotypic characteristics is reasonable

Spring Chinook Salmon
The currently adopted multi-agency Fishery Management Action adopted for Battle Creek is to close the hatchery's upstream ladder on August 1st. The agencies reasoned that closing the ladder around August 1 would allow the vast majority of spring Chinook to ascend past the barrier weir while, at the same time, preventing fall Chinook access to upper Battle Creek. Some fall Chinook salmon can enter Battle Creek during August, and closing the upstream fish ladder reduces the likelihood that fall Chinook will negatively impact naturally spawning spring Chinook salmon through hybridization, or competition, including superimposition of redds. This management strategy could result in late-migrating spring Chinook salmon being blocked below the barrier weir after the fish ladder is closed in August; however, this is considered unlikely as this is not characteristic of the spring Chinook life history and spawning of spring Chinook salmon should be largely complete at that time.

Hatchery- and natural-origin Steelhead
Steelhead broodstock are collected concurrently with fall Chinook salmon at Coleman NFH. Due to distinct morphological differences between salmon and steelhead, there are no issues related to identification of steelhead during efforts to target fall Chinook salmon. Since 1998, all hatchery-origin steelhead have been marked with an adipose-fin clip prior to release. Hatchery- and natural-origin steelhead are differentiated by the presence or absence of an adipose fin. Hatchery-origin steelhead encountered during the fall Chinook spawning process are placed in the hatchery holding ponds (Pond 4 or Pond 5) and held until steelhead spawning commences. Central Valley steelhead are a federally listed (threatened) species and a small remnant population is known to exist in Battle Creek. Until the 2009 return season, natural-origin steelhead were either held for spawning or released into upper Battle Creek above the Coleman NFH barrier weir. However, the Service has temporarily discontinued the collection of natural origin steelhead from Battle Creek until the population increases to levels that can withstand the removal of natural-origin fish for use as broodstock.

Target Population: Hatchery–origin Late-fall Chinook Salmon collected from Battle Creek
Collection of late-fall Chinook salmon from Battle Creek at the Coleman NFH occurs from November through late February. All late-fall Chinook salmon released from Coleman NFH are marked with an adipose fin clip and coded-wire tagged. Identification and disposition of non-target salmonids collected at Coleman NFH during collection of late-fall Chinook broodstock are described below:

Hatchery-origin Fall Chinook Salmon
Differentiation between hatchery-origin fall and hatchery-origin late-fall Chinook salmon is accomplished during the initial sorting process based on fin-clip status (adipose) and physical appearance (including coloration, amount of fungus, and degree of ripeness or "firmness"), similarly to that described above for differentiating target fall Chinook salmon from hatchery – origin late-fall Chinook salmon. Since 2007 (brood year 2006), fall Chinook salmon smolts released from Coleman NFH have been marked with an adipose fin-clip and tagged (CWT) at a rate of 25%. All late-fall Chinook originating at the hatchery have been marked (adipose fin-clipped) since 1992. Based on different mark rates, fall and hatchery-origin late-fall Chinook salmon can be differentiated largely on the basis of mark status (presence or absence of an adipose fin), and during the late-fall Chinook spawning season only adipose fin-clipped fish are

spawned. However, during the first few late-fall Chinook spawning dates (i.e., late-December), marked fish which are dark and have excessive fungus are also excluded as they may be fall Chinook salmon. Effectiveness of these procedures is supported by the fact that only one recovery of a CWT fall Chinook salmon has been made from fish spawned during late-fall Chinook salmon spawning from 1991-2008 (Service unpublished data from 1991-2008).

Natural-origin Fall, Late-Fall, and Winter Chinook salmon
Unmarked adults encountered during the late-fall spawning season may be either hatchery-origin fall Chinook, or natural-origin fall, late-fall, spring, or a stray winter Chinook salmon from the Sacramento River. All unmarked Chinook salmon collected at Coleman NFH, after mid-December, during the late-fall Chinook spawning season, regardless of phenotypic appearance, will be returned to Battle Creek above the Coleman NFH barrier weir at the time of initial sorting.

Steelhead
Steelhead broodstock are collected concurrently with late-fall Chinook salmon at Coleman NFH. Hatchery-origin steelhead encountered during the late-fall Chinook spawning process are placed in the hatchery ponds and held until mature. Natural-origin steelhead encountered during the broodstock collection process will be released into Battle Creek upstream of the Coleman NFH barrier weir.

Target Population: Natural-origin Late-fall Chinook Salmon collected from Keswick Dam Fish Trap
Unmarked (natural-origin) Chinook from the Keswick Dam fish trap that are phenotypically identified as late-fall will be targeted for incorporation as broodstock at Coleman NFH. Natural-origin late-fall Chinook salmon captured but not needed as broodstock will be released into the Sacramento River at Posse Grounds. Criteria for distinguishing late-fall Chinook salmon from other runs of salmonids collected at the Keswick Dam fish trap are described below.

Fall Chinook Salmon
Collection of late-fall Chinook salmon at the Keswick Dam fish trap begins in December. Fall Chinook salmon are not likely to be collected so late in the year. However, to avoid incorporating any fall Chinook salmon into the late-fall Chinook salmon spawning matrix, Chinook salmon are excluded if they are extremely flaccid, very dark in coloration, or covered with a large amount of fungus. Phenotypic fall Chinook will be to the Sacramento River at Posse Grounds boat ramp, Redding, California, where they will be released.

Hatchery-origin Fall and Late-fall Chinook Salmon
Hatchery-origin fall and late-fall Chinook salmon, identified by phenotypic characteristics and marked with a clip of the adipose fin, will be euthanized for recovery of the CWT.

Hatchery-origin Winter Chinook Salmon
Late-fall Chinook broodstock are differentiated from winter Chinook based on phenotypic characteristics. It is very unlikely that a winter Chinook would be confused as a late-fall Chinook (i.e., ripe and capable of spawning prior to March). Marked salmon phenotypically identified as winter Chinook are released into the Sacramento River at Redding, CA. If a marked

winter Chinook captured at this time was misidentified as a late fall Chinook based on phenotypic characteristics, it would be sacrificed for recovery of the coded wire tag. However, based on CWT data, this has never occurred.

Natural-origin Winter Chinook Salmon
Natural-origin winter Chinook salmon are distinguished from natural-origin late-fall Chinook salmon through phenotypic characteristics including lighter color, more muscle tone, and lesser amount of fungus. It is very unlikely that a winter Chinook would be confused as a late-fall Chinook (i.e., ripe and capable of spawning prior to March). Unmarked Chinook, including natural-origin winter Chinook, will be released into the Sacramento River at Posse Grounds boat ramp, Redding, California.

Steelhead
Steelhead and resident rainbow trout are inadvertently captured in the Keswick Dam fish trap during collection of late-fall Chinook broodstock. Steelhead collected from the Keswick Dam fish trap are released into the Sacramento River at Redding, CA.

Target Population: Natural-origin Winter Chinook Salmon
Hatchery- and natural-origin salmonids from different runs co-exist with winter Chinook in the Sacramento River, and may be collected in the Keswick and RBDD fish traps while trapping for winter Chinook broodstock. Winter Chinook salmon are differentiated from other Chinook salmon based on both phenotype and genotype. This process is similar for the different salmon runs, so the descriptions for differentiating winter Chinook salmon from fall, late-fall, and spring runs are described together below.

Fall, Late-fall, and Spring Chinook Salmon
Marked and unmarked winter Chinook salmon collected at the Keswick and RBDD fish traps are initially distinguished from other Chinook salmon runs through phenotypic characteristics. Chinook salmon are sorted based on color, degree of ripeness (firmness), body size, and amount of fungus. In late-February and March, early in the process of collecting winter Chinook broodstock, ripe, dark, and fungussed salmon are selected *against*; fish with these characteristics are more likely to be late-fall Chinook than winter Chinook. Conversely, firm (unripe), bright, and clean (minimal fungus) salmon are more likely to be winter Chinook. As the winter Chinook broodstock collection season progresses into April and May, firm, bright, and very clean salmon are selected *against*; fish with these characteristics are likely to be spring Chinook salmon. Also, during this time, over-ripe, dark salmon with a large amount of fungus are also selected *against,* as fish with these characteristics are likely to be late-fall Chinook salmon. During this time, winter Chinook tend to be firm, dark, and clean in appearance. By the end of broodstock collection (late-May through mid-July), selection criteria for winter Chinook broodstock include ripe, dark, and fungussed salmon. Spring and fall Chinook are the only other adult salmon in the Sacramento River at that time, and they are characterized as firm, bright, and clean. Marked Chinook that do not satisfy the phenotypic criteria of winter Chinook are sacrificed for recovery of the CWT. Unmarked Chinook that do not satisfy the phenotypic criteria of winter Chinook, and any winter Chinook not needed for the program (e.g., exceeding monthly collection target) are transported to the Sacramento River at Redding, CA and released.

All fish phenotypically identified as a winter Chinook salmon are subsequently subjected to genetic verification of run determination. Tissue samples are taken from each candidate broodstock prior to placement into a quarantine tank, and a color-coded and alphanumeric floy tag is attached to the salmon just below the dorsal fin. Within 24 hours, tissue samples are sent to the Service's Abernathy Fish Technology Center for genetic analyses. Run determination from the genetic analyses is usually available 24 to 48 hours after tissue samples arrive at the laboratory. Computer simulations and "blind tests" show that the genetic discrimination techniques are capable of accurate and consistent identification of winter Chinook salmon. Broodstock selection criteria are intended to be conservative, in that some winter Chinook salmon may be rejected from the program to guard against spawning any non-winter Chinook salmon. Using past methodology, the probability of wrongly identifying winter Chinook salmon (false positives) was less than 0.2% and the probability of excluding a winter Chinook salmon from the propagation program (false negatives) was less than 6.1%. Modifications to the procedure, including analyzing more loci, have further reduced the potential genetic risks of the artificial propagation program, thus protecting the genetic integrity of the naturally-reproducing winter Chinook population. Additional information on the genetic selection criteria for winter Chinook salmon is presented in Appendix 6C.

Winter Chinook salmon meeting both phenotypic and genetic criteria are placed into an adult holding tank and retained for broodstock. Chinook that are genetically determined to be "non-winter" Chinook are relocated to the mainstem Sacramento River at Posse Grounds or Caldwell Park. Floy tags are not removed from Chinook salmon destined for relocation, as observations of these fish during carcass surveys may provide valuable information to assess mortality rates of relocated fish.

Target Population: Hatchery-Origin Steelhead
Steelhead broodstock are collected from Battle Creek from October through February. Due to distinct morphological differences between salmon and steelhead, there are no issues related to identification of Chinook salmon during efforts to target steelhead. Also, since brood year 1998, all steelhead released from Coleman NFH have been mass-marked by clipping the adipose fin. Consequently, hatchery- and natural-origin steelhead are differentiated by assessing mark status.

7.5 Proposed number to be collected

Collection and Spawning Targets
Since 2001, the Service has implemented protocols for spawning fall Chinook, late-fall Chinook, and steelhead that incorporate more broodstock than necessary to meet egg targets. Inventory reductions occur at the eyed-egg stage. Spawning increased numbers of adults helps to maintain within-population genetic diversity and reduce the potentially deleterious effects of inbreeding. See Section 8 for a more detailed discussion.

<u>Fall Chinook Salmon</u>
Currently, the minimum spawning target for fall Chinook salmon is 5,200 adults (with approximately a 1:1 sex ratio). This spawning target is back-calculated based on a release target of 12 million smolts, estimated fecundity of broodstock (eggs/female), and estimated mortality during incubation and rearing at the hatchery. Refer to Section 1.12 and Table 1-2 for more

information. Actual numbers spawned from 2001 through 2008 have averaged 8,352 (Table 7-3).

The Service often collects fall Chinook from lower Battle Creek in excess of the number needed for broodstock. This action is conducted to alleviate excessively high concentrations of fish in lower Battle Creek and promote successful natural reproduction. This activity is expected to be reviewed and specific goals developed in a fishery management plan that is currently being developed for Battle Creek.

Late-fall Chinook Salmon

Currently, the minimum spawning target for late-fall Chinook is 540 adults (with a 1:1 sex ratio). This number is back-calculated based on a release target of 1 million smolts, estimated fecundity of broodstock (eggs/female), and estimated mortality during incubation and rearing at the hatchery. Refer to Section 1.12 and Table 1-2 for more information. Since brood year 2002, natural-origin late-fall Chinook salmon collected from the Keswick Dam fish trap have been incorporated into the Coleman NFH broodstock. A target of approximately 10-15% of the juvenile late-fall Chinook produced at the Coleman NFH will be the progeny of natural-origin broodstock. The collection goal for natural origin late-fall Chinook salmon at the Keswick Dam fish trap is 54-81 salmon. The number of late-fall Chinook salmon collected at Coleman NFH and Keswick Dam from 1988 through 2008 is shown in Table 7-4.

Winter Chinook Salmon

The winter Chinook propagation program targets 15% of the estimated run size, with a minimum of 20 and a maximum of 120 winter Chinook adults to be retained for any brood year. Therefore, when the estimated winter Chinook run size is greater than 800, an attempt is made to collect the full allocation of up to 120 broodstock. The program attempts to secure equal sex ratios of the adults retained.

Winter Chinook broodstock collection targets are designed to ensure appropriate representation of the complete run timing of winter Chinook. A schedule of proposed monthly collection targets for winter Chinook broodstock is forecasted prior to the beginning of winter Chinook salmon broodstock collection. The pre-season collection schedule is determined by allocating the total annual collection goal (which is determined from the estimated run size) throughout the total duration of historical winter Chinook salmon migration timing. The monthly percentage of the historical run timing past RBDD is multiplied by the total annual collection goal to get monthly collection goals (Table 7-5). For example, if the estimated run size is 800 the total number of adults targeted for captured would be 800 x 15% = 120. Based on historical information, 8.89% of the winter Chinook migrated past RBDD during the month of May. In this example, the collection target for May is therefore 8.89% x 120 = 11 adults.

The Service attempts to collect all of the targeted winter Chinook salmon from the Keswick Dam fish trap. The number of winter Chinook salmon collected from 1989 through 2008 is shown in Table 7-6. Males and females are enumerated separately.

Steelhead

Currently, the spawning target for steelhead is about 800 adults (with a 1:1 sex ratio). This number is back-calculated based on a release target of 600,000 smolts, estimated fecundity of broodstock (eggs/female), and estimated mortality during incubation and rearing at the hatchery and then doubled for genetic considerations (see Campton et al. 2004 and Section 8). Refer to Section 1.12 and Table 1-2 for more information on broodstock targets. Currently, broodstock consist of only marked (adipose fin-clipped) steelhead. However, as recent as 2008, natural-origin steelhead collected at Battle Creek were incorporated into the Coleman NFH broodstock. The Service temporarily discontinued the collection of natural-origin steelhead broodstock from Battle Creek prior to the 2009 return year due to a low abundance of natural-origin steelhead in that tributary. The number of steelhead collected at Coleman NFH from 1995 through 2008 is shown in Table 7-7.

Table 7-3 Numbers of fall Chinook salmon broodstock collected at the Coleman National Fish Hatchery, return years 1990-2008. Jacks (i.e., males with a fork length < 650 mm) are included with "Males" for counts of spawned fish only.

Return Year	Collected				Spawned		
	Females	Males	Jacks	Total	Females	Males	Total
1990	6,405	7,095	1,150	14,650	5,411	5,502	10,913
1991	5,834	4,242	613	10,689	4,692	3,709	8,401
1992	2,970	3,266	1,039	7,275	2,693	2,674	5,367
1993	3,753	3,269	565	7,587	3,487	2,770	6,257
1994	4,308	7,240	7,443	18,991	3,771	4,728	8,499
1995	11,138	13,656	1,883	26,677	3,882	4,277	8,159
1996	8,888	9,935	2,355	21,178	4,264	4,713	8,977
1997	24,467	20,171	6,032	50,670	4,104	4,840	8,944
1998	19,809	22,166	1,878	43,853	3,136	4,462	7,598
1999	10,670	12,377	3,921	26,968	2,297	3,101	5,398
2000	9,554	11,233	872	21,659	2,552	2,853	5,405
2001	6,965	11,814	5,919	24,698	3,863	4,210	8,073
2002	18,997	42,759	4,049	65,805	5,607	6,980	12,587
2003	41,513	41,380	5,388	88,281	4,054	4,425	8,479
2004	20,881	30,676	16,672	68,229	3,375	3,663	7,038
2005	70,455	59,565	2,599	132,619	3,805	3,434	7,239
2006	30,727	24,075	985	55,787	4,222	4,063	8,285
2007	6,399	4,950	198	11,547	4,295	3,311	7,606
2008	4,662	5,452	460	10,574	3,910	3,600	7,510

Table 7-4 Numbers of late-fall Chinook salmon broodstock collected at the Coleman National Fish Hatchery and the Keswick Dam Fish Trap, return years 1991-2008. Jacks (i.e., males with a fork length < 650 mm) are included with "Males" for counts of spawned fish only.

Brood Year	Collection Location	Collected				Spawned		
		Females	Males	Jacks	Total	Females	Males	Total
1990	Battle Creek	41	40	11	92	31	30	61
	Keswick	35	63	2	100	22	43	65
1991	Battle Creek	65	81	15	161	60	65	125
	Keswick	49	65	4	118	45	53	98
1992	Battle Creek	164	171	9	344	119	95	214
	Keswick	239	157	3	399	161	77	238
	Battle Creek & Keswick	11	10	0	21	11	10	21
1993	Battle Creek	187	169	172	528	130	159	289
	Keswick	168	200	7	375	124	131	255
1994	Battle Creek	197	232	169	598	151	145	296
	Keswick	80	70	4	154	62	48	110
1995	Battle Creek	222	225	45	492	162	130	292
	Keswick	115	99	10	224	97	67	164
1996	Battle Creek	541	422	374	1,337	231	164	395
	Keswick	29	18	1	48	25	16	41
1997	Battle Creek	1,996	2,131	451	4,578	368	414	782
1998	Battle Creek	1,328	1,249	492	3,069	403	359	762
1999	Battle Creek	2,528	3,838	709	7,075	422	542	964
2000	Battle Creek	2,417	1,297	480	4,194	207	272	479
2001	Battle Creek	1,023	1,139	197	2,359	256	437	693
2002	Battle Creek	1,472	1,074	163	2,709	580	552	1,132
2003	Battle Creek	1,380	1,190	481	3,051	564	536	1,131
	Keswick	15	17	0	32	15	16	
2004	Battle Creek	1,711	2,015	1,373	5,099	601	611	1,254
	Keswick	30	11	1	42	11	31	
2005	Battle Creek	2,735	2,488	1,237	6,460	653	530	1,215
	Keswick	15	15	3	33	15	17	
2006	Battle Creek	9,350	5,097	326	14,773	754	724	1,482
	Keswick	2	3	0	5	1	3	
2007	Battle Creek	2,911	1,638	694	5,243	585	482	1,134
	Keswick	38	32	0	70	36	31	
2008	Battle Creek	2,992	3,059	324	6,375	572	516	1,088

Table 7-5 Monthly collection goals for adult winter Chinook salmon broodstock based on a run-size estimate of 800 or greater, a trapping level of 15%, and the estimated proportion of the run migrating past the Red Bluff Diversion Dam by month. Passage data provided by the California Department of Fish and Game, Red Bluff, California.

Month	Monthly Percentage	Cumulative Percentage	Capture Target
December	1.75	1.75	2
January	5.10	6.85	6
February	9.55	16.40	12
March	35.99	52.39	43
April	28.56	80.95	34
May	8.89	89.84	11
June	6.76	96.60	8
July	3.39	100.00	4
Total			120

Table 7-6 Broodstock collection of winter Chinook salmon from Keswick Dam and Red Bluff Diversion Dam, return years 1990-2008. Salmon were propagated at Coleman National Fish Hatchery (1989-1997) and at Livingston Stone National Fish Hatchery (1998-2008). Jacks (i.e., males with a fork length < 650 mm) are included with counts of “Males”.

Return Year	Collection Location	Spawned		
		Females	Males	Total
1990	Keswick	1	1	2
1991	Keswick and RBDD	6	13	19
1992	Keswick	13	13	26
1993	Keswick and RBDD	11	3	14
1994	Keswick	16	11	27
1995	Keswick	21	16	37
	Captive Broodstock	21	6	27
1996	Captive Broodstock	38	30[a]	68
1997	Captive Broodstock	109	45[b]	154
1998	Keswick	61	35	96
1999	Keswick and RBDD	9	14	23
	Captive Broodstock	20	0	20
2000	Keswick and RBDD	44	34	78
	Captive Broodstock	66	60	126
2001	Keswick and RBDD	50	47	97
	Captive Broodstock	100	32[a]	132
2002	Keswick	48	40	88
	Captive Broodstock	95	25[a]	120
2003	Keswick	45	33	78
	Captive Broodstock	99	21[a]	120
2004	Keswick	37	36	73
	Captive Broodstock	45	23[a]	68
2005	Keswick	51	44	95
	Captive Broodstock	46	21[a]	67
2006	Keswick	37	52	89
	Captive Broodstock	60	31[a]	91
2007	Keswick	19	25	44
2008	Keswick	46	47	93

a Males were collected from the Sacramento River and were also used for natural-origin crosses.
b Includes cryopreserved milt from 19 captive broodstock males.

Table 7-7 Broodstock collection of steelhead at Coleman National Fish Hatchery, return years 1988 through 2008.

Return Year	Origin[a]	Returned			Spawned		
		Females	Males	Total	Females	Males	Total
1988	Unknown	546	344	890	222	174	396
1989	Unknown	175	292	467	27	18	45
1990	Unknown	1,905	2,267	4,172	629	463	1,092
1991	Unknown	661	482	1,143	394	436	830
1992	Unknown	2,185	2,244	4,429	323	205	528
1993	Unknown	652	510	2,862	343	332	675
1994	Unknown	1,805	1,582	3,387	363	322	685
1995	Unknown	1,088	949	2185[b]	311	279	590
1996	Unknown	1,323	1,324	3106[c]	231	215	446
1997	Unknown	1,342	1,187	2,529	181	186	367
1998	Unknown	738	671	1,409	193	187	380
1999	Unknown	908	847	1,755	164	165	329
2000	Unknown	976	1,000	1,976	183	187	370
2001	Unknown	1,160	1,134	2,294	179	190	369
2002	Unknown	1,895	1,591	3,486	298	315	613
2003	Hatchery	1,062	825	2,261[d]	326	276	602
	Natural	265	162	427	3	9	12
2004	Hatchery	718	660	1,378	439	378	817
	Natural	127	98	225	19	19	38
2005	Hatchery	629	714	1,343	450	485	935
	Natural	186	126	312	22	15	37
2006	Hatchery	527	467	994	362	287	649
	Natural	158	124	282	10	15	25
2007	Hatchery	703	677	1,380	536	475	1,011
	Natural	91	73	164	11	17	28
2008	Hatchery	1,342	1,626	2,968	454	450	904
	Natural	83	101	184	11	12	23

a Since 1998 all hatchery-origin steelhead released from Coleman NFH have been marked with an adipose-fin clip. Prior to return year 2003 differentiating hatchery- and natural-origin steelhead was not possible.
b Includes 148 that were not identified to gender.
c Includes 459 that were not identified to gender.
d Includes 374 that were not identified to gender.

7.6 Disposition of surplus and unripe adults

Hatchery personnel individually assess and sort collected adults as to their final disposition based on phenotypic criteria, current and projected availability of broodstock, and spawning targets. During the sorting process unripe and surplus Chinook salmon and steelhead are separated from adults that will be used as broodstock. Non-target fishes are also identified and separated from broodstock. Following the initial sorting process, collected salmon adults may be either spawned, culled (salmon only), released, or returned to the hatchery ponds for holding.

Fall Chinook Salmon

Disposition of Surplus Adults

Surplus fall Chinook adults (in excess of daily egg-take goals) collected in the hatchery ponds are either culled or returned to the hatchery ponds for holding for a future spawning event. Disposition of unspawned fall Chinook salmon depends on the date of capture, availability of replacement broodstock, physical condition, and maturation status of collected fish. During years when escapement of fall Chinook to Battle Creek exceeds broodstock needs and the carrying capacity of the creek, the Coleman NFH has initiated a culling program, hereafter referred to as "excessing," whereby adults are collected at the hatchery and euthanized without spawning. The intent of the excessing program is to remove some of the biomass from lower Battle Creek 1) to improve the natural spawning success for those fish that remain, and 2) to provide beneficial use of the resource through transfer to Native Americans or the California Emergency Foodlink. From 2001 through 2007, an estimated average of nearly 64,000 fall Chinook salmon returned to Battle Creek, greatly exceeding broodstock requirements at Coleman NFH and estimated availability of natural spawning habitats. During these same years, an average of over 53,000 fall Chinook salmon were excessed during fall Chinook spawning operations with those carcasses being provided to local Native Americans, the Department of Justice for the federal prison system, or to the California Emergency Foodlink (Table 7-8).

Disposition of Unripe Adults

Unripe fall Chinook salmon encountered during the sorting process may be either excessed or returned to the hatchery holding ponds for ripening, depending on the broodstock needs and the abundance of replacement broodstock. For example, when the abundance of fall Chinook broodstock is high, unripe fall Chinook salmon collected at the beginning of the fall Chinook spawning season are typically excessed because replacement broodstock are readily available. Conversely, late in the fall Chinook spawning season (e.g., early- to mid-November), collections of fall Chinook broodstock, especially males, may become scarce[5]. At that time, unripe males may be returned to the hatchery holding ponds for spawning at a later date.

Late-fall Chinook Salmon

Disposition of Surplus Adults

Surplus collections of hatchery-origin late-fall Chinook salmon at Coleman NFH are either returned to the hatchery ponds for holding until the next scheduled spawn date or excessed, depending on the availability of replacement broodstock. During recent years, surplus collections of hatchery-origin late-fall Chinook salmon have been excessed because the number of adults collected has greatly exceeded broodstock requirements at the hatchery.

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[5]Adult fall Chinook salmon are generally available in substantial numbers in lower Battle Creek through late-November, however, fall Chinook broodstock collections at the hatchery generally decrease dramatically in early-November. This apparently results from the onset of natural pairing, redd construction, and spawning - leading to a decreased propensity for upstream migration.

Disposition of Unripe Adults

Unripe hatchery-origin late-fall Chinook salmon collected at Coleman NFH will be separated from ripe spawners during the initial sorting process. At that time, unripe adults may be either excessed or returned to the hatchery holding ponds for ripening, depending on the need and abundance of replacement broodstock. For example, unripe hatchery origin late-fall Chinook encountered during the initial sort are typically excessed if replacement broodstock are readily available. All natural-origin late-fall Chinook collected from Battle Creek are returned to the creek during the sorting process. Unripe natural-origin late-fall Chinook captured at the Keswick Dam fish trap will be returned to the Sacramento River. Excess natural-origin late-fall Chinook will not be collected from the Sacramento River or culled at the hatchery.

Table 7-8 Estimated return of fall Chinook salmon to Battle Creek, return to Coleman National Fish Hatchery (NFH), and number excessed at Coleman NFH from 1991 through 2008.

Return Year	Estimated Return to Battle Creek[a]	Return to Coleman NFH	Number Excessed
1991	17,241	10,689	1,340
1992	12,708	7,275	853
1993	18,616	7,587	422
1994	43,265	18,991	9,016
1995	83,192	26,677	15,074
1996	73,587	21,178	9,448
1997	101,414	50,670	39,570
1998	98,308	43,853	34,876
1999	119,899	26,968	18,713
2000	75,106	21,659	14,313
2001	125,686	24,698	14,494
2002	463,296	65,805	50,445
2003	153,045	88,281	77,318
2004	92,093	68,229	60,633
2005	162,803	132,619	124,492
2006	77,510	55,787	46,460
2007	21,682	11,547	1,075

a Estimated run-size was generated by the California Department of Fish and Game.

Winter Chinook Salmon

Disposition of Surplus Adults

Monthly trapping efforts for winter Chinook salmon are frequently adjusted to stay within monthly collection targets. Winter Chinook collected in excess of year-to-date collection targets are released into the Sacramento River. Number and percent of the total run of winter Chinook salmon captured and held for spawning at Coleman (1991-1995) and Livingston Stone (1998-2008) National Fish Hatcheries are shown in table 7-9.

Table 7-9 Number and percent of the total run of winter Chinook salmon captured and held for spawning at Coleman (1991-1995) and Livingston Stone (1998-2008) National Fish Hatcheries.

Return Year	Estimated Run-Size[a]	Adults Captured	Percent of Run Captured	Adults Retained	Percent of Run Retained
1991	211	23	11	23	11
1992	1,240	69	6	29	2
1993	387	24	6	20	5
1994	186	29	16	29	16
1995	1,297	190[b]	15	47	4
1996	1,337	No adults collected, moratorium on broodstock collection			
1997	880	No adults collected, moratorium on broodstock collection			
1998	3,002	108	4	106	4
1999	3,288	25	1	24	1
2000	1,352	109	8	89	7
2001	8,224	145	2	100	1
2002	7,464	197	3	96	1
2003	8,218	285	3	85	1
2004	7,869	346	4	85	1
2005	15,839	393	2	109	1
2006	17,334	312	2	93	1
2007	2,542	156	6	53	2
2008	2,850	198	7	105	4

a Estimated run-size was generated by the California Department of Fish and Game.
b Majority of these fish were collected on 6/27 and 6/28/95.

Steelhead
Disposition of Surplus and Unripe Adults
Surplus collections of hatchery-origin steelhead at Coleman NFH may be either spawned, returned to the hatchery ponds for holding, or stripped of eggs and placed into the hatchery's reconditioning pond. Early in the collection season, nearly all steelhead encountered at the hatchery are very green (firm, bright, and without fungus) and are returned to the hatchery ponds for holding. Steelhead collected in excess of broodstock needs are stripped (not spawned) of eggs or milt and placed into the pre-release pond at the Coleman NFH, reconditioned, and released into Battle Creek at a future date. As Coleman NFH steelhead are included in the DPS of ESA-listed Central Valley steelhead, no steelhead are excessed. However, for purposes of program evaluation, all steelhead collected at Coleman NFH are passed through a tunnel-type CWT detector (Northwest Marine Technology, Inc. Shaw Island, WA) to identify tagged steelhead. Coded-wire tagged steelhead are sacrificed for CWT recovery.

7.7 Health maintenance and sanitation procedures applied
Fall and Late-fall Chinook Salmon and Steelhead
At Coleman NFH, the number of adults entering the adult collection and holding ponds is monitored to prevent overcrowding and minimize pre-spawn mortality. To do this, ponds are inspected daily and the number of fish in the adult collection and holding ponds are visually

estimated. A bar rack is lowered near the fish ladder mouth to eliminate additional entry into the fish ladder and adult holding pond: when the visual inspections indicate the daily collection target has been reached and/or when ability to conduct continued close monitoring of fish entry is precluded (e.g., dusk at the end of a work day). The maximum number of adults allowed into the collecting ponds is usually 2,000 to 2,500. In the event that conditions in the hatchery ponds become unfavorable for holding adult salmonids (e.g., warm or turbid water), fewer fish may be allowed to enter the ponds.

Steelhead are separated from Chinook during the initial sorting process. The two species are separated by netting steelhead first from the anesthetic bath, which reduces level of anesthetization and potential for injury/mortality that could result from the thrashing of larger-bodied Chinook salmon. After they are initially sorted, adult steelhead and Chinook are maintained separately.

Several sanitary practices are used to reduce the chance of introducing or spreading pathogens at the hatchery. Equipment and personal gear used in the spawning building is routinely disinfected with iodophor and may not be used for other hatchery activities involving juvenile salmonids. This practice helps prevent transmission of pathogens from one life stage to another and across different areas of the hatchery. A portable ozone generator is used to sanitize raceways prior to stocking with steelhead or Chinook fry.

Winter Chinook Salmon
Various drugs and therapeutic and prophylactic treatments are used on winter Chinook salmon to increase survival of adults, reduce risks of disease transmission to offspring, and to aid in synchronous maturation (Table 7-10). Additionally, anesthetics and artificial slime are used to reduce stress on broodstock. The applications of most drugs used at Livingston Stone NFH follow the U. S. Food and Drug Administration Investigational New Animal Drug procedure. Fish health is monitored closely by hatchery personnel and staff from the Service's CA-NV FHC.

Table 7-10 Drugs and treatments applied to maintain health of winter Chinook broodstock at Livingston Stone National Fish Hatchery. The following listing should not be considered all-inclusive as other drugs and treatments may be used as necessary and as recommended.

Type	Dosage	Method	Application
oxytetracycline	20 mg/kg	IP injection	antibacterial
erythromycin	20 mg/kg	dorsal sinus injection	antibacterial
erythromycin		oral	antibacterial
iodophor	75 parts per million	bath	antibacterial
malachite green	1 parts per million	bath	antifungal
formalin	167 parts per million	flow through	antifungal
MS-222		bath	anesthetic
Luteinizing hormone Releasing hormone analog (LH-RHa)	30 µg/kg solution or 30 µg/kg implant	IP injection	induce maturation
Vibrio spp. vaccine		bath	vaccination against salt-water *Vibrio* spp.
salt		bath/flow through	stress reducer
artificial slime	1 qt/1,200 gallons	bath/flow through	stress reducer

7.8 Disposition of carcasses

Fall and Late-fall Chinook Salmon and Steelhead

Fresh Chinook carcasses collected at the hatchery are transferred to the California Food Foodlink through a Memorandum of Understanding. The California Emergency Foodlink provides a contractor that works at the hatchery to directly secure the carcasses. Carcasses are also provided to a contractor working for the Bureau of Indian Affairs who then distributes these carcasses to Native Americans through the Redding Rancheria. Carcasses transferred to Native Americans are covered in a Memorandum of Agreement between the Service and the Bureau of Indian Affairs. Carcasses of non-fresh Chinook salmon and steelhead are transferred to a rendering plant via a local contractor.

Winter Chinook Salmon

Carcasses of winter Chinook salmon cannot be rendered or donated because they are treated with chemicals. They must be disposed in a landfill.

7.9 Risk aversion measures to reduce the likelihood for adverse genetic or ecological effects on naturally-produced salmonids

Fall Chinook Salmon

Genetic and ecological risks to the natural population of fall Chinook salmon in Battle Creek are reduced through a variety of risk aversion measures. Fall Chinook salmon in Battle Creek are managed as an integrated population of hatchery- and natural-origin, however, because not all hatchery fish are marked the relative rates of production for hatchery and natural fish is not known. The vast majority of fall Chinook salmon entering Battle Creek are considered to be hatchery-origin, and naturally spawning fall Chinook salmon in Battle Creek undoubtedly share recent ancestry from Coleman NFH. Collection targets for fall Chinook broodstock at Coleman

NFH include both hatchery- and natural-origin adults. By incorporating natural-origin adults, genetic and ecological differences (and therefore risks) between hatchery and natural populations are reduced (see Appendix 6D for a more thorough discussion of genetic risks to natural populations from hatchery propagation). Genetic risks of hybridization between different runs are reduced by selecting broodstock based on phenotypic characteristics and mark status (see Section 7.4). Genetic and ecological risks from founder effects and artificial selection are reduced by: 1) collecting and spawning broodstock across the natural run and spawn timing, and 2) spawning large numbers of broodstock (>5,000) (See Section 8).

Considerable natural spawning by fall Chinook salmon has occurred in Battle Creek, primarily below the Coleman NFH barrier weir. The offspring of these naturally spawning adults, as well as strays of naturally spawning fall Chinook salmon from the Sacramento River, may return to Battle Creek and be obstructed by the Coleman NFH barrier weir. Natural-origin fall Chinook salmon blocked from upper Battle Creek by the barrier weir may attempt passage over the barrier weir, remain in lower Battle Creek to spawn naturally, enter the Coleman NFH collection ponds, or return to the Sacramento River to spawn naturally. Stress from handling and collection is reduced by preventing excessive crowding in the ponds and using anesthetics to decrease handling time and stress on the fish. Fall Chinook salmon are blocked from ascending Battle Creek upstream of the Coleman NFH barrier weir to minimize the risk of super imposition of spring Chinook salmon redds or direct hybridization with endangered spring Chinook salmon.

Late-fall Chinook Salmon

Genetic and ecological risks to the natural population of late-fall Chinook salmon are reduced in a variety of ways, including: 1) integrating natural-origin adults as hatchery broodstock (see Appendix 6D for a more complete discussion of genetic risks to natural populations from hatchery propagation efforts), 2) spawning large numbers of adults as broodstock (> 540) to minimize risk of genetic drift and founder effects (see Section 8), and 3) collecting and spawning adults across the range of their run/spawn timing.

Risks to natural late-fall Chinook associated with broodstock collection and congregation activities are minimized through a variety of management practices. Late-fall Chinook salmon arrive at Battle Creek primarily during December and January (Figure 7-5). Nearly all late-fall Chinook salmon entering Battle Creek are the result of hatchery production. Only hatchery-origin late-fall Chinook collected at Battle Creek (as indicated by an adipose fin-clip) are used as broodstock at Coleman NFH. Unmarked Chinook salmon collected during the late-fall spawning season are released into Battle Creek above the barrier weir. Migration delays of natural-origin late-fall Chinook salmon which enter the collection ponds are $\leq$7 days. Stress from handling and collection is minimized by preventing over crowding and using anesthetics to decrease handling time and stress on the fish.

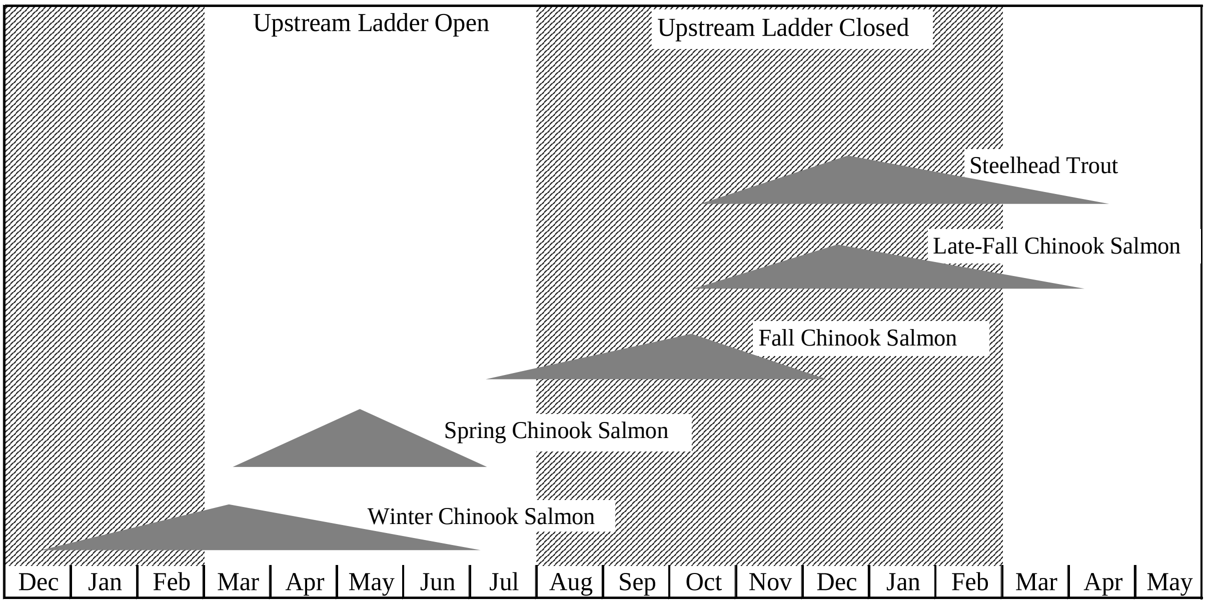

Figure 7-5 Approximate timing for salmonid migration in Battle Creek and operation of the Coleman National Fish Hatchery barrier weir. Peaks correspond to peaks in migration, and spread indicates range of migration timing. Area does not indicate the proportion of the run passing. Adapted from Vogel and Marine (1991) and U.S. Fish and Wildlife Service (unpublished data).

Natural-origin late-fall Chinook salmon from the Keswick Dam fish trap are incorporated as broodstock at Coleman NFH. Salmon phenotypically identified as late-fall Chinook will be transported to Coleman NFH. Risks associated with transport and handling are minimized by using salt, artificial slime, ice, and anesthetics as necessary within an aerated and insulated transport tank.

Winter Chinook Salmon

A viable population of winter Chinook salmon does not currently exist in Battle Creek. As appropriate habitat is restored through the Battle Creek Salmon and Steelhead Restoration Project and winter Chinook salmon are restored to the creek the Service will request consultation to assess impacts of the propagation programs at the Coleman NFH.

The purpose of the winter Chinook propagation program at Livingston Stone NFH is to assist in the recovery of the natural population. Considerable effort has been made to minimize any adverse genetic or ecological effects to the natural population. For example, limits have been established for the collection of natural-origin winter Chinook broodstock; the lower collection limit is set at 20 fish and the upper collection limit is the lesser of 120 fish or no more than 15% of estimated run-size. The lower limit is designed to ensure genetic variability while the upper limit guards against removing too many fish from the naturally spawning population. In addition, the Service has limited spawning of hatchery-origin broodstock to reduce the effects of domestication. Until 2009, the proportion of hatchery-origin winter Chinook included was limited to 10%. Beginning in 2010, the Service has completely discontinued the spawning of hatchery-origin winter Chinook.

Spring Chinook Salmon
Genetic and ecological risks to spring Chinook salmon populations are reduced through implementation of several risk aversion measures. The fish ladder at the Coleman NFH barrier weir is open to permit upstream migration in Battle Creek from early March through July. The majority of the spring Chinook migration occurs during this time (Figure 7-5). A portion of spring Chinook migration may be blocked when the upstream fish ladder is closed, however, this occurrence has not been documented and it would indicate a migration strategy atypical of Central Valley spring Chinook. Spring Chinook salmon blocked from upper Battle Creek by the barrier weir may attempt passage over the barrier weir, remain in lower Battle Creek to spawn naturally, enter the Coleman NFH collection ponds, or return to the Sacramento River to spawn naturally.

Salmonids captured at the Keswick Dam fish trap are transported to and sorted at Livingston Stone NFH. Phenotypically identified spring Chinook salmon are returned to the Sacramento River at the Posse Grounds or Caldwell Park boat ramp in Redding, CA. Spring Chinook salmon that are mistakenly classified as phenotypic winter Chinook are delayed approximately 1-3 days while awaiting the results of genetic analyses to verify the run call. When the genetic results are received, any spring Chinook would be sorted from winter Chinook and returned to the Sacramento River at Redding. The risk of fish being injured during transport and handling are reduced by using salt, artificial slime, ice, and anesthetics as necessary within an aerated and insulated transport tank.

Steelhead
Genetic and ecological risks of the propagation programs to the natural population of steelhead are reduced in a variety of ways, including: 1) integrating natural-origin adults as hatchery broodstock (see Appendix 6D for a more complete discussion of genetic risks to natural populations from hatchery propagation efforts), 2) spawning relatively large numbers of adults as broodstock (> 800) to minimize risk of genetic drift and founder effects, and 3) collecting and spawning adults across the range of their run/spawn timing.

Steelhead migrate into Battle Creek from October through April with the majority of fish entering Coleman NFH between November and January (Figure 7-5). Steelhead in Battle Creek are considered to be of mixed-origin, representing the progeny of hatchery production at Coleman NFH and natural production in Battle Creek. Natural steelhead production in upper Battle Creek results from escapement above the barrier weir and regulated passage of steelhead adults through Coleman NFH.

Steelhead blocked by the Coleman NFH barrier weir may attempt passage over the weir, remain in lower Battle Creek to spawn naturally, enter the Coleman NFH collection ponds, or migrate downstream to the Sacramento River. Fish that enter the hatchery are usually sorted within three days (range 1-7 days). Steelhead are separated from Chinook during the initial sorting process to reduce the likelihood of being injured by the larger salmon. Stress from handling and collection is reduced by preventing overcrowding in the collecting ponds and using anesthetics to decrease handling time and stress on the fish. In the future, the Service would like to resume the goal of producing 10% of hatchery steelhead production from natural-origin parents (n = 40), however, the Service has temporarily discontinued collection of natural-origin steelhead for broodstock due to the low abundance of the population in Battle Creek. The Service will re-initiate consultation with the NMFS prior to collection of natural-origin steelhead broodstock in the future. All natural-origin steelhead entering the broodstock collection pond will be returned to Battle Creek above the barrier weir.

7.10 Annual take levels for ESA-listed fish resulting from broodstock congregation and collection at Coleman and Livingston Stone NFH

Congregation and collection of broodstock from Battle Creek and the Sacramento River (i.e., at RBDD, Keswick Dam, and Coleman NFH barrier weir) may negatively affect natural ESA-listed populations of winter and spring Chinook salmon and steelhead. Take may occur as collection, handle, transport, tissue sample, and intentional or unintentional lethal take. Additionally, listed and unlisted salmonids may be delayed or blocked from accessing spawning and rearing habitats in Battle Creek. Battle Creek, above the Coleman NFH barrier weir, includes designated critical habitat for steelhead (63 FR 7764; February 16, 2000) and restorable, high-quality habitat for spring and possibly winter Chinook salmon. Estimated future annual take of ESA-listed salmonids resulting from broodstock congregation and collection in Battle Creek are shown in Table 7-11. These estimates are based on the largest single-year of incidental take observed for the period 2006-2010. Estimated take of spring Chinook at the Coleman NFH is for adipose-clipped and CWT fish from the Feather River Fish Hatchery. Impacts of delayed migration at the Coleman NFH barrier weir are anticipated to be low. Design criteria for fish attraction and passage at the barrier weir fish ladder are similar to those used for fish ladders upstream of the Coleman NFH. In an evaluation of fish passage at the Coleman NFH barrier weir, Null et al (2011) showed median time for late-fall Chinook salmon to locate the ladder entrance was 1.7 hours and the median time to ascend the ladder was 0.6 hours (Null et al. 2011). In that study, 98% of late-fall Chinook salmon migrated through the ladder in less than three days (Null et al. 2011).

Battle Creek

Passage at the Coleman NFH barrier weir is blocked from August 1 through early-March. During that time, target stocks of fall and late-fall Chinook and steelhead will be congregated and collected as hatchery broodstock. Non-target stocks of ESA-listed winter and spring Chinook and natural origin steelhead may also be blocked by the barrier weir or collected at Coleman NFH.

<u>Winter Chinook Salmon</u>

Winter Chinook salmon migration in the upper Sacramento River extends from mid-December through mid-July, with a peak in March. Based on sampling conducted at RBDD, 16.5% of returning adults migrate past RBDD by March 1. Migration of winter Chinook in Battle Creek occurs primarily from March through July. Estimated numbers of winter Chinook returning to Battle Creek from 2002 through 2007 have ranged from 0 to 3 for natural-origin fish and 0 to 5 for hatchery-origin fish (Newton et al 2008). Only 1 winter Chinook (hatchery-origin) was recovered during the Coleman NFH broodstock collection period for late-fall Chinook. As restoration actions improve conditions for natural-origin salmonids in Battle Creek, we expect the abundance of winter Chinook in Battle Creek to increase. As a result of the expected increase in the winter Chinook population, incidental take resulting from facilities and operations at the Coleman NFH will also increase.

Incidental take of winter Chinook salmon may occur as migration delay, blockage, capture, handling, or unintentional mortality. Winter Chinook migrating in Battle Creek prior to March 1, during the late-fall Chinook spawning season, would likely be diverted into the adult collection ponds. Natural-origin winter Chinook salmon collected in the hatchery ponds will be unmarked. Unmarked Chinook salmon will be sorted from hatchery-origin late-fall Chinook salmon during the initial sorting process and promptly released into Battle Creek upstream of the barrier weir. Holding of adults in the hatchery ponds prior to the initial sorting process generally lasts from one to three days, but may be as long as seven days. Winter Chinook collected during the late-fall spawning season are generally in good physical condition (bright, firm, and non-fungussed) so mortality is expected to be low.

Table 7-11 Estimated take of ESA-listed salmonids resulting from broodstock congregation and collection in Battle Creek. Where a fish may be affected by more than one type of take it is included in the category that would have the greatest impact; such that the total number of potentially affected individuals of each species can be estimated by the sum of each column.

	Species/Run		
Type of Take	Winter Chinook	Spring Chinook [a]	Natural-origin Steelhead
Capture, hold, handle, mark, sample, and release[b]	4	0	466
Unintentional lethal take[c]	2	11	5
TOTAL	6	11	471

a Estimated unintentional lethal take of spring Chinook at the Coleman NFH are for adipose-fin clipped spring Chinook from the Feather River Fish Hatchery.

b Take occurring due to collections at the hatchery prior to release into Battle Creek upstream of the hatchery

c Unintentional mortality of listed fish, including loss of fish during holding prior to spawning or prior to release into the wild.

Spring Chinook Salmon

Historic records of spring Chinook migration timing indicate arrival in the upper Sacramento River and tributaries from mid-March through the end of July, with the peak of migration in late-May and early-June. Spring Chinook migration patterns observed in Mill and Deer Creeks, tributaries of the upper Sacramento River, follow a similar pattern with migrations typically beginning in March, peaking in May, and ending in early-July (Colleen Harvey, CDFG, Red Bluff, CA, pers. com.).

Current spring Chinook migration into Battle Creek is believed to follow a similar temporal distribution to Mill and Deer Creeks (Figure 7-6). Monitoring at the Coleman NFH barrier weir during 2000 showed adult Chinook salmon migrating from early-March (when the weir was opened) until mid-July. From mid-July to mid-August, no Chinook salmon passed the barrier weir. Adult Chinook salmon re-appeared at the weir in mid-August. Chinook salmon observed passing the barrier weir between August 13 and September 1 include two marked (adipose fin clipped) fish out of 29 total (plus 1 "unknown" mark status) for a 7% mark rate, indicative of fall Chinook salmon originating at Coleman NFH. Closing the barrier weir on August 1 prohibits early-arriving fall Chinook from accessing spring Chinook spawning areas in upper Battle Creek.

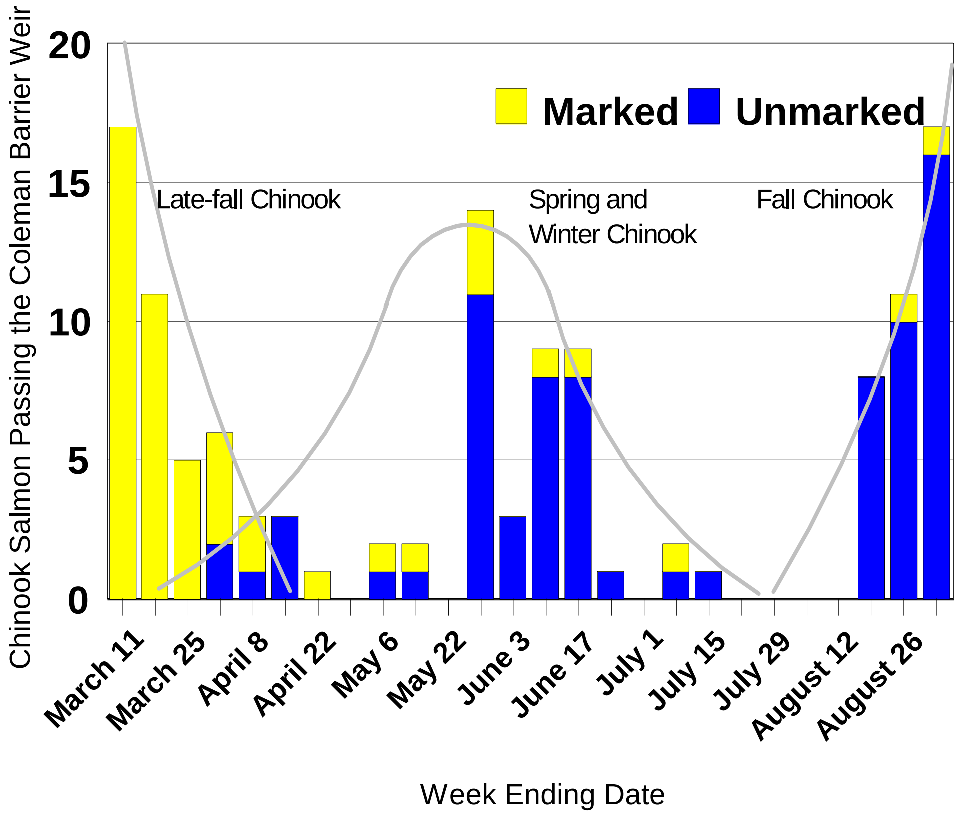

Figure 7-6 Number of Chinook salmon passing the Coleman NFH barrier weir from March 7 to September 1, 2000. Also shown are probable run compositions of three discrete migration periods.

Based on migrational patterns of spring Chinook, we believe that it is unlikely that natural-origin spring Chinook will be blocked at the Coleman NFH barrier weir or collected at Coleman NFH. Migration of natural-origin spring Chinook in the upper Sacramento River typically begins in mid-March, while the upstream fish ladder is opened at the Coleman NFH barrier weir on March 1. The spring Chinook migration into Battle Creek likely ends in July when water temperatures in the lower section of the creek become warm. Spring Chinook salmon migrating in Battle Creek from early-March through July will be permitted to ascend the fish ladder to pass upstream of the Coleman NFH barrier weir. Passage may be temporarily delayed while they locate the ladder entrance; however, locating and passing through the open fish ladder is not believed to pose a problem of extended delays to migration. Spring Chinook migrating prior to March 1 could be delayed or blocked by the Coleman NFH barrier weir. Spring Chinook migrating prior to March would likely enter the hatchery where they would be identified as natural-origin by mark status (unclipped ad-fin) and immediately released above the barrier weir in Battle Creek. Delay resulting from collection in the hatchery ponds is expected to be <7 days.

Access into upper Battle Creek by fall Chinook salmon is restricted beginning August 1 by closing the upstream fish ladder on the Coleman NFH barrier weir. The decision to close the ladder in the barrier weir on August 1 was a made by various fishery management agencies (Service, CDFG, NMFS), with the intent to afford additional protections to spring Chinook in Battle Creek. Previously, the upstream ladder had remained open through the month of August, and it was closed on September 1 to begin congregating fall Chinook broodstock for the hatchery. Closure of the barrier weir on August 1 maintains spatial and temporal separation between fall and spring Chinook in upper Battle Creek. If the upstream ladder were left open after August 1 there would be an increased likelihood of redd superimposition and hybridization between fall and spring Chinook salmon in upper Battle Creek. For example, snorkel surveys conducted in upper Battle Creek from 1997 through 1999, it was observed that Chinook salmon abundance in the Wildcat and Eagle Canyon reaches increased when fall Chinook begin to congregate below (and escape past) the Coleman NFH barrier weir (unpublished data, Service, Red Bluff, CA). These sections of Battle Creek are considered high quality habitat for spring Chinook salmon. The effects of future dam removals associated with the Battle Creek restoration process on maintaining spatial and temporal separation between fall and spring Chinook salmon in Battle Creek is unknown.

Some late-migrating spring Chinook could be blocked at the Coleman NFH barrier weir after the upstream fish ladder is closed on August 1. Chinook salmon migrating in Battle Creek after August 1 would be blocked at the hatchery weir and possibly collected in the hatchery ponds. Whereas this would be timing atypical for natural-origin spring Chinook migration in the Sacramento River, it is likely that some hatchery-origin spring Chinook from the Feather River Hatchery may be blocked from ascending into upper Battle Creek. Spring Chinook from the Feather River hatchery sometimes exhibit migration timing atypical of natural-origin spring Chinook due to hybridization with fall Chinook. From 2001 through 2010, an average of four adipose-fin clipped spring Chinook (range: 0-11) from the Feather River Hatchery entered the Coleman NFH hatchery ponds. Spring Chinook entering the hatchery at that time would be characterized as fall Chinook salmon due to the inability to distinguish the two races based on phenotypic characteristics.

<u>Steelhead</u>

The majority of steelhead migration in Battle Creek occurs when the upstream fish ladder at the Coleman NFH barrier weir is closed (Figure 7-5) for hatchery broodstock collection. Natural-origin steelhead are present in Battle Creek during the congregation and collection of hatchery broodstock, and take may occur as capture, handle, unintentional lethal take, or blockage from critical habitats in upper Battle Creek.

Natural-origin steelhead will be separated during the initial sorting process at Coleman NFH. Initial sorting generally occurs within two to three days, but may be up to seven days after entering the hatchery ponds. Handling procedures used during the sorting process are designed to minimize the potential of injury to steelhead (e.g., using anesthetics during handling and separating steelhead from larger Chinook). Natural-origin steelhead will be immediately released upstream of the barrier weir during the initial sorting process.

Sacramento River

Keswick Dam Fish Trap

Late-fall and winter Chinook broodstock collections at the Keswick Dam fish trap extend from December through July. Spring Chinook salmon and steelhead co-exist in the upper Sacramento River with late-fall and winter Chinook salmon, and may be incidentally collected in the Keswick Dam fish trap along with the target stocks. Take of these ESA-listed species may occur as capture, handle, transport, tissue sample, and intentional or unintentional lethal take. All fishes captured at the Keswick Dam fish trap are transported to the Livingston Stone NFH where they are sorted. Non-target fishes are separated and released near suitable spawning habitats in Redding, CA.

Steelhead are often captured while collecting winter Chinook broodstock at the Keswick Dam fish trap. From 2004 to 2010, an average of 54 steelhead were inadvertently collected at the Keswick Dam fish trap from March 1 through July, a time period typical of the period of winter Chinook broodstock collection (Table 7-12). The maximum number of steelhead collected during this period was 68, which occurred in 2004. Steelhead are also collected during late-fall Chinook salmon broodstock collection from late-December through February. The maximum number of steelhead collected during late-fall broodstock collection was 26 in 2004. Steelhead collected at the Keswick Dam fish trap are sorted at Livingston Stone NFH and returned to the Sacramento River at Redding, CA. Total time in captivity is approximately two to four hours. Incidental mortality of steelhead resulting from this activity is expected to be low.

Table 7-12 Numbers of steelhead incidentally collected while trapping for late-fall and winter Chinook broodstock at the Keswick Dam fish trap, 2004-2010. Life history type of collected steelhead is not known.

Year	Late-fall Chinook broodstock collection period	Winter Chinook broodstock collection period	Total
2004	36	68	104
2005	19	20	39
2006	16	16	32
2007	5	46	51
2008	10	50	60
2009	14	33	47
2010	8	39	47
Average	13	41	54

Migration of spring Chinook salmon into the upper Sacramento River begins during March when winter Chinook broodstock are being collected at the Keswick Dam fish trap. Chinook salmon collected at the Keswick Dam fish trap are assessed for run identity based on phenotypic characteristics. Phenotypically identified natural-origin spring Chinook and hatchery-origin winter Chinook captured in the Keswick trap are tissue sampled, Floy tagged, and released at Redding, CA. These fish may spend two to four hours in captivity before they are released. Phenotypically identified natural-origin winter Chinook and hatchery-origin spring Chinook salmon are tissue sampled and placed in quarantine while a genetically-based run assignment is determined. Genetic analysis may require three to five days. Quarantined fish that are subsequently identified by genetics as non-winter Chinook are transported to the Sacramento River at Redding, CA where they are released. Genetically-identified natural-origin winter Chinook are retained as broodstock. Short-term mortality occurring directly as a result of capture, transport, and holding is expected to be less than 5% (Table 7-13).

Data from previous trapping activities for winter Chinook salmon can be used to estimate future incidental take of spring Chinook salmon at the Keswick Dam fish trap. Chinook salmon collected at the Keswick Dam fish trap are identified as either “winter” or “non-winter” Chinook based on results of genetic microsatellite analyses. Non-winter Chinook could be either late-fall or spring Chinook. Because, non-winter Chinook collected at the Keswick Dam fish trap are not routinely differentiated to a run using genetic analyses, we estimated take of spring Chinook using a combination of collection date and a “non-winter” genetic call. We assume non-winter Chinook salmon collected at the Keswick Dam fish trap prior to March 15 are late-fall Chinook, whereas non-winter Chinook collected subsequent to March 15 are assumed to be spring Chinook (J. Rueth, Livingston Stone NFH, personal communication). Based on these criteria, an average of 86 spring Chinook salmon were collected annually at the Keswick Dam fish trap from 2006-2010. The maximum handled in a single year was 162, which occurred during 2008.

Based on the aforementioned assumptions, we estimate 162 spring Chinook will be captured, detained (possibly), and released annually while trapping for winter Chinook broodstock at the Keswick Dam (Table 7-13). Injury and incidental mortality could possibly result from trapping, handling, or transport; however, since spring Chinook salmon are generally in good physical condition at the time of year when winter Chinook broodstock are being collected, incidental short-term mortality of spring Chinook is expected to be less than 1% of the number handled.

Table 7-13 Estimated incidental take of ESA-listed salmonids resulting from broodstock collection at Keswick Dam fish trap. Where a fish may be affected by more than one type of take it is included in the category that would have the greatest impact; such that the total number of potentially affected individuals of each species can be estimated by the sum of each column.

	Species		
Type of Take	Spring Chinook	Steelhead [a]	Winter Chinook
Capture, handle, transport, tissue sample, mark-tag, hold, and release[bc]	140	102	173
Intentional Lethal Take[c]	20	0	0
Unintentional lethal take[d]	2	2	2
TOTAL	162	104	175

a Includes both anadromous steelhead and non-anadromous rainbow.

b Take occurring due to collections of non-target fish at the Keswick Dam fish trap prior to release into the Sacramento River.

c Take resulting from mis-identification of winter Chinook salmon, quarantine during genetic analysis, and release into the Sacramento River, Redding, California.

d Unintentional mortality of listed fish, including loss of fish during holding prior to spawning or prior to release into the wild.

8 MATING

8.1 Selection method

Fall and Late-fall Chinook Salmon

Broodstock selection for fall and late-fall Chinook salmon occurs quasi-randomly from the total number of ripe salmon ≥650 mm FL collected in the hatchery ponds on spawning days. Males and females are paired (1:1). Male salmon may be spawned with more than one female, if necessary because their availability is limited. Jacks (male salmon less than 650 mm FL) are targeted to be spawned at a rate of approximately 5% the total number spawned.

Winter Chinook Spawning

Winter Chinook broodstock at the Livingston Stone NFH are examined twice weekly to assess their state of sexual maturity. To do this, fish are crowded into a pie-shaped containment area using a hinged crowder consisting of two solid vinyl-covered screens. Tricane methanesulfonate (MS-222) is added to anaesthetize the fish so they could be examined for maturity and overall fish health.

Luteinizing Hormone-Releasing Hormone analogue ($LH\text{-}RH_a$) implants are administered, as necessary, to accelerate final gamete maturation to synchronize maturation of broodstock. The $LH\text{-}RH_a$ implants release 30% of their content in the first three days after injection and the remaining hormone over a 20-day period to sustain an effective concentration within the fish. Implants are injected into the dorsal muscle lateral and anterior to the dorsal fin.

When a female salmon is identified as being sexually mature, it is removed from the tank, euthanized, and rinsed in fresh water to remove any remaining MS-222. Each female is assigned a number and each male is assigned a letter. The caudal artery of the female is severed so that blood does not mix into the eggs. Eggs are removed by making an incision from the vent to the pectoral fin. Expelled eggs are separated into two approximately equal groups. Each group is fertilized with semen from a different male, forming two half-sibling family groups. For example, when female 1 is spawned with males A and B, "family groups" 1A and 1B are created. After mixing semen and eggs, tris-glycine buffer is added to extend sperm life and motility. Spawned males are either returned to the holding tank for additional spawning or euthanized. Males are typically spawned a maximum of four times.

Steelhead

Steelhead are live-spawned at the Coleman NFH. Ripe steelhead adults are selected from fish being detained in the hatchery's two indoor ponds. Initial anesthetization of steelhead is accomplished with CO_2. If a fish is determined to be ready to be spawned it will be further anesthetized with MS-222 to render them completely immobile. This process is done to allow the fish to be live spawned and it reduces stress and likelihood for physical trauma while being handled. Egg removal from female steelhead is accomplished by inserting a large diameter hypodermic needle into the body cavity near the pelvic fin. Low pressure air (approx. 2 pounds per square inch) from an air compressor fills the body cavity and displaces the eggs out the vent. After all eggs are expelled, the fish is turned upside down and the body cavity of the fish is gently palpated to remove the air. Male steelhead are palpated to express milt. The milt is expressed directly into the pan of eggs collected from a female and water is added to effect fertilization. Males and females are paired (1:1). A male steelhead may be pairwise spawned with more than one female, if alternate males are not available. Steelhead shorts (<554 mm FL) are spawned at the rate of their collection prior mid-December.

Broodstock selection practices for steelhead previously used at the Coleman NFH excluded the spawning of smaller-sized fish. From 1990 until 2002, broodstock selection for steelhead excluded the spawning of steelhead <554 mm FL (locally referred to as "shorts"). This practice was based on evidence suggesting shorts may represent remnants of hybridized crossings with a non-anadromous strain of rainbow trout previously propagated at the hatchery. Specifically scale analysis of Coleman NFH steelhead broodstock conducted during the late-80s suggested that 92% of returning fish ≥554 mm FL were anadromous steelhead, whereas 76% of fish < 554 mm FL were non-anadromous (Service, unpublished data). Based on this information, in 1990 the Service began breeding only individuals ≥554 mm FL in attempt to "breed-out" characteristics of non-anadromy.

Since 2002, steelhead ≥406 mm FL have been included in the hatchery spawning plan. Subsequent reexamination of scales and, most importantly, analysis of otolith microchemistry brought to question the previous finding that most steelhead shorts are non-anadromous. In otolith microchemistry analysis, concentration of the element strontium varies in direct proportion to the salinity of the water; otoliths of anadromous fishes show a transition from relatively low levels of strontium to higher levels of strontium, whereas otoliths from non-anadromous fishes a relatively low and constant rate of strontium. Strontium distribution patterns from steelhead collected at Coleman NFH have demonstrated that the majority of fish over 406 mm FL are anadromous. This criterion is consistent with that used by CDFG to separate trout and steelhead. Based on this new information, steelhead ≥406 mm FL have been spawned at the Coleman NFH beginning with return year 2002.

8.2 Spawn timing

Steelhead and fall and late-fall Chinook are spawned according to schedules that are generally consistent across years and reflect the expected availability of ripe broodstock at the hatchery. Spawning of fall Chinook salmon begins in early-October and extends through mid-November. Spawning of late-fall Chinook and steelhead begins in late-December and continues through early-March. Winter Chinook at the Livingston Stone NFH are not spawned according to a schedule. The spawn timing of winter Chinook is conducted ad lib according to the maturation of broodstock. Appendix 8A shows spawn timing for fall and late-fall Chinook salmon at the Battle Creek Station and Coleman NFH from 1909 through 2008. Appendices 8B and 8C show previous spawn timing at Coleman NFH for winter Chinook salmon and steelhead, respectively.

Spawning Schedules

Hatchery spawning schedules for fall and late-fall Chinook and steelhead, including spawn dates and number of broodstock to be spawned, are determined prior to the onset of each spawning season. Spawning schedules at Coleman NFH are designed to mimic the hypothetical bell-shaped distribution of natural spawning populations. For example, the number of fish spawned at the tails of the spawning distribution (beginning and end of the run) are generally smaller and the egg-takes are less frequent as compared to the middle (mode) of the spawning distribution where egg-takes are generally larger and spawning events occur more frequently.

The minimum number of female broodstock to be spawned is determined by dividing the total egg collection target (see Section 9.1) by the estimated fecundity of hatchery broodstock. Fecundity estimates for fall and late-fall Chinook are based on long-term averages for number of eggs per female. Periodic fecundity estimates are conducted using egg counts from females collected for broodstock to compare present fecundity with long-term averages. Based on information collected during within season fecundity counts, the spawning schedule may be adjusted as needed to meet production targets. Fall Chinook salmon average approximately 5,400 eggs per female. Based on a minimum total egg collection target of 14,054,000, the estimated number of female spawners is 2,600 fall Chinook salmon. Late-fall Chinook salmon average approximately 4,600 eggs per female. Based on a minimum total egg collection target of 1,247,000, the estimated number of female spawners is 270. Steelhead average approximately 3,900 eggs per female. Based on a minimum total egg collection target of 783,000, the estimated number of female spawners is 200.

The actual numbers of fall and late-fall Chinook and steelhead spawned at the Coleman NFH are typically much larger than the minimum number of broodstock required to achieve egg collection targets. The spawning of increased numbers of adults helps to maintain within-population genetic diversity and reduce the likelihood of inbreeding. In 2003, the Service began spawning larger numbers of adults (>500 for steelhead and late-fall Chinook salmon and >5,000 for fall Chinook salmon). Maintenance of adaptive genetic variation over longer periods of time (e.g., centuries) is believed to require an effective population size averaging >500 (Mace and Lande 1991; Allendorf et al. 1997; Lynch and Lande 1998; Hilderbrand and Kershner 2000).

After eggs have reached the "eyed" stage, inventories are conducted and eggs are culled to levels sufficient to achieve production targets. Culling is conducted in a manner such that the progeny of all spawned adults are represented in the juveniles reared to release. The use of large numbers of adults, coupled a pairwise mating protocol, are designed to reduce the loss of genetic variation in the hatchery population.

Facilitating fish culture in the hatchery environment is another consideration when determining spawning schedules for fall and late-fall Chinook and steelhead. The number of eggs taken for any spawning event (referred as an "egg take") is determined such that resulting fry and smolts will completely fill a predetermined number of rearing units. This is an important consideration to ensure that similarly-sized fish are reared together, which facilitates improved rearing and growth. Egg takes are conducted such that final pond loadings will be from a single egg take or a combination of egg-takes no more than one week apart. Fall Chinook are typically spawned in increments of about 115 females, as this will yield the final ponding target of 428,600 smolts per 15-feet x 150-feet raceway. Late-fall Chinook salmon are spawned in increments of about 30 females as this yields the final ponding target of 75,000 smolts per 15-feet x 150-feet raceway. Steelhead are spawned in increments of about 28 females, ≥554 mm FL, as this will yield the final ponding target of 45,000 smolts per 15-feet x 150-feet raceway. The actual number of female steelhead spawned, per raceway, is on a sliding scale based on the number of spawned females that are labeled as "long" or "short." Increasing the number of "short" females spawned for egg collection, results in an increase in the total females spawned for that raceway.

8.3 Back-up, precocious, and repeat spawners

Fall and Late-fall Chinook Salmon

Prior to brood year 2000 (fall) and brood year 2001 (late-fall), jacks (FL <650 mm) were incorporated at some small but unknown percent. Since then, jacks have been spawned at the rate they are collected at the Coleman NFH, up to a maximum rate of approximately 5% of the number spawned. The actual spawn rates of fall and late-fall jacks tend to be somewhat less than the rate of collection because it is typical for a pulse of jacks to return late in the spawning season.

Near the end of the spawning season, some fall and late-fall Chinook salmon may be retained for possible spawning at a later date. Detaining salmon helps to ensure an adequate number of broodstock is available to meet egg-take goals, particularly at the end of the run when replacement broodstock may be difficult to collect. Back-up males are not used.

Winter Chinook

Winter Chinook jacks are randomly incorporated into the spawning matrix at the Livingston Stone NFH. Back-up males are not used.

Steelhead

All steelhead ≥406 mm FL returning to Coleman NFH are considered for broodstock. Fish <406 mm FL are excluded from spawning because of concerns that these fish are non-anadromous. Steelhead arrive at Coleman NFH before they are fully mature, so they are detained in hatchery ponds (referred as “banked”) until spawning. Banking of steelhead is described in more detail in Section 7 (broodstock collection). Back-up males are not used.

Steelhead are live spawned at Coleman NFH. The primary purpose of live spawning the steelhead is to provide opportunity for spawning during a subsequent year (i.e., iteroparity). After spawning, hatchery-origin steelhead are placed in an earthen and concrete 201 feet x 60 feet pond (Pond 1) and held for about 1-3 months. This holding time affords the opportunity for fish to recover from the stress of maturation and the spawning process and is referred to as “kelt reconditioning.” During reconditioning, steelhead are fed salmon eggs and commercial fish food. Detaining hatchery-origin steelhead at the hatchery for a few months post-spawning eliminates the potential for these fish to recycle through the spawning process and reduces the potential for predation and competition on naturally reproducing salmonids in lower Battle Creek. Reconditioned kelts are released into Battle Creek downstream of the Coleman NFH barrier weir in late-March or early-April.

All steelhead kelts released from the Coleman NFH since 2005 have been marked with either a floy tag, a CWT, or a visible implant elastomer tag prior to release. The Service is currently using a visible implant elastomer tag to mark all adult steelhead that are released after spawning and to identify the fish that return in subsequent spawning years. Data collected from 2005-2008 show that 23-39 repeat spawners returned annually comprising an average of 2% of the total adult returning population (Table 8-1). Repeat spawning steelhead are incorporated into the broodstock randomly.

Table 8-1 Numbers of hatchery-origin steelhead and steelhead kelts (repeat spawners) returning to Coleman NFH 2005-2008.

Return Year	Number of repeat spawners			Number of hatchery-origin steelhead			Percent repeat spawners
	Male	Female	Total	Male	Female	Total	
2005	8	16	24	714	629	1,343	1.79%
2006	2	22	24	467	527	994	2.41%
2007	4	35	39	677	703	1,380	2.83%
2008	9	14	23	1,626	1,342	2,968	0.77%

8.4 Fertilization

Fall and Late-fall Chinook Salmon

Hatchery spawning of fall and late-fall Chinook salmon is conducted with approximately equal sex ratios and a 1:1 mating scheme. Infrequently, gametes from more than a single male may be used to fertilize the eggs of an individual female if either the gametes of the first male encountered are suspected to be of poor quality, or if the quantity of ripe males is limited. Additionally, males are occasionally used to fertilize the eggs from more than one female if the availability of males is less than needed to make the daily egg collection target. Eggs are then transferred to the incubation building where they are placed into Heath Trays for incubation.

Winter Chinook

Eggs from each winter Chinook female are separated into two approximately equal groups. Each group is then fertilized with semen from a different male, forming two half-sibling family groups. For example, when female 1 is spawned with males A and B, “family groups” 1A and 1B are created. After mixing semen and eggs, tris-glycine buffer is added to extend sperm life and motility. Spawned males are either returned to the holding tank for additional spawning or euthanized. Males are typically spawned a maximum of four times.

Steelhead

Spawning protocol for steelhead is similar to that of Chinook salmon, using equal sex ratios and a 1:1 mating scheme.

8.5 Cryopreserved gametes

Coleman NFH has not used cryopreserved semen for spawning of fall or late-fall Chinook salmon or steelhead. Cryopreserved semen is used for the winter Chinook propagation program, as necessary to prevent the waste of eggs,

9 INCUBATION AND REARING

This section describes current and anticipated incubation and rearing practices at the Colman NFH and Livingston Stone NFH. Actual incubation and rearing practices at the hatchery may differ from the information presented in this section due to improvements of fish culture techniques or modifications necessary to deal with unforeseen circumstances (e.g., disease, unusually low or high rate of growth). All artificial propagation practices used at Coleman NFH, including incubation and rearing, are managed adaptively with the goal of producing high quality fish that maximize opportunity to accomplish program goals while reducing negative impacts to natural stocks.

9.1 Incubation

Egg Collection

<u>Fall and Late-fall Chinook Salmon and Steelhead</u>

Annual egg collection targets for fall and late-fall Chinook and steelhead are determined prior to the beginning of the spawning season by back-calculating from the release targets and accounting for anticipated levels of mortality during the different stages of incubation and rearing at Coleman NFH. Survival rates by life stage, total egg take targets, and release targets are given in Table 9-1.

<u>Winter Chinook Salmon</u>

After fertilization, winter Chinook eggs are placed in Heath incubator trays and disinfected with a 75 parts per million iodophor bath for 15 minutes. Incubating eggs are treated twice a week with a 15 minute flow-through treatment of 1,400 parts per million of formalin to prevent excessive fungus. Initial water flow in the incubator trays is four gallons per minute (gpm) and later increased to six gpm at eye-up. After eye-up, eggs are temperature shocked and non-viable eggs were removed. Formalin treatments are discontinued once eggs hatch. Sac fry are left in the incubator trays until button-up, at which time they were transferred to 30-inch diameter (10.2 cubic foot) circular tanks and started on commercial feed.

Annual egg collection targets for winter Chinook salmon at Livingston Stone NFH are based on the number of broodstock collected. Survival rates by life stage are given in Table 9-1. The number of eggs collected from winter Chinook salmon have varied greatly between years, depending on the number of broodstock collected.

Table 9-1 Survival estimates, total egg take targets and release targets for salmonid stocks propagated at Coleman and Livingston Stone National Fish Hatcheries. Estimates are based on historical data (U.S. Fish and Wildlife Service, unpublished data).

	Survival Rate					
Broodstock	Green egg to eyed egg	Eyed egg to ponding	Ponding to release	Over-all egg to release	Total egg take target	Release target
Coleman						
Fall Chinook	0.85	0.99	0.97	0.82	16,650,000	12,000,000
Late-fall Chinook	0.80	0.95	0.89	0.68	1,700,000	1,000,000
Steelhead	0.85	0.96	0.93	0.75	790,000	600,000
Livingston Stone						
Winter Chinook[a]	0.92	0.78	0.80	0.58	variable	250,000[a]

a Survival rates are based on a two year average (2006 and 2007) that does not include captive broodstock crosses.

Surplus Egg Takes

Fall and Late-fall Chinook Salmon and Steelhead

Spawning schedules for fall and late-fall Chinook and steelhead have been designed to achieve hatchery production targets, accounting for anticipated levels of mortality during incubation and rearing. Within-season fecundity counts are conducted to verify pre-season estimates of fecundity and minimize the likelihood of over or under production. Excess eggs are typically collected to ensure that production targets are met in the event of unanticipated levels of mortality occurring early in the period of incubation. In the event that mortality exceeds the anticipated levels, the excess eggs will be incorporated into hatchery production so that production targets are achieved. Additional egg takes may also be conducted to ensure that fish production targets are achieved in the event that insufficient broodstock are available throughout the course of the spawning schedule. Eggs that are not needed to meet production targets are culled.

Winter Chinook Salmon

Winter Chinook salmon are reared in a manner which promotes maximum survival of the offspring. No culling is performed on winter Chinook salmon eggs or juveniles.

Loading Densities

Fall and Late-fall Chinook Salmon and Steelhead

Incubation units consist of sixteen-tray vertical fiberglass incubators (Heath Incubation Trays). The top tray of each incubation stack is not loaded with eggs for purpose of reducing the exposure of incubating eggs to light and silt. Initial loading densities[6] are influenced by the number of parent pairs and the fecundity of broodstock combined into each tray. Typically, the eggs from two females are placed into a loading tray for fall and late-fall Chinook, whereas the eggs from 3-5 steelhead are combined into each incubation tray. Initial loading densities are

[6] Loading densities refer to numbers of individuals per containment unit. "Individuals" may be eggs, fry, or other life history stages.

approximately 10-11,000 eggs per tray for fall Chinook salmon and 9-10,000 eggs per tray for late-fall Chinook salmon. Steelhead eggs are initially loaded at 9-20,000 eggs per incubation tray for steelhead longs and 12-15,000 eggs per tray for steelhead shorts.

Initial loading levels are maintained through inventory, when densities are reduced. Approximate tray loading densities after inventory are approximately 7,800 (100 oz. / tray) for fall and late-fall Chinook and 11,100 for steelhead longs and 13,700 for steelhead shorts (50 oz. / tray). These loading levels are maintained until ponding.

<u>Winter Chinook Salmon</u>
Incubation units for winter Chinook salmon are sixteen-tray vertical fiberglass incubators, similar to those used for fall and late-fall Chinook and steelhead. Loading densities of winter Chinook salmon typically range between 1,700 and 3,000 eggs per tray. These densities are lower than those used for other hatchery stocks of Chinook salmon because the progeny of each winter Chinook mating (referred to as a "family group") are maintained separately in order to quantify relative contribution by each parent. Each female winter Chinook is mated with two males, and each family group is maintained separate during incubation.

Fish Health Maintenance and Monitoring
Fish culture protocols at Coleman and Livingston Stone NFHs are designed to produce healthy juveniles. Sanitary conditions are maintained during the egg incubation stage by disinfecting all equipment between different egg lots. Standard disinfection protocol for this task is surface contact of iodophor solution at 500 parts per million for a one minute contact time. Additionally, eggs surfaces are disinfected with iodophor during the spawning process. Disinfection of eggs using an iodophor solution (100 parts per million for 15 minutes) occurs during water hardening. Eggs are also periodically treated with formalin washes (1,667 parts per million for 15 minutes) as a prophylactic treatment for fungus while in the incubation trays. After eye-up, non-viable eggs are separated and removed from healthy eggs in the incubation trays.

9.2 Rearing
Survival Rates
Survival of Chinook salmon and steelhead at the Coleman NFH differ between stocks and various life stages (Table 9-1). Fall Chinook salmon generally exhibit higher overall rates of survival as compared to late-fall and winter Chinook and steelhead.

Density and Loading Criteria
<u>Fall Chinook Salmon</u>
Fall Chinook fry are transferred from incubation trays into outside rearing units after they are buttoned up and swimming well. Button-up fry are transferred from the incubation trays to the 15-feet x 150-feet raceways at a final loading of approximately 500,000 per raceway. Flows in the raceways are approximately 600 - 800 gpm. Density indices at the time of ponding average 0.13 with a final loading density index of 0.25 (Table 9-2). Final rearing density is typically around 0.5 lbs/cfs.

Late-fall Chinook Salmon

Current hatchery protocol is to transfer late-fall Chinook button-up fry from the incubation stacks directly into the 8 feet x 80 feet outdoor raceways. Late-fall Chinook are transferred to the 15 feet x 150 feet raceways when they reach a size of approximately 66 mm FL. Late-fall Chinook will remain in the larger raceways until they are released at a size of approximately 130 mm FL (Table 9-2). Final pond loadings for the large raceways are approximately 75,000 smolts per raceway. Transfers to final ponding densities are completed during mid-August to mid-September. The initial loading density index for small raceways averages 0.18; final loading density index averages 0.19 (Table 9-2). Initial loading density index for large raceways averages 0.07, and final loading densities average 0.13. Flows for small and large raceways are similar to those used for fall Chinook.

Table 9-2 Density indices, final densities, and final fork lengths for three stocks of salmonids propagated at Coleman National Fish Hatchery. Data are five-year averages from 1995 through 1999 (U.S. Fish and Wildlife Service, unpublished data).

Broodstock	Type of rearing unit (feet x feet)	Density index[a] Initial (SD)	Density index[a] Final (SD)	Final density lbs/cfs	Final fork length mm (in)
Fall Chinook Salmon	8 x 80 raceway	0.1718 (0.0314)	0.3244 (0.0774)	0.55	43 (1.70)
	15 x 150 raceway	0.1319 (0.0379)	0.2527 (0.0646)	0.43	46 (1.79)
	split 15 x 150 raceway[b]	0.1160 (0.0255)	0.2463 (0.0440)	0.67	75 (2.95)
Late-fall Chinook Salmon[c,d]	indoor tanks (16 x 3.25)	0.1817 (0.0399)	0.3020 (0.1089)	0.58	49 (1.92)
	8 x 80 raceway (from incubation trays)	0.1253 (0.0310)	0.1896 (0.0485)	0.50	66 (2.60)
	15 x 150 raceway	0.0668 (0.0230)	0.1274 (0.0304)	0.67	134 (5.28)
Steelhead Trout	indoor tanks	0.1288 (0.0329)	0.3065 (0.0846)	0.51	43 (1.68)
	8 x 80 raceway	0.1110 (0.0540)	0.1369 (0.0534)	0.46	86 (3.37)
	15 x 150 raceway	0.0411 (0.0138)	0.1547 (0.0198)	1.35	195 (7.68)

a Density indices are calculated using the following equation: DI = W/(FL*V), where DI = density index, W = weight of fish in rearing unit, FL = average fork length (in), and V = volume (cfs) of rearing unit.

b Fall Chinook salmon are split once after initial loading into 15-feet x 150-feet raceways. Presented data are from after that split.

c Some late-fall Chinook salmon were transferred to the indoor tanks after leaving incubation, others were transferred directly to the 8-feet x 80-feet raceways.

d Some late-fall Chinook salmon are raised to final stocking size in 8-feet x 80-feet raceways to accommodate experimental designs. Parameters associated with experimental groups are not presented in this table.

Winter Chinook

Winter Chinook sac fry are left in the incubator trays until button-up, at which time they are transferred by family groupings to 30-inch diameter (10.2 cubic foot) circular tanks and started on commercial feed. Family groups are combined as fish size increases due to limitations of tank space at the Livingston Stone NFH.

Steelhead

Steelhead fry are transferred into fiberglass early-rearing tanks located in the hatchery building soon after hatching. Flows of about 30 gpm are maintained through each tank. At a size of about 500/lb (approx. June 1), steelhead fry are moved outside to the small raceways where they rear to approximately 86 mm FL (Table 9-2). Steelhead are transferred to the larger raceways when densities reach approximately 0.5 lbs/cfs. The initial loading density index for small raceways averages 0.11; final loading density index averages 0.14 (Table 9-2). Initial loading density index for large raceways averages 0.04 and final loading density index averages 0.15.

Feeding and Food Conversion

Feed rations for fall and late-fall Chinook salmon and steelhead are based on percent body weight per day. Food types and conversion efficiencies are presented in Table 9-3. In general, conversion rates for younger fish tend to be better than conversion rates for older fish.

Table 9-3 Food type and conversion efficiencies for two rearing ages of Chinook salmon and steelhead. Stocks are propagated at Coleman National Fish Hatchery. Conversion efficiencies are based on five-year averages from 1995 through 1999 (U.S. Fish and Wildlife Service, unpublished data). Fish and food weights presented are "wet weights".

Stock	Approximate age from spawning (days)	Food type (pellet)	Conversion efficiency (lbs of feed / lbs of fish)
Fall Chinook	119	Semi-moist	1.06
Salmon	178	Semi-moist	1.03
Late-fall	185	Semi-moist	1.31
Chinook Salmon	308	Semi-moist	1.31
Steelhead	161	Semi-moist	1.02
	284	Dry	1.31

Winter Chinook fry are initially fed a Soft Moist Starter. *Artemia nauplii* (Cyclop-eeze™ from Argent Chemical Laboratories) are added to increase interest in the feed. The fish are subsequently transitioned to Soft Moist Starter #1 and then Soft Moist Starter #2, which is their diet until release. Feeding rates are determined using manufacturers feeding guidelines, which indicate the appropriate feed ration based on average monthly water temperature.

Fish Health Maintenance and Monitoring

Fish culture operations at Coleman and Livingston Stone NFHs are designed to produce healthy juveniles. Sanitary conditions are maintained during fish rearing by disinfecting (with iodophor) all equipment between uses in raceways. The CA-NV FHC conducts applied research on-site to control disease epizootics. Fish are observed on a daily basis for mortalities and behavioral irregularities. Dead and moribund fish are removed from rearing units. Necropsies are conducted on diseased and dead fish to diagnose cause of death. Examinations of live juveniles are performed routinely to assess health status and detect problems before they progress into clinical disease or mortality. Appropriate treatments (prophylactics, therapeutics, or modified fish culture practices) are used to alleviate disease-contributing factors. More complete descriptions of relevant pathogens and disease epizootics at Coleman NFH are presented in Section 10.5 (Disease management).

Smolt Development Indices

Fall Chinook Salmon

Data on smolt development are limited for fall Chinook salmon at Coleman NFH. Results from saltwater challenges and gill ATPase experiments have been somewhat contradictory, with later release groups showing higher survival rates in the saltwater challenge experiment and earlier release groups showing higher gill ATPase activity (Free and Foott 1998). Despite this discrepancy, data indicate that fall Chinook salmon with a wide range of FL (61 to 92 mm) have the ability to osmoregulate (Foott and Williamson 1997), including salmon at the current size of release (75 mm FL).

Late-fall Chinook Salmon

Data on smolt development are limited for late-fall Chinook salmon. Based on saltwater challenges and gill ATPase experiments from brood year 1994 through 1997, late-fall Chinook at Coleman NFH have reached an advanced degree of smolt development by early November. Degree of smoltification has been shown to be unrelated to FL after late-fall Chinook reached approximately 110 mm FL (CA-NV FHC, unpublished data). Current mean FL (135 mm) of late-fall Chinook salmon at release is well above this size.

Winter Chinook

Winter Chinook are released at the pre-smolt stage, with the intent that they rear in the freshwater environment prior to smoltification.

Steelhead

Reliable data on smolt development of steelhead at Coleman NFH are not currently available.

10 JUVENILE RELEASES

10.1 Juvenile release levels and release strategies

Release levels and strategies for fall, late-fall, and winter Chinook salmon and steelhead are described below. Release levels for the past twelve years are also presented. For more complete data on releases of Chinook salmon from Coleman and Livingston Stone NFHs refer to Appendix 10A. For a complete listing of releases of steelhead/rainbow trout see Appendix 10B.

Fall Chinook Salmon

The annual release target for fall Chinook salmon propagated at Coleman NFH is twelve million smolts, at a size of about 90/lb (approx. 75mm). Releases of juvenile fall Chinook salmon shall not exceed program production targets by more than 15% (i.e. 13,800,000). The majority of fall Chinook salmon are liberated into Battle Creek during April downstream of the Coleman NFH barrier weir. Approximately 10% of the total number released is transported to the San Pablo Bay for release.

The strategy for conducting on-site releases from the Coleman NFH separates the total on-site release number into two approximately equally sized groups. Each of the two large groups of fall Chinook smolts are pumped from the raceways directly into Battle Creek around mid-April, separated by about a week. Fall Chinook salmon are released in large groups to encourage an en masse migration through the river. This strategy of releasing fish en masse is thought to increase survival during emigration satiating predators. The en masse release practice is also believed to reduce negative effects on natural-origin salmonids by decreasing the duration of concurrent residence in the Sacramento River.

Monitoring of emigration patterns show that fall Chinook smolts from Coleman NFH travel downstream rapidly, moving out of the upper Sacramento River in large pulses, with few fish exhibiting delayed emigration. Emigration past the RBDD typically begins about 1.5 days after release into Battle Creek. By the fourth day after release, the vast majority of fall Chinook salmon have passed RBDD (Figure 10-1). Emigration downstream of Red Bluff occurs at an equally rapid rate. Juvenile monitoring conducted during 1998 and 1999 at Knights Landing (RM 90) showed that the majority of fall Chinook smolts released from Coleman NFH emigrate past that location from one to three weeks post-release, with no marked hatchery-origin fall Chinook salmon being captured after May (Snider and Titus 2000). This emigration rate equates to a sustained rate of at least nine miles per day through Battle Creek and the Sacramento River, 181.5 miles downstream to Knights Landing.

Approximately 10% of the fall Chinook produced at the Coleman NFH since 2008 have been transported to the San Pablo Bay for release. This temporary action was initially prompted by the extremely low abundance of fall Chinook returning to the Central Valley of California in 2007, and will cease after the ocean fishery is reestablished. Releases into the San Pablo Bay are conducted using a net pen barge operated by the California Fishery Foundation. Salmon distribution trucks are off-loaded into a net pen barge docked at either Mare Island or Conoco Phillips. The barge is then towed from the dock into the open water of the Bay where the fish are liberated. This practice is thought to promote rapid emigration and decreased predation, thereby, providing an increase in abundance which is expected to benefit the commercial and recreational ocean salmon fisheries.

Proposed future releases of fall Chinook salmon total 12 million smolts per year, with up to 10% of all releases occurring in the San Pablo Bay (Table 10-1) while the ocean fishery is being reestablished. Over the recent 12 years, fall Chinook salmon production at Coleman NFH averaged almost 14 million fish (Table 10-2); however, this number is buoyed by substantial fry production program that was terminated after brood year 1998 (Appendix 10A).

Table 10-1 Anticipated numbers of juvenile fall Chinook salmon to be released from Coleman National Fish Hatchery (NFH) annually. Fish will be released into Battle Creek at Coleman NFH and the San Pablo Bay. Temporary releases of fall Chinook into the San Pablo Bay have been implemented to increase abundance of fall Chinook salmon to benefit the commercial and recreational ocean salmon fisheries.

Release number (x1,000)	Average fork length at release (mm)	Release location	Release timing	Purpose
1,200	85	San Pablo Bay	May	Increased Ocean Abundance
10,800	75	Battle Creek at Coleman NFH (creek mile 5.7)	Apr	General Production

Late-fall Chinook Salmon
Late-fall Chinook juveniles are reared at Coleman NFH for approximately one year. General production late-fall Chinook are released into Battle Creek from December through early-January at approximately 13/lb (approx. 135 mm FL), with a release target of 1 million. Releases of juvenile late-fall Chinook salmon shall not exceed program production targets by more than 15% (i.e. 1,150,000). Releases are conducted over the course of one or two days and are timed to coincide with high flow and turbidity events, which promote rapid emigration and afford protection to out-migrating juveniles by discouraging predation. Occasionally, alternative release times and locations are utilized to accommodate the requirements of various investigations or, infrequently, to facilitate pond/water management at the hatchery. A long-standing commitment exists to release up to 210,000 late-fall Chinook juveniles separately from the general production group. The occurrence of these fish at the Delta pumping plants Delta are used as surrogates to determine “take” and estimate impacts of the pumping operations on spring Chinook. Experimental releases from Coleman NFH are coordinated with and approved by the NMFS and CDFG on an individual basis.

Production of late-fall Chinook salmon at Coleman NFH has been consistently around 1,000,000 per year over the last 12 years (Table 10-3). Previous to the mid-1990s, total production of late-fall Chinook varied greatly, ranging between almost 207,000 (1990) and over 2.5 million (1981;

Appendix 10A). Proposed future late-fall Chinook salmon releases total 1 million smolts annually (Table 10-4).

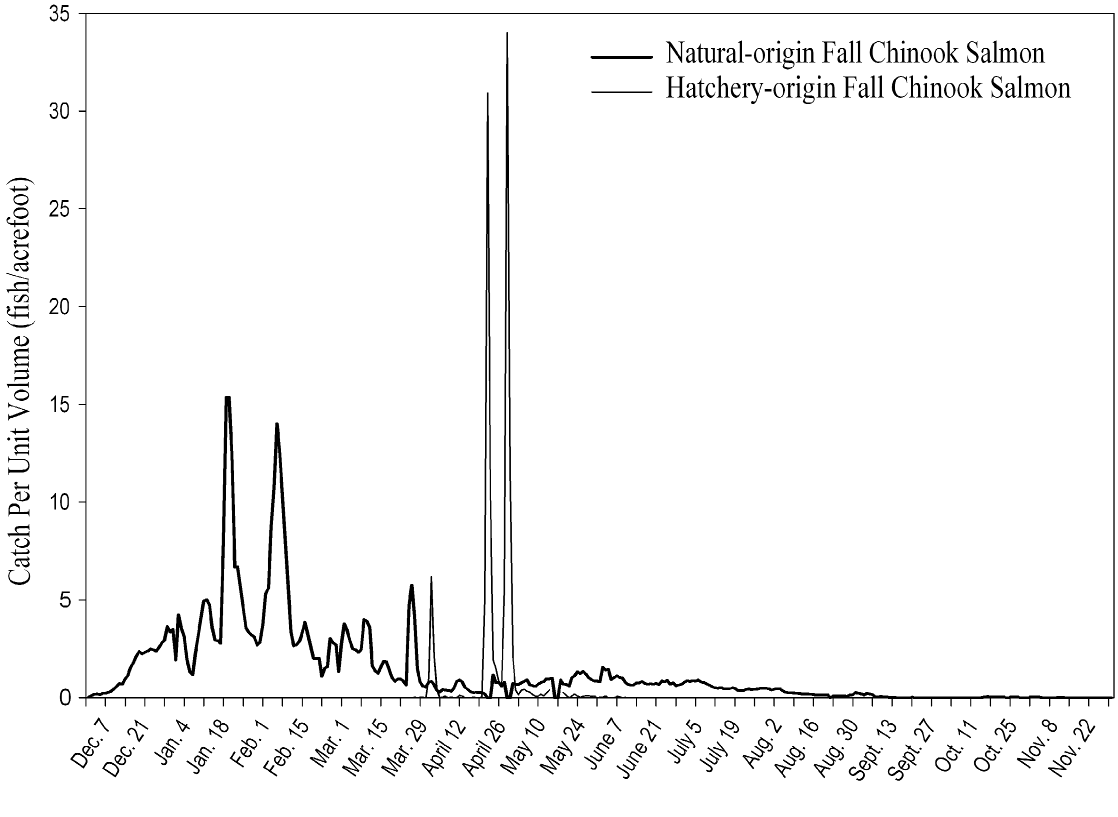

Figure 10-1 Catch per unit volume (CPUV) of hatchery- and natural-origin juvenile fall Chinook salmon, brood year 1998. Data are from rotary screw traps operated on the Sacramento River, Red Bluff Diversion Dam (river mile 243). Displayed CPUV for natural-origin fall Chinook salmon has been smoothed by calculating 3-day rolling averages. Daily CPUV is shown for hatchery-origin fall Chinook salmon. Hatchery-origin juveniles were released at Coleman National Fish Hatchery, Battle Creek. Hatchery release dates were March 31 and April 20, 21, 27 and 28, 1999.

Table 10-2 Fall Chinook salmon production at Coleman National Fish Hatchery, brood years 1996-2007.

Brood Year	Fry Number	Fry Fish/lb	Smolt Number	Smolt Fish/lb	Total Released	Other[a]	Total Production
1996	7,983,601	390-568	12,441,976	78-125	20,425,577	8,304	20,433,881
1997	8,203,920	423-668	12,775,200	104-205	20,979,120	6,541	20,985,661
1998	1,236,788	290-833	12,549,282	58-192	13,786,070	17,500	13,803,570
1999	0	0	11,702,537	78-95	11,702,537	206,215	11,908,752
2000	0	0	12,463,910	87-115	12,463,910	200,675	12,664,585
2001	0	0	11,117,019	78-120	11,117,019	201,009	11,318,028
2002	0	0	13,837,145	79-114	13,837,145	200,832	14,037,977
2003	0	0	12,900,936	79-129	12,900,936	200,629	13,101,565
2004	0	0	11,706,886	74-99	11,706,886	146,802	11,853,688
2005	0	0	13,157,164	75-109	13,157,164	198,181	13,355,345
2006	0	0	12,113,601	77-125	12,113,601	202,592	12,316,193
2007	0	0	12,499,450	74-158	12,499,450	201,125	12,700,575
Average	1,452,026		12,438,759		13,890,785	149,200	14,039,985

[a] These releases are generally associated with experiments and likely did not exhibit the same survival as the primary releases.

Table 10-3 Late-fall Chinook salmon production at Coleman National Fish Hatchery, brood years 1996-2007.

Brood Year	Smolt Number	Smolt Fish/lb	Other Experimental Production	Total Production
1996	1,081,109	9-40	5,056	1,086,165
1997	1,138,224	14-37	19,974	1,158,198
1998	1,102,539	19-40	142,986[a]	1,245,525
1999	1,117,325	11-22	7,368	1,124,693
2000	826,150	11-25	300	826,450
2001	1,065,675	13-48	1,430	1,067,105
2002	1,008,445	8-18	450	1,008,895
2003	1,047,772	11-20	0	1,047,772
2004	952,463	10-26	42,323	994,786
2005	947,025	11-23	56,113	1,003,138
2006	1,113,310	13-18	51,719	1,165,029
2007	982,915	13-22	78,392	1,061,307
Average	1,031,913		33,843	1,065,755

a Includes 125,892 fry put into the Coleman NFH abatement pond, an estimated 44,137 escaped into Battle Creek.

Table 10-4 Anticipated numbers of juvenile late-fall Chinook salmon to be released from Coleman National Fish Hatchery (NFH) annually.

Release number (x1,000)	Average fork length at release (mm)	Release location	Release timing	Purpose
210	125-140	Battle Creek at Coleman NFH (Creek Mile 5.7)	Dec-Jan	Experimental - Spring Chinook Surrogates
800	135	Battle Creek at Coleman NFH (Creek Mile 5.7)	January	General Production

Winter Chinook Salmon

Winter Chinook juveniles are propagated at Livingston Stone NFH until they reach a size of approximately 80/lb (approx. 85 mm FL). Releases occur generally around late January or early February; however, actual release timing may occur outside of this target window in order to time the release of winter Chinook juveniles to coincide with a high flow and high turbidity event. Winter Chinook are released into the Sacramento River at Caldwell Park, Redding, California (RM 299). Juvenile winter Chinook salmon are transported to the release site in two groups. This is done to avoid the catastrophic loss of an entire brood year that could be caused by potential difficulties experienced during transport or release (e.g., traffic accident). Hatchery releases of winter Chinook are conducted at dusk to reduce the risk of predation while juveniles acclimate to the river.

Hatchery production of winter Chinook salmon has varied greatly (Table 10-5). The largest influence on the high amount of variability was the moratorium on the collection of natural origin broodstock, which occurred during 1996 and 1997; however, substantial variation occurs on an annual basis, depending mostly on the number of broodstock collected. Annual releases of winter Chinook salmon from Coleman NFH from 1945 through 2007 are shown in Appendix 10A. In the near future, the Service anticipates releasing approximately 200,000 juvenile winter Chinook salmon annually from Livingston Stone NFH.

Table 10-5 Winter Chinook salmon production at Coleman (CNFH) and Livingston Stone (LSNFH) National Fish Hatcheries and Bodega Marine Laboratory (BML), brood years 1996-2007.

Brood Year	Facility Number	Pre-Smolt Number	Pre-Smolt Fish/lb	Other Experimental Production	Total Production
1996	BML, CNFH	4,718	205	0	4,718 [a]
1997	BML, CNFH, LSNFH	21,271	86	10,066	31,337[a]
1998	BML, LSNFH	153,912	58-119	1,218	155,130
1999	LSNFH	30,841	46-123	1,204	32,045
2000	LSNFH	166,207	62-112	1,224	167,431
2001	LSNFH	252,685	56-125	416	253,101
2002	LSNFH	233,612	54-144	402	234,014
2003	LSNFH	218,517	49-97	217	218,734
2004	LSNFH	168,260	51-111	0	168,260
2005	LSNFH	173,343	45-94	0	173,343
2006	LSNFH	196,268	33-73	0	196,268
2007	LSNFH	71,883	49-81	0	71,883
Average		140,960		1,229	142,189

a All production for brood years 1996 and 1997 were from captive-origin broodstock crosses.
b Includes 4,318 produced from captive x natural broodstock crosses.
c Transferred to Bodega Marine Lab for captive broodstock.
d Transferred to Steinhart Aquarium for captive broodstock.
e Transferred to Steinhart Aquarium for display purposes only.
f Held at Livingston Stone NFH for captive broodstock.

Steelhead
Steelhead production at Coleman NFH averaged approximately 620,000 fish per year over the last 12 years (Table 10-6). Since the beginning of the steelhead program in 1947, total

production has varied greatly, ranging from just a few thousand during the program's founding years to a high of almost 3 million smolts in 1965 (Appendix 10A, also see Appendix 6B). The Coleman NFH release target for steelhead is 600,000 yearling smolts (Table 10-7). Releases of juvenile steelhead shall not exceed program production targets by more than 15% (i.e. 690,000). Juvenile steelhead are released into the mainstem Sacramento River at Bend Bridge (RM 258) in January, at approximately 4/lb (approx. 195 mm).

Table 10-6 Steelhead production at Coleman National Fish Hatchery, brood years 1996-2007.

Brood Year	Fry Number	Smolt		Total Released	Other Experimental Production	Total Production
		Number	Fish/lb			
1996	399,328	540,287	4	939,615	0	939,615
1997	117,434	544,579	4	662,013	200	662,213
1998	49,928	496,525	4	546,453	0	546,453
1999	0	520,203	4	520,203	1,129	521,332
2000	0	391,173	4-6	391,173	205,170	596,343
2001	0	446,138	4-5	446,138	243,714	689,852
2002	0	362,784	5-10	362,784	166,580	529,364
2003	0	230,653	4-8	230,653	127,265	357,918
2004	0	585,873	3-6	585,873	103,927	689,800
2005	0	606,967	3-4	606,967	0	606,967
2006	0	672,686	3-4	672,686	0	672,686
2007	0	641,085	4-5	641,085	0	641,085
Average	47,224	503,246		550,470	70,665	621,136

Table 10-7 Anticipated numbers of juvenile steelhead to be released from Coleman National Fish Hatchery, annually.

Release number (x 1,000)	Average fork length at release (mm)	Release location	Release timing	Purpose
600	195	Sacramento River at Bend Bridge (river mile 258)	January	General production

10.2 Acclimation procedures

Juvenile fall and late-fall Chinook salmon and steelhead from Coleman NFH do not undergo any deliberate periods of acclimation to receiving waters prior to release. The majority of juveniles currently released from Coleman NFH are liberated in either Battle Creek (fall and late-fall Chinook salmon) or the upper Sacramento River (steelhead). All late-fall Chinook and the majority of fall Chinook are pumped from raceways directly into Battle Creek. Up to 10% of the fall Chinook production will be transported to the San Pablo Bay to temporarily increase the ocean abundance of fall Chinook salmon and rebuild the ocean fishery. Bay releases are conducted using a net pen barge operated by the California Fishery Foundation, which provides a

short time period for acclimation (perhaps a few hours) prior to liberation. Steelhead are trucked approximately 15 miles to Bend Bridge.
The release location for winter Chinook salmon is the upper Sacramento River at Redding, California (RM 299). Releases of winter Chinook salmon occur at dusk to reduce the risk of predation while they acclimate to the river environment. Because winter Chinook salmon are reared and released near to their rearing location (i.e., minimal travel time) and with essentially identical physical (e.g., temperature, turbidity) and chemical (e.g., acidity, dissolved gas concentrations, alkalinity and hardness) characteristics, there is no need to hold them in acclimation pens prior to release.

10.3 Marks applied, and proportions of the total hatchery population marked

A portion of the juvenile salmonids propagated at Coleman NFH are given an externally identifiable mark by removing (clipping) the adipose fin and an internal CWT inserted in the snout[7]. Over the past fifty years, the proportions of juvenile fall and late-fall Chinook salmon and steelhead that have been marked at the Coleman NFH have varied. Until the 1990s, the marking rates at Coleman NFH were generally low and marks were applied only to specific study groups. Recently, marking rates at Coleman NFH have increased substantially. Currently, all programs except the fall Chinook salmon production program have a 100% mark rate (Table 10-8). Beginning with brood year 2006, general production fall Chinook salmon at the Coleman NFH and all other hatcheries in the Central Valley have been marked at a rate of 25%. Winter Chinook salmon released from Livingston Stone NFH (and previously Coleman NFH) have been 100% marked and CWT since 1991. A brief discussion of marking and tagging rates, by stock, is presented below.

Table 10-8 Projected release number, anticipated number marked (adipose fin clip), mark rates, and mark type for all runs/species produced at Coleman and Livingston Stone National Fish Hatcheries; brood year 2009. CWT = coded-wire tag.

Stock	Number Released	Number Marked and Tagged	Mark Rate (%)	Mark / Tag Type
Coleman				
Fall Chinook[a]	12,000,000	3,000,000	25	Adipose clip / CWT
Late-fall Chinook	1,010,000	1,000,000	100	Adipose clip / CWT
Steelhead	600,000	600,000	100	Adipose clip / no tag
Livingston Stone				
Winter Chinook	200,000	150,000	100	Adipose clip / CWT

[7] Currently, all Chinook salmon at Coleman NFH that are tagged with a CWT are also marked with an adipose fin-clip. Coded-wire tag recovery information from marked and tagged Chinook salmon is typically used for stock assessments and fishery investigations. Steelhead at Coleman NFH are mass-marked (adipose fin-clipped), and may or may not contain a CWT.

Fall Chinook Salmon
Prior to brood year 1995, marking and tagging of fall Chinook at the Coleman NFH was generally limited to relatively small study groups, and marked and tagged fish represented low proportion of the total number released annually (<300,000; 0-3% of number released). A large-scale marking and tagging program was initiated on brood year 1995 fall Chinook to evaluate survival through the Sacramento River. From brood year 1995 through brood year 2000, approximately one million fall Chinook salmon at Coleman NFH, representing about 8% of the hatchery production, were marked and CWT annually. The rate of marking and CWT increased for brood years 2000 and 2001, achieving rates of 14% and 18% respectively. This substantial increase was accomplished by using the automated mass-marking machine (Northwest Marine Technology, Inc., Shaw Island, WA). Between brood years 2002 and 2005 no general production fall Chinook were marked and tagged due to lack of funding. Beginning with brood year 2006, general production fall Chinook from the Coleman NFH and all of the Central Valley hatcheries have been marked and tagged at a rate of at least 25%. This program is referred to as the constant fractional marking or CFM program. Marking and tagging for this program is conducted by the PSMFC, using automated trailers owned by the CDFG. Continuation of this marking and tagging rate for fall Chinook salmon at Coleman NFH is contingent on securing long-term funding for tags, tag application, and tag recovery. The fishery management agencies are continuing to evaluate long-term marking and tagging needs for Central Valley hatcheries.

Late-fall Chinook Salmon
Beginning with brood year 1992, all late-fall Chinook salmon released from the Coleman NFH have received a fin-clip and CWT prior to release. The primary purpose for 100% marking of late-fall Chinook is to differentiate hatchery-origin late-fall Chinook salmon from natural-origin, ESA-listed, winter Chinook salmon. Complete marking of hatchery-origin late-fall Chinook allows visual discrimination of the two groups at downstream sampling locations and pumping/salvage facilities in the delta.

Winter Chinook Salmon
All winter Chinook salmon produced either at Coleman NFH (1991 - 1997) or Livingston Stone NFH (1998 -present) have been adipose fin-clipped and CWT. Marking and tagging of winter Chinook salmon is necessary to evaluate the success of the hatchery supplementation program. Ocean recoveries of CWT winter Chinook salmon have also provided valuable information that has been used to evaluate and regulate harvest by the commercial and recreational salmon fishery. The 100% mark rate also allows personnel to distinguish between hatchery- and natural-origin salmon, which assists future broodstock mating strategies/pairings.

Steelhead
Prior to 1998, the highest mark rate that had been applied to juvenile steelhead at Coleman NFH was 25%. Since 1998 all steelhead produced at Coleman NFH, as well as all other hatcheries in the Central Valley, have been mass-marked with an adipose fin-clip. Infrequently, CWT may be applied to a portion of the steelhead at Coleman NFH in association with specific studies. However, no steelhead have received a CWT at Coleman NFH since brood year 2004.

10.4 Disposition of fish identified at the time of release as surplus to approved levels
Surplus inventories at the time of release are unlikely to occur at either Coleman NFH or

Livingston Stone NFH. Production inventories for stocks propagated at Coleman NFH are conducted periodically throughout the duration of incubation, rearing, and tagging and it is therefore highly unlikely that unknown surpluses will occur at the time of release. Culling of surplus production will be accomplished at the earliest possible stage of development, prior to eggs eyeing up. Because of the strict limits on the collection of winter Chinook broodstock, no excess production is possible. No juvenile winter Chinook salmon will be culled.

10.5 Disease management

The occurrence and spread of infectious disease in the hatchery environment is caused by the interaction of pathogen(s), environment, and a susceptible host. An infection may occur, for example, when a virulent pathogen meets a susceptible fish in a stressful environment. Infection doesn't necessarily guarantee disease occurrence. Both healthy hatchery- and natural-origin fish harbor many infections throughout their life, oftentimes without direct detrimental effects on apparent health or survival. Natural and hatchery environments contain a variety of microorganisms that may include bacteria, parasites, virus, and fungi that are capable of causing disease. From a fish health perspective, the occurrence of disease in natural-origin salmonids is considered more of a phenomenon than a problem (Hastein and Lindstatd 1991).

Natural-origin salmonids in the Sacramento River tend to be susceptible to infection by the same pathogens as salmonids cultured at Coleman NFH and Livingston Stone NFH. Susceptibility to similar infections is a consequence of similar ancestry and co-mingling by free-ranging parental stocks. Most pathogens endemic to Sacramento River salmonids evolved with their salmonid hosts and are not recent introductions. Endemic pathogens which have caused significant health problems in Central Valley salmon hatcheries include: *Yersinia ruckeri, Flavobacterium columnaris, Ceratomyxa shasta, Ichthyophthirius multifilis,* and *Nanophyetus salmincola* (Cox 1993). Numerous other bacterial, parasitic, and fungal species have also been identified as being pathogenic to hatchery populations under appropriate conditions.
Overly crowded or unsanitary conditions may cause stress in salmon and result in increased susceptibility to some types of infection. Hatchery fish that are raised in a stressful environment may be more prone to infection or amplification of existing infections than the same fish reared in a natural environment. This phenomenon is not necessarily a result of the method of fish reproduction or rearing (i.e., hatchery or natural), but rather, is a consequence of rearing conditions in the hatchery environment that could predispose these individuals to infection. Fish culture practices and rearing conditions at the Coleman and Livingston Stone NFH's are designed to reduce stress to the fishes being propagated.

The following discussion will focus on the obligate pathogens (pathogens with specific host requirements) which are considered to be potentially the most devastating at Coleman NFH, and pose the greatest potential risk to natural-origin populations (Scott Foott, CA-NV FHC, pers. comm.). Facultative pathogens (pathogens that opportunistically infect their hosts) have also been responsible for disease outbreaks at Coleman NFH, but are not considered as potentially devastating as obligate pathogens. In recent years, two obligate pathogens have occurred with hatchery broodstock: (1) IHNV and (2) *Renibacterium salmoninarum* or Bacterial Kidney Disease. With the inception of the ozone water treatment plant at Coleman NFH in 2000, these pathogens have not been a health problem in juveniles. Since 2000, health problems in juvenile salmonids have been limited to external parasites (*Ichthyobodo* sp.), *Flavobacterium columnare*, *Yersinia ruckeri*, or non-infectious issues (feed, water quality, coagulated yolk, and gill irritation due to debris).

Infectious Hematopoeitic Necrosis Virus
Infectious hematopoeitic necrosis virus is an acute rhabdoviral infection characterized by dark coloration, exopthalmia, ascites, and hemorrhaging on skin and internal organs. This virus is indigenous to North America and to Chinook salmon populations of the upper Sacramento River (Parisot and Pelnar 1962). The virus has been found in both natural- and hatchery-origin Chinook salmon in the Central Valley.

The Sacramento River strain of IHNV is considered moderately virulent to juvenile Chinook salmon. Fish stocks susceptible to IHNV at Coleman and Livingston Stone NFH's include fall, late-fall, and winter Chinook salmon. The virus is commonly detected in 46-100% of the adult fall, late-fall, and winter Chinook salmon returning to Coleman and Livingston Stone NFH's. Late-fall Chinook salmon show the highest incidence of infection with IHNV. From 1992 to 1995 returning adult hatchery-origin late-fall Chinook salmon tested positive for IHNV infection at a rate of 71-100% (S. Foott pers. comm.). The IHNV virus has not been detected in either juvenile fall or juvenile late-fall Chinook at Coleman NFH since ozone water treatment began full scale operations. Steelhead are resistant to disease from the Sacramento strain of IHNV (La Patra et al. 1993).

Renibacterium salmoninarum or Bacterial Kidney Disease
Bacterial kidney disease is a chronic disease of salmonids worldwide (Fryar 1981 in Foott 1996a) and is a primary concern in the propagation programs at Coleman NFH and Livingston Stone NFH. *Renibacterium salmoninarum* has been found in winter Chinook juveniles, and was associated with severe episodes of Bacterial Kidney Disease both at Coleman NFH and at off-site facilities (Bodega Marine Laboratory, Steinhart Aquarium, and Livingston Stone NFH). Treatments with erythromycin at these facilities exhibit short-term control.

Assessment of Impacts Resulting from Releases of Juvenile Salmonids from the Coleman and Livingston Stone NFH

10.6 Risk assessment framework
We assessed impacts of juvenile releases from Coleman and Livingston Stone NFHs based on a qualitative assessment of risks. While substantial information exists to quantitatively determine levels of negative impacts resulting from various hatchery activities (e.g., broodstock collection, hatchery water supply, and facility operations), we cannot explicitly quantify with a reasonable level of certainty the effects of juvenile releases. The difficulty in quantifying impacts is complicated by the complex biology of salmon and steelhead and the multitude of factors that can simultaneously affect both hatchery and natural salmonids.

The purpose of this risk assessment is to describe, in a broad sense, impacts to ESA-listed and candidate species of anadromous salmonids occurring as a result of releasing hatchery-origin Chinook salmon and steelhead from Coleman and Livingston Stone NFH's. Releases of juvenile salmonids from Coleman NFH and Livingston Stone NFH have been analyzed in regard to potential risks posed to each stock of natural-origin salmonids. This assessment of risk or “jeopardy” is based on the concept of population viability. In other words, at what level do proposed release numbers and strategies threaten the continued existence of the various ESU of natural-origin Central Valley salmonids.

We have evaluated potential risks of juvenile releases both at the scale of ESU (to evaluate potential risks at the scale of populations) and at the scale of watershed local to the hatchery (to evaluate potential risks to the Battle Creek restoration process). In determining risks to Battle Creek populations, we limited our consideration to the lower six miles of the creek (i.e., below the Coleman NFH barrier weir). All juvenile salmon and steelhead released into Battle Creek are liberated below the Coleman NFH barrier weir. Since juvenile salmonids in lower Battle Creek cannot pass above the Coleman NFH barrier weir, lower Battle Creek is the only reach of the creek where an ecological interaction between natural- and hatchery-origin juveniles can occur. Because we consider impacts only to the section of Battle Creek below the Coleman NFH barrier weir, the levels of risk identified in this analysis are likely greater than the impact to the entire Battle Creek population of a specific stock.

Impacts of juvenile releases have been characterized as No Impact, Low Impact, Moderate Impact, and High Impact. Definitions of these impacts, shown below, are adopted from the Bonneville Power Administration (Bonneville Power Administration 1997).

No Impact: Activity not likely to affect fish abundance.

Low Impact: Activity likely to result in a small changes of abundance, but would remain within expected year-to-year variability, and would not ultimately affect population viability.

Moderate Impact: Action is likely to produce a moderate change in abundance similar in magnitude to changes in abundance witnessed during atypical conditions (e.g., drought). Should conditions or impacts persist, population viability may be affected.

High Impact: Likely to cause large immediate changes in abundance similar to a catastrophic natural event.

Releasing hatchery-origin salmon and steelhead into Battle Creek and the Sacramento River has the potential to impact natural-origin populations of ESA-listed and candidate species via: 1) predation, 2) competition/displacement, and 3) disease transmission. The following section presents a brief explanation of these potential impacts, and presents a set of criteria to objectively assess potential risks resulting from releasing hatchery-origin juveniles from Coleman NFH into Battle Creek and the Sacramento River.

Predation

Significant predation may occur when yearling hatchery-origin salmonids are released during the emergence of natural-origin salmon (Steward and Bjornn 1990). It is well recognized that juvenile hatchery-origin salmonids can prey on natural-origin salmonids, if the hatchery fish are large enough (Horner 1978, Menchen 1981, Partridge 1985 and 1986, Beauchamp 1987 and 1990, Hillman and Mullan 1989, Viola and Schuck 1991, Martin et al. 1993; Cannamela 1993).

Sholes and Hallock (1979) estimated 500,000 yearling Chinook salmon released in the Feather River, California consumed 7,500,000 emergent Chinook salmon and steelhead fry. Hallock (1989) reported that sampling of stomach contents of steelhead yearlings released into Battle Creek in February and March 1975 revealed an average of 1.4 fall Chinook salmon per steelhead stomach.

The ability of a hatchery-origin Chinook salmon or steelhead to locate, identify, pursue, capture, and swallow prey items is a function of prey and predator abundance, temporal and spatial overlap, environmental conditions, predator/prey size relationships, and predatory skill. In this risk analysis, we have examined potential impacts of predation on natural-origin salmonids following the releases from Coleman and Livingston Stone NFH by assessing the following criteria:

- Temporal and spatial overlap between hatchery and natural populations: release of hatchery-origin fish results in substantial temporal and spatial overlap with natural-origin salmonids (i.e., release occurs during peak emergence/rearing periods at or near primary nursery/rearing areas)
- Predator/prey size ratio: 3:1 predator/prey size ratio; with minimum predator FL = 120 mm
- "Training time" for hatchery fish to become effective predators
- Environmental conditions: turbidity < 24 nephelometric turbidity units (NTU)

<u>Relative Abundance - Temporal and Spatial Overlap</u>

Predator and prey must co-occur for predatory interactions to occur. If both hatchery- and natural-origin salmonids are present in substantial numbers, there exists an increased potential for predatory interactions. In examining relative abundance of hatchery- and natural-origin stocks for this analysis we use life history information for natural-origin stocks as presented in Fisher (1994), Johnson et al. (1992) and Vogel and Marine (1991). Hatchery release information is based on general release sizes and timing.

<u>Predator/prey Size Relationships and the Onset of Piscivory</u>

For a hatchery-origin salmonid to be a predator on natural-origin fish, the predator must have a substantial size advantage over the potential prey. Pearsons and Fritts (1999) reported the size of prey items for some salmonids (coho salmon and steelhead juveniles) can be up to 46% of the predator's length. Size criteria suggested by Parkinson et al. (1989 in Cannamela 1992) indicate predators rarely select prey items exceeding one third their length. Gape width has been suggested as a major constraint to the onset of piscivory (Mittelbach and Persson 1998), and has been proposed as a major factor determining the maximum size of prey a predator can ingest (Hoyle and Keast 1987 and 1988; Mittelbach and Persson 1998). However, prey ingestion may also be influenced by throat diameter (Petrusso 1998). Gregory and Levings (1998) observed age-0 coho and Chinook salmon as small as 90 mm demonstrating piscivory.

Feeding habits of Sacramento River fall Chinook salmon were investigated by Petrusso (1998), by analyzing the stomach contents of 189 juvenile fall Chinook salmon captured from April through June of 1996. Fork lengths of these fish ranged between 33 and 91 mm. Low levels of piscivory were observed in that investigation; however, the author did not observe evidence of predation upon salmonids. Observed predation was of larval fish (3-19 mm total length), potentially cyprinids and catostomids, which comprised 2.4% of the diet of juvenile fall Chinook salmon. Chironomids were identified as the predominant prey item (approx. 60% of diet). Based on the aforementioned information, we consider 120 mm FL as the minimum size necessary for hatchery-origin Chinook salmon and steelhead to successfully predate on other salmonids due to sufficient size of all necessary criteria: gape, throat diameter, and predator/prey relationship (Bonneville Power Administration 1997).

Training Time

Following the release of artificially propagated salmonids from Coleman or Livingston Stone NFH, hatchery-reared salmonids likely experience a lag time associated with prey (food) recognition and perhaps additional lag time associated with the development of effective capture techniques. The feeding activity of piscivorous fishes can be parsed into the following phases: 1) food recognition; 2) positioning; 3) approach; 4) seizure; and, 5) ingestion. The ability to develop effective pursuit and capture tactics must be "learned" by juveniles which have been reared on diets of manufactured foods. Ware (1971) reported that hatchery-reared rainbow trout required an average of four days of experience before approaching novel prey. In that investigation, the distance from which a hatchery-origin fish attacked novel prey doubled by the twelfth day.

Environmental Conditions

Environmental conditions such as flow and turbidity affect the ability of a predator to locate and capture prey. Most piscivorous fishes visually detect and attack prey (Hobson 1979 in Gregory and Levings 1998). Environmental conditions reducing visual acuity (i.e., turbidity and darkness) have been shown to reduce the effectiveness of predators (Gregory and Levings 1998, Ginetz and Larkin 1976). Chapman and Bjornn (1969; as cited in Maslin et al. 1996) report moderate levels of turbidity (24 nephelometric turbidity units) reduce the feeding efficiency of Chinook salmon. Conditions in Battle Creek and the Sacramento River are typically around 1-2 nephelometric turbidity units but, can quickly exceed 100 during rain events.

Recent Research involving Predation

The Service recently initiated a study to evaluate the stomach contents of emigrating hatchery-origin late-fall Chinook and steelhead in the Sacramento River. During the winter of 2009, the Service captured emigrating juveniles at rotary screw traps at the RBDD, Glenn-Colusa Irrigation District (GCID), and Knights Landing. Stomach contents of 282 juvenile late-fall Chinook and 96 juvenile steelhead trout were examined. Captured fish ranged in size from 73-247 mm FL (average 128.8, SD = 24.9) for Chinook and 113-263 mm FL (average 204.3, SD = 29.5) for steelhead trout. Only one fish, a Chinook (150 mm FL), was found to contain a fish in its stomach; the prey species is unknown. The stomach of other fishes contained the following: fish food pellets (consumed prior to release), small gastropods, vegetation, and insects. This study is ongoing.

Competition/Displacement

Competition for food and space may occur when hatchery- and natural-origin fishes overlap in time and space and with a limited supply of needed resources (Steward and Bjornn 1990, Cannamela 1992). Weber and Fausch (2004 and 2005) assessed competition between hatchery- and natural-origin Chinook salmon residing in the upper Sacramento River near Red Bluff, California. The authors observed that hatchery-origin fish were not commonly found at the stream margins, presumably because they were outmigrating nearer to the thalweg. However, when hatchery- and natural-origin fish did co-occur in stream margin, natural-origin fish experienced decreased growth caused by the presence of hatchery-origin fish. The authors further examined duration of concurrent residence between hatchery and natural fall Chinook in the upper Sacramento River and concluded that mid-April was a relatively effective time to release hatchery fall Chinook to reduce potential interactions with natural-origin Chinook in stream margin rearing areas.

We assessed the potential for competition/displacement of natural-origin salmonids resulting from hatchery-origin releases based on criteria suggested by Steward and Bjornn (1990) and McMicheal et al. (1999), including:

1) Duration of temporal and spatial overlap (i.e., release occurs during peak emergence or rearing periods and at or near primary nursery and rearing areas)
2) Carrying capacity of the receiving environment
3) Prior residence: hatchery-origin fish are released but fail to disperse or are in place prior to the emergence of natural-origin juveniles
4) Relative body size of hatchery- and natural-origin fish: larger fish have a competitive advantage[8].

Disease Transmission
Detecting and verifying pathways of disease transmittance is complicated by uncertain interactions between disease and host, making cause-and-effect relationships difficult to determine. Theoretical aspects of disease dissemination processes in fish populations suggest that disease transmission and amplification could result from hatchery propagation programs that release infected fish into natural environments to interact with natural-origin populations. The likelihood of adverse impacts to natural-origin populations is increased when hatchery releases are severely infected, large in number, and when infected hatchery fishes co-exist for an extended duration with natural-origin fishes. Potential for disease transmission associated with releases of juvenile salmonids from Coleman NFH were assessed using the following criteria:

1) Amount of temporal and spatial overlap with natural-origin salmonids (i.e., release occurs during peak emergence/rearing periods at or near primary nursery/rearing areas)
2) Release groups undergoing disease epizootic at time of release

10.7 Strategies designed to minimize potential negative impacts from juvenile releases

Reduce Temporal and Spatial Overlap
Strategies for releasing salmon and steelhead from the Coleman NFH are designed to reduce

[8] It is also possible that a size difference between fishes of hatchery- and natural-origin may lead to differences in habitat selection, thereby reducing the potential for competition/displacement. Hampton (1988) reports larger juveniles select deeper water and faster velocities and fry use low velocity areas at the stream margin where substrate irregularities and other instream features create velocity breaks. As juveniles grow, they move away from the shoreline into higher velocity areas, especially for feeding (Rich 1997 in CDFG 1998).

potential for negative impacts on natural-origin salmonids via the following strategies: 1) reducing the duration of concurrent residence in Battle Creek and the Sacramento River, 2) releasing fish at sizes that will reduce their impacts on natural-origin juveniles, and 3) releasing healthy fish.

To reduce or avoid impacts of hatchery-origin salmonids on their natural-origin counterparts, many fishery scientists advocate that hatchery releases be timed to minimize the duration of concurrent residence with natural-origin fish in the freshwater environment (e.g., Northwest Power Planning Council 1999, Integrated Hatchery Operations Team 1995). Releases of fall Chinook salmon from Coleman NFH are timed to occur after the emigration of natural-origin fall Chinook, which are often associated with high flow/turbidity events. Weber and Fausch (2004) concluded this release strategy was relatively effective in reducing potential interactions between hatchery- and natural-origin fish in the upper Sacramento River rearing areas. Releases of late-fall Chinook and steelhead from Coleman NFH are timed to coincide with high flow events in Battle Creek and the Sacramento River. Chinook salmon and steelhead are released from Coleman NFH at the time of smoltification. These strategies are intended to promote rapid emigration from Battle Creek and the upper Sacramento River (see Figure 10-1 of this report for timing of juvenile outmigration of fall Chinook in the upper Sacramento River and Appendix 10C in Service 2001b for outmigration of juvenile salmonids in Battle Creek).

Disease Transmission

The surest way to reduce potentially deleterious effects of disease transmission and amplification from hatchery- to natural-origin populations is to produce and release healthy fish. Fish culture practices and health management programs at Coleman and Livingston Stone NFH are designed to produce healthy smolts. Many precautionary measures are taken to reduce the risk of infection to juvenile fish at Coleman NFH and to reduce potential impacts to natural stocks after release. The general strategy involves maintaining a good rearing environment, good nutrition, and reducing exposure to pathogens and stress. An ozone water disinfection system at the Coleman NFH has been used since 2000 to substantially alleviate disease concerns, both on station and after release. Propagation of healthy juveniles also contributes to achieving program goals at the Coleman NFH Complex, including mitigation, augmentation, supplementation, or conservation/preservation.

Release strategies at Coleman NFH are designed to reduce the potential for disease transmission and amplification resulting from large releases of hatchery fish. Releases of fall and late-fall Chinook salmon and steelhead are conducted in a manner such that hatchery-origin fish will emigrate en-masse and rapidly, thus decreasing the duration of interaction with natural-origin stocks in the upper Sacramento River (see Section 10.1 on releases of juveniles). This is accomplished by releasing fish at the proper time and size, and at an advanced state of smoltification. Emigration data verifies that fall and late-fall Chinook salmon, and steelhead from Coleman NFH emigrate rapidly through the river. Very little is known regarding the potential for disease transmission to natural-origin populations in the estuarine and ocean environments.

10.8 Analysis of risks resulting from releases of hatchery-origin fall Chinook salmon

A summary of impacts to natural-origin salmonid populations resulting from releases of juvenile fall Chinook salmon from Coleman NFH is presented in Table 10-9. Detailed explanations follow.

Fall Chinook salmon comprise the largest production program in the Central Valley and one of the largest salmonid production programs on the Pacific Coast. Approximately 12 million fall Chinook smolts are released annually into Battle Creek from mid- to late-April. Based on the large size of the program, the release of fall Chinook juveniles has the potential to impart relatively large impacts to natural origin salmonids in the Central Valley. Despite the size of the fall Chinook production program at Coleman NFH, we believe that impacts of predation, competition/displacement, and disease transmission resulting from releases of hatchery-origin fall Chinook salmon from Coleman NFH will be low for the following reasons: 1) hatchery-origin fall Chinook emigrate during a time when few natural-origin salmonids emigrate; 2) hatchery-origin fall Chinook emigrate en-masse and rapidly from upper Sacramento River; and, 3) hatchery-origin fall Chinook are non-piscivorous when they are released from the hatchery.

Table 10-9 Summary of impacts to natural-origin salmonid populations resulting from releases of juvenile fall Chinook salmon from Coleman National Fish Hatchery. See text (Section 10.6) for definitions of impact ratings and descriptions of criteria.

	Impact Rating					
	Battle Creek			ESU		
Impacted Natural-Origin Species / Run	Predation	Competition / Displacement	Disease	Predation	Competition / Displacement	Disease
Fall Chinook	None	Low	Low	None	Low	Low
Late-fall Chinook	None	Low	Low	None	Low	Low
Winter Chinook	None	Low	Low	None	Low	Low
Spring Chinook	None	Low	Low	None	Low	Low
Steelhead	None	Low	Low	None	Low	Low

Predation

Occurrences of predation to natural-origin Chinook salmon and steelhead resulting from releases of hatchery-origin fall Chinook juveniles are expected to be low. The average size of fall Chinook smolts at the time of release in April is 76 mm (range: 40-109 mm, SD = 7; Figure 10-2). With the exception of newly-emerged late-fall Chinook salmon and steelhead, all natural-origin salmonids potentially co-occurring with hatchery-origin fall Chinook salmon after their release in April are larger, and are therefore incapable of being consumed by hatchery-origin fall Chinook (Table 10-10). Natural-origin young-of-the-year late-fall Chinook and steelhead are emerging during April when hatchery-origin fall Chinook are released. However, extensive predation by hatchery-origin fall Chinook salmon is considered unlikely because juvenile fall Chinook are believed to be largely non-piscivorous at the size and life stage when they are liberated from the hatchery because of their small body size, gape limitation, and non-piscivorous feeding patterns. For these reasons, predatory interactions involving fall Chinook smolts upon natural-origin salmonids are expected to be low in the freshwater environment.

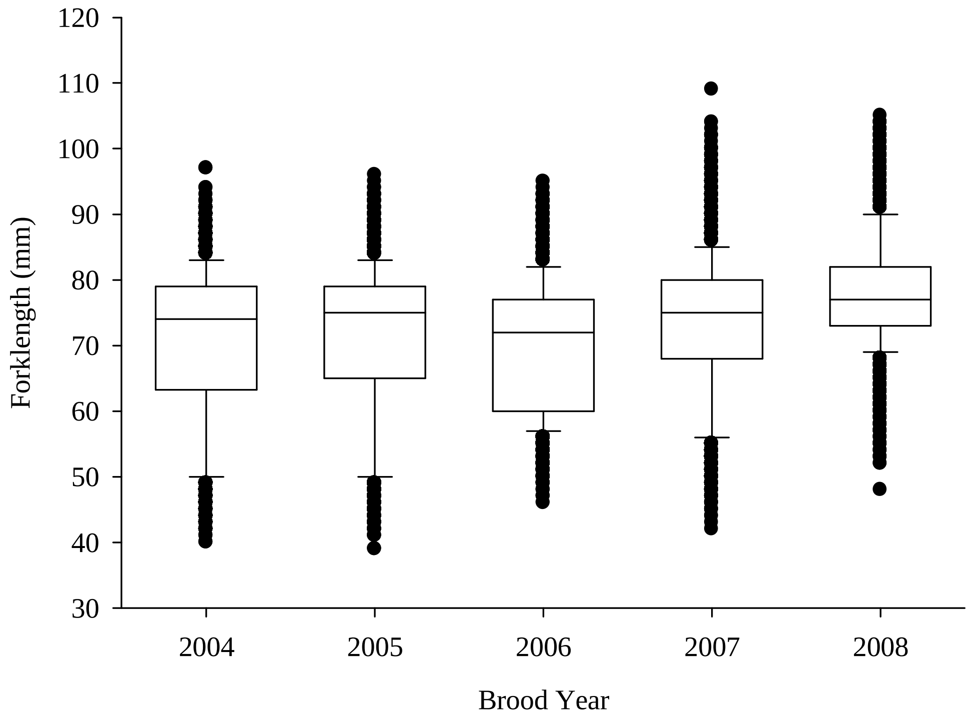

Figure 10-2 Box plots for fork lengths of fall Chinook salmon released from the Coleman National Fish Hatchery, brood years 2004-2008.

Table 10-10 Length ranges of natural-origin Chinook salmon and steelhead potentially co-occurring in Battle Creek and the Sacramento River with hatchery-origin fall Chinook salmon (range = 40-109 mm) during April.

	Fork length (mm)	
Stock	Young-of-Year	Yearling
Fall Chinook[a]	34 - 89	none
Late-fall Chinook[a]	22 - 40	201- 270
Spring Chinook[a]	none	73 - 120
Winter Chinook[a]	none	99 - 201
Steelhead[b]	20 - 75	140-200

a Length ranges for natural-origin Chinook salmon were taken from a daily length increment table (Sheila Green, Department of Water Resources).

b Steelhead length ranges were back-calculated from scale analysis for upper Sacramento River *Onchorynchus mykiss* (CDFG, unpublished data).

Competition /Displacement

Releases of fall Chinook smolts from Coleman NFH occur during a time when relatively few natural-origin salmon and steelhead are emigrating from Battle Creek and the upper Sacramento

River (see Appendix 10C in Service 2001b for timing of juvenile salmonid outmigration in Battle Creek, a tributary of the upper Sacramento River). Yearling natural-origin late-fall, spring, and winter Chinook salmon and steelhead emigrate from the Sacramento River primarily from November through March, during periods of high flows and high turbidity (Service, RBFWO unpublished data). Likewise, juvenile fall Chinook salmon emigrate primarily from January through March, soon after emergence from the gravels (Service, RBFWO unpublished data; Johnson and Martin 1997; Johnson et al. 1992). Winter Chinook young-of-the-year emigrate primarily from August through March. The few winter Chinook salmon remaining in the Sacramento River during March and April range in size from approximately 99 to 270 mm FL (Johnson et al. 1992) and would have a competitive advantage over smaller hatchery-origin fall Chinook salmon.

Newly-emergent young-of-the-year late-fall Chinook salmon and steelhead co-occur in the upper Sacramento River with hatchery-origin fall Chinook following hatchery releases in April. Potential interactions including competition/displacement between hatchery-origin fall Chinook salmon and young-of-the-year late-fall Chinook and steelhead are reduced as a result of rapid migration tendencies exhibited by hatchery-origin fall Chinook salmon. Monitoring of juvenile emigration patterns shows that April releases of fall Chinook salmon smolts from Coleman NFH travel downstream rapidly, in large pulses, and few fish exhibit delayed emigration past Red Bluff (Service, RBFWO unpublished data; see Section 10.1 for emigration data on hatchery releases for a more complete discussion). Hatchery-origin fall Chinook also emigrate rapidly through the Sacramento River downstream of Red Bluff.

Some natural-origin Chinook salmon juveniles (young-of-the-year fall Chinook and yearling late-fall, spring, and winter Chinook) may remain in the upper Sacramento River until April and move downstream in-concert with hatchery releases of fall Chinook salmon. Natural-origin juveniles emigrating with hatchery-origin fall Chinook salmon may benefit from increased survival due to schooling and predator swamping; the same protective measures designed primarily to benefit survival of hatchery-origin fall Chinook salmon.

Carrying Capacity of Lower Battle Creek

Releasing 12 million hatchery-origin fall Chinook smolts into Battle Creek would greatly exceed the carrying capacity of that tributary if hatchery-origin fall Chinook reared in the tributary for an extended period of time. However, hatchery-origin fall Chinook salmon emigrate rapidly from Battle Creek and the upper Sacramento River (Service, unpublished data). Emigration patterns exhibited by natural-origin fall Chinook salmon in lower Battle Creek are similarly large and rapid. Natural-origin production of fall Chinook salmon in Battle Creek for brood years 2003 – 2007 averaged nearly 12.7 million, well beyond the expected carrying capacity of that system for extended rearing. However, nearly all of these natural-origin juveniles dispersed from Battle Creek from January through March, soon after emergence from the gravels and prior to the release of fall Chinook from the Coleman NFH (Service, RBFWO unpublished data). These data show that neither hatchery-origin nor natural-origin fall Chinook salmon exhibit a propensity for extended rearing in lower Battle Creek. Rather, both hatchery- and natural-origin stocks of fall Chinook salmon use lower Battle Creek as a migration corridor to facilitate rapid downstream emigration and dispersal.

Disease Transmission
Because hatchery-origin fall Chinook salmon emigrate rapidly and en-masse from the upper Sacramento River, and because the emigration timing of hatchery-origin fall Chinook does not greatly overlap with emigration of natural-origin salmonid populations, the incidence of disease transmission to natural-origin populations in the river environment is considered low.

Hatchery-origin fall Chinook salmon emigrate rapidly from the upper Sacramento River, averaging approximately nine miles per day. This rapid rate of emigration suggests only a transient period of rearing in the upper river environment. To sustain this rapid rate of emigration, hatchery-origin fall Chinook likely congregate in swiftly-flowing sections of the river, unlike newly-emergent natural-origin late-fall Chinook and steelhead which tend to seek refuge at the river margins for extended rearing.

10.9 Analysis of risks resulting from releases of hatchery-origin late-fall Chinook Salmon

General production late-fall Chinook salmon from Coleman NFH are released as yearlings into Battle Creek in January. Additionally, experimental groups of late-fall Chinook are released into Battle Creek during November and December. Total releases of late-fall Chinook from Coleman NFH are approximately one million annually.

Potential interactions between natural-origin salmonids and hatchery-origin late-fall Chinook include predation, competition/displacement, and disease transmission. Because of their comparatively larger body size and different release timing as compared to hatchery-origin fall Chinook, potential impacts to juvenile natural-origin salmonid populations may be greater for releases of late-fall Chinook salmon from Coleman NFH (Table 10-11).

Table 10-11 Summary of impacts to natural-origin salmonid populations resulting from releases of juvenile late-fall Chinook salmon from Coleman National Fish Hatchery. See text (Section 10.6) for definitions of impact ratings and descriptions of criteria.

	Impact Rating					
	Battle Creek			ESU		
Natural-Origin Species / Run	Predation	Competition / Displacement	Disease	Predation	Competition / Displacement	Disease
Fall Chinook	Moderate	Low	Low	Moderate	Low	Low
Late-fall Chinook	Low	Low	Low	Low	Low	Low
Winter Chinook	Low	Low	Low	Low	Low	Low
Spring Chinook	Low	Low	Low	Low	Low	Low
Steelhead	Low	Low	Low	Low	Low	Low

Predation
The average size of hatchery-origin late-fall Chinook smolts at the time of release in January is

135 mm FL (range: 65-202 mm, SD = 19.9; Figure 10-3). The size ranges of natural-origin Chinook salmon and steelhead potentially co-occurring with hatchery-origin late-fall Chinook salmon in Battle Creek and the Sacramento River are shown in Table 10-12. Based on the body size of hatchery-origin late-fall Chinook salmon, size ranges of natural-origin salmonid stocks, and predator-prey size constraints (i.e., prey less than half of predator length), hatchery-origin late-fall Chinook could potentially consume natural-origin fall, spring, and winter Chinook juveniles following their release from Coleman NFH (Table 10-12).

Although hatchery-origin late-fall Chinook juveniles could potentially capture and consume spring and winter Chinook juveniles, impacts are likely greatest on juvenile fall Chinook salmon. Hatchery-origin late-fall Chinook salmon are likely inefficient predators immediately following their release into Battle Creek. During January, when late-fall Chinook are released from Coleman NFH, fall Chinook salmon are beginning to emerge from the gravel. Inexperienced hatchery-origin late-fall Chinook are therefore more likely to predate on abundant and less-agile newly emerged fall Chinook fry than winter and spring Chinook salmon which are relatively scarce, larger, and more agile. With an average rate of emigration of over 30 miles per day (discussed below) through Battle Creek and the Sacramento River, hatchery-origin late-fall Chinook smolts would likely travel a substantial distance down the Sacramento River system prior to becoming efficient predators on larger, more evasive organisms.

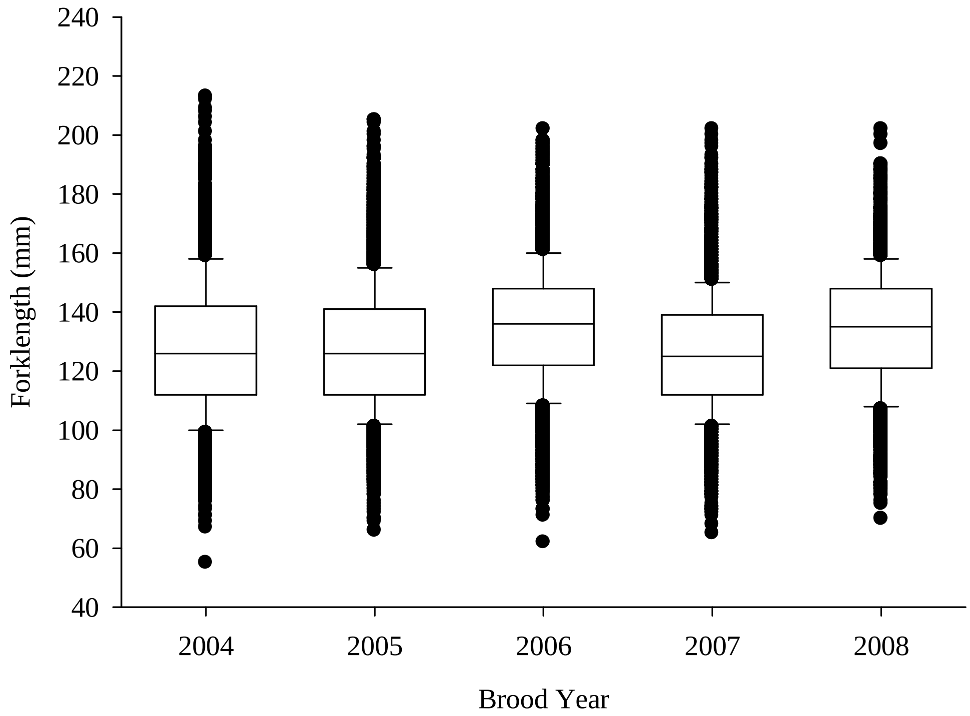

Figure 10-3 Box plots for fork lengths of late-fall Chinook smolts released from the Coleman NFH, brood years 2004-2008.

Table 10-12 Length ranges of natural-origin Chinook salmon and steelhead potentially co-occurring in Battle Creek and the Sacramento River with hatchery-origin late-fall Chinook salmon (range: 65-202 mm) during January.

	Fork Length (mm)	
Species / Run	Young-of-Year	Yearling
Fall Chinook[a]	0 - 50	202 - 270
Late-fall Chinook[a]	none	111 - 246
Spring Chinook[a]	41 - 67	202 - 270
Winter Chinook[a]	55 - 135	none
Steelhead[b]	none	140 - 200

a Length ranges for natural-origin Chinook salmon were taken from a daily length increment table (Sheila Green, CA Department of Water Resources).

b Steelhead length ranges were back-calculated from scale analysis for upper Sacramento River *Onchorynchus mykiss* (CDFG, unpublished data).

The timing of late-fall Chinook releases are scheduled to coincide with winter storm events. Cool water temperature, high flows, and elevated turbidity levels associated with winter storm events create conditions both favorable for rapid downstream emigration (Godin 1981) and unfavorable for foraging (Gregory and Levings 1998). Water temperature in Battle Creek and the Sacramento River are commonly below 10^{o}C during January, reducing the metabolic requirements of predators, and consequently reducing consumption by hatchery-origin late-fall Chinook salmon. Sacramento River flows during January are highly variable and erratic depending on precipitation events (Figure 10-4). Dramatic increases of flow in the Sacramento River are usually accompanied by elevated turbidity (Figure 10-5). Migration of juvenile salmonids is commonly associated with floods and increased water turbidity which reduce underwater light transmission (see review in Godin 1981). The strong tendency of salmonid juveniles to emigrate during periods of high flow and turbidity has been considered an adaptation to avoid predation.

Hatchery-origin late-fall Chinook salmon released from Coleman NFH exhibit rapid emigration from the upper Sacramento River. Downstream monitoring conducted during 1993 showed that the majority of hatchery-origin late-fall Chinook smolts emigrated past GCID diversion dam (RM 205) two days and Sherwood Harbor (RM 55) seven days following their release into Battle Creek (Service unpublished data, CDFG unpublished data). Monitoring efforts conducted at the RBDD during 1995 and 1996 show similar trends. During those years, approximately 50% of hatchery-origin late-fall Chinook sampled were collected from two to six days following release into Battle Creek. These data demonstrate a rapid emigration by hatchery-origin late-fall Chinook salmon released into Battle Creek during January, equal to more than 30 miles per day (Service, RBFWO unpublished data).

During the winter of 2009, the Service captured emigrating juveniles at rotary screw traps at the RBDD, GCID, and Knights Landing to evaluate stomach contents of emigrating hatchery-origin late-fall Chinook salmon. Stomach contents of 282 juvenile late-fall Chinook ranging in size from 73-247 mm FL (average 128.8, SD = 24.9) revealed one fish. The prey species is unknown. The stomach of other fishes contained the following: fish food pellets (consumed prior to release), small gastropods, vegetation, and insects. This study supports the assessment of low levels of predation by hatchery-origin late-fall Chinook.

Competition/Displacement

Ecological risks of competition/displacement occurring as a result of releasing hatchery-origin late-fall Chinook salmon are considered to be low. Interactions between hatchery-origin late-fall Chinook and natural-origin salmonid stocks are reduced by the following factors: 1) late-fall Chinook are released when they are smolting, encouraging rapid emigration from freshwater environments and low levels of delayed migration; 2) the release timing of late-fall Chinook will be scheduled to coincide, to the extent practicable, with episodes of high river discharge and turbidity, resulting in rapid downstream travel; and 3) to attain a rapid rate of emigration, late-fall Chinook likely congregate in areas of high velocity, resulting in a large degree of microhabitat segregation from salmonids rearing for extended durations. Data from other areas indicate that hatchery salmon smolts compete minimally if they migrate without delay (Stewart and Bjornn 1990).

Disease Transmission

Hatchery-origin late-fall Chinook are released as smolts and emigrate rapidly and en-masse from the upper Sacramento River, reducing the amount of temporal and spatial overlap with natural-origin salmonid populations in the freshwater environment. To sustain this rapid rate of emigration, hatchery-origin late-fall Chinook likely congregate in swiftly-flowing sections of the river, unlike newly-emergent natural-origin late-fall Chinook and steelhead which tend to seek refuge at the river margins for extended rearing. Because hatchery-origin late-fall Chinook do not generally rear for extended duration in Battle Creek or the upper Sacramento River, the potential for disease transmission to natural-origin salmonids in the river environment is reduced. In addition, the ozone water disinfection system at Coleman NFH has largely ameliorated concerns of disease both on-station and after release.

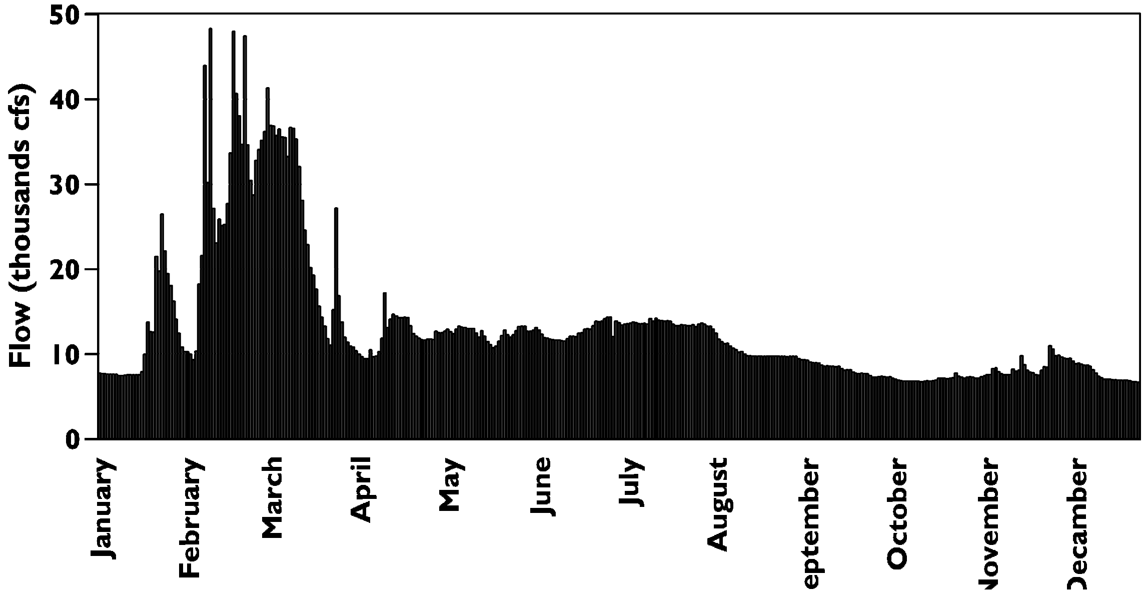

Figure 10-4 Hydrograph of average daily discharge in cubic feet per second (cfs) for the Sacramento River at Bend Bridge (river mile 258), 1999. Data are from the California Data Exchange Center (CDEC), March 5, 2000.

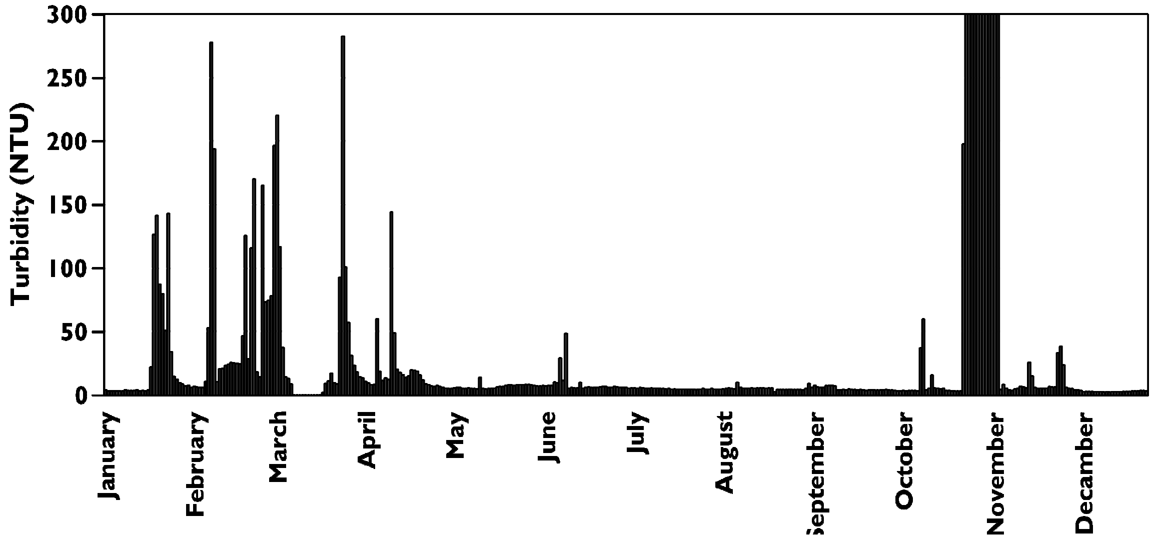

Figure 10-5 Average daily turbidity in nephelometric turbidity units (NTU) for the Sacramento River at Bend Bridge (river mile 258), 1999. Data are from the California Data Exchange Center (CDEC), March 5, 2000.

10.10 Analysis of risks resulting from releases of hatchery-origin winter Chinook salmon

A summary of impacts to natural-origin salmonid populations resulting from releases of juvenile winter Chinook salmon from Livingston Stone NFH is presented in Table 10-13. Detailed explanations follow.

Winter Chinook pre-smolts are released from Livingston Stone NFH during late-January. Juveniles are transported at dusk from the hatchery to the Sacramento River at Caldwell Park, Redding, California (RM 299) where they are liberated near suitable rearing habitats. The number of winter Chinook released depends largely upon the number of winter Chinook adults collected and spawned at the hatchery and survival of artificially propagated juveniles. Total releases of winter Chinook salmon may approach 200,000 annually.

Both hatchery- and natural-origin winter Chinook salmon are listed as endangered under the ESA. The goal of the winter Chinook propagation program at Livingston Stone NFH is to supplement natural-origin winter Chinook salmon in the upper Sacramento River, leading to recovery and de-listing of that population. Because the winter Chinook propagation program at Livingston Stone NFH is designed to supplement the only endangered salmonid population in the Central Valley, and because both hatchery- and natural-origin populations are listed as endangered under the ESA, we consider potential impacts of releasing hatchery-origin winter Chinook juveniles only in regards to the natural-origin population of winter Chinook salmon. Detrimental effects to other races of salmon are unlikely, however, because of the low number of winter Chinook juveniles released annually from Livingston Stone NFH.

Table 10-13 Summary of impacts to natural-origin salmonid populations resulting from releases of juvenile winter Chinook salmon from Livingston Stone National Fish Hatchery. See text (Section 10.6) for definitions of impact ratings and descriptions of criteria.

	Impact Rating					
	Battle Creek			ESU		
Natural-Origin Species / Run	Predation	Competition / Displacement	Disease	Predation	Competition / Displacement	Disease
Fall Chinook	N.A.	N.A.	N.A.	None	None	None
Late-fall Chinook	N.A.	N.A.	N.A.	None	None	None
Winter Chinook	N.A.	N.A.	N.A.	None	None	None
Spring Chinook	N.A.	N.A.	N.A.	None	None	None
Steelhead	N.A.	N.A.	N.A.	None	None	None

Predation

The average size of hatchery-origin winter Chinook salmon pre-smolts at the time of release in January is 88 mm FL (range: 46-123 mm, SD = 8.4; Figure 10-6). Natural-origin winter Chinook salmon potentially co-occurring with hatchery-origin winter Chinook salmon (after their release) range in size from 55 to 135 mm (Daily length increment chart, Sheila Green, California Department of Water Resources, Sacramento). Because hatchery- and natural-origin winter Chinook are approximately equal in size during their co-residence in the Sacramento River, predatory interactions are unlikely.

Competition/Displacement
An objective of the winter Chinook salmon propagation program is that hatchery-origin pre-smolts integrate with natural-origin winter Chinook in the Sacramento River. Potential negative effects of competition/displacement between hatchery- and natural-origin winter Chinook would likely occur at low levels because: 1) rearing habitats in the upper Sacramento River are not considered to be a factor limiting the abundance of winter Chinook salmon; 2) hatchery- and natural-origin winter Chinook salmon are of similar size at the time of the hatchery release; and, 3) hatchery-origin winter Chinook are released after natural-origin winter Chinook have established home-territories.

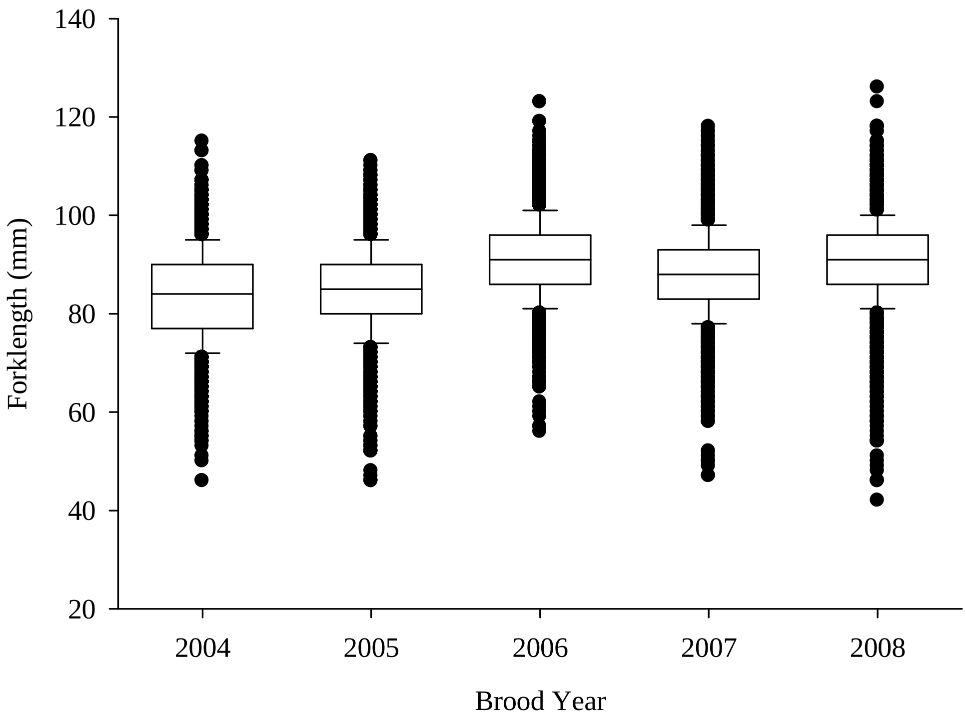

Figure 10-6 Box plots for fork lengths of winter Chinook smolts released from the Livingston Stone NFH, brood years 2004-2008.

Disease Transmission
Increased transmission of disease is not expected to result from releasing hatchery-origin winter Chinook salmon from Livingston Stone NFH. It is assumed that hatchery-origin winter Chinook salmon pre-smolts integrate with natural-origin winter Chinook salmon in the Sacramento River. These stocks likely co-exist in similar habitats and in close proximity to one another in the river, delta, bay, and ocean environments. Therefore, disease transmission from hatchery-origin fish could be a major concern if the hatchery released infected or immuno-compromised juveniles.

However, winter Chinook juveniles from Livingston Stone NFH have been notably healthy and free of disease problems. There have been no outbreaks of IHNV or Bacterial Kidney Disease at Livingston Stone NFH. Lack of disease outbreaks at Livingston Stone NFH can be attributed to effective prophylactic treatments, good fish culture practices, and the anadromous-free water supply from Shasta Lake.

10.11 Analysis of risks resulting from releases of hatchery-origin juvenile steelhead

A summary of impacts to natural-origin salmonid populations resulting from releases of steelhead from Coleman NFH is presented in Table 10-14. Detailed explanations follow.

Approximately 600,000 steelhead smolts are released from Coleman NFH in January at the Sacramento River at Bend boat ramp[9] (RM 258). Steelhead are trucked to the release site using the hatchery's two fish distribution vehicles. In the past, up to 150,000 of the total steelhead production from the hatchery pre-release pond were released directly into Battle Creek at the hatchery; however, this practice was discontinued after brood year 2001.

Because juvenile steelhead are transported and released 13-miles downstream of Battle Creek, juvenile hatchery-origin steelhead are not expected to impact Battle Creek. However, interactions between salmonids from Coleman NFH and natural-origin salmonids in the Sacramento River are potentially greatest for hatchery-origin steelhead because of their comparatively larger body size, a general tendency for piscivory at the time of release, and a proclivity for adopting alternate life-history patterns (e.g., residualization).

Predation

Yearling steelhead smolts average 212 mm (range: 82-302 mm, SD = 27.1) at the time of release from Coleman NFH (Figure 10-7). The size ranges of natural-origin Chinook salmon and steelhead potentially co-occurring with hatchery-origin steelhead in the Sacramento River are shown in Table 10-15. Based on the size of hatchery-origin steelhead, size ranges of natural-origin salmonid stocks, and predator-prey size constraints (i.e., prey less than half of predator length), hatchery-origin steelhead could potentially capture and consume young-of-the-year fall, spring, and winter Chinook juveniles.

[9] Steelhead from Coleman NFH have been released at Bend boat ramp since brood year 1999. The previous release site at Balls Ferry Bridge (RM 276) was abandoned due to concerns of mortality of released fish due to boat traffic and concerns of potential predation by steelhead upon newly-emerged fall Chinook salmon. Changing the steelhead release site to Bend boat ramp may benefit natural-origin fall Chinook salmon that have recently emerged from the congregation of redds typically located near the Balls Ferry Bridge.

Table 10-14 Summary of impacts to natural-origin salmonid populations resulting from releases of juvenile steelhead from Coleman National Fish Hatchery. See text (Section 10.6) for definitions of impact ratings and descriptions of criteria.

	Impact Rating					
	Battle Creek			ESU		
Natural-Origin Species / Run	Predation	Competition / Displacement	Disease	Predation	Competition / Displacement	Disease
Fall Chinook	None	None	None	Moderate	Low	None
Late-fall Chinook	None	None	None	Low	Low	None
Winter Chinook	None	None	None	Low	Low	None
Spring Chinook	None	None	None	Low	Low	None
Steelhead	None	None	None	Low	Low	None

Although hatchery-origin steelhead juveniles could potentially capture and consume spring and winter Chinook juveniles, impacts are likely reduced because of the relatively greater abundance and ease of capturing newly emergent fall Chinook. During January, when steelhead are released from Coleman NFH, millions of fall Chinook salmon are beginning to emerge from the gravels (Johnson et al. 1992). Steelhead are opportunistic feeders, and are therefore more likely to prey on the abundant and less-agile newly-emerged fall Chinook fry rather than winter and spring Chinook salmon, which are larger and less abundant. Menchen (1981) examined the stomach contents of 910 yearling steelhead released in Battle Creek and found 103 stomachs contained a total of 1,125 emergent fall Chinook fry. Chinook salmon of other runs were not observed in that investigation. Hallock (1989) sampled the stomach contents of yearling steelhead in Battle Creek and found an average of 1.4 fall Chinook salmon. Subsequent studies conducted by Bigelow et al. (1995a) and the Service (unpublished data) examined stomach contents from 133 and 98 hatchery-origin steelhead, respectively, and found no evidence of piscivory in steelhead emigrating through the Sacramento River.

Environmental conditions common in the Sacramento River during January likely reduce predation by hatchery-origin steelhead. Steelhead are released from Coleman NFH during early-January, a time of year when winter storm bring high flows, elevated turbidities, and cool water temperatures. Winter storm events create conditions favorable for rapid downstream emigration (Godin 1981) but unfavorable for foraging (Gregory and Levings 1998). Water temperature in Battle Creek and the Sacramento River are commonly below 10^{o}C during January, reducing the metabolic requirements of predators, and likely reducing consumption by hatchery-origin steelhead. Flow and turbidity in the Sacramento River during January are highly variable and erratic depending on precipitation events (Figures 10-4 and 10-5). Migration of juvenile salmonids is commonly associated with floods and increased water turbidity which reduce underwater light transmission (see review in Godin 1981), interfering with the abilities of predators to see and identify prey.

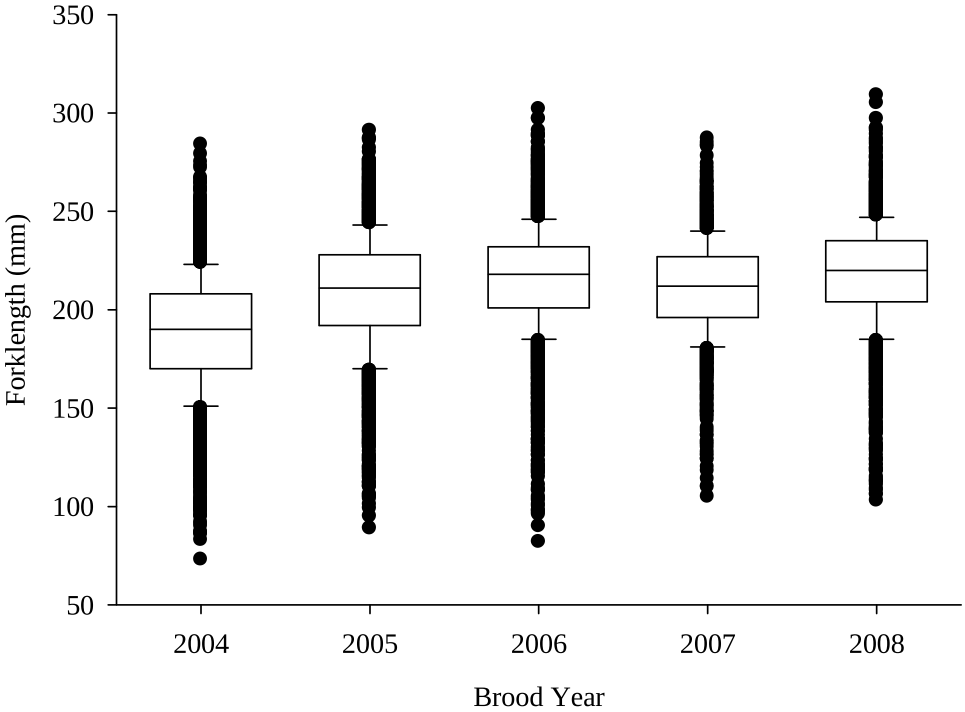

Figure 10-7 Box plots for fork lengths of steelhead smolts released from the Coleman NFH, brood years 2004-2008.

Table 10-15 Length ranges of natural-origin Chinook salmon and steelhead potentially co-occurring in the Sacramento River with hatchery-origin steelhead following their release (range: approx. 82-302 mm) in January.

	Fork Length (mm)	
Species / Run	Young-of-Year	Yearling
Fall Chinook[a]	0 - 50	202 - 270
Late-fall Chinook[a]	none	111 - 246
Spring Chinook[a]	41 - 67	202 - 270
Winter Chinook[a]	55 - 135	none
Steelhead[b]	none	140 - 200

a Length ranges for natural-origin Chinook salmon were taken from a daily length increment table (Sheila Green, CA Department of Water Resources).
b Steelhead length ranges were back-calculated from scale analysis for upper Sacramento River Onchorynchus mykiss (CDFG, unpublished data).

Residualization

Predation by hatchery-origin steelhead on natural-origin Chinook salmon and steelhead could be substantial if a large number of hatchery-origin steelhead residualize. The size of steelhead smolts at release is known to affect the rate of residualism. Whitesel et al. (1993) and Jonasson et al. (1994) showed that the majority of residualized steelhead resulted from the smallest fish within a particular release group. Studies in the Snake River, Idaho showed that hatchery-origin steelhead less than 165 mm FL have a greater tendency to residualize (Bigelow et al. 1995b). Tipping et al. (1995) reported larger steelhead (>190 mm) emigrated at greater rates than smaller steelhead (< 190 mm). Of 13,958 fish sampled for pre-release length from brood years 2003 - 2007, approximately 10.7% were less than 165 mm (Service, RBFWO, unpublished data). The majority of the steelhead released from Coleman NFH are greater than 190 mm (68.1%).

Several studies have been conducted by the Service's RBFWO to assess residualization of steelhead released from Coleman NFH. High levels of steelhead residualization at Coleman NFH have not been observed during any of these investigations. In the first study, sampling for steelhead released on January 27, 1993 in the upper Sacramento River produced no mainstem recaptures after February 17, three weeks after release (Bigelow et al. 1995a). In another investigation of steelhead residualization, 150,000 steelhead were released into Battle Creek during February 1994. Subsequently five surveys were conducted in Battle Creek between March and September using four different sampling techniques; no hatchery-origin steelhead were observed (Service 1995). During 1999, steelhead residualism was further investigated using otolith microchemistry. Otoliths were sampled from adult steelhead returning to Coleman NFH and examined for isotopes indicative of ocean rearing. In that study, the vast majority of steelhead returning to Coleman NFH, and all steelhead greater than about 450 mm, were shown to be anadromous. The Service is currently analyzing a much larger number of otoliths collected from steelhead that returned in 2007-2008 to assess the amount of residualism that is occurring.

Competition/Displacement

Rapid emigrations of hatchery-origin steelhead smolts from the Coleman NFH are believed to reduce competition with natural-origin salmonids. Competition by hatchery-origin salmonids is reduced if hatchery-origin steelhead migrate without delay (Stewart and Bjornn 1990). Rapid emigration of Coleman NFH steelhead is encouraged by: 1) releasing steelhead when they are smolting; and, 2) releasing steelhead at times of high river discharge and turbidity. Two groups of steelhead smolts released in January 1993 were recaptured at the GCID diversion 5 and 22 days post-release (Bigelow et al. 1995a). Differing rates of emigration observed in that investigation were associated with prevailing flow conditions. Steelhead released from Coleman NFH on January 8, 1996 were sampled emigrating past the RBDD primarily on January 16 (8-days post-release), translating to an emigration rate of approximately four miles per day. Similar emigration patterns of hatchery-origin steelhead from Coleman NFH have been documented through rotary screw trap monitoring at RBDD for brood year 1996 through 1998 (Service, RBFWO unpublished data).

Disease Transmission

Hatchery-origin steelhead are released as yearling smolts. Releasing steelhead at the smolt stage is intended to promote rapid, en-masse emigration from the upper Sacramento River, thereby reducing the amount of temporal and spatial overlap with natural-origin salmonid populations in the freshwater environment. The January release of steelhead is commonly associated with high flow and high turbidity events, which further promote rapid emigration through the Sacramento River. The potential for disease transmission to natural-origin populations is reduced if hatchery-origin fish do not rear in the same area. Additionally, the ozone water disinfection system at Coleman NFH has largely ameliorated concerns of disease both on-station and after release.

10.12 Other potential risks to natural salmonid populations from hatchery releases

Additional risks to natural-origin salmonid populations resulting from hatchery releases have been identified, including: interactions between hatchery- and natural-origin populations in estuarine and ocean environments, alterations in migratory behavior of natural-origin fish triggered by large numbers of outmigrating hatchery-origin fish, and increases in straying when hatchery-origin fish are released off-site.

Potential Risks from Interactions in Estuarine and Ocean Environments

We have not attempted to determine potential negative impacts resulting from hatchery releases to natural-origin stocks occurring in the ocean environment. Scientific information is particularly sparse regarding interactions between hatchery- and natural-origin salmonids occurring in estuarine and ocean environments. Recent analyses show variation in survival of salmon in the ocean is probably related to cycles of ocean productivity (Hare et al. 1999, NMFS 2009a). However, it is neither currently possible to determine the carrying capacity for Chinook salmon and steelhead in ocean environments nor to determine whether density-dependent factors resulting from hatchery propagation might decrease survival rates of natural-origin salmonids.

Potential Risks of Altered Migratory Behavior (i.e., Pied Piper Effect)

We were unable to assess potential effects from altered migratory behaviors that may result from hatchery releases (i.e., the “pied piper” effect). Releases of large numbers of hatchery-origin juveniles from Coleman NFH have the potential to alter the migratory patterns of juvenile natural-origin salmonids in the Sacramento River. Alteration of migratory patterns may detrimentally impact natural-origin salmonids by subjecting them to undue predation or by promoting premature entrance into saltwater (i.e., if the fish is not physiologically ready). However, it is also possible that natural-origin salmonids that migrate concurrently with hatchery-origin releases are benefited by increased protections associated with migrating en-masse (e.g., predator swamping). Currently, little is known about effects to natural-origin populations that may result from altered migratory patterns.

Potential Risks from Straying of Hatchery-origin Salmonids

Straying of natural-origin salmonids has been reported to range from <1% to 25% (Shapovalov and Taft 1954, Quinn et al. 1987, Labelle 1992). The Service believes that the current rearing and release practices reduce straying to background levels for onsite releases of fall and late-fall Chinook, winter Chinook released into the Sacramento River at Redding, and steelhead released into the Sacramento River at Bend Bridge. Genetic effects from hatchery fish straying at these background rates are somewhat ameliorated by the fact that all stocks share a common lineage and are integrated with proximate natural populations.

Straying is increased when hatchery fish are released at distant locations from the hatchery. Beginning with brood year 2008, approximately 10% of fall Chinook produced at Coleman NFH have been released into the San Pablo Bay. This temporary action was initiated to boost ocean fisheries following a collapse of the fishery. Previous analyses show that straying of Chinook salmon released into the Bay-Delta can be substantial (e.g., 70-90% adults escaping to spawn). Furthermore, the geographic distribution of straying increased as the distance to off-site release locations increases (Service 1996c). See Appendix 10D in Service 2001b for our analysis of stray rates and a discussion of the potential genetic impacts of straying. However, potential impacts from trucking 10% of fall Chinook to the San Pablo Bay are believed to have been ameliorated by the long history of releasing hatchery-origin Central Valley fall Chinook into the Bay. The existing ESU of Central Valley fall Chinook appear to be one genetically homogeneous population, with no indication of genotypic differentiation related to geographic proximity (Williamson and May 2005).

11 MONITORING AND EVALUATION OF PERFORMANCE INDICATORS

11.1 Monitoring and evaluation of performance indicators

Monitoring and evaluation of hatchery programs at Coleman and Livingston Stone NFHs are integral components of the Service's propagation programs for Chinook salmon and steelhead in the Central Valley of California. Most activities involving monitoring and evaluating these hatcheries are coordinated out of the Service's RBFWO. Monitoring and evaluation activities related to fish health concerns are conducted primarily by the CA-NV FHC.

The two overall goals of the RBFWO Hatchery Evaluation program are: 1) assisting the hatcheries to maximize contributions to commercial and sport fisheries and/or escapement to the upper Sacramento River; and 2) conducting research and monitoring to assess impacts of propagation programs on natural-origin salmonids. The Hatchery Evaluation Program works closely with the Coleman NFH to identify and investigate areas of uncertainty and, when possible, to recommend changes to propagation strategies to increase benefits and reduce negative effects resulting from hatchery operations.

Much of the work associated with monitoring and evaluating the propagation programs at the Coleman NFH Complex is dependent on marking and tagging of juvenile salmon and steelhead. Subsequent recovery of marked and tagged fish harvested in the fisheries, recovered in natural spawning areas, or returning to the hatchery provide valuable information to assess hatchery benefits and unintended impacts on natural stocks. Approximately 5 million hatchery-origin juvenile salmonids are tagged and/or marked annually at the Coleman NFH Complex. Recoveries of tagged Chinook salmon in fisheries, natural spawning areas, and at the hatchery are conducted by personnel from RBFWO, CDFG, Department of Water Resources, and others.

Handling, sampling, and tagging of ESA-listed species incidentally captured at the Coleman NFH or Keswick Dam fish trap is conducted to gather information on natural stocks, mark them for future identification, and to assess impacts of hatchery operations. These activities constitute "take" of listed species. The Service seeks authorization for incidental take for the following activities associated with handling, sampling, and tagging of listed species captured incidentally to the collection of broodstock for the Coleman and Livingston Stone NFHs:

- Collecting biological information and samples and applying marks and/or tags to spring and winter Chinook salmon and natural-origin steelhead incidentally trapped at the Coleman NFH or Keswick fish trap during broodstock collection activities for the Coleman and Livingston Stone NFHs. Information collected may include length, weight, and gender. Fishes may be evaluated for applied marks and scanned electronically to assess for internal tags. Samples collected from incidentally collected, ESA-listed fishes may include fin tissue and scales. Additionally, otoliths and other tissues may be collected from fishes accidentally killed during activities associated with the artificial propagation programs. Prior to release, fish may be marked using fin clips or fin punches, T-bar (e.g, Floy®) or dart-type (e.g., Hallprint®) tags, visible implant elastomer, and other low-impact methods. To conduct these activities associated with monitoring and evaluating the Coleman and Livingston Stone NFHs, fishes will be held using nets or hands. Sampled fishes may be anaesthetized using either carbon dioxide or MS-222 to subdue them and reduce the risk of injury. All anaesthetized fishes will be allowed to fully recover equilibrium before release into the wild. Estimates of take for these activities are included with those provided in Chapter 7 (Broodstock Collection) and summarized in Chapter 2 (Program Effects on Listed Populations) of this document.

Additional functions of the Service's Hatchery Evaluation program of the Coleman NFH Complex include activities that are helpful to assess and evaluate the performance of the fish propagation programs at the Coleman NFH Complex but either do not involve the take of listed species or have obtained allowances for take through separate permitting processes (e.g., section 10 research permits). Data resulting from these monitoring efforts will be used to adaptively manage the hatchery programs to increase benefits and reduce potential risks resulting from artificial propagation programs at Coleman and Livingston Stone NFHs. Examples of such activities listed below. All of the indicated monitoring projects are intended to be implemented on an annual basis, but are contingent upon necessary resources of staff and funding. Some of the indicated monitoring and evaluation measures rely upon data collected by entities outside of the control of the Service's Hatchery Evaluation program.

11.2 Performance indicators addressing hatchery benefits

Performance Standard B1: Optimize abundance of anadromous salmonids in Battle Creek by integrating Coleman NFH with Battle Creek Restoration

Monitoring and Evaluation:

- Conduct real-time monitoring of salmon abundance during fall Chinook spawning operations (FCS)
- Conduct video monitoring and adult trapping at the Coleman NFH barrier weir to enumerate passage of salmonids from March through July (LFCS, SCS, WCS, STT)
- Monitoring assess current and future levels of natural production within Battle Creek (LFCS, WCS, STT)
- Conduct managed passage of salmonids upstream of the Coleman NFH barrier weir (LFCS, STT)
- Conduct video monitoring at a seasonally-installed weir to estimate the abundance of fall Chinook salmon migrating into Battle Creek
- Conduct surveys by walking, wading, and boating in Battle Creek, the Sacramento River, and proximate tributary streams to assess for hatchery-origin fishes and to deploy receivers for acoustic tags

Performance Standard B2: Increase or maintain harvest opportunities for commercial and sport fisheries (FCS, LFCS, STT)

Monitoring and Evaluation:

- Continue to mark and tag all, or representative portions, of each stock produced at Coleman and Livingston Stone NFHs (FCS, LFCS, WCS, STT)

- Compiling, summarizing, and distributing information of hatchery releases, adult returns, and mark recoveries (FCS, LFCS, WCS, STT)
- Conduct on-site “bio-sampling” (e.g., tag recovery and measuring biological characteristics) of all salmonids returning to Coleman NFH (FCS, LFCS, STT)
- Estimate fishery contribution (rates and total numbers) of hatchery Chinook salmon and steelhead to Pacific Ocean commercial and sport fisheries and the Sacramento River sport fishery (FCS, LFCS, STT)

Performance Standard B3: Assist in the restoration of listed stocks of anadromous salmonids (WCS, STT)

Monitoring and Evaluation:

- Conduct field surveys to generate run-size estimates and evaluate survival, spawning success, and integration of hatchery propagated winter Chinook salmon with the natural population (WCS)
- Monitor and evaluate genetic risks of the winter Chinook propagation program to measure potential genetic effects on the natural population (WCS)
- Monitor natural-origin salmonids returning to Coleman NFH and passing upstream of the barrier weir (LFCS, STT)
- Maintaining an archive of tissue samples collected for genetic analyses (FCS, LFCS, WCS, STT)

Performance Standard B4: Maintain stock integrity and conserve genetic and life history diversity (FCS, LFCS, WCS, STT)

Monitoring and Evaluation:

- At the conclusion of each spawning season, analyze CWTs from spawned fish to verify selection of target broodstock (FCS, LFCS)
- Analyze trends in fecundity, survival for different life stages, return rates, return timing, spawn timing, adult size and age composition, and other parameters as surrogates for measures of “fitness” of the hatchery stock (FCS, LFCS, WCS, STT)

Performance Standard B5: Provide fish for experimental purposes

Monitoring and Evaluation:

- Facilitate requests for hatchery-origin fishes and determine participation in experimental investigations

Performance Standard B6: Conduct research to monitor and evaluate hatchery operations and practices

Monitoring and Evaluation:

- Evaluate contribution to ocean fisheries (FCS, LFCS)
- Continue mark screening and mark/tag recovery efforts on adults returning to Coleman NFH and the Keswick Dam Fish Trap (FCS, LFCS, WCS, STT)

- Collect and analyze information obtained through adult trapping and video monitoring at the Coleman NFH barrier weir in Battle Creek (FCS, LFCS, WCS, STT)
- Summarize and analyze ocean harvest data (PSMFC-RMIS) (FCS, LFCS, WCS, STT)
- Summarize and analyze information collected during mainstem Sacramento River adult carcass surveys (LFCS, WCS, STT)
- Analyze information collected from juvenile emigration monitoring programs on Battle Creek and the Sacramento River (FCS, LFCS, WCS, STT)

Performance Standard B7: Improve survival of propagated species/stock using appropriate incubation, rearing, and release strategies (FCS, LFCS, WCS, STT)

Monitoring and Evaluation:

- Analyze trends in survival for different life stages at the hatchery (FCS, LFCS, WCS, STT)
- Analyze trends in ocean and freshwater harvest rates and escapement (FCS, LFCS, WCS, STT)

Performance Standard B8: Improve survival by preventing disease introduction, spread, or amplification

Monitoring and Evaluation:

Analyze survival trends for different life stages at the hatcheries (FCS, LFCS, WCS, STT)

Performance Standard B9: Provide local, state, and regional economic enhancement

Monitoring and Evaluation:

- Estimate direct and indirect economic enhancement of local, state, and regional economies resulting from propagation programs at Coleman NFH by calculating input to local economy and commercial and sport value of the fishery attributable to the hatchery (FCS, LFCS)

11.3 Performance Indicators addressing hatchery risks

Performance Standard R1: Reduce potential negative effects of Coleman NFH on restoration of Battle Creek (FCS, LFCS, STT)

Monitoring and Evaluation:

- Analyze adult escapement and natural production of Battle Creek both upstream and downstream of the hatchery barrier weir (FCS, LFCS, STT)
- Monitor emigration of hatchery releases (FCS, LFCS, STT)
- Monitor quality of effluent water from Coleman NFH

Performance Standard R2: Reduce potential interactions between hatchery- and natural-origin stocks

Monitoring and Evaluation:

- Analyze stray rates of fish groups of fish released different sizes and/or off-site locations (FCS, LFCS)
- Analyze emigration rates and timing of hatchery- and natural-origin Chinook salmon and steelhead (FCS, LFCS, WCS, STT)
- Preparing documentation to fulfill ESA, National Environmental Policy Act, and CESA requirements necessary to conduct propagation programs for listed and non-listed species. (Environmental Assessments, Biological Assessments, Section 10 enhancement permits, etc.)

Performance Standard R3: Do not introduce, spread, or amplify pathogens of natural stocks (FCS, LFCS, WCS, STT)

Monitoring and Evaluation:

- Examine trends of ocean harvest, freshwater harvest, and hatchery escapement in regards to documented history of disease incidence at Coleman NFH and Livingston Stone NFH
- Examine on-station mortality

Performance Standard R4: Reduce the potential for negative genetic effects of artificial propagation programs on natural stocks (FCS, LFCS, WCS, STT)

Monitoring and Evaluation:

- Analyze CWTs following each spawning season to verify selection of target broodstock (FCS, LFCS)
- Monitor and analyze trends in fecundity, survival for different life stages, return rates, return timing, spawn timing, adult size and age composition, and other parameters to indicate potentially deleterious changes occurring in the hatchery stock (FCS, LFCS, WCS, STT)
- Calculate effective population size estimates for releases of winter Chinook salmon

Performance Standard R5: Do not exceed carrying capacity of fluvial, estuarine or ocean habitats

Monitoring and Evaluation:

- Freshwater - Evaluate emigration rates of hatchery-origin juveniles to verify rapid emigration (FCS, LFCS, STT)
- Estuarine & Ocean - Limited ability to assess

Performance Standard R6: Conduct research to evaluate potential effects on natural stocks and adaptively manage hatchery operations and activities

Monitoring and Evaluation:

- Serve as principle liaison between the hatchery and other agencies / interested parties (i.e., NMFS, CDFG, etc.)

- Monitor emigration of juvenile salmonids originating naturally in Battle Creek above and below the barrier weir
- Monitor straying of fall and late-fall Chinook salmon produced at Coleman NFH (FCS, LFCS)

12 RESEARCH

The Service's RBFWO and CA-NV FHC work closely with the Coleman NFH Complex to develop research projects to resolve scientific uncertainties associated with propagation programs at the Coleman NFH Complex. The following list describes some of the Service's ongoing research projects. Permitting for research projects is conducted, when necessary, through the section 10 process.

12.1 Studies associated with monitoring the winter Chinook propagation program

The Service's RBFWO cooperates with the CDFG on a winter Chinook salmon escapement survey to generate an estimate of winter Chinook abundance and evaluate the effectiveness of the winter Chinook propagation program. This survey has been conducted continuously since 1996 (Snider et al. 1997a, 1998b, 1999c, 2000a, and 2001; Service 2003b, 2004a, 2004b, 2006a, 2006b, 2007b, 2008b, and 2009). The take of ESA-listed species associated with this survey is covered under the Service's section 10 enhancement permit.

12.2 Studies associated with monitoring the Battle Creek Restoration Process

The Service's RBFWO will coordinate and conduct monitoring activities associated with assessing progress toward Battle Creek restoration. Planned monitoring activities include videotaping and trapping adults as they pass through the upstream fish ladder in The Coleman barrier weir. Take associated with Battle Creek monitoring activities is covered under the Service's section 10 research permit.

12.3 Investigation of steelhead/rainbow trout life history using otolith microchemistry

The life history of rainbow trout entering Coleman NFH is being investigated by to determine the portion of hatchery-origin steelhead returning to the Coleman NFH that exhibit Anadromy. The goal of this project is to help determine age at maturity and length of freshwater and ocean residency in hatchery-origin steelhead returning to Battle Creek, California. This will be accomplished by assessing the Sr^+/Ca^+ ratios within the primordia and rings of otoliths.

12.4 Reproductive success of naturally spawning winter Chinook salmon

The Fish Conservation Genetics Laboratory at the Service's Abernathy Fish Technology Center, Coleman NFH Complex, and RBFWO are collaborating on a genetic grandparentage analysis to confirm reproductive success of naturally-spawning hatchery-origin winter Chinook salmon in the upper Sacramento River.

12.5 Acoustic monitoring of emigrating hatchery-origin late-fall Chinook

The Coleman NFH Complex and RBFWO are collaborating with several researchers to conduct research to examine post-release survival and migratory patterns of hatchery-origin late-fall Chinook. Acoustic transmitters are surgically implanted in hatchery-origin smolts prior to their release. Electronic signals emitted by acoustic tags are logged as tagged salmon emigrate past acoustic receivers located throughout the migratory corridor in Battle Creek, the Sacramento River, Bay-Delta, and into the Pacific Ocean.

13 CITATIONS, APPENDICES, AND ATTACHMENTS

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13.2 APPENDICES

Appendix 4A Derivation of take estimates for ESA-listed salmonids at the Coleman National Fish Hatchery associated with use of Intake #2. All flow measurements are in units of cubic feet per second (cfs).

Month	(A) Battle Creek Average Daily Discharge at Coleman NFH (1961-2008)	(B) Agricultural Diversions at Coleman NFH Intakes	(C) Abatement Pond Outflow	(D) Orwick Agricultural Diversion	(E) Total Battle Creek flow at Intake #2	(F) Coleman NFH Water Requirements	(G) Total Diversions through Coleman NFH Intakes	(H) Proportion of Total Battle Creek flow diverted through unscreened Intake #2
January	742	13	6	50	811	109	122	0.089
February	737	13	6	50	806	98	111	0.076
March	732	13	6	50	801	98	111	0.076
April	654	13	6	50	723	73	86	0.050
May	629	13	6	50	698	41	54	0.006
June	485	13	6	50	554	47	60	0.018
July	331	13	6	50	400	55	68	0.045
August	265	13	6	50	334	62	75	0.075
September	260	13	6	50	329	78	91	0.125
October	294	13	6	50	363	109	122	0.198
November	396	13	6	50	465	109	122	0.155
December	558	13	6	50	627	109	122	0.115

(E) Total Battle Creek flow at the site of hatchery Intake #2 was estimated by summing the following data: (1) average daily discharge of Battle Creek 1961-2008, as measured at the USGS gauging station at Coleman NFH (USGS gauging station 11376550); (2) the agricultural diversion collected at the Coleman NFH intakes (13 cfs year-round); (3) the outflow of the hatchery's pollution abatement pond (estimated at 6 cfs), and; (4) diversions through the Orwick agricultural diversion (estimated at 50 cfs year-round).

(F) Based on monthly water requirements for fish culture activities at the hatchery.

(I) Value modified to reflect reduced flow due to prior withdraw at Intake #2.

(J) Monthly spring Chinook passage (J) was estimated by a rotary screw trap sampling program conducted by the Red Bluff Fish and Wildlife Office (see worksheet "Passage Estimates").

(K) The monthly emigration of juvenile spring Chinook salmon observed in Dec 2009-July 2010 (J) was multiplied by the proportion of Battle Creek Flow diverted through the Coleman NFH Intake #2 (H) multiplied by estimated percent of time Intake 2 in use to estimate the take of Spring Chinook salmon (K).

Appendix 4A Extended

	Spring Chinook Salmon			Steelhead/Rainbow Trout			Winter Chinook Salmon	
(I) Proportion of Total Battle Creek flow diverted through screened Intake #3	(J) Average Monthly Juvenile Spring Chinook Passage	(K) Total Estimated Take at Intake #2	(L) Estimated Take at Intake #2 attributable to Coleman NFH	(M) Average Monthly Juvenile Steelhead Passage	(N) Total Estimated Take at Intake #2	(O) Estimated Take at Intake #2 attributable to Coleman NFH	(P) Average Monthly Winter Chinook Passage	(Q) Total Estimated Take at Coleman NFH Intake #2
0.075	66,825	164	147	967	2	2	0	0
0.074	5,629	13	12	309	1	1	0	0
0.075	627	1	1	99	0	0	0	0
0.081	3,220	5	4	429	1	1	0	0
0.080	1,902	2	1	605	0	0	0	0
0.105	451	1	1	2,275	1	1	0	0
0.160	0	0	0	351	0	0	0	0
0.208	0	0	0	0	0	0	0	0
0.228	0	0	0	0	0	0	0	0
0.225	0	0	0	0	0	0	0	0
0.154	0	0	0	0	0	0	0	0
0.103	17,879	57	51	77	0	0	0	0
Annual Total	96,533	243	216	5,112	6	5	0	0
Percent of Total		0.25%			0.11%			
Requested Allowance for Incidental Take			243			6		0

(L) Estimated take at Intake #2 attributable to Coleman NFH is the product of Total Estimated Take at Intake #2 "(K)" and the proportion of water diversion at Intake #2 used at the hatchery " (F/G)."

(M) Monthly steelhead/rainbow trout passage (M) was estimated by a rotary screw trap sampling program conducted by the Red Bluff Fish and Wildlife Office (see worksheet "Passage Estimates").

(N) The monthly emigration of juvenile steelhead observed Dec 2009-July 2010 was multiplied by the proportion of Battle Creek Flow diverted through the Coleman NFH Intake #2 (H) multiplied by estimated percent of time Intake 2 in use to estimate the take of Steelhead (N).

(O) Estimated take at Intake #2 attributable to Coleman NFH is the product of Total Estimated Take at Intake #2 "(N)" and the proportion of water diversion at Intake #2 used at the hatchery " (F/G)."

(P) Zero juvenile winter Chinook salmon are estimated to emigrate from Battle Creek during the period of closure of PG&E's Coleman Powerhouse based on observation of no adult winter Chinook.

Appendix 6A Summary of Chinook spawning at Coleman and Livingston Stone National Fish Hatcheries including brood year, run (race); collection location; capture and spawning dates; number of females, males, and jacks collected and spawned; number of eggs collected; and lot number. Information in this table may be cross-tabulated with distribution data (Appendix 10A) using "lot number."

Brood Year	Species / Run	Adult Collection Location	Begin Capture Date	End Capture Date	Total Fish Handled	Total Females	Total Males	Total Jacks	Begin Spawn Date	End Spawn Date	Spawned			Total Eggs	Lot Number
											Females	Males	Jacks*		
1909	FCS	BC Racks							10/26/1909	11/21/1909	1,250			7,568,985	
1910	FCS	BC Racks							10/25/1910	12/1/1910	2,568			15,446,515	
1911	FCS	BC Racks							10/25/1911	12/22/1911	1,653			11,590,000	
1912	FCS	BC Racks							10/25/1912	12/5/1912	887			6,604,000	
1913	FCS	BC Racks							10/27/1913	12/15/1913	2,400			16,424,310	
1914	FCS	BC Racks							10/21/1914	11/30/1914	3,681			22,895,000	
1915	FCS	BC Racks							10/26/1915	12/2/1915	1,800			11,147,060	
1916	FCS	BC Racks							10/19/1916	12/8/2016	2,419			14,295,000	
1917	FCS	BC Racks							10/25/1917	12/5/1917	844			5,977,000	
1918	FCS	BC Racks							10/24/1918	12/18/1918	782			5,384,000	
1919	FCS	BC Racks							10/25/1919	12/17/1919	619			4,078,000	
1920	FCS	BC Racks							10/20/1920	11/21/1920	342			2,450,000	
1921	FCS	BC Racks							10/22/1921	12/3/1921	578			5,840,000	
1922	FCS	BC Racks							10/21/1922	11/28/1922	288			1,704,000	
1923	FCS	BC Racks							10/25/1923	12/4/1923	248			1,620,400	
1924	SCS	Coleman Powerhouse							latter part of Sept., 1924		96			446,000	
1924	FCS	BC Racks							10/23/1924	12/1/1924	158			687,500	
1925	FCS	BC Racks							10/23/1925	12/5/1925	259			1,785,100	
1925	FCS	Mill Creek Station												60,000	
1926	FCS	BC Racks and Sacramento River							10/19/1926	12/1/1926	576			4,004,600	
1926	FCS	Mill Creek Station												960,000	
1927	FCS	BC Racks and Sacramento River							10/23/1927	11/28/1927	318			2,373,200	
1928	FCS	BC Racks and Sacramento River							10/23/1928	11/27/1928	312			2,347,200	
1929	FCS	BC Racks							10/22/1929	12/6/1929	1,056			7,674,800	
1930	FCS	BC Racks							10/28/1930	11/26/1930	1,419			11,130,800	
1931	FCS	BC Racks							10/24/1931	12/1/1931	1,096			9,941,600	
1932	FCS	BC Racks							10/27/1932	11/30/1932	526			4,159,000	
1933	FCS	BC Racks							10/27/1933	11/28/1933	179			1,452,600	
1934	FCS	BC Racks							10/25/1934	11/26/1934	461			2,884,000	
1935	FCS	BC Racks							10/23/1935	12/4/1935	1,565			8,580,700	
1936	FCS	BC Racks			6,106*	535		5,417	11/2/1936	12/8/1936	525	154		3,234,205	
1937	FCS	BC Racks							11/1/1937	11/19/1937	1,359			8,039,960	
1938	FCS	BC Racks			3,915	2,071		215	11/1/1938	11/28/1938	1,834	1,626		12,001,000	

Appendix 6A (cont.) Summary of Chinook salmon spawning at Coleman and Livingston Stone National Fish Hatcheries including brood year, run (race), collection location, capture and spawning dates, number of males, females, and jacks collected and spawned, number of eggs collected, and lot number.

Brood Year	Species / Run	Adult Collection Location	Begin Capture Date	End Capture Date	Total Fish Handled	Total Females	Total Males	Total Jacks	Begin Spawn Date	End Spawn Date	Spawned Females	Spawned Males	Spawned Jacks*	Total Eggs	Lot Number
1939	FCS	BC Racks			14,861	1,179		12,695	10/30/1939	12/4/1939	847	937		5,223,636	
1939	SCS	BC Racks							10/2/1939	10/19/1939	29			173,000	
1940	FCS	BC Racks			4,088	2,445		316	10/31/1940	11/30/1940	2,383	1,325		12,204,000	
1941	FCS	BC Racks			2,608	1,733		187	10/31/1941	11/25/1941	1,683	736		8,088,000	
1942	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA		NA	NA
1943	SCS	Battle Creek	9/12/1943	10/20/1943										934,802	
1943	SCS	Balls Ferry & Keswick	9/12/1943	10/20/1943										118,863	
1943	FCS	Balls Ferry	10/20/1943	11/29/1943										8,320,853	
1944	SCS	Battle Creek	9/18/1944	10/25/1944										476,666	
1944	SCS	Balls Ferry & Keswick	9/18/1944	10/25/1944										3,563,984	
1944	FCS	Balls Ferry	10/18/1944	11/20/1944										11,298,880	
1945	SCS	BC Racks	9/16/1945	10/22/1945	462				9/27/1945	10/15/1945	31			127,668	8
1945	SCS	Balls Ferry	9/16/1945	10/22/1945					9/26/1945	10/26/1945	220			1,153,604	9
1945	FCS	Balls Ferry & Keswick	10/13/1945	11/29/1945					10/13/1945	12/15/1945	3,004			20,579,463	10
1945	FCS	BC Racks							12/13/1945	1/21/1946	200			3,256,000	11
1945	FCS	BC Racks												10,444,000	12
1946	SCS	Keswick	5/1/1946	10/4/1946	2,391						236			1,287,000	13
1946	SCS	BC Racks	June		2,450				9/23/1946	10/15/1946	333			1,476,000	12
1946	FCS	Keswick	11/4/1946	11/26/1946	7,536	2,385			11/6/1946	12/5/1946	2,379			14,403,000	15
1946	FCS	BC Racks & Diversion into Station	10/8/1946	11/7/1946	10,831	2,076			10/8/1946	11/20/1946	1,801			10,775,000	14
1947	SCS	BC Racks	8/13/1947	9/26/1947	1,003				9/16/1947	10/6/1947	38	16		165,000	17
1947	FCS	BC Racks & Diversion into Station	10/1/1947	12/5/1947	16,151 (est.)			5,324	10/21/1947	12/5/1947	1,947	528		10,875,000	18
1948	FCS	Keswick	10/16/1948	10/30/1948	102	27			12/16/1948	12/30/1948	27	25		150,000	
1948	FCS	BC Racks	10/5/1948	11/30/1948	2,374	794		1,259	10/26/1948	11/30/1948	674	219		3,770,000	19
1948	SCS	BC Racks	6/28/1948	9/22/1948	55			34						No Eggs Collected	
1949	FCS	BC Racks	10/1/1949	12/12/1949	5,528	2,391		1,835	10/20/1949	12/12/1949	2,221	782		13,221,464	23
1949	SCS	BC Racks	9/1/1949	10/17/1949	112	42		21	10/7/1949	10/17/1949	40	30		206,513	22
1950	FCS	Keswick	11/6/1950	12/22/1950	1,149	532		233			508	196		3,152,155	28
1950	SCS	BC Dam & Ponds			830	194		314	10/1/1950	10/23/1950	153	105		870,469	27
1950	FCS	BC Racks			4,105	1,604		1,669	10/22/1950	12/18/1950	1,384	492		7,438,254	28
1951	SCS	BC Dam & Ponds	9/18/1951	11/20/1951	1,832	158		1,464	9/18/1951	10/19/1951	158	94		986,926	32

Appendix 6A (cont.) Summary of Chinook salmon spawning at Coleman and Livingston Stone National Fish Hatcheries including brood year, run (race), collection location, capture and spawning dates, number of males, females, and jacks collected and spawned, number of eggs collected, and lot number.

Brood Year	Species / Run	Adult Collection Location	Begin Capture Date	End Capture Date	Total Fish Handled	Total Females	Total Males	Total Jacks	Begin Spawn Date	End Spawn Date	Spawned Females	Spawned Males	Spawned Jacks*	Total Eggs	Lot Number
1951	FCS	BC Racks			9,508	3,151		5,190			2,855	796		17,307,719	33
1951	FCS	Keswick	11/13/1951	12/3/1951	3,008	953		1,127	11/13/1951	12/7/1951	925	330		5,805,824	33
1952	FCS	BC Racks & Dam/Ponds	9/26/1952	11/26/1952	11,459	3,902		3,880	9/22/1952	12/10/1952	3,607	979		20,074,443	38
1952	FCS	Keswick	11/18/1952	12/5/1952	4,661	2,369		653	11/19/1952	12/19/1952	2,097	556		14,248,478	38
1953	FCS	BC Racks & Dam/Ponds	10/1/1953	11/18/1953	12,498	4,763		4,641	9/30/1953	12/8/1953	4,335	763		26,552,505	43
1953	FCS	Keswick	11/16/1953	12/9/1953	8,221	3,316		1,276	11/18/1953	12/17/1953	2,750	464		18,231,873	43
1954	FCS								9/1/1954	11/1/1954					45
1954	FCS	BC Racks & Dam/Ponds	10/1/1954	11/16/1954	7,812	2,248		3,179	9/30/1954	12/22/1954	2,091	569		11,191,249	46
1954	FCS	Keswick	11/15/1954	12/15/1954	5,997	2,389		1,480	11/18/1954	12/23/1954	2,160	827		12,308,482	
1955	FCS	BC Dam & Ponds	9/14/1955	1/16/1956	10,576				9/30/1955	1/16/1956	4,929 BC & Kes combined	1,316 BC & Kes combined		15,906,918	5CM
1955	FCS	Keswick	11/17/1955	12/19/1955	6,450				11/18/1955	1/9/1956				13,605,710	5CM
1955	WCS	Keswick	3/22/1955	4/2/1955	184						2				
1956	FCS	BC Dam & Ponds	9/21/1956	1/21/1957	7,358				10/4/1956	1/21/1957	3,606 BC & Kes combined	873 BC & Kes combined		15,042,946	6CM
1956	FCS	Keswick	11/19/1956	12/27/1956	2,641				11/20/1956	1/21/1957				6,551,079	6CM
1957	FCS	BC Dam & Ponds	9/30/1957	2/26/1958	3,045				10/4/1957	2/10/1958	2,889 BC & Kes combined	682 BC & Kes combined		4,105,534	7CM-56
1957	FCS	Keswick	11/14/1957	1/13/1958	9,111				11/15/1957	1/27/1958				15,154,263	11MT
1958	WCS	BC Dam & Ponds	4/23/1958	6/16/1958	309					6/16/1958	146			381,165 (BC & Kes)	8-CM-60
1958	FCS	BC Dam & Ponds	9/16/1958	2/4/1959	15,671				10/6/1958	2/4/1959	3,629			19,681,398	8-CM-62
1958	WCS	Keswick	4/21/1958	5/26/1958	420				4/25/1958	5/23/1958	90			381,165 (BC & Kes)	
1958	FCS	Keswick	11/17/1958	2/16/1959	9,373				11/20/1958	2/16/1959	2,916			17,268,438	8-CM-62
1958	FCS	Klamath River			8,024									220,800	
1958	FCS	Nimbus												51,840	8-CAL-64
1959	FCS	BC Dam & Ponds	9/28/1959	1/29/1960	10,863	5,903		824	9/28/1959	1/29/1960				33,474,000	9-CM-56
1959	FCS	Keswick	11/16/1959	1/29/1960	7,566	3,402		605	11/17/1959	1/29/1960	3,093			19,189,000	9-CM-66
1960	FCS	BC Dam & Ponds	9/13/1960	1/16/1961	9,605			3,866	10/5/1960	1/16/1961	2,706			18,612,000	9-CM-74
1960	FCS	Keswick	11/16/1960	1/9/1961	9,859			2,320	11/17/1960	1/23/1961	3,429			21,900,000	9-CM-74
1960	FCS	Spring Creek, WA												308,936	0-SC-73
1960	FCS	Fall Creek												40,113	0-CAL-75
1960	FCS	Nimbus												111,679	0-CAL-75

Appendix 6A (cont.) Summary of Chinook salmon spawning at Coleman and Livingston Stone National Fish Hatcheries including brood year, run (race), collection location, capture and spawning dates, number of males, females, and jacks collected and spawned, number of eggs collected, and lot number.

Brood Year	Species / Run	Adult Collection Location	Begin Capture Date	End Capture Date	Total Fish Handled	Total Females	Total Males	Total Jacks	Begin Spawn Date	End Spawn Date	Spawned Females	Spawned Males	Spawned Jacks*	Total Eggs	Lot Number
1961	FCS	BC Dam & Ponds	9/28/1961	1/24/1962	8,503	3,661		1,645	10/6/1961	1/24/1962	3,475			22,221,000	1-CN-78
1961	FCS	Keswick	11/15/1961	1/5/1962	5,647	2,556		427	11/17/1961	1/15/1962	2,263			13,315,000	1-CN-78
1961	FCS	Klamath River												100,800	1-CAL-79
1961	FCS	Nimbus												120,000	1-CAL-79
1961	WCS	Keswick	5/1/1961	5/5/1961											
1962	FCS	BC Dam & Ponds	10/1/1962	12/31/1962	4,761			1,356	10/8/1962	3/5/1963	1,645			9.125,000 (incomplete)	2-CN-83
1962	FCS	Keswick	11/13/1962		10,589	4,078		1,416	11/14/1962	3/5/1963	3,131			17,181,000 (incomplete)	2-CN-83
1962	WCS (LFS)	Keswick												60,000	1-CN-82
1962	WCS	Keswick	4/30/1962	5/7/1962	63										
1963	WCS	Keswick	5/22/1963	7/12/1963	514				5/23/1963	7/12/1963	53			235,700	3-CN-88
1963	FCS	BC Dam & Ponds	10/3/1963	4/14/1964	5,114				10/7/1963	2/18/1964	2,356			14,500,000	4-CN-89
1963	FCS	Keswick	11/17/1963	3/24/1964					11/17/1963	3/24/1964	2,105			13,500,000	4-CN-89
1964	WCS	Keswick	5/31/1964	6/29/1964	15										
1964	FCS	BC Dam & Ponds	10/1/1964	3/22/1965	3,873				10/8/1964	1/18/1965	1,585			10,103,500	5-CN-93
1964	FCS	Keswick	11/26/1964	3/16/1965	2,769				11/30/1964	3/16/1965	1,239			8,053,500	5-CN-93
1964	FCS	Nimbus												10,588,500	5-CAL-94
1965	WCS	Keswick	6/14/1965	6/30/1965	48				6/21/1965	7/1/1965	16	6		60,000	
1965	FCS	BC Dam & Ponds	10/5/1965	3/7/1966	3,194				10/12/1965	2/13/1966	2898 (BC & Kes combined)			19,291,000	6-CN-1
1965	FCS	Keswick	11/15/1965	2/23/1966	2,966				10/12/1965	2/13/1966					
1965	FCS	Nimbus												1,086,000	6-CAL-2
1966	WCS	Keswick	6/3/1966	6/30/1966					6/20/1966		2			8,000	6-CN-6
1966	FCS	BC Dam & Ponds	10/3/1966	3/31/1967	3,995				10/31/1966	3/31/1967	1900 (BC & Kes combined)			12,696,200	7-CN-9
1966	FCS	Keswick	11/1/1966	3/31/1967					10/31/1966	3/31/1967					
1967	WCS	Keswick	5/29/1967	6/16/1967					6/6/1967	6/16/1967	7			17,500	7-CN-13
1967	FCS	BC Dam & Ponds	10/13/1967	3/25/1968	7,440				10/16/1967	3/25/1968	3,094	2,151		18,400,200	8-CN-15
1967	FCS	Keswick	11/6/1967	3/25/1968					10/16/1967	3/25/1968					
1968	FCS	BC Dam & Ponds	10/1/1968	3/21/1969	7,167						2,077	1,465		11,479,497	9-CN-20

Appendix 6A (cont.) Summary of Chinook salmon spawning at Coleman and Livingston Stone National Fish Hatcheries including brood year, run (race), collection location, capture and spawning dates, number of males, females, and jacks collected and spawned, number of eggs collected, and lot number.

Brood Year	Species / Run	Adult Collection Location	Begin Capture Date	End Capture Date	Total Fish Handled	Total Females	Total Males	Total Jacks	Begin Spawn Date	End Spawn Date	Spawned Females	Spawned Males	Spawned Jacks*	Total Eggs	Lot Number
1968	FCS	Keswick	11/15/1968	3/21/1969											
1968	FCS	A.C.I.D. Trap	10/9/1968	11/13/1968											
1968	FCS	Nimbus												5,643,641	9-UC-23
1969	FCS	BC Dam & Ponds			2,726				10/10/1969	1/10/1970	2,951	1,831		16,716,328	9-CN-26
1969	FCS	Keswick	11/19/1969		4,112					3/20/1970					
1970	FCS	BC Dam & Ponds			3,466				10/16/1970	3/22/1971	3,335	1,782		20,314,565	0-CN-31
1970	FCS	Keswick	10/29/1970		4,053					3/22/1971					
1971	FCS	BC Dam & Ponds			2,112				10/22/1971	3/8/1972	1,811	918		11,858,896	1-CN-37
1971	FCS	Keswick			2,186										
1971	FCS	Nimbus												11,145,920	1-UCA-38
1972	FCS	BC Dam & Ponds	9/20/1972		3,225			1,461	10/6/1972	1/5/1973	913	721		5,729,245	2-CM-43
1972	FCS	Nimbus												2,498,780	2-UCA-44
1973	LFS	Keswick			403				11/9/1972	1/10/1973					
1973	FCS	BC Dam & Ponds			3,502			839	10/12/1973	12/12/1973	1,547	1,139		8,690,174	3-CM-50
1974	LFS	Keswick	1/14/1974	3/14/1974	705			57	1/24/1974	3/15/1974	310	248		2,149,257	3-CM-55
1974	FCS	Nimbus												6,556,880	3-UCA-51
1974	FCS	Feather River												4,138,260	3-UCA-52
1974	FCS	BC Dam & Ponds	10/1/1974		1,607			353	10/18/1974	12/6/1974	1,096	638		6,389,597	4-CM-56
1975	LFS	Keswick	11/15/1974	2/28/1975	2,066			78	12/10/1974	3/7/1975	638	527		4,113,022	4-CM-57
1975	FCS	Nimbus												3,418,765	4-UCA-58
1975	FCS	BC Dam & Ponds	10/1/1975	12/5/1975	2,711			696	10/10/1975	12/5/1975	1,122	746		7,036,664	5-CM-63
1976	LFS	Keswick	11/10/1975		911			29	12/2/1975	1/16/1976	200	229		1,277,175	5-CM-65
1976	FCS	Nimbus												8,246,725	5-UCA-64
1976	FCS	Sacramento River @ RBDD			5,600			823	9/24/1976	12/3/1976	1,491	890		9,608,235	6-CM-72
1976	FCS	Nimbus												2,426,000	6-UCA-73
1977	LFS	Keswick	9/21/1976		756				12/10/1976	2/11/1977	273	20		1,610,277	6-CM-74
1977	FCS	Sacramento River @ RBDD			4,825			492	9/27/1977	12/2/1977	1,976	866		12,670,069	7-CM-78
1977	FCS	Feather River												1,553,466	7-UCA-79
1977	FCS	Nimbus												1,589,594	7-UCA-83
1977	FCS	Nimbus												1,575,000	7-UCA-84
1977	SCS	Keswick													
1978	LFS	Keswick			1,853			110	12/6/1977	1/7/1978	470	536		2,854,249	7-CM-82
1978	WCS	Keswick			63				5/2/1978	6/23/1978	29	34		121,125	8-CM-86

Appendix 6A (cont.) Summary of Chinook salmon spawning at Coleman and Livingston Stone National Fish Hatcheries including brood year, run (race), collection location, capture and spawning dates, number of males, females, and jacks collected and spawned, number of eggs collected, and lot number.

Brood Year	Species / Run	Adult Collection Location	Begin Capture Date	End Capture Date	Total Fish Handled	Total Females	Total Males	Total Jacks	Begin Spawn Date	End Spawn Date	Spawned Females	Spawned Males	Spawned Jacks*	Total Eggs	Lot Number
1978	FCS	BC Dam & Ponds			1,872			830	10/13/1978	12/1/1978	452	374		2,121,881	8-CM-87
1978	FCS	Mad River Fish Hatchery												815,870	8-UCA-88
1978	SCS	Keswick												none	
1978	FCS	Nimbus												3,676,430	
1979	LFS	Keswick			829			21	12/8/1977	2/9/1978	325	335		1,738,304	8-CM-90
1979	FCS	BC Dam & Ponds			8,729			3,894	10/2/1979	11/30/1979	2,669	1,747		15,639,290	9-CM-91 & 9-CM-94
1980	LFS	Keswick			867			38	12/10/1979	2/29/1980	373	276		1,939,000	9-CM-93
1980	FCS	BC Dam & Ponds			7,628			572	10/10/1980	11/28/1980	3,580	2,918		17,804,000	0-CM-96
1981	LFS	Keswick			2,065			190	12/1/1980	2/11/1981	814	684		3,614,000	0-CM-97
1981	FCS	BC Dam & Ponds			10,173			7,323	10/2/1981	11/30/1981	2,233	1,035		11,515,000	1-CM-99
1981	FCS	Keswick			1,300										
1982	LFS	Keswick			1,886			218	12/3/1981	2/18/1982	553	567		2,765,000	2-CM-02
1982	LFS	BC Dam & Ponds			141										
1982	WCS	Keswick			57				5/11/1982	5/25/1982	7 (5)	11		35,000	2-CM-03
1982	FCS	BC Dam & Ponds			19,361			3,276	10/4/1982	11/29/1982	5,519	5,264		26,624,000	2-CM-04
1982	FCS	Keswick			93										
1983	LFS	BC Dam & Ponds			183			31	12/2/1982	3/11/1983	356	342		1,888,000	2-CM-06
1983	LFS	RBDD			343				12/2/1982	3/11/1983					
1983	LFS	Keswick			432				12/2/1982	3/11/1983					
1983	FCS	Keswick			212			3,401	10/3/1983	12/5/1983	2,725	1,295		9,845,886	3-CM-08
1983	FCS	BC Dam & Ponds			8754										
1983	FCS	Feather River												900,000	3-UCA-09
1984	LFS	BC Dam & Ponds			51			289	12/14/1983	3/15/1984	177	94		669,901	3-CM-12
1984	LFS	RBDD			153										
1984	LFS	Keswick			424										
1984	WCS	Keswick & RBDD			34						0	0			
1984	FCS	BC Dam & Ponds			21,543			2,916	10/1/1984	12/12/1984	7,841	8,723		27,814,636	4-CM-13
1985	LFS	BC Dam & Ponds			23			42	12/19/1984	2/26/1985	141	142		597,378	5-CM-15
1985	LFS	Keswick			365				12/19/1984	2/26/1985					
1985	WCS	Keswick & RBDD						0			32	0			
1985	FCS	BC Dam & Ponds			26,205			4,561	10/1/1985	12/10/1985	4,495	5,641		24,700,000	5-CM-16

Appendix 6A (cont.) Summary of Chinook salmon spawning at Coleman and Livingston Stone National Fish Hatcheries including brood year, run (race), collection location, capture and spawning dates, number of males, females, and jacks collected and spawned, number of eggs collected, and lot number.

Brood Year	Species / Run	Adult Collection Location	Begin Capture Date	End Capture Date	Total Fish Handled	Total Females	Total Males	Total Jacks	Begin Spawn Date	End Spawn Date	Spawned Females	Spawned Males	Spawned Jacks*	Total Eggs	Lot Number
1985	FCS	Keswick			636				10/1/1985	12/10/1985					
1986	LFS	BC Dam & Ponds			354			29	12/17/1985	2/13/1986	216	208		1,060,000	6-CM-18
1986	LFS	Keswick			376				12/17/1985	2/13/1986					
1986	FCS	BC Dam & Ponds			19,744			1,221	10/6/1986	12/11/1986	5,421	5,360		23,818,300	6-CM-19
1986	FCS	Keswick			228				10/6/1986	12/11/1986					
1987	LFS	BC Dam & Ponds			349			13	12/18/1986	2/19/1987	341	287		1,941,227	7-CM-22
1987	LFS	Keswick			454				12/18/1986	2/19/1987					7-CM-21
1987	FCS	BC Dam & Ponds			18,446			6,289	10/4/1987	12/16/1987	4,952	3,706		25,661,469	
1988	LFS	BC Dam & Ponds			53			38	12/23/1987	3/15/1988	186	169		1,051,500	8-CM-26
1988	LFS	Keswick			411				12/23/1987	3/15/1988					8-CM-25
1988	WCS														
1988	FCS	BC Dam & Ponds			15,552	6,683	7,694	1,175	10/6/1988	12/14/1988	5,139	6,565		25,884,382	8-CM-27
1989	LFS	Keswick			817	392	423	2	1/4/1989	4/6/1989	318	318		1,761,218	9-CM-30
1989	LFS	BC Dam & Ponds			65	29	24	12	12/21/1988	4/6/1989	22	20		96,591	9-CM-29
1989	WCS	RBDD & Keswick	3/15/1989	5/2/1989	42	22	20	0	6/29/1989	6/29/1989	1	1		6,191	9-CM-32
1989	FCS	BC Dam & Ponds			11,986	4,127	6,052	1,807	10/5/1989	12/18/1989	3,237	5,343		18,096,155	FCS-BCW-89-COL
1990	LFS	BC Dam & Ponds			92	41	40	11	1/3/1990	2/12/1990	31	30		138,087	LFS-BCW-90-COL
1990	LFS	Keswick			100	35	63	2	1/3/1990	3/27/1990	22	43		112,208	LFS-KEW-90-COL
1990	WCS	Keswick	1/22/1990	5/1/1990	14	10	4	0	5/9/1990	5/9/1990	1	1		5,012	WCS-SRW-90-COL
1990	FCS	BC Dam & Ponds			14,650	6,405	7,095	1,150	10/3/1990	12/27/1990	5,411	5,502		28,609,707	FCS-BCW-90-COL
1991	LFS	BC Dam & Ponds			161	65	81	15	1/4/1991	2/19/1991	60	65		217,344	LFS-BCW-91-COL
1991	LFS	Keswick			118	49	65	4	1/4/1991	2/19/1991	45	53		235,497	LFS-KEW-91-COL
1991	WCS	RBDD & Keswick	3/29/1991	6/5/1991	23	10	5	8	4/18/1991	6/17/1992	6	13		29,919	WCS-SRW-91-COL
1991	FCS	BC Dam & Ponds			10,689	5,834	4,242	613	10/10/1991	12/13/1991	4,692	3,709		25,187,384	FCS-BCW-91-COL
1992	LFS	BC Dam & Ponds			344	164	171	9	12/27/1991	2/24/1992	119	95		534,355	LFS-BCW-92-COL
1992	LFS	Keswick			399	239	157	3	12/18/1991	2/18/1992	161	77		783,758	LFS-KEW-92-COL
1992	LFS	BC & Keswick			21		21							57,659	LFS-BxK-92-COL
1992	WCS	Keswick	4/10/1992	5/4/1992	29	14	15		5/5/1992	7/1/1992	13	13		59,445	WCS-SRW-92-COL
1992	FCS	BC Dam & Ponds			7,275	2,970	3,266	1,039	10/13/1992	12/17/1992	2,693	2,674		14,134,423	FCS-BCW-92-COL
1993	LFS	BC Dam & Ponds			528	187	169	172	12/30/1992	3/2/1993	130	159		536,408	LFS-BCW-93

Appendix 6A (cont.) Summary of Chinook salmon spawning at Coleman and Livingston Stone National Fish Hatcheries including brood year, run (race), collection location, capture and spawning dates, number of males, females, and jacks collected and spawned, number of eggs collected, and lot number.

Brood Year	Species / Run	Adult Collection Location	Begin Capture Date	End Capture Date	Total Fish Handled	Total Females	Total Males	Total Jacks	Begin Spawn Date	End Spawn Date	Spawned			Total Eggs	Lot Number
											Females	Males	Jacks*		
1993	LFS	Keswick			375	168	200	7	12/30/1992	3/2/1993	124	131		739,935	LFS-KEW-93
1993	WCS	RBDD & Keswick	4/23/1993	6/4/1993	18	12	4	2	4/30/1993	7/27/1993	11	3		47,157	WCS-SRW-93-COL
1993	FCS	BC Dam & Ponds			7,587	3,753	3,269	565	10/8/1993	12/7/1993	3,487	2,770		17,979,774	FCS-BCW-93-COL
1994	LFS	BC Dam & Ponds			598	197	232	169	12/28/1993	3/1/1994	151	145		527,914	LFS-BCW-94-COL
1994	LFS	KES	12/13/1993		154	80	70	4	12/28/1993	2/15/1994	62	48		300,423	LFS-KEW-94-COL
1994	WCS		2/10/1994	4/22/1994	29	18	11		5/24/1994	7/5/1994	16	11		61,814	WCS-SRW-94-COL
1994	FCS	BC			18,991	4,308	7,240	7,443	10/6/1994	11/22/1994	3,771	4,728		19,595,404	FCS-BCW-94-COL
1995	LFS	BC			492	222	225	45	12/28/1994	2/7/1995	162	130		730,558	LFS-BCW-95-COL
1995	LFS	Keswick			224	115	99	10	12/28/1994	3/1/1995	97	67		527,800	LFS-KEW-95-COL
1995	WCS	Keswick	3/1/1995	6/27/1995	85		85		6/20/1995	7/24/1995	21	16		83,005	WCS-SRW-95-COL
1995	FCS	BC			26,677	11,138	13,656	1,883	10/10/1995	11/27/1995	3,882	4,277		21,311,599	FCS-BCW-95-COL
1996	LFS	BC			1,337	541	422	374	12/28/1995	2/27/1996	231	164		1,082,716	LFS-BCW-96-COL
1996	LFS	Keswick			48	29	18	1	1/16/1996	2/5/1996	25	16		154,757	LFS-KEW-96-COL
1996	FCS	BC			21,178	8,888	9,935	2,355	10/9/1996	11/19/1996	4,264	4,713		24,556,946	FCS-BCW-96-COL
1997	LFS	BC			4,578	1,996	2,131	451	12/26/1996	2/19/1997	368	414		1,615,277	LFS-BCW-97-COL
1997	WCS	Captive Broodstock	NA	NA			0		7/31/1997	8/13/1997	107	68		181,834	WCS-CAP-97-BML
1997	FCS	BC			50,670	24,467	20,171	6,032	10/7/1997	11/19/1997	4,104	4,840		23,996,644	FCS-BCW-97-COL
1998	LFS	BC			3,069	1,328	1,249	492	12/30/1997	2/24/1998	403	359		1,845,361	LFS-BCW-98-COL
1998	WCS	Keswick	4/8/1998	5/21/1998	108	72	36		5/1/1998	7/2/1998	61	35		205,668	WCS-SRW-98-LIV
1998	FCS	BC			44,350	19,809	22,663	1,878	10/7/1997	11/19/1997	3,136	4,440	22	15,680,000	FCS-BCW-98-COL
1999	LFS	BC	12/9/1998	3/2/1999	7,075	2,528	3,838	709	12/29/1998	3/2/1999	422	542	0	1,366,069	LFS-BCW-99-COL
1999	WCS	Keswick and RBDD	4/14/1999	6/17/1999	42*	14	8	18	5/1/1999	7/8/1999	9	2	12	68,892	WCS-SRW-99-LIV
1999	WCS	Captive Broodstock	NA	NA			0		6/18/1999	8/6/1999	20	15		30,500	WCS-CAP-99-BML
1999	FCS	BC			26,968	10,670	12,377	3,921	10/12/1999	11/16/1999	2,297	2,938	163	14,280,476	FCS-BCW-99-COL
2000	LFS	BC			4,194	2,417	1,297	480	12/28/1999	3/2/2000	207	250	22	1,093,668	LFC-BCW-00-COL
2000	WCS	Keswick and RBDD	3/15/2000	7/5/2000	102	60	42		4/25/2000	7/10/2000	44	34		216,000	WCS-SRW-00-LIV
2000	WCS	Captive Broodstock	NA	NA	NA	NA	NA		7/14/2000	8/15/2000	66	60		88,001	WCS-CAP-00-BML
2000	FCS	BC			21,659	9,554	11,233	872	10/17/2000	11/15/2000	2,552	2,702	151	16,081,656	FCS-BCW-00-COL
2001	LFS	BC			2,359	1,023	1,139	197	12/27/2000	2/14/2001	256	417	20	1,287,449	LFS-BCW-00-COL
2001	WCS	Keswick and RBDD	2/28/2001	7/2/2001	205	88	117		6/5/2001	7/12/2001	50	47		236,864	WCS-SRW-01-LIV
2001	WCS	Captive Broodstock	NA	NA	NA	NA	NA		7/3/2001	7/31/2001	100	32		105,958	WCS-CAP-01-BML
2001	FCS	BC			24,698	6,965	11,814	5,919	10/11/2001	11/20/2001	3,863	3,892	318	13,377,264	FCS-BCW-01-COL
2002	LFS	BC			2,709	1,472	1,074	163	12/27/2001	2/26/2002	580	513	39	1,896,336	LFS-BCW-02-COL

Appendix 6A (cont.) Summary of Chinook salmon spawning at Coleman and Livingston Stone National Fish Hatcheries including brood year, run (race), collection location, capture and spawning dates, number of males, females, and jacks collected and spawned, number of eggs collected, and lot number.

Brood Year	Species / Run	Adult Collection Location	Begin Capture Date	End Capture Date	Total Fish Handled	Total Females	Total Males	Total Jacks	Begin Spawn Date	End Spawn Date	Spawned Females	Spawned Males	Spawned Jacks*	Total Eggs	Lot Number
2002	WCS	Keswick and RBDD	2/20/2002	7/8/2002	197	104***	90		4/24/2002	7/8/2002	48	40		231,375	WCS-SRW-02-LIV
2002	WCS	Captive Broodstock	NA	NA	NA	NA	NA		6/4/2002	7/30/2002	95	25		122,411	WCS-CAP-02-BML
2002	FCS	BC			65,805	18,997	42,759	4,049	10/8/2002	11/21/2002	5,607	6,657	323	21,184,675	FCS-BCW-02-COL
2003	LFS	BC			3,053	1,380	1,192	481	12/31/2002	2/20/2003	564	474	62	2,289,203	LFS-BCW-03-COL
2003	LFS	Keswick			32	15	17	0	12/31/2002	2/20/2003	16	15	0	110,528	LFS-BCW-03-COL
2003	WCS	Keswick and RBDD	1/13/2003	7/23/2003	285	157**	128		5/6/2003	7/23/2003	45	33		223,269	WCS-SRW-03-LIV
2003	WCS	Captive Broodstock	NA	NA	NA	NA	NA		6/23/2003	8/5/2003	99	21		140,641	WCS-CAP-03-BML
2003	FCS	BC			88,281	41,513	41,380	5,388	10/7/2003	11/18/2003	4,054	4,096	329	19,673,109	FCS-BCW-03-COL
2004	LFS	BC			5,099	1,711	2,015	1,373	12/30/2003	2/24/2004	601	502	109	2,456,464	LFS-BCW-04-COL
2004	LFS	Keswick			42	11	30	1	1/8/2004	2/19/2004	11	30	1	227,205	LFS-BCW-04-COL
2004	WCS	Keswick	1/7/2004	7/29/2004	346	68	278		5/19/2004	7/26/2004	37	36		192,387	WCS-SRW-04-LIV
2004	WCS	Captive Broodstock	NA	NA	NA	NA	NA		7/6/2007	8/13/2004	45	23		42,129	WCS-CAP-04-LIV
2004	FCS	BC			68,229	20,881	30,676	16,672	10/5/2004	11/23/2004	3,375	3,459	204	17,518,800	FCS-BCW-04-COL
2005	LFS	BC			6,460	2,735	2,488	1,237	12/29/2004	2/23/2005	653	460	70	2,969,993	LFS-BCW-05-COL
2005	LFS	Keswick			32	14	15	3	12/29/2004	2/23/2005	14	15	2	152,255	LFS-BCW-05-COL
2005	WCS	Keswick	4/27/2005	7/14/2005	393	224	169		4/27/2005	7/14/2005	51	39	5	267,803	WCS-SRW-05-LIV
2005	WCS	Captive Broodstock	NA	NA	NA	NA	NA		7/20/2005	8/11/2005	46	24		50,063	WCS-CAP-05-LIV
2005	FCS	BC			132,619	70,455	59,565	2,599	10/4/2005	11/22/2005	3,805	3,333	101	19,786,000	FCS-BCW-05-COL
2006	LFS	BC			14,773	9,350	5,097	326	12/28/2005	2/22/2006	754	679	45	3,289,500	LFS-BCW-06-COL
2006	LFS	Keswick			5	2	3	0	2/15/2006	2/15/2006	1	3	0	18,000	LFS-BCW-06-COL
2006	WCS	Keswick	2/21/2006	7/11/2006	312	149	163****		5/5/2006	7/20/2006	52	37****		279,853	WCS-SRW-06-LIV
2006	WCS	Captive Broodstock	NA	NA	NA	NA	NA		7/26/2006	8/15/2006	60	31		81,814	WCS-CAP-06-LIV
2006	FCS	BC			55,787	30,727	24,075	985	10/3/2006	11/21/2006	4,222	3,971	92	17,353,438	FCS-BCW-06-COL
2007	LFS	BC			5,243	2,911	1,638	694	12/27/2006	2/21/2007	585	439	43	2,398,500	LFS-BCW-07-COL
2007	LFS	Keswick			70	38	32	0	12/27/2006	2/21/2007	36	31	0	261,000	LFS-BCW-07-COL
2007	WCS	Keswick	3/13/2007	6/26/2007	156	99	57		5/29/2007	7/19/2007	25	19		121,341	WCS-SRW-07-LIV
2007	FCS	BC			11,547	6,399	4,950	198	10/4/2007	11/14/2007	4,295	3,215	96	16,515,000	FCS-BCW-07-COL
2008	LFS	BC			6,375	2,992	3,059	324	12/27/2007	2/20/2008	572	493	23	2,529,000	LFS-BCW-08-COL
2008	WCS	Keswick	2/26/2008	7/8/2008	198	103	95		5/23/2008	7/23/2008	49	44		260,370	WCS-SRW-08-LIV
2008	FCS	BC			10,574	4,662	5,452	460	10/7/2008	11/18/2008	3,910	3,369	231	17,595,000	FCS-BCW-08-COL

*Includes two fish of unknown sex
**Includes two fish of unknown sex
***Includes three fish of unknown sex
****Includes adult males and jacks

Appendix 6B Summary of steelhead and rainbow trout spawning at Coleman National Fish Hatchery including: brood year, stock, stock source, capture and spawning dates, total number of fish handled, numbers of females and males spawned, number of eggs collected, and lot number. Historic data presented were reconstructed from hatchery records that are incomplete and may not be accurate. This table may be cross-tabulated with distribution data (Appendix 10B) using "lot number" as an index field.

Brood Year	Stock	Source	Date Received	Begin Capture Date	End Capture Date	Total Fish Handled	Begin Spawn Date	End Spawn Date	Spawned Females	Spawned Males	Total Eggs	Lot Number
1947	Steelhead	Keswick		2/20/1947	2/26/1947				19		31,250	16
1949	Steelhead	Station Broodstock		12/16/1948	3/14/1949				9		147,133	20
1950	Steelhead	Station Broodstock		11/25/1949	3/3/1950				126		268,385	24
1950	Kamloops	British Columbia, CAN	6/29/1949								2,119	21
1951	Steelhead	Station Broodstock		10/26/1950					79		159,936	29
1951	Kamloops	British Columbia, CAN	7/26/1950								100,000	26
1951	Rainbow Trout	Pocatello, ID	2/8/1950								230,395	25
1951	Kamloops	British Columbia, CAN	7/22/1951								150,000	31
1952	Steelhead	Battle Creek		1/28/1952	3/10/1952				78		167,964	35
1953	Steelhead	Battle Creek		12/17/1952	3/25/1953		1/1/1953	3/25/1953	121		259,711	40
1953	Kamloops	British Columbia, CAN	7/13/1952								283,995	37
1953	Kamloops	Greenough, MT	2/13/1952								39,005	36
1954	Steelhead	Battle Creek		12/9/1953	3/15/1954	381	12/16/1953	3/15/1954	158	106	379,563	44
1954	Kamloops	Missoula, MT	2/23/1953								176,045	41 & 42
1955	Steelhead	Battle Creek			5/4/1955	960	1/3/1955	3/12/1955	156	88	465,970	5CM
1956	Steelhead	Battle Creek and Keswick		9/14/1955	3/30/1956	920	1/3/1956	3/30/1956	169	69	501,342	6CM
1956	Rainbow Trout	Hagarman, ID	6/15/1955								23,600	5H
1957	Steelhead	Battle Creek and Keswick		9/21/1956	3/29/1957	889	1/2/1957	2/28/1957	286	45	600,000	7-CM-54
1957	Rainbow Trout	Hagarman, ID									50,880	6H
1957	Kamloops	Station Broodstock		9/21/1956	3/29/1957		1/2/1957	2/28/1957				7CM
1957	Kamloops	Fort Klamath, OR									209,875	7-ORE-55
1958	Steelhead	Battle Creek and Keswick		9/30/1957	4/28/1958	1,527	1/8/1958	2/20/1958	256	82	706,249	8-CM-59
1958	Kamloops	Coleman, CA									47,625	8-CM-65
1958	Kamloops	Diamond Lake, ORE									100,000	8-ORE-61
1958	Rainbow Trout	Mount Shasta, CA									50,800	8-CAL-58
1959	Steelhead	Battle Creek and Keswick		9/16/1958	3/30/1959		1/15/1959	3/30/1959	287	137	827,127	9-CM-66
1960	Steelhead	Battle Creek and Keswick		9/28/1959	4/15/1960		1/29/1960	4/15/1960	357	207	791,000	0-CM-71
1960	Kamloops	Diamond Lk., OR									102,295	9-ORE-67
1960	Kamloops	Coleman, CA									45,526	9-CM-70
1960	Kamloops	Coleman, CA									110800	0-CM-76
1960	Kamloops	Diamond Lake, OR					6/24/1960				102,900	0-ORE-72
1961	Steelhead	Battle Creek and Keswick	8/13/1960	9/13/1960	2/24/1961		1/9/1961	2/24/1961	545	195	1,583,000	1-CN-77
1962	Steelhead	Battle Creek and Keswick		9/28/1961	2/24/1962		1/9/1962	3/28/1962	699	256	1,810,000	2-CN-81
1962	Kamloops	Coleman, CA		12/14/1960							110,000	1-CN-76

Appendix 6B (cont.) Summary of steelhead and rainbow trout spawning at Coleman National Fish Hatchery including: brood year, stock, stock source, capture and spawning dates, total number of fish handled, numbers of females and males spawned, number of eggs collected, and lot number.

Brood Year	Stock	Source	Date Received	Begin Capture Date	End Capture Date	Total Fish Handled	Begin Spawn Date	End Spawn Date	Spawned Females	Spawned Males	Total Eggs	Lot Number
1962	Kamloops	Coleman, CA		12/19/1961							213,000	2-CN-80
1963	Steelhead	Battle Creek and Keswick		10/1/1962							2,000,000	3-CN-86
1963	Kamloops	Coleman, CA		12/7/1962							185,000	3-CN-84
1964	Steelhead	Battle Creek and Keswick		10/3/1963	4/14/1964	1,594	1/7/1964	4/24/1964	732	303	2,250,000	4-CN-91
1964	Kamloops	Coleman, CA					12/5/1963				372,000	4-CN-90
1965	Steelhead	Battle Creek and Keswick		10/1/1964	3/22/1965	2920			1,481	890	3,713,000	5-CN-96
1966	Steelhead	Spillway		10/5/1965	3/7/1966		1/5/1966	3/21/1966			1,900	6-CN-8
1966	Kamloops	Battle Creek		10/1/1964	3/22/1965						600,000	5-CN-95
1966	Steelhead	Battle Creek		10/5/1965	3/7/1966	1,643			737		2,561,000	6-CN-4
1966	Kamloops	Coleman, CA									781,000	6-CN-3
1966	Rainbow Trout	Winthrop NFH									35,480	6-WP-5
1967	Steelhead	Battle Creek					1/5/1967	3/7/1967	854	483	2,706,087	7-CN-11
1967	Kamloops	Station Broodstock							381	150	968,000	7-CN-10
1967	Rainbow Trout	Ennis, MT									75,100	7-E-12
1968	Steelhead	Battle Creek									3,000,000	8-CN-18
1968	Kamloops										3,374	6-CN-7
1968	Kamloops										1,148,000	8-CM-16
1968	Rainbow Trout	Ennis, MT									3,003	7-DS-14
1968	Rainbow Trout	Ennis, MT									206,500	8-E-19
1969	Steelhead	Battle Creek		10/1/1968	3/21/1969	4,939	12/19/1968	2/7/1969	647	335	2,596,242	9-CN-22
1969	Kamloops	Station Broodstock							615	493	1,685,200	9-CN-21
1969	Rainbow Trout	Winthrop NFH									200,300	9-WP-24
1969	Rainbow Trout	MT. Whitney SFH (CDFG)									100,500	9-UC-25
1970	Steelhead	Battle Creek and Keswick		10/10/1969		3,967			758	204	2,810,526	9-CN-28
1970	Kamloops	Station Broodstock							720		1,007,804	O-CN-27
1970	Rainbow Trout										30,258	O-E-29
1970	Rainbow Trout										175,400	O-UC-30
1971	Steelhead	Battle Creek and Keswick		10/1/1970		3,529			900		3,309,877	0-CN-32
1972	Kamloops	Station Broodstock							835	734	1,987,832	1-CN-33
1972	Kamloops	Clark Fork Hatchery, ID									46,200	1-UID-34
1972	Rainbow Trout	Calif Dept of Fish and Game									98,975	0-UC-35
1972	Rainbow Trout	Calif Dept of Fish and Game									1,037,604	1-UC-36
1972	Steelhead	Battle Creek and Keswick				1,377	12/22/1971		393	350	1,282,437	1-CM-40
1972	Steelhead	Nimbus Hatchery									1,039,363	1-UCA-41
1972	Rainbow Trout	Ennis, MT									1,297,746	2-EN-39
1973	Steelhead	Battle Creek		9/20/1972	1/5/1973	2,645			1,007	900	3,131,355	2-CM-45
1973	Kamloops	Hot Creek SFH, CDFG									231,000	3-UCA-46

Appendix 6B (cont.) Summary of steelhead and rainbow trout spawning at Coleman National Fish Hatchery including: brood year, stock, stock source, capture and spawning dates, total number of fish handled, numbers of females and males spawned, number of eggs collected, and lot number.

Brood Year	Stock	Source	Date Received	Begin Capture Date	End Capture Date	Total Fish Handled	Begin Spawn Date	End Spawn Date	Spawned Females	Spawned Males	Total Eggs	Lot Number
1973	Kamloops	Station Broodstock									1,112,005	3-UID-47
1973	Rainbow Trout	Mount Shasta Hatchery, CA									309,474	3-UCA-48
1974	Steelhead	Battle Creek and Keswick				1,746	12/19/1973		655	218	2,129,239	3-CM-54
1974	Kamloops	Station Broodstock							808	1,291	2,283,505	4-UID-53
1975	Steelhead	Battle Creek		10/1/1974			12/17/1974	2/12/1975	431	301	1,840,077	4-CM-59
1975	Steelhead	Nimbus Hatchery							63		423,879	4-UCA-60
1975	Kamloops	Station Broodstock									2,554,546	5-UID-61
1975	Kamloops	Darrah Springs									9,924	Darrah Sp
1976	Steelhead	Battle Creek		10/1/1975			12/16/1975	2/19/1976	588	636	2,356,868	5-CM-66
1976	Steelhead	Nimbus Hatchery, CA									99,990	5-UCA-67
1976	Kamloops	Station Broodstock							475		1,324,588	6-UID-68
1976	Kamloops	Station Broodstock									5,021	5-UID-61
1976	Kamloops	Station Broodstock									376,700	6-CM-69
1976	Kamloops	Nimbus SFH ?									>33488	6-UCA-71
1977	Steelhead	Battle Creek and Keswick					12/20/1976	3/1/1977	630		2,187,500	6-CM-75
1977	Steelhead	Nimbus Hatchery, CA									219,240	6-UCA-76
1977	Kamloops	Clark Fork Hatchery, ID							846		2,169,095	7-UID-77
1978	Steelhead	Sacramento River @ RBDD									623,000	7-CM-80
1978	Steelhead	Mad River									1,456,000	7-UCA-85
1978	Kamloops	Hot Creek Hatchery, CA									795,000	8-UCA-81
1979	Steelhead	Battle Creek									955,541	8-CM-89
1980	Steelhead	Battle Creek							751		3,229,115	9-CM-92
1980	Steelhead	Eel River Strain returns to B.C.							23		95,616	9-CM-92
1981	Steelhead	Battle Creek							324		1,000,000	0-CM-98
1982	Steelhead	Battle Creek				1,250	12/15/1981	2/23/1982	525		1,575,000	2-CM-01
1983	Steelhead	Battle Creek and Keswick				870	12/8/1982	2/16/1983	380	183	1,398,000	2-CM-05
1983	Steelhead	Feather River Hatchery									500,000	2-UCA-07
1984	Steelhead	Battle Creek and Keswick				521	12/21/1983	2/22/1984	295	232	459,672	3-CM-10
1984	Steelhead	Nimubs Hatchery, CA									700,000	3-UCA-11
1985	Steelhead	Battle Creek and Keswick				2,020	12/11/1984	2/26/1985	715	363	2,723,830	5-CM-14
1986	Steelhead	Battle Creek and Keswick				2,042	12/13/1985	1/30/1986	909		2,983,600	6-CM-17
1987	Steelhead	Battle Creek				1,194	12/17/1986	3/11/1987	260	248	1,092,000	7-CM-20
1988	Steelhead	Battle Creek				890	12/17/1987	3/1/1988	222	174	958,628	8-CM-24
1989	Steelhead	Battle Creek				467	12/21/1988	2/9/1989	27	18	118,913	9-CM-28
1989	Steelhead	Feather River SFH, CDFG									47,000	STT-SBW-89-COL
1990	Steelhead	Battle Creek		10/4/1989	2/12/1990	4,172	12/11/1989	2/12/1990	629	463	2,574,104	STT-SBW-90-COL

Appendix 6B (cont.) Summary of steelhead and rainbow trout spawning at Coleman National Fish Hatchery including: brood year, stock, stock source, capture and spawning dates, total number of fish handled, numbers of females and males spawned, number of eggs collected, and lot number.

Brood Year	Stock	Source	Date Received	Begin Capture Date	End Capture Date	Total Fish Handled	Begin Spawn Date	End Spawn Date	Spawned Females	Spawned Males	Total Eggs	Lot Number
1991	Steelhead	Battle Creek		10/2/1990	2/19/1991	1,143	12/12/1990	2/19/1991	394	436	1,732,341	STT-SBW-91-COL
1992	Steelhead	Battle Creek		10/9/1991	3/3/1992	4,429	12/19/1991	2/24/1992	323	205	1,343,039	STT-SBW-92
1993	Steelhead	Battle Creek		10/12/1992	3/2/1993	2,862	12/29/1992	3/2/1993	343	332	1,519,175	STT-SBW-93-COL
1994	Steelhead	Battle Creek		10/7/1993	3/8/1994	3,387	12/16/1993	3/1/1994	363	322	1,683,653	STT-SBW-94-COL
1995	Steelhead	Battle Creek		10/5/1994	2/15/1995	2,185	12/27/1994	1/12/1995	311	279	1,493,013	STT-SBW-95-COL
1996	Steelhead	Battle Creek		10/9/1995	2/27/1996	3,106	12/21/1995	1/30/1996	231	215	1,167,484	STT-SBW-96-COL
1997	Steelhead	Battle Creek		10/8/1996	3/3/1997	2,529	12/20/1996	2/12/1997	181	186	885,046	STT-SBW-97-COL
1998	Steelhead	Battle Creek		10/6/1997	3/2/1998	1,409	12/17/1997	2/10/1998	193	187	940,045	STT-SBW-98-COL
1999	Steelhead	Battle Creek		10/6/1998	3/2/1999	1,755	1/14/1999	3/2/1999	164	165	739,306	STT-SBW-99-COL
2000	Steelhead	Battle Creek		10/5/1999	3/2/2000	1,976	1/3/2000	2/15/2000	183	187	798,308	STT-SBW-00-COL
2001	Steelhead	Battle Creek		10/4/2000	2/22/2001	2,294	1/4/2001	2/22/2001	179	190	870,195	STT-SBW-01COL
2002	Steelhead	Battle Creek		10/3/2001	2/26/2002	3,484	12/28/2001	2/26/2002	298	315	1,042,193	STT-SBW-02-COL
2003	Steelhead	Battle Creek		10/1/2002	2/27/2003	2,688	1/7/2003	2/27/2003	329	285	1,122,040	STT-SBW-03-COL
2004	Steelhead	Battle Creek		9/30/2003	3/19/2004	1,598	12/15/2003	3/11/2004	455	395	1,981,500	STT-SBW-04-COL
2005	Steelhead	Battle Creek		10/4/2005	3/4/2005	1,655	12/14/2004	3/2/2005	472	500	1,791,000	STT-SBW-05-COL
2006	Steelhead	Battle Creek		9/27/2005	2/28/2006	1,300	12/29/2005	2/28/2006	402	330	1,311,000	STT-SBW-06-COL
2007	Steelhead	Battle Creek		10/2/2006	2/27/2007	1,544	12/21/2006	3/1/2007	547	492	1,873,500	STT-SBW-07-COL
2008	Steelhead	Battle Creek		10/2/2007	2/22/2007	3,152	12/20/2007	2/22/2008	465	462	1,579,500	STT-SBW-08-COL

Appendix 6C Genetic selection of winter Chinook salmon broodstock

The following information on genetic selection of winter Chinook broodstock is excerpted from the Service's 1998 ESA Section 10 permit supplements justifying a re-initiation of the winter Chinook salmon propagation program.

A genetic run discrimination project supported with funding from the California Department of Water Resources was awarded to Dr. Dennis Hedgecock of Bodega Marine Laboratory (BML) in May 1994. This project was designed to identify genetic markers (microsatellites) through non-lethal tissue sampling allowing the discrimination of winter Chinook from fall, late-fall and spring Chinook salmon. By 1995 three polymorphic DNA markers had been characterized by the BML genetics laboratory, including the powerful locus Ots-2 which is particularly discriminating for winter Chinook salmon (Banks et al. 1996).

These technologies were applied to tissues collected from the spawned and unspawned groups of Chinook salmon collected during the 1995 winter Chinook salmon trapping operations. Results of this analysis indicated potential hybridization between brood year 1995 winter Chinook salmon adults and other runs of Chinook salmon (spring run) in the winter Chinook propagation program at Coleman NFH (Hedgecock et al. 1995). The genotypic proportions in the spawned group departed significantly from random-mating expectations and in a manner suggesting admixture (Hedgecock et al. 1995; Arkush et al. 1997). Although individual salmon identified as non-winter run had the phenotypic spawn timing criteria (mid-April through mid-August) and run-timing criteria previously accepted for winter Chinook salmon, genetic analysis suggested a number of individuals spawned in 1995 were not winter Chinook salmon. The individual adults (five males) most likely responsible for Hardy-Weinberg equilibrium failure were identified by BML and, as a precautionary measure, all juveniles resulting from those matings were destroyed (approximately 1,300). Subsequent analysis of previous brood years (1993 and 1994) also resulted in the conclusion that hybridization may have occurred in those brood years as well (two females in 1993 and one female in 1994). These findings of potential hybridization within the hatchery population, together with an imprinting problem causing hatchery fish to return to Battle Creek instead of the Sacramento River, led to a moratorium on the future capture of adult salmon for this program. The moratorium was expected to remain in effect until a genetic testing protocol was developed that would reduce potential risk of hybridization attributable to the artificial propagation program.

<u>Verification of the genetic discrimination tool</u>

False Positive Results

By 1997, opportunities to evaluate the ability of the genetic tool to discriminate winter Chinook salmon from other runs of salmon became available. Continuing work at the BML genetics laboratory resulted in the development of two new diagnostic microsatellite markers (five total), and substantially increased the number of fish used in the baseline data set. The discriminating power of the five microsatellite markers was evaluated on two separate occasions in 1997 and 1998. The first test characterized to run a blind submission of tissue samples (i.e., tissue samples only, all other information withheld from the researcher) sent to BML from the CDFG's Rancho Cordova tissue archive. The second test characterized to run a set of tissues obtained from a trapping and relocation effort for winter Chinook salmon returning to Battle Creek from March-

May 1997. The results from both the genetic tests and the accuracy of identifying winter and non-winter Chinook salmon, suggested the genetic tool performed adequately. The genetic discrimination methodology demonstrated 100% accuracy in its ability for selection against other runs (i.e., no “false positives,” or non-winter Chinook salmon identified as winters). Additionally, the test involving submission of tissues from CDFG’s tissue archive demonstrated reproducibility of the methods used for genetic identification.

More robust testing of the potential for false positive results generated through use of the genetic discrimination tool was accomplished through computer simulations and modeling, which would involve randomly drawing a sample from the available baselines, and determining the accuracy of the resultant genetic call. Preliminary modeling (jackknife allocations) of this nature has been conducted (M. Banks, pers. comm., January 1998), on the same baselines used during the Battle Creek trapping operation. During this simulation, analysis of approximately 782 fish resulted in one “false positive,” an error rate of 0.0013. Therefore, data generated through actual tissue submissions and computer simulations suggest the current probability of selecting a non-winter-run Chinook salmon for inclusion in the hatchery program is less than 0.2%.

False Negative Results
The Battle Creek trapping operation allowed an estimate to be made of the occurrence of “false negatives” (i.e., failing to select an actual winter Chinook salmon for the program). For this analysis, the ability to identify suspect hybrid fish are included to test the genetic tools ability to identify a winter Chinook (suspect hybrid or not). The discrimination of suspected hybrid salmon as winter Chinook salmon may be more difficult due to their genomic make-up, the generated data can be used to describe worst-case scenarios, which are more appropriate in conducting a risk analysis. Three of the 14 known winter Chinook salmon or suspect hybrid groups (lineage information based on CWT recoveries) captured and sacrificed during Battle Creek trapping efforts during 1997 and 1998 were identified as non-winter Chinook salmon. Additionally, one of the 68 relocated fish from Battle Creek was subsequently recovered during the Sacramento River carcass survey, and CWT extraction confirmed this as a brood year 1994 winter Chinook salmon. Therefore, the total sample size in determining the rejection rate (“false negatives”) of actual winter Chinook salmon is 82 (14 sacrificed + 68 relocated). With three of those individuals called non-winter Chinook, an estimate of “false negatives” would be approximately 5% (3/82 = 3.7%). Two salmon which were sacrificed but resulted in no CWT recovery might also be considered in this analysis as the first genetic call also identified these two as fall Chinook, with the second call being winter. These two additional salmon fit the pattern of the three salmon called fall Chinook but verified as winter Chinook through CWT recovery. Because CWT recovery on these two additional fish was not possible, they could be considered to be misidentified, thereby increasing the estimate of “false negatives” to 6.1%. For the purpose of this risk analysis, the 6.1% rate of misidentification will be noted as a worst case scenario. False negatives will not likely harm the genetic integrity of the stock as they will be released to spawn in the wild.

The probability of rejecting an actual winter Chinook salmon from the program based on genetic analysis was presented in the February 20, 1998 Section 10 Permit Supplement as approximately 6.1%. That value was based on evaluation of the results of genetic analysis against known coded-wire tagged samples or other samples of known origin. The genetic selection criteria adopted by the Winter Chinook Salmon Captive Broodstock Committee, however, used a LOD score ≥ 2[10]. This selection criterion coincides with a 99% confidence that a particular call is actually a winter Chinook salmon. This high confidence for selection of winter Chinook salmon may increase the probability of rejecting actual winter Chinook salmon from the program above the 6.1% presented in the Permit Supplement. Jackknife allocations using a LOD of ≥2 were conducted by BML. These allocations resulted in a rejection rate for winter Chinook salmon (false negatives) of approximately 8%. The genetic risk associated with this rate of rejection of actual winter Chinook salmon from the program was also deemed acceptable by the group, and refinement of the baselines lead to the refinement of both false positives and false negatives.

Use of the genetic discrimination tool in conjunction with phenotypic selection criteria (capture timing and spawning timing) would further reduce the risk for the incorporation of a non-winter Chinook salmon into the program (false positive). Using the combination of phenotypic and genetic selection criteria, the probability of selecting an individual non-winter Chinook salmon for the program has been estimated at only 0.01%. A decision making tree which describes the risk probabilities at each step is shown below. The decision making tree uses information from three steps to estimate the risk of collecting and incorporating a non-winter Chinook salmon into the propagation program.

> ***Step 1--Meets Phenotypic Capture Criteria***: Winter Chinook salmon are expected to be arriving in the upper Sacramento River from December through August. Therefore, the first criterion is that an individual is captured during this time period (March-August in collection year 1998). During the capture window, data from 1995 were used to represent the worst case scenario in which approximately 50% of the individuals (although captured during the right time period), did not spawn during the spawning window (May 1-Aug 1). Therefore, based on phenotypic spawn timing, these fish would not be considered winter Chinook even though they were captured during the winter collection period. So worst case is **50%** of the fish collected during the collection window could be non-winter Chinook salmon.

> ***Step 2--Meets Genetic Criteria:*** An LOD score ≥ 2 must be achieved for a particular salmon to be retained in the program. Preliminary modeling (jackknife allocations) suggests the likelihood of a non-winter Chinook salmon being retained for the program following genetic analysis is approximately 0.1% (M. Banks, pers. comm.). During the simulation, analysis of approximately 782 fish resulted in one "false positive," an error rate of 0.0013. Therefore, data generated through actual tissue submissions and computer simulations suggest that the probability of a non-winter Chinook salmon being retained for the program following genetic analysis is approximately 0.2%.

[10]LOD score is the log base 10 of the ratio of the likelihood functions of the two runs from which a particular fish is most likely to belong, and have been even further improved to incorporate MSA information (Dennis Hedgecock, email transmission, March 2000). Likelihood functions are generated based on allele frequency distributions at multiple loci. See the 20 February 1998 Permit Supplement for further description of this value.

Step 3--Meets Phenotypic Spawn Timing: Although the spawning window for winter Chinook is generally considered to be mid-April through mid- August, the Service has condensed this spawning window for this program to reduce the potential for mating winter Chinook salmon with other runs (Service 1993). Currently, winter Chinook used in the artificial propagation program must spawn between May 1 and August 1. Fish captured for the program that meet the genetic selection criteria must then meet the spawn timing criterion. This means that of the 50% non-winter Chinook collected in Step 1, 0.2% might be retained for the program through Step 2 (50% x 0.2% = 0.1%). Although 100% or 0% of those non-winters retained could be spawned in the program, data again from 1995 suggest that of approximately 43 non-winter (genetically or phenotypically), five were spawned within the spawning window criteria (12%). These data allow an estimate (**12%**) to be generated for the probability of a non-winter Chinook salmon "passing" criteria for the first two steps, and meeting the final spawn timing criterion resulting in the contribution of gametes to the program. The final risk analysis would be the product of the three values from above as follows:

50% non-winters captured for the program
X
0.2% of non-winters captured retained for the program after meeting genetic criteria
X
12% of non-winters retained for program meeting spawn timing criterion
= **0.012%**

Recent improvements to the genetic discrimination tool

Beginning with brood year 1999, the genetic selection criterion of LOD $\geq$ 1 using microsatellites has been used to select individuals for inclusion into the hatchery program. This criterion was adopted by the genetic subcommittee of the Winter Chinook Salmon Captive Broodstock Committee as a result of the refinement of genetic marker sets (i.e., including two additional loci, for a total of seven loci). The currently adopted value of LOD $\geq$ 1 reduces the potential of rejecting actual winter Chinook salmon from the program, however, a quantitative assessment of this reduction has not been calculated.

Broodstock collection criteria for the winter Chinook propagation program are conservative; some winter Chinook salmon may be rejected from the program, while, based on the results of these tests and computer simulations, non-winter Chinook salmon will likely not be selected for the program. The results from tests and computer simulations show that genetic analysis is capable of discriminating winter Chinook salmon from other upper Sacramento River stocks of Chinook salmon. The potential genetic impacts of "false positives" occurring at a rate ~0.1% and "false negatives" occurring at a rate of ~8% has been discussed by the Genetics Subcommittee of the Winter Chinook Salmon Captive Broodstock Committee and is considered sufficient to reduce the potential genetic risks of the artificial propagation program, thus protecting the genetic integrity of the naturally-reproducing population the program is designed to supplement.

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Appendix 6D Genetic Risks of Hatchery Propagation

Introduction

Genetic effects of artificial propagation to natural salmonid populations is a complex and controversial issue. In the western United States, salmon hatcheries are viewed as both a cause for the decline of Pacific salmonids and a tool to assist in recovering populations. Direct genetic effects potentially resulting from hatchery propagation include: 1) genetic effects of artificial propagation on hatchery fish, and 2) genetic effects resulting from hatchery and natural fish interbreeding (Campton 1995). Additional indirect genetic effects can result from ecological interactions between hatchery and natural fish (e.g., competition, predation, disease transfer) or from management decisions (e.g., mixed-stock fishing mortality; Campton 1995).

The general approach of the Service for managing genetic risks of hatchery propagation programs at Coleman NFH is to maintain genetic similarity with natural stocks and minimize adaptation to the hatchery environment. These objectives are accomplished by propagating locally-adapted populations, implementation of 'genetically-conscious' protocols for hatchery operations (e.g., one-to-one matings, spawning throughout run timing, maintaining large effective population size), and incorporating natural-origin adults as hatchery broodstock. By implementing these strategies, the Service believes genetic risks of hatchery propagation programs at Coleman NFH are minimized.

Potential Genetic Impacts

Several studies have shown genetic differences between hatchery and wild populations of Pacific salmonids resulting from artificial propagation (see review in Campton 1995), and many report decreased fitness of natural populations following hatchery introgression (e.g., Chilcote et al. 1986, Nickelson et al. 1986, Fleming and Gross 1992 and 1993, Currens et al. 1997, Unwin 1997, Unwin and Glova 1997[11]). In many of these studies, however, interpretation of results are confounded because either: 1) phenotypic differences were initially apparent between hatchery and natural populations (e.g., Reisenbichler and McIntyre 1977, Nickelson et al. 1986); 2) hatchery stocks did not originate from local natural populations (e.g., Chilcote et al. 1986, Currens et al. 1997); or, 3) hatchery stocks had been propagated in isolation from natural populations (e.g., Chilcote et al. 1986, Fleming and Gross 1992 and 1993, Unwin 1997, Unwin and Glova 1997). In several of these studies, it is likely that more than one of these factors influenced the results. Regardless, the preponderance of published literature appears to suggest that genetic changes resulting from artificial propagation can reduce genetic fitness of the hatchery stock in the wild, possibly leading to reduced productivity and viability of natural populations. Reisenbichler and Rubin (1999) reported at least three studies which used hatchery and natural stocks from local populations that also concluded that artificial propagation programs resulted in significant genetic change.

Potential detrimental genetic effects from artificial propagation programs include: 1) extinction; 2) loss of within population genetic variability; 3) loss of between population genetic variability;

[11]An additional list of available literature on potential genetic impacts follows the literature cited for this section.

and, 4) domestication (Hindar et al. 1991, Waples 1991, Busack and Currens 1995, Campton 1995). General descriptions of these risks are presented below.

Extinction. Artificial propagation programs may result in a loss of natural production directly by removing adults from the naturally spawning population. If an artificial propagation program continues to remove adults from the naturally spawning population (sometimes referred to as 'mining' the natural population), the propagation program becomes a population 'sink'. When the propagated species is at an extremely low level of abundance, a population sink could lead to extinction through a direct loss of individuals and their genetic material. However, there is no documented evidence of stock extinctions resulting from artificial propagation programs. To the contrary, artificial propagation has been used with the intent to reduce the short-term risk of extinction (e.g., the Service's winter Chinook program) - the success of this is being evaluated.

Loss of within-population variation. Small population sizes in a hatchery breeding program can lead to losses of within-population genetic variability through inbreeding depression and genetic drift (Waples 1991). Both of these genetic concerns are increased when dealing with small or declining populations. Decreased within-population genetic variation resulting from inbreeding depression may cause reductions in viability, survival, growth, or egg production, and increased rate of abnormalities (Cuenco et al. 1993). Genetic drift can also result in the loss of rare alleles. Both inbreeding depression and genetic drift could reduce the fitness of the hatchery stock in the wild by decreasing the potential for adaptation to local environments.

Loss of between-population variation. Artificial propagation programs may decrease between-population genetic variability through outbreeding depression. Outbreeding depression may occur by excessive straying of hatchery fish, spawning of non-local broodstock at the hatchery, or through transfers of stocks between hatcheries. If hatchery fish stray at rates or numbers that are high compared to naturally producing stocks, then hatchery strays may reduce between-population genetic diversity by interbreeding with distant populations. Hatchery spawning of two or more populations may directly result in hybridization at the hatchery. Between-population genetic variability could also be reduced by transferring gametes, juveniles, or adults between hatcheries. Loss of between-population genetic variability due to outbreeding depression can lower the genetic fitness of the natural population by breaking up locally-adapted gene complexes that work together to increase fitness (Lynch 1991, Allendorf and Waples 1996) and by combining genes from different sources that do not work well together (Emlen 1991).

Domestication selection. Selection pressures in the hatchery environment that are relaxed or otherwise different from the natural environment may cause genetic differences between hatchery and natural stocks through a process called domestication selection. Domestication selection can result in the survival of certain individuals in a hatchery environment that, under completely natural conditions, would have perished. Within the complete cycle of artificial production, these "marginal" individuals may then contribute their genes to their progeny, which may in turn exhibit a decreased ability to survive under natural conditions (Vincent 1960). Domestication selection causes a hatchery stock to diverge genetically from the local/donor population; this is thought to decrease the fitness of the hatchery population in the wild.

It is important to distinguish genetic changes associated with fish culture practices (loss of between and within population variation) from genetic changes caused by the hatchery environment (domestication selection). For example, fish culture practices such as broodstock transfers, broodstock selection, spawn timing, and release location can be modified to eliminate or minimize negative genetic impacts by changing hatchery operations. The Service has implemented several 'genetically conscious' management practices to minimize genetic risks associated with fish culture practices including: 1) collecting and spawning broodstock for all propagated stocks across the range of run and spawn timing; 2) spawning large numbers of broodstock (5,200 for fall Chinook, 540 for late-fall Chinook, and 400 for steelhead trout); 3) no deliberate selection (except to distinguish between stocks, e.g., late-fall and fall Chinook) for particular phenotypic characteristics is used to choose broodstock; 4) a one to one mating scheme is used (i.e., one male fertilizes one female); and, 5) the majority of hatchery juveniles are released on-site or within the upper Sacramento River to minimize straying (these measures are discussed in more detail in Sections 6, 7, and 10 and are not included in the remainder of this discussion).

In contrast, genetic changes resulting from domestication selection (e.g., little or no predation, increased density during rearing, simplified environment, decreased selection pressure) are considered to be an unavoidable consequence of artificial propagation (Reisenbichler and McIntyre 1986, Lichatowich and McIntyre 1987, Waples 1991, Cuenco et al. 1993, Utter et al. 1993, Campton 1995, Allendorf and Waples 1996). Domestication selection is unavoidable because selection pressures in the hatchery environment are largely different from those incurred by naturally produced fish, generally resulting in a much higher rate of survival for hatchery fish. Practically speaking, the effects of domestication selection cannot be eliminated because, if the survival benefit of rearing fish in a hatchery environment were eliminated, then hatchery fish would survive at the same rate as naturally produced fish. This would limit the usefulness of hatchery propagation programs. Busack and Currens (1995) considered domestication selection to be one of the unavoidable "costs of using hatcheries." While it is not possible to eliminate entirely the effects of domestication selection, it may be possible to minimize domestication effects through regular infusion of natural-origin spawners as hatchery broodstock or incorporating some aspects of natural rearing (e.g., Natural Rearing Enhancement System rearing strategies).

Managing potential genetic impacts to natural populations from hatchery propagation

The only strategy to ensure artificial propagation programs at Coleman NFH do not impart any deleterious genetic impacts on co-occurring natural populations of Pacific salmonids is to terminate the hatchery programs. However, cessation of the hatchery propagation programs at Coleman NFH would result in failure of the Service to fulfill its responsibility to mitigate for negative effects resulting from habitat losses caused by Shasta Dam, and would have unknown and potentially harmful effects to Chinook salmon and steelhead trout populations in the upper Sacramento River system. For example, hatchery Chinook salmon and steelhead trout originating from Coleman NFH currently comprise a large portion of total escapement to the upper Sacramento River. Based solely upon abundance, hatchery-origin Chinook salmon and steelhead trout likely contain a large portion of the total genetic diversity remaining within each upper Sacramento River stocks. Therefore, hatchery-origin Chinook salmon and steelhead trout from Coleman NFH may serve as a “genetic storehouse,” and termination of the propagation programs at Coleman NFH could potentially cause dramatic reductions in genetic variability for remaining stocks.

Although the potential exists for hatcheries to cause adverse genetic impacts to natural populations, most fishery managers understand the necessity for and role of hatchery propagation. Even as many of the factors that have caused salmonid populations to decline are being corrected, it appears likely that hatchery propagation will continue to have a role in the upper Sacramento River. Hatchery propagation will continue to be used to compensate for lost and degraded habitats (e.g., upstream of Shasta Dam), and future salmonid production will be undoubtedly comprised of both natural and hatchery components. Therefore, if we are to accept that hatchery propagation will continue to have a role in the upper Sacramento River ecosystem, it is imperative to identify the best strategy to minimize any adverse genetic consequences of artificial propagation.

Strategies for minimizing negative genetic impacts to natural populations from hatchery propagation

In most cases where hatchery programs and natural populations coexist, managers have two general options for managing genetic impacts from artificial propagation programs: 1) manage the hatchery stock to be ecologically, behaviorally, morphologically, and genetically different from the natural population so that hatchery-origin adults do not (or cannot) spawn in the wild with natural adults (isolation); and, 2) manage the hatchery stock so that it is ecologically, behaviorally, morphologically, and genetically similar to the natural population, thereby minimizing the genetic risks when hatchery adults spawn in the wild with natural adults (integration).

> *Isolation* - The management strategy of isolation is intended to segregate the hatchery stocks from naturally spawning populations by separating adult spawners temporally, spatially, and/or reproductively, so that hatchery and natural populations do not (or cannot) interbreed in the wild. Available management options to accomplish long-term reproductive isolation include: manipulation of run timing through selective breeding; isolation of returning hatchery adults through incorporation of a terminal fishery or broodstock collection location; complete marking of all hatchery stocks and selective spawning of only hatchery fish; and outplanting of completely sterile juveniles.
>
> *Integration* - This strategy is intended to minimize genetic and ecological differences between hatchery and natural stocks so that risks to natural populations are maintained within acceptable limits. The negative effects of gene flow from hatchery stocks to natural populations can be reduced by assuring that genetic differences between hatchery fish and the natural recipient population are as small as possible (Hindar et al. 1991). Hatchery management options that can be employed to minimize differences between hatchery and natural stocks include: obtaining founding broodstock from the locally adapted population and maintaining continual gene flow from the natural population (e.g., by incorporating naturally produced adults as broodstock).

Isolation as a strategy to minimize genetic risks to natural populations
Attempts to completely isolate (spatially, reproductively, or temporally) hatchery stocks at Coleman NFH from natural populations are unlikely to be successful because: 1) hatchery and natural fish will stray; 2) all hatchery fish (e.g., fall Chinook) are not currently marked at Coleman NFH so hatchery fish cannot be distinguished from natural fish on an individual basis; 3) hatchery and natural stocks may spawn together because of proximal spawning areas; and, 4) hatchery and natural stocks have inherent variability in run and spawn timing. The inability to control all of these and other factors would likely preclude successful implementation of the isolation strategy.

For example, reproductive isolation is problematic. Sterilization programs are still largely experimental and may even be detrimental if large numbers of sterile but sexually active male fish compete with fertile males for territory or mates, effectively reducing production by natural-origin adults. This strategy would also increase pressure on natural populations since hatchery adults would not be available for broodstock. In addition, all of the hatchery fish produced at Coleman NFH are not currently marked, so incorporating only hatchery-origin adults as broodstock would not be possible, at least for fall Chinook salmon. Efforts to reproductively isolate hatchery stocks from natural stocks by selectively breeding a change in spawn timing would also be largely ineffective, and may even be detrimental, given the inherent variation in spawn timing and the likelihood that the hatchery stock would interbreed with one of the other stocks present in the system (e.g., if hatchery fall Chinook were selectively bred to spawn later in the year to prevent spawning with spring Chinook, straying hatchery fall Chinook would likely spawn with late-falls or winters). Localization (spatially isolating the artificial propagation program) is also difficult where natural and hatchery populations coexist. Even under best-case scenarios of long-term rearing and on-site releases (as with Coleman NFH), some artificially-produced fish will undoubtedly stray and possibly spawn with natural populations.

Integration as a strategy to minimize genetic risks to natural populations
Given that total isolation of hatchery stocks from natural populations is unlikely or even impossible when hatchery and natural populations coexist, some level of integration between hatchery and natural populations is desirable to minimize genetic risks to natural populations. Researchers generally agree that incorporating natural broodstock is necessary to decrease divergence between hatchery and natural populations (e.g., Reisenbichler and McIntyre 1986, Lichatowich and McIntyre 1987, Cuenco et al. 1993, NMFS 2000); however, efforts to quantify the level of incorporation necessary to prevent large amounts of divergence are just beginning. Preliminary research indicates that natural adults should be incorporated as broodstock at the highest proportion possible (e.g., Harada et al. 1998). It is appropriate, however, to balance between genetic risks of hatchery propagation and reducing the effects of removing spawners from the natural population.

While the goals of the propagation programs are different for the various stocks of Chinook salmon and steelhead trout propagated at Coleman NFH (i.e., mitigation for fall and late-fall Chinook salmon, supplementation and mitigation for steelhead trout), each of the hatchery programs employs a similar genetic management strategy: integration of hatchery stocks with their respective naturally spawning population. Hatchery broodstocks were founded from indigenous, locally-adapted salmonid populations from the upper Sacramento River and Battle

Creek. Furthermore, natural-origin adults have been incorporated regularly and frequently into the hatchery populations to avoid genetic divergence between hatchery and natural stocks. By using locally adapted broodstock as the hatchery's founding population and by continuously infusing natural-origin adults into the broodstock, the Service has attempted to reduce the genetic risks resulting from the artificial propagation programs and maintain a genetically fit hatchery population.

Another benefit of maintaining genetically integrated hatchery stocks at Coleman NFH is the option of using hatchery fish for conservation and recovery of imperiled salmonid populations, both for stocks that are currently depressed and stocks that may suffer future reductions of abundance. Cuenco et al. (1993) described three potential uses of artificial propagation for rebuilding natural fish populations: 1) to seed unoccupied habitats capable of supporting viable salmonid populations; 2) to increase abundance in sparsely seeded habitats above a minimum viable population size to decrease the risk of extirpation; and, 3) to decrease the time required to rebuild a depressed stock. Allendorf and Waples (1996) recognized an additional role for hatcheries in the conservation of natural fish populations, to avoid immediate extinction of endangered populations. For all of these applications of artificial propagation in rebuilding natural fish populations, it is essential that cultured stocks are biologically, ecologically, and genetically suited to their receiving environments. It is generally accepted that reproduction, growth, and survival will be optimized by mimicking those characteristics of the locally adapted natural population. To ensure that adaptive traits are as similar as possible between hatchery and natural populations, it, it is generally desirable to match and maintain the genetic lineages of the hatchery stock and the locally adapted natural population (Cuenco et al. 1993).

Using spatial isolation and genetic integration to minimize genetic risks to natural populations
While most aspects of the isolation strategy are not compatible with hatchery-natural integration efforts (e.g., reproductive isolation and temporal isolation), spatial isolation (or localization) may be used in conjunction with integration efforts to minimize risks of hatchery propagation to natural populations in Battle Creek. The Service does not intend for hatchery-origin fish from Coleman NFH to spawn with natural adults in the wild.

Genetic baseline: assessment of current genetic structure, integrity, and similarity of hatchery and natural populations in Battle Creek
Artificial production has been conducted in the Battle Creek watershed for over a century, beginning in 1895 with fall Chinook salmon production and the construction of the Battle Creek Egg Taking Station. Fall Chinook production was shifted to Coleman NFH in 1942 following the construction of that facility, and propagation of additional runs (e.g., late-fall, spring, and winter Chinook salmon and steelhead trout) was subsequently initiated.

Currently, hatchery and natural stocks in the Battle Creek and the upper Sacramento River comprise a mixed population, including commingling and spawning together naturally as adults. Since the construction of Coleman NFH, natural- and hatchery-origin Chinook salmon and steelhead trout have been incorporated as broodstock. Coleman NFH broodstock have been collected in Battle Creek and at the Keswick Dam fish trap in the mainstem Sacramento River. Natural-origin late-fall Chinook salmon broodstock have been captured at the Keswick Dam fish trap annually, with the exception of years 1997-2002 when broodstock was collected from hatchery-origin returns to Battle Creek. Natural- and hatchery-origin fall Chinook salmon and steelhead trout broodstock have been regularly collected in Battle Creek since the origins of the programs. The Service proposes to continue incorporating natural origin adults as hatchery broodstock to maintain a constant infusion of genetic material and minimize divergence from natural populations.

Banks et al. (2000) used microsatellite DNA methods to show substantial divergence among the four runs of salmon in the Central Valley. They found evidence of five major, more-or-less homogenous, populations of Chinook salmon in the Central Valley: winter, spring, Butte Creek spring, fall and late fall. Key points from the Banks et al. (2000) research are: 1) microsatellite DNA research shows hatchery-origin fall and late-fall Chinook salmon adults and naturally-produced fall and late-fall Chinook salmon adults appear to be genetically similar, at least based on the sub-set of loci examined[12]; and, 2) measurable genetic diversity exists between runs supporting the original phenotypic descriptions of Central Valley Chinook salmon. Therefore, despite concern over irreversible loss of genetic heterogeneity due to habitat restrictions and hatchery influence, substantial genetic diversity and population structure remains. Banks et al. (2000) do, however, state that evidence for hybridization in hatcheries remains a pressing concern. All stocks of Chinook salmon at Coleman NFH are included within the ESU's of their respective natural populations. Previous allozyme analyses of steelhead trout tissue have demonstrated Coleman NFH steelhead trout are genetically similar to the remaining natural population in Mill and Deer creeks. Based partly upon this research, the Coleman NFH steelhead trout stock is included within the ESU of Central Valley steelhead (Busby et al. 1996).

Conclusion
While evidence of behavioral, physiological, and genetic changes in hatchery populations compared to wild populations is increasing, it remains difficult or impossible to predict the genetic effects of hatcheries operating under various combinations of influences including: broodstock origins; fish stocks (differing life-history types); operational strategies; and levels of integration with natural stocks. In other words, "Although one can hypothesize that exposure to the hatchery environment, for even a small portion of the fish's life cycle, allows some genetic divergence from the natural genome, the degree and consequences of the change remain unknown." (Cuenco et al. 1993).

The level of genetic risk posed to natural salmonid populations resulting from interbreeding with hatchery-origin fish should be evaluated on a case-by-case basis, considering the multitude of factors that affect the level of similarity between hatchery and natural stocks. Most geneticists consider interbreeding among *exogenous or genetically diverged* hatchery and natural salmonid populations to be disadvantageous to the natural populations, resulting in a loss of fitness (see Waples 1991, Cuenco et al. 1993, Allendorf and Waples 1996, Reisenbichler and Rubin 1999, NMFS 2000). Salmonids have evolved in synchrony with their natural environments, and salmonid populations have adapted to the specific characteristics of their respective habitats (Scientific Review Team 1998). Spawning time, emergence time, juvenile distribution, and

[12]Most of the microsatellite DNA loci examined are likely selectively neutral (i.e., non-protein coding). Therefore, these loci are not likely reflective of adaptive differences.

marine orientation and distribution are not random processes, but occur in specific patterns of time and space for each population (Brannon 1984) and are undoubtedly characteristics that represent adaptation to ecological and geographic factors that cannot be replicated or improved through culture in the hatchery environment. Changes within cultured populations for characteristics such as growth rate, age at smolting, spawn timing, and various social behaviors may result in increased performance in hatcheries but may reduce performance and survival in the natural environment. In situations where interbreeding between hatchery and natural stocks is desirable, as in the case of the steelhead trout supplementation program, or when interbreeding is unavoidable, as with fall and late-fall Chinook salmon at Coleman NFH, it is clearly beneficial to minimize the genetic differences between hatchery and natural stocks.

The role of the Service's fish production programs at Coleman NFH include mitigation for lost spawning habitats, supplementation of at-risk stocks, and, potentially, recolonization of populations in restored habitats. While conducting artificial propagation activities to fulfill these responsibilities, the Service is also obligated to ensure that negative impacts resulting from artificial propagation programs are minimized. The Service believes the hatchery genetic integration strategy discussed above will ensure that hatchery-origin Chinook salmon and steelhead trout from Coleman NFH are integrated into the ecosystem, so negative impacts on natural populations are minimized. Every effort will be made to minimize potential impacts and maintain genetic integrity of the stock (the potential genetic risks and benefits of Coleman NFH operations are listed in Sections 1.9 and 1.10 under Performance Standards and Indicators B4 and R4).

Available literature suggests domestication selection will likely occur (and has occurred) despite all attempts to minimize this impact (e.g., Reisenbichler and McIntyre 1977). Genetic divergence between the hatchery and natural populations may occur very rapidly and may become more pronounced if the hatchery programs were to use exclusively hatchery-origin adults for broodstock. This would increase risks to the natural population following hatchery introgression in the natural environment. By using local natural populations as founding broodstock, eliminating out-of-basin transfers, and incorporating natural adults as broodstock for all of Coleman NFH's propagation programs, the Service intends to reduce negative genetic effects to natural populations in Battle Creek and the upper Sacramento River resulting from hatchery-origin adults spawning in the natural environment.

Although many unknowns still persist regarding the impacts of artificial propagation on natural populations, the Service will continue to incorporate best available information and technologies to minimize genetic risks. Genetic risks can theoretically be minimized as long as genetic differences between the hatchery and natural populations is initially small (i.e., using local broodstock), and specific breeding and rearing guidelines (i.e., spawning fish from all segments of the run; using large numbers of broodstock to limit founder effects, inbreeding, and genetic drift; maximizing survival of eggs and progeny to avoid losses of specific genotypes, etc.) are followed in hatchery programs (Meffe 1986, Simon 1991, Reisenbichler et al. 1992). Furthermore, the Service will make efforts to minimize domestication selection by systematically incorporating natural-origin adults as hatchery broodstock. Although these actions will not eliminate the potential for the hatchery fish to impart negative genetic impacts on natural populations, they will reduce the potential for genetic differences between the hatchery and natural populations which will, in turn, reduce the genetic risks to natural populations (Meffe 1986, Reisenbichler et al. 1992).

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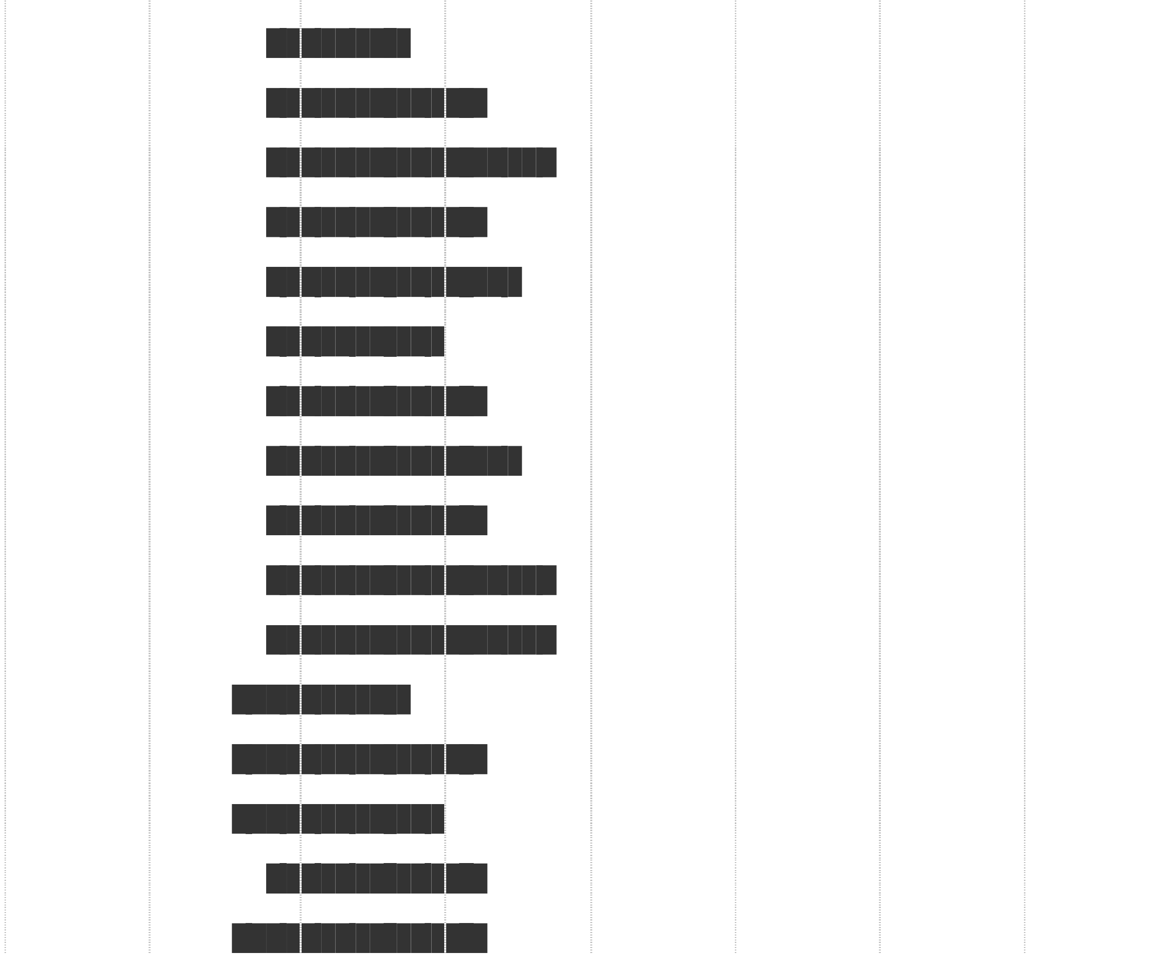
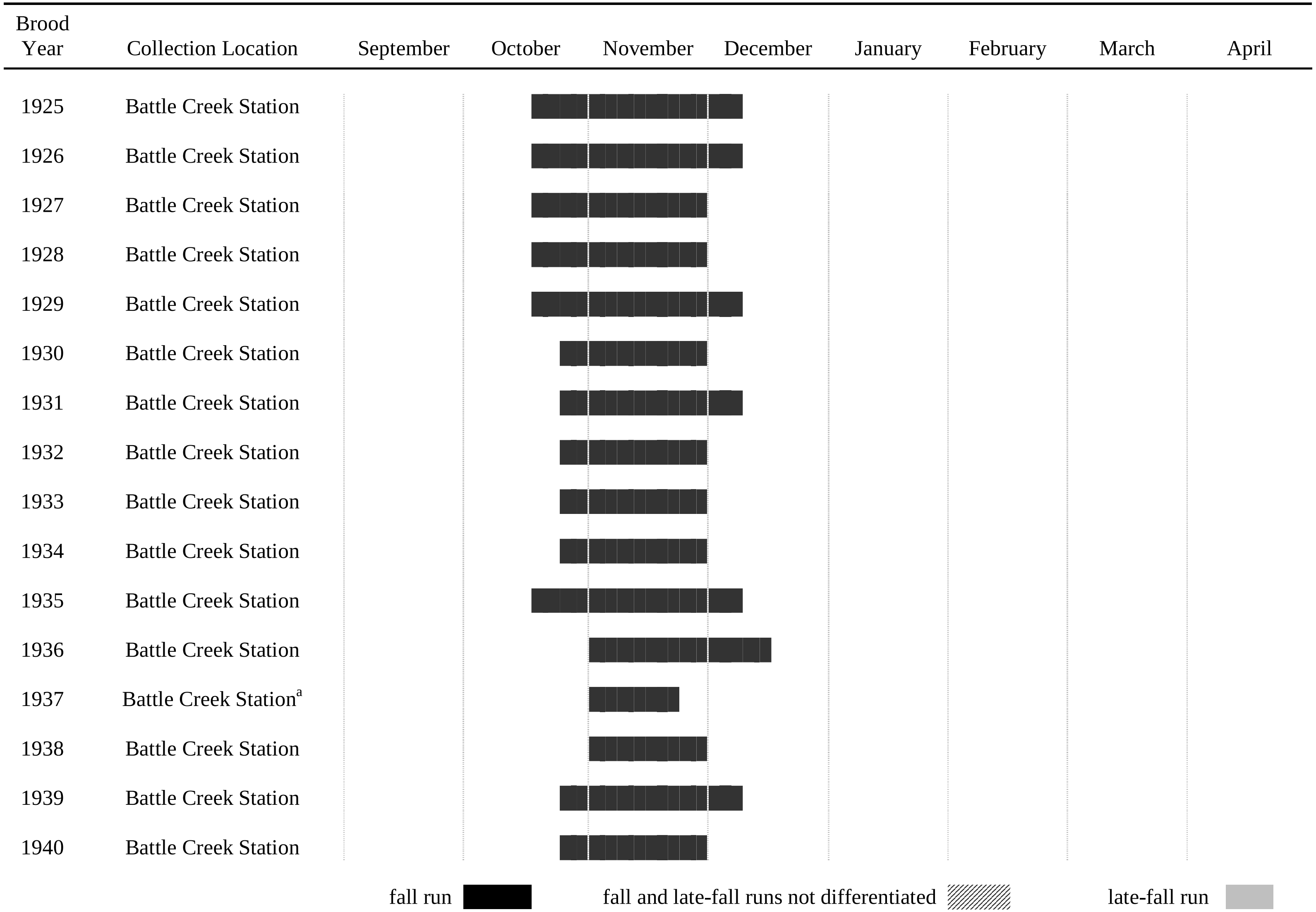
Appendix 8A Collection locations and approximate spawn timing of fall and late-fall Chinook salmon for Battle Creek Egg Taking Station, 1909-1941, and Coleman National Fish Hatchery, 1942-2008.

Brood Year	Collection Location	September	October	November	December	January	February	March	April
1909	Battle Creek Station								
1910	Battle Creek Station								
1911	Battle Creek Station								
1912	Battle Creek Station								
1913	Battle Creek Station								
1914	Battle Creek Station								
1915	Battle Creek Station								
1916	Battle Creek Station								
1917	Battle Creek Station								
1918	Battle Creek Station								
1919	Battle Creek Station								
1920	Battle Creek Station								
1921	Battle Creek Station								
1922	Battle Creek Station								
1923	Battle Creek Station								
1924	Battle Creek Station								



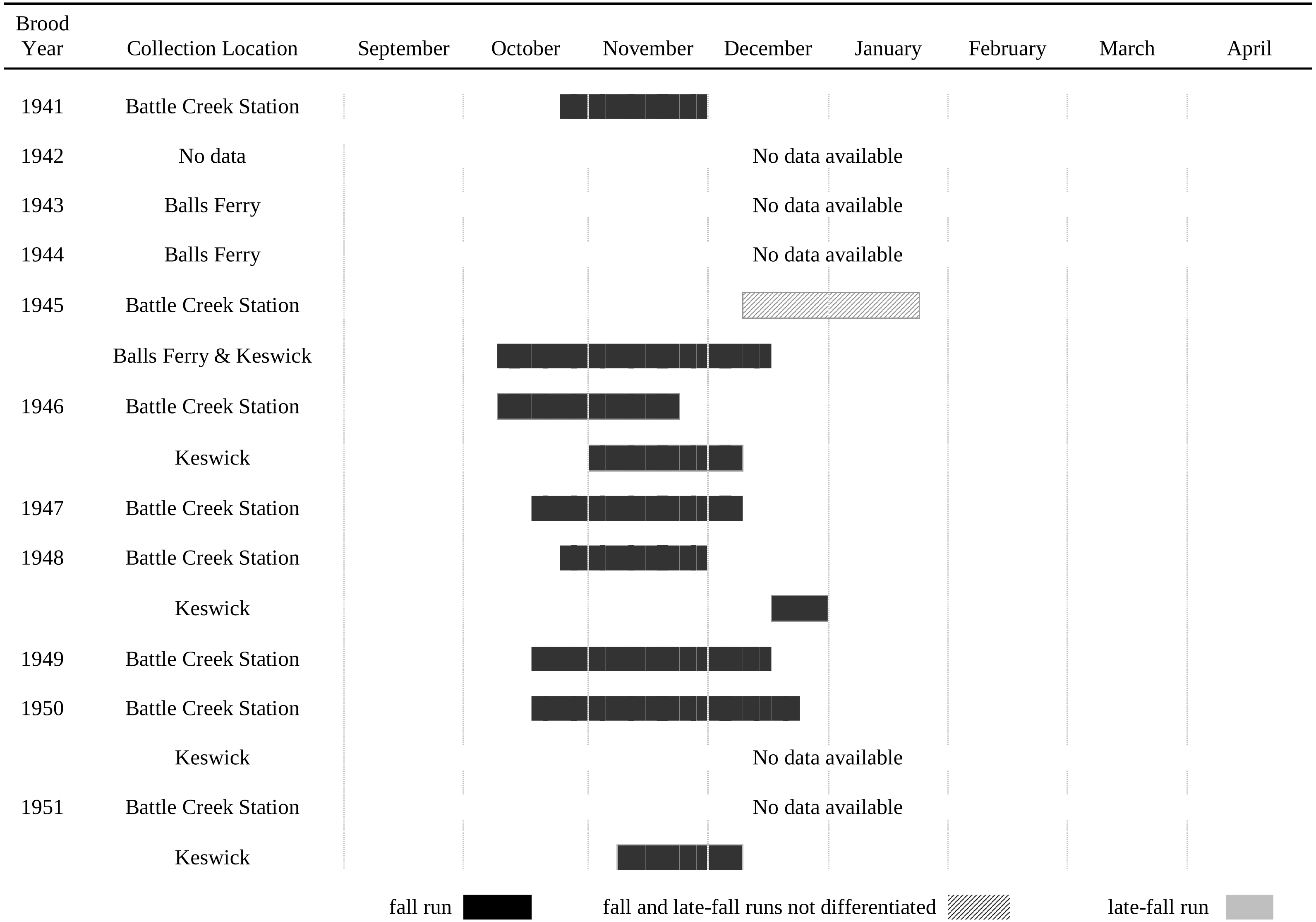
fall run — fall and late-fall runs not differentiated — late-fall run

Appendix 8A (cont.) Collection locations and approximate spawn timing of fall and late-fall Chinook salmon for Battle Creek Egg Taking Station, 1909-1941, and Coleman National Fish Hatchery, 1942-2008.

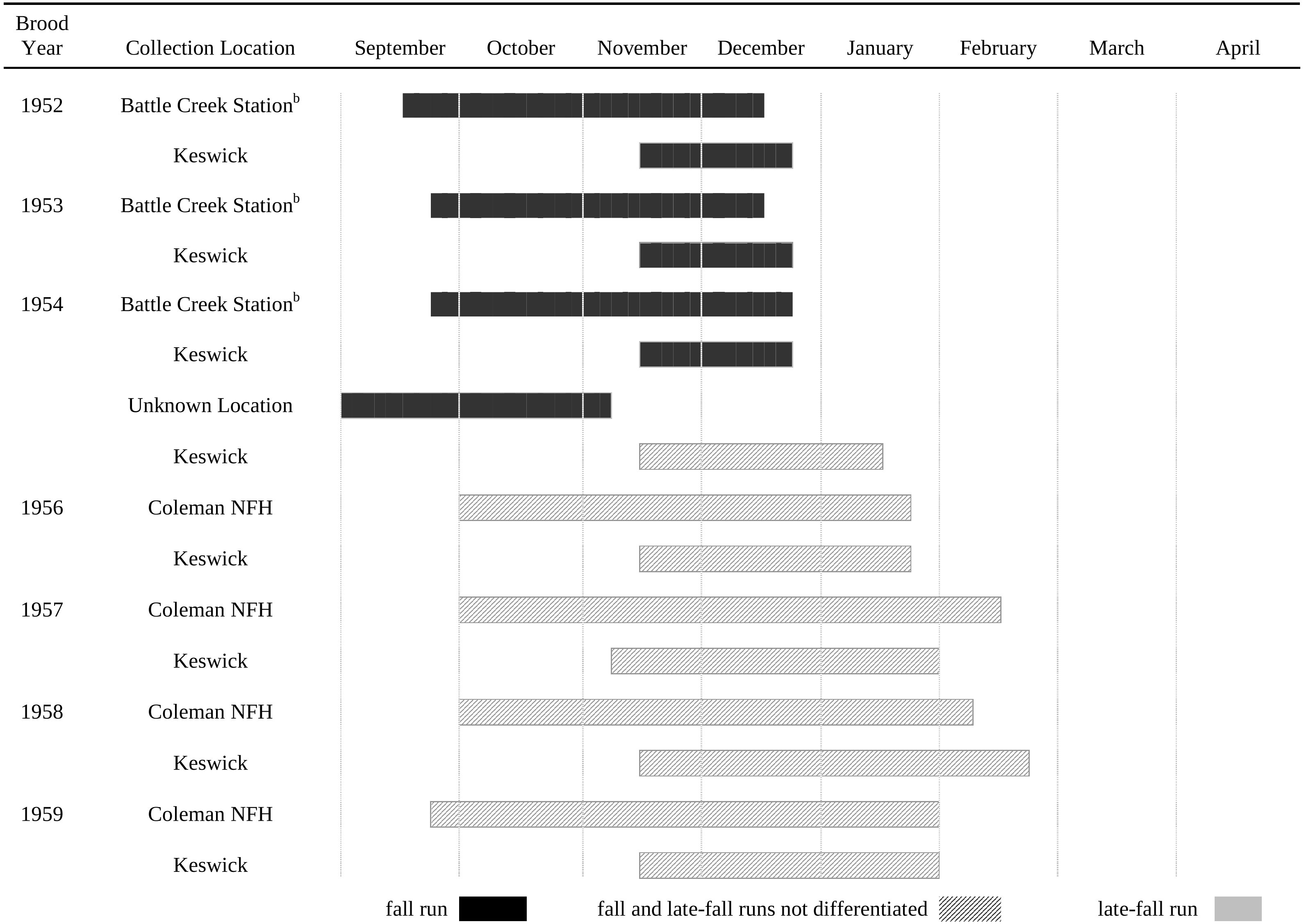


a Heavy rain damaged Battle Creek Racks on 11/16/37. Seining was conducted on 11/16-11/19 on small tributaries to Battle Creek near the station.

Appendix 8A (cont.) Collection locations and approximate spawn timing of fall and late-fall Chinook salmon for Battle Creek Egg Taking Station, 1909-1941, and Coleman National Fish Hatchery, 1942-2008.

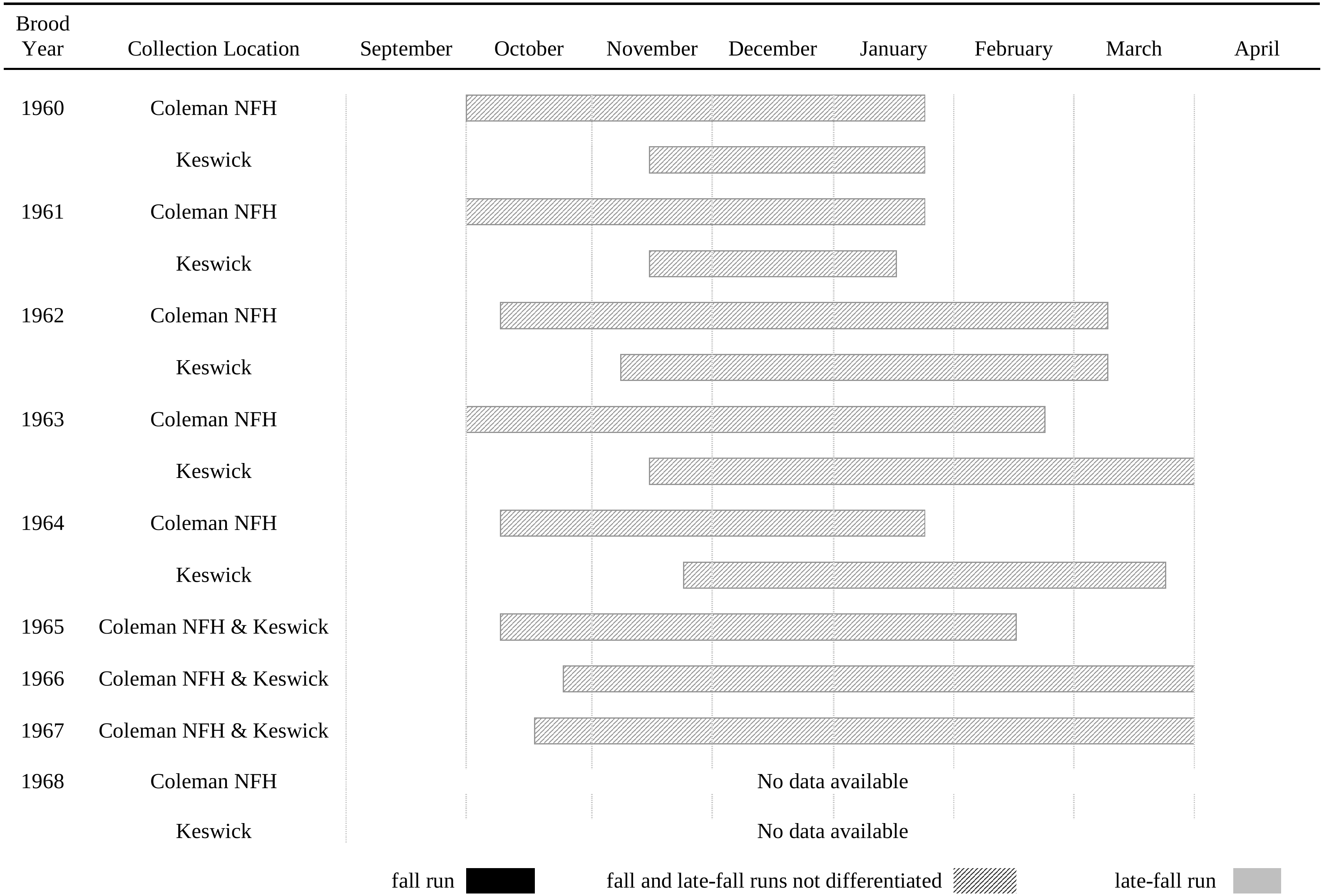


Appendix 8A (cont.) Collection locations and approximate spawn timing of fall and late-fall Chinook salmon for Battle Creek Egg Taking Station, 1909-1941, and Coleman National Fish Hatchery, 1942-2008.

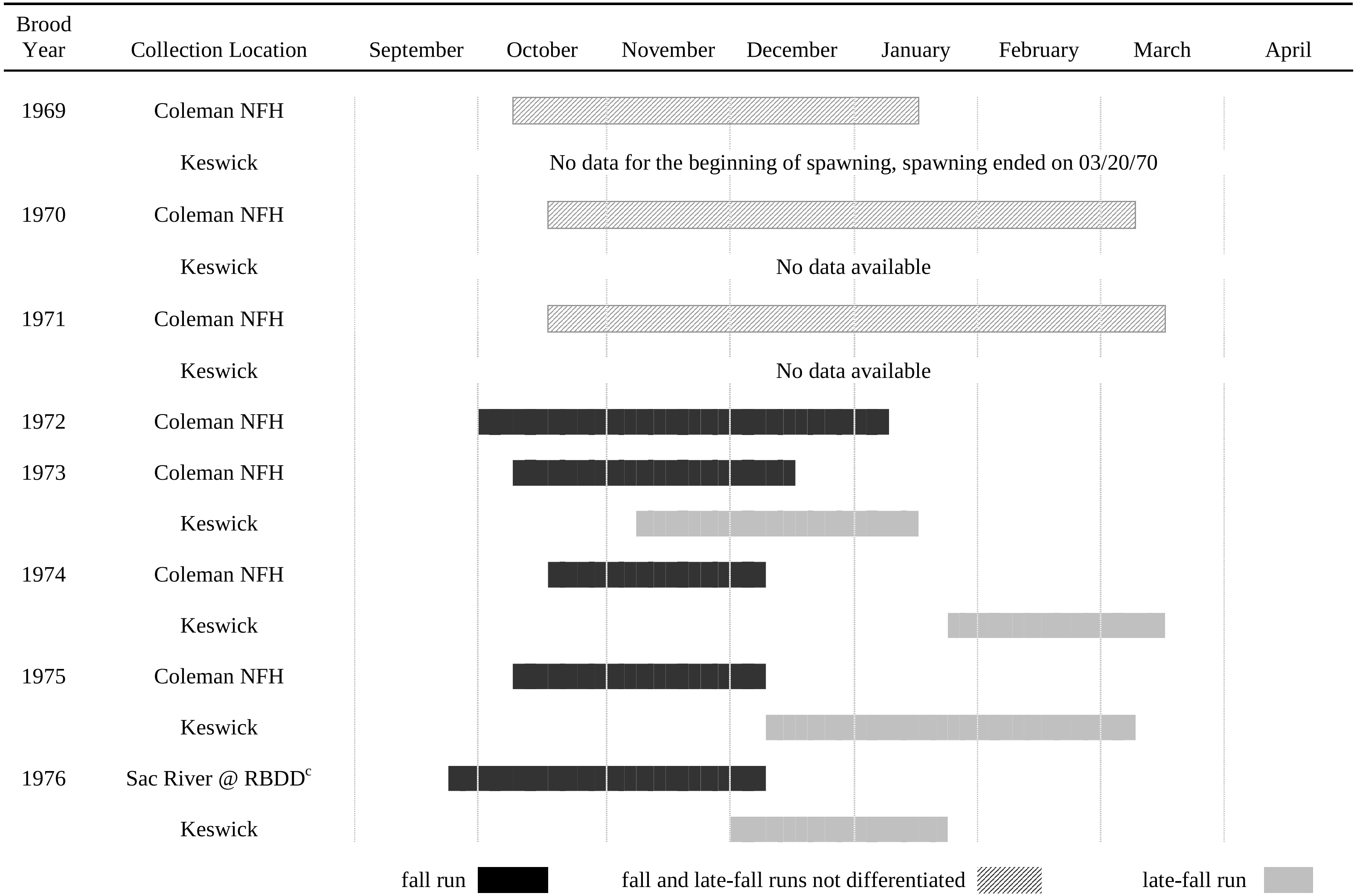


b Collection was at Battle Creek Station and Coleman National Fish Hatchery.

Appendix 8A (cont.) Collection locations and approximate spawn timing of fall and late-fall Chinook salmon for Battle Creek Egg Taking Station, 1909-1941, and Coleman National Fish Hatchery, 1942-2008.

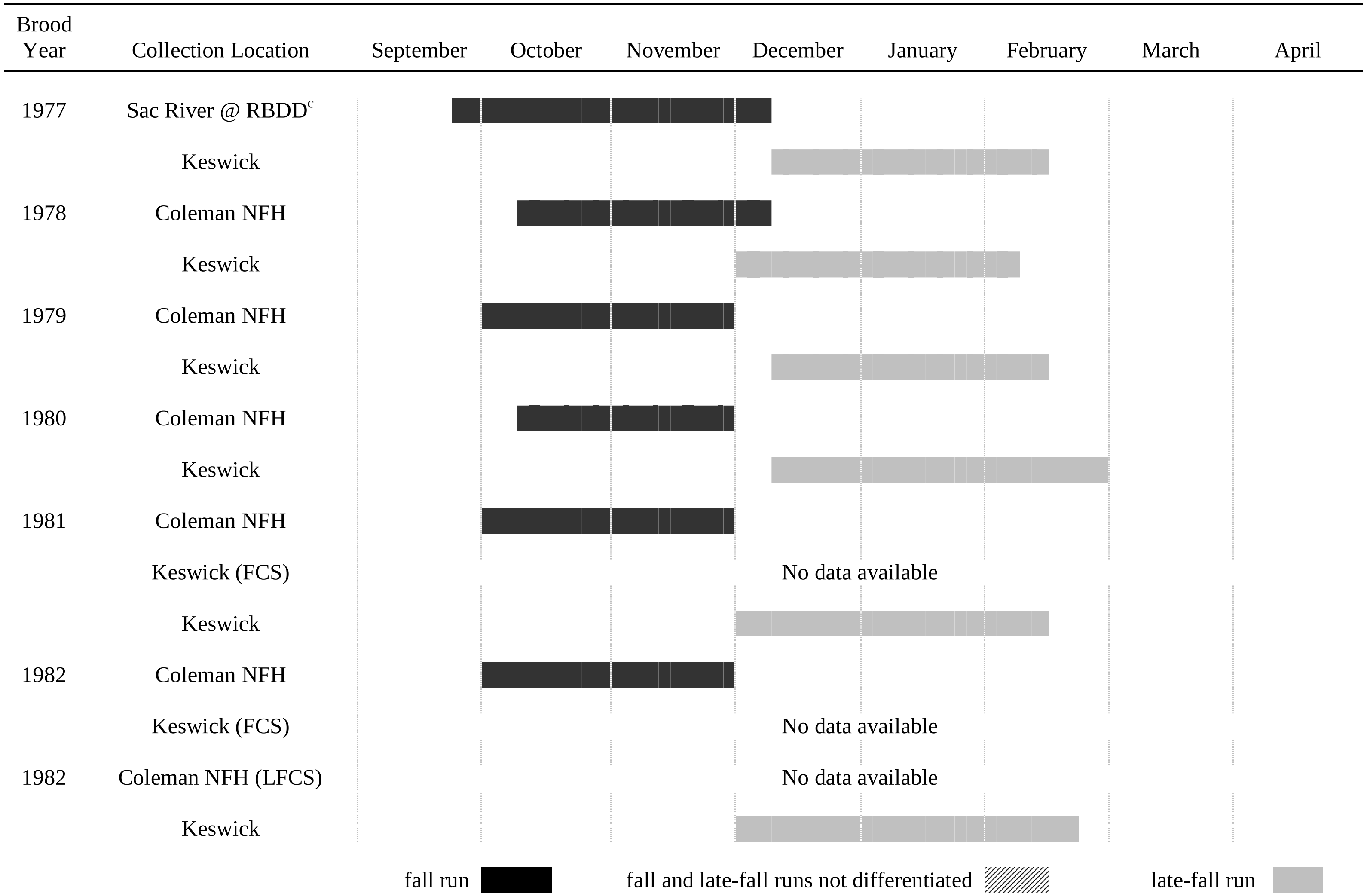


Appendix 8A (cont.) Collection locations and approximate spawn timing of fall and late-fall Chinook salmon for Battle Creek Egg Taking Station, 1909-1941, and Coleman National Fish Hatchery, 1942-2008.



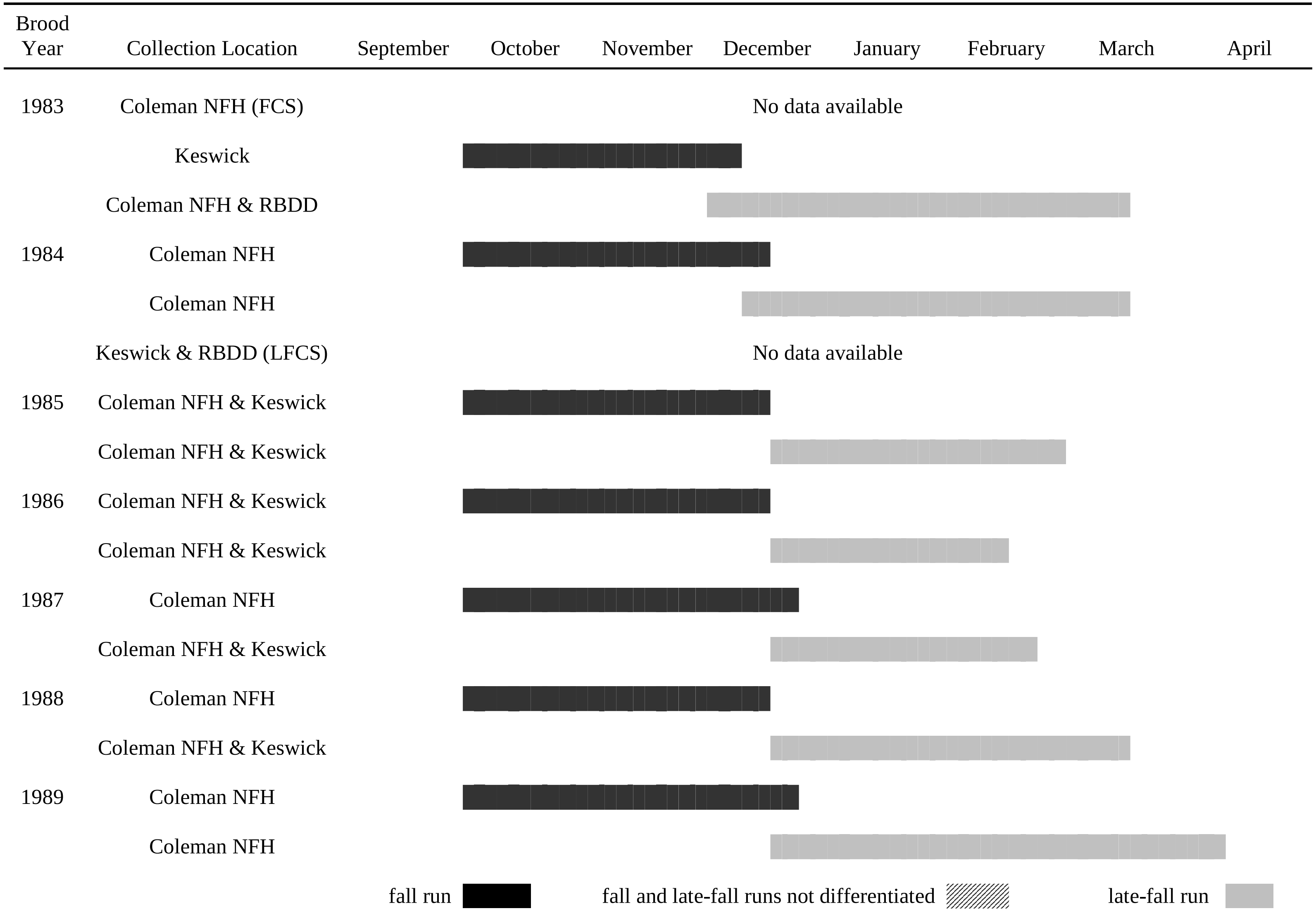
c Drought years. Anadromous fish passage was blocked at the Red Bluff Diversion Dam (RBDD) due to unfavorable water temperature conditions in the upper Sacramento River. Fish were hauled by truck to CNFH.

Appendix 8A (cont.) Collection locations and approximate spawn timing of fall and late-fall Chinook salmon for Battle Creek Egg Taking Station, 1909-1941, and Coleman National Fish Hatchery, 1942-2008.

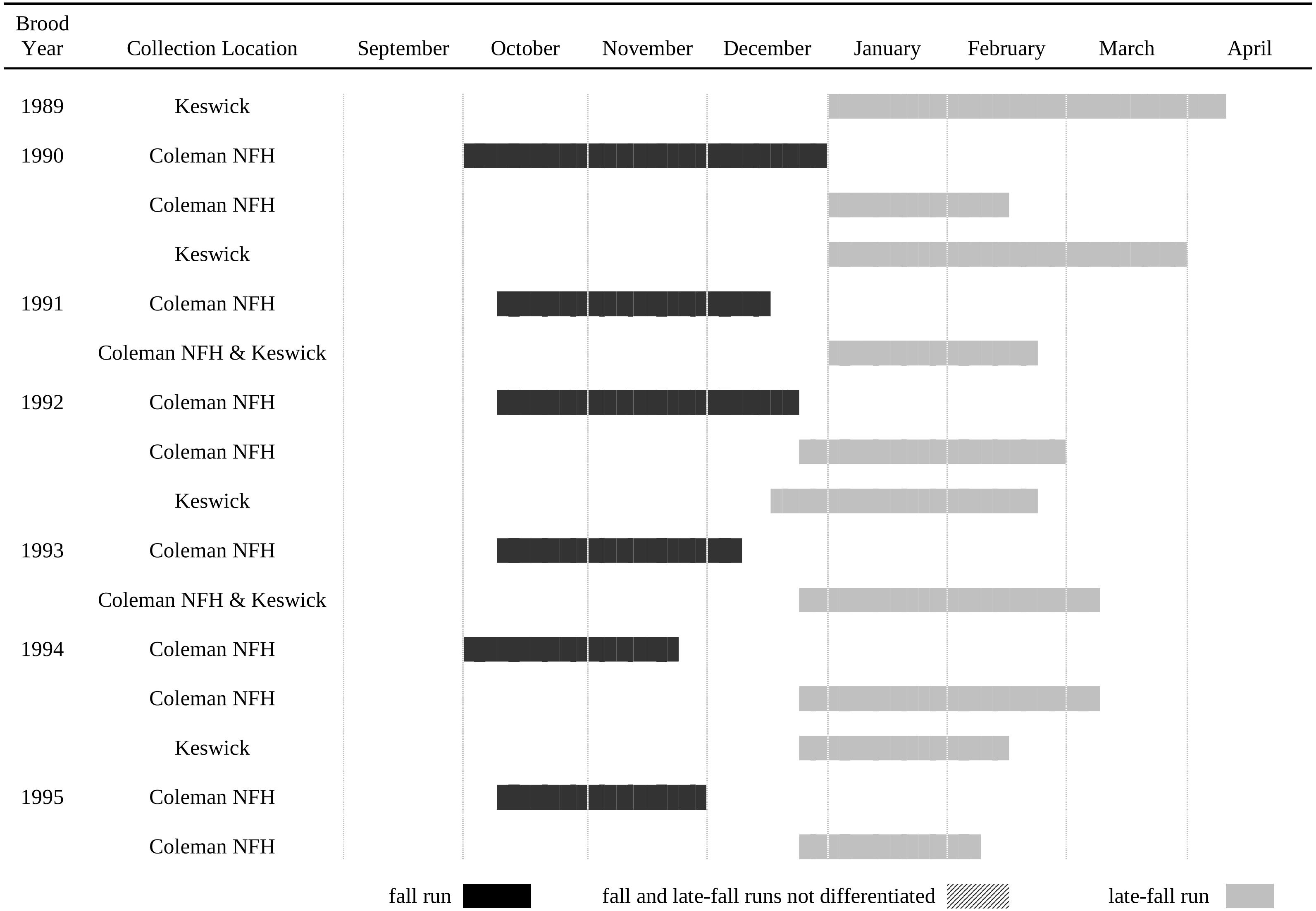


c Drought years. Anadromous fish passage was blocked at the Red Bluff Diversion Dam (RBDD) due to unfavorable water temperature conditions in the upper Sacramento River. Fish were hauled by truck to CNFH.

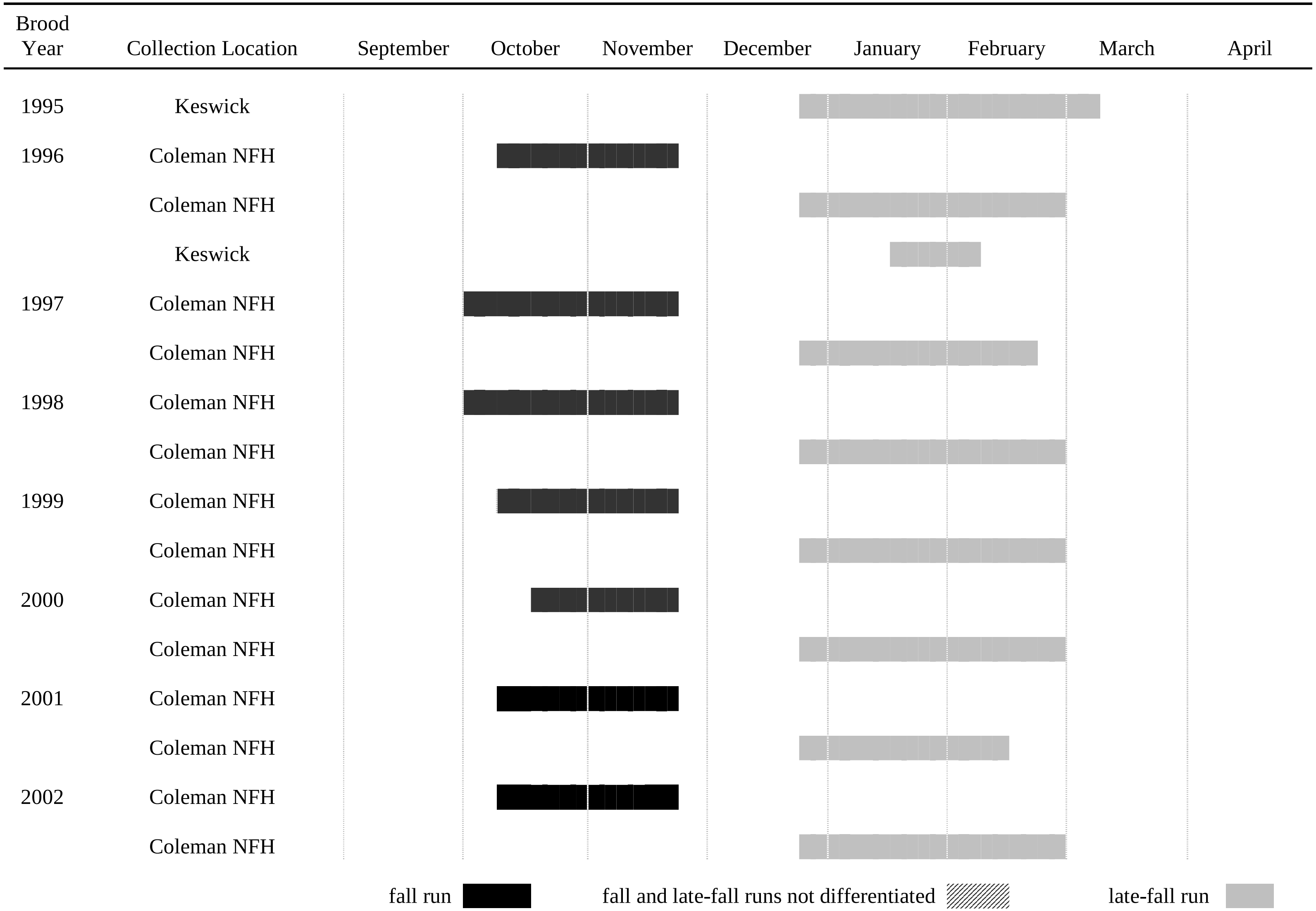
Appendix 8A (cont.) Collection locations and approximate spawn timing of fall and late-fall Chinook salmon for Battle Creek Egg Taking Station, 1909-1941, and Coleman National Fish Hatchery, 1942-2008.



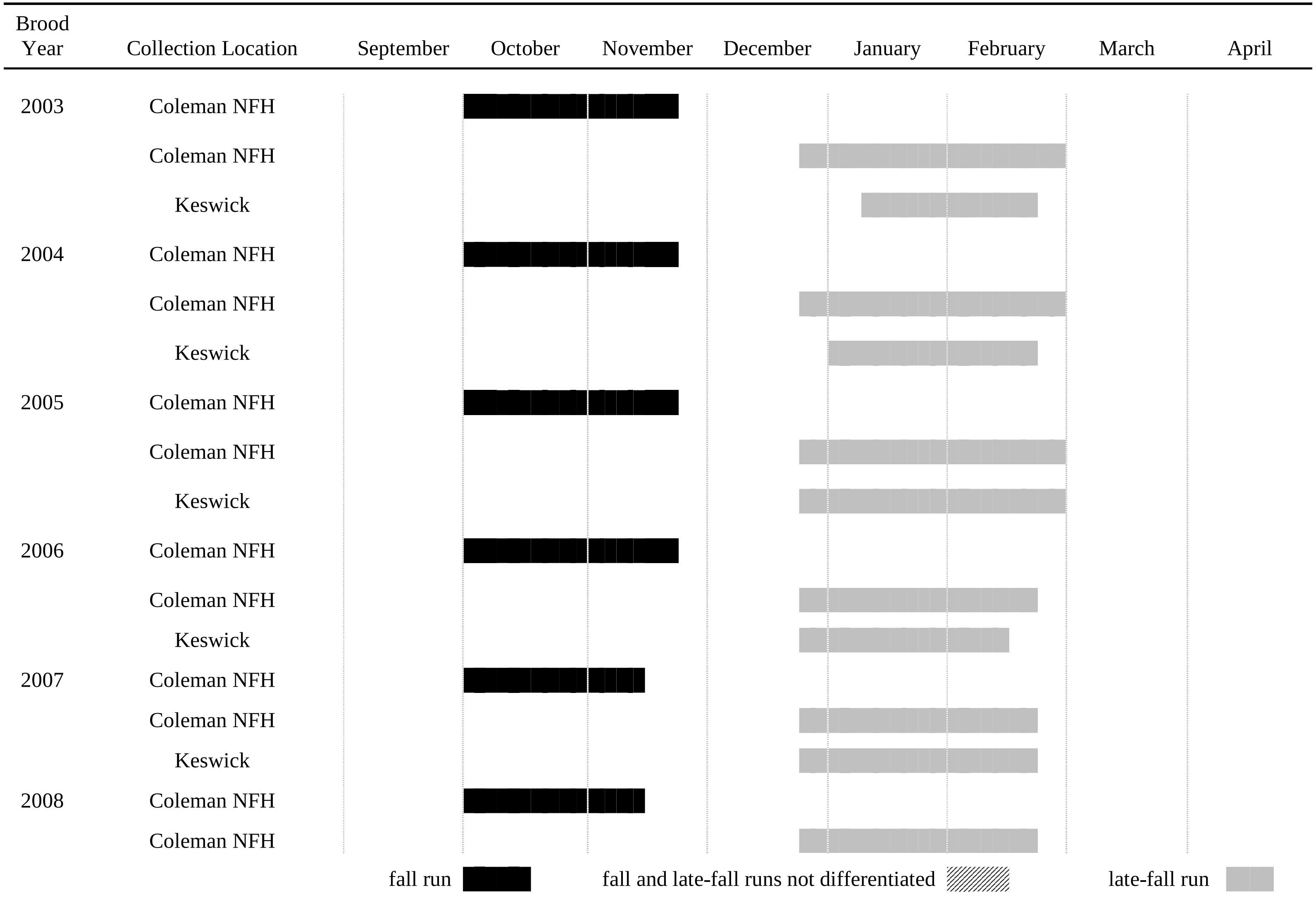
Appendix 8A (cont.) Collection locations and approximate spawn timing of fall and late-fall Chinook salmon for Battle Creek Egg Taking Station, 1909-1941, and Coleman National Fish Hatchery, 1942-2008.



Appendix 8A (cont.) Collection locations and approximate spawn timing of fall and late-fall Chinook salmon for Battle Creek Egg Taking Station, 1909-1941, and Coleman National Fish Hatchery, 1942-2008.



Appendix 8A (cont.) Collection locations and approximate spawn timing of fall and late-fall Chinook salmon for Battle Creek Egg Taking Station, 1909-1941, and Coleman National Fish Hatchery, 1942-2008.

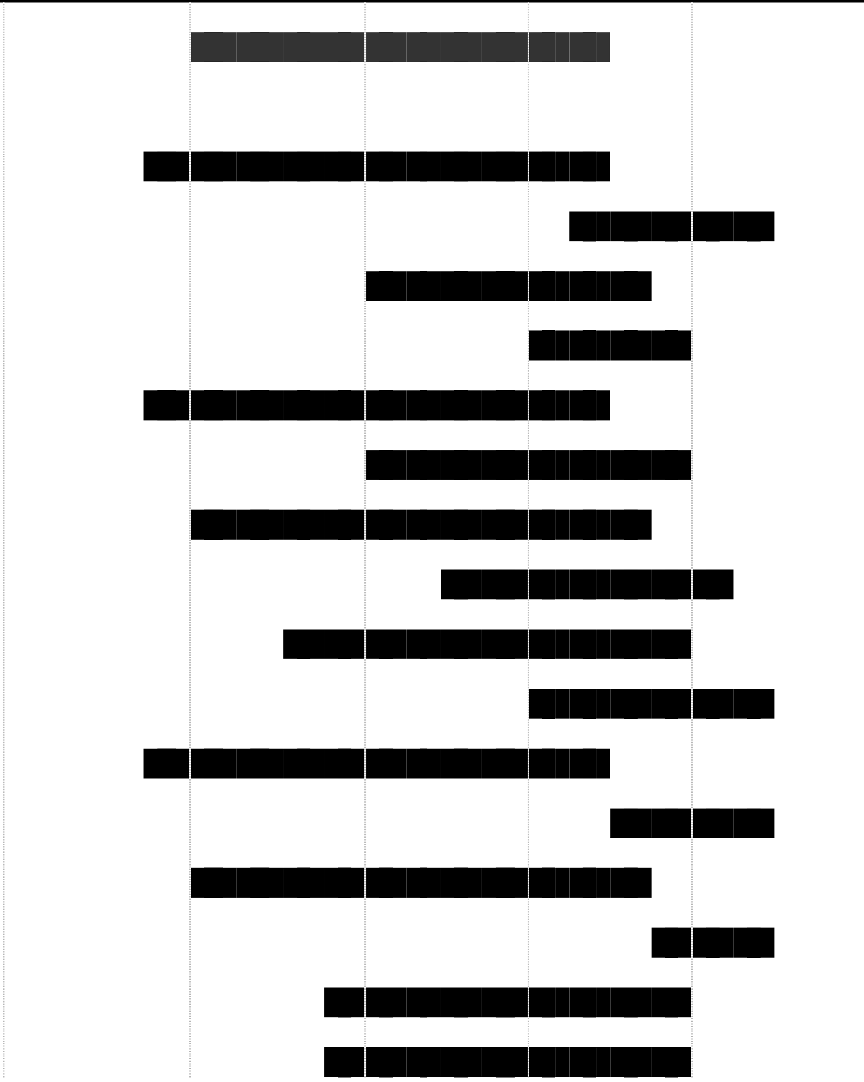


Appendix 8B Collection location and spawn timing of winter Chinook salmon for Coleman National Fish Hatchery, brood years 1955-1997 and Livingston Stone National Fish Hatchery, brood years 1998-2008.

Brood Year	Collection Location	April	May	June	July	August
1955	Keswick	Heavy mortality of captive adults, only 2 females spawned, remainder released into Battle Creek				
1958	Coleman NFH	No data for beginning of spawning, spawning ended on 6/16/1958				
	Keswick					
1961	Keswick	No winter Chinook spawned, captured fish released below A.C.I.D.				
1962	Keswick	No winter Chinook spawned, captured fish released into Battle Creek				
1963	Keswick					
1964	Keswick	No winter Chinook spawned, captured fish released below A.C.I.D.				
1965	Keswick					
1966	Keswick	Spawning began on 6/20/1966, no data for the end of spawning				
1967	Keswick					
1978	Keswick					
1982	Keswick					
1983	Keswick	Eleven winter Chinook collected, but all died. No progeny were produced (Service, BA 1993)				
1984	Keswick	Thirty two winter Chinook trapped, all but four males died				
1985	Keswick	Thirty five adults trapped, all but one died. No progeny produced.				
1989	RBDD & Keswick					
1990	Keswick					
1991	RBDD & Keswick					
1992	Keswick					
1993	RBDD & Keswick					
1994	no data					
1995	Keswick					
1996	Captive Broodstock					
1997	Captive Broodstock[a]					
1998	Keswick					

Appendix 8B (cont) Collection location and spawn timing of winter Chinook salmon for Coleman National Fish Hatchery, brood years 1955-1997 and Livingston Stone National Fish Hatchery, brood years 1998-2008.

Brood Year	Collection Location	April	May	June	July	August
1999	RBDD & Keswick and Captive Broodstock					
2000	Keswick					
	Captive Broodstock[b]					
2001	Keswick					
	Captive Broodstock[b]					
2002	Keswick					
	Captive Broodstock[c]					
2003	Keswick					
	Captive Broodstock[c]					
2004	Keswick					
	Captive Broodstock[c]					
2005	Keswick					
	Captive Broodstock[c]					
2006	Keswick					
	Captive Broodstock[c]					
2007	Keswick					
2008	Keswick					



a Captive broodstock, spawned at Bodega Marine Lab, incubated at Coleman NFH and transferred to Livingston Stone NFH.
b Captive broodstock spawned and reared at BML, no progeny were released.
c Captive broodstock spawned at Livingston Stone NFH; crossed with a natural-origin male.

Appendix 8C Collection locations and spawn timing of steelhead trout at Coleman National Fish Hatchery, brood years 1948-2008.

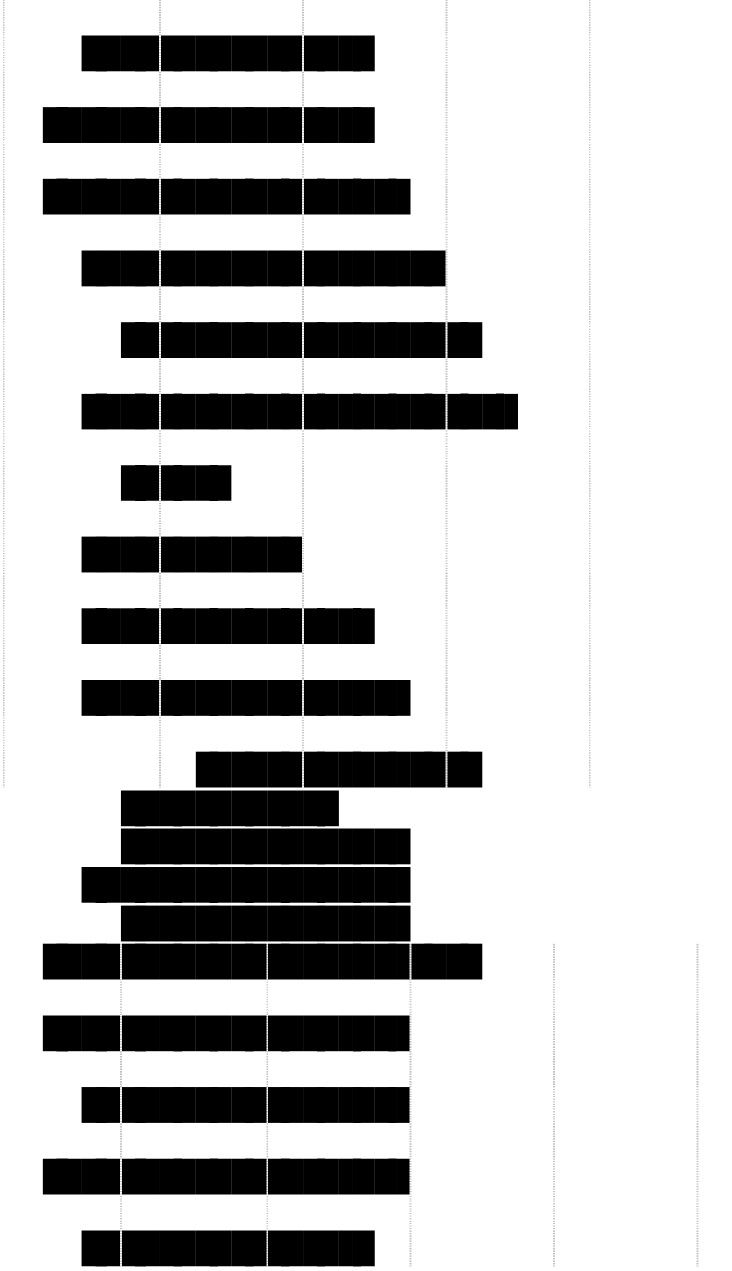
Brood Year	Collection Location	December	January	February	March	April
1948	Keswick			No data available		
1949	Station Broodstock			No data available		
1950	Station Broodstock			No data available		
1951	Station Broodstock			No data available		
1952	Coleman NFH			No data available		
1953	Coleman NFH					
1954	Coleman NFH					
1955	Coleman NFH					
1956	Coleman NFH & Keswick					
1957	Coleman NFH & Keswick					
1958	Coleman NFH & Keswick					
1959	Coleman NFH & Keswick					
1960	Coleman NFH & Keswick			No data available		
1961	Coleman NFH & Keswick					
1962	Coleman NFH & Keswick					
1963	Coleman NFH & Keswick			No data available		
1964	Coleman NFH & Keswick					
1965	Coleman NFH & Keswick			No data available		
1966	Coleman NFH			No data available		
	Coleman Powerhouse Spillway					
1967	Coleman NFH					

Appendix 8C (cont.) Collection locations and spawn timing of steelhead trout at Coleman National Fish Hatchery, brood years 1948-2008.

Brood Year	Collection Location	December / January / February / March / April
1968	Coleman NFH	
1969	Coleman NFH	
1970	Coleman NFH & Keswick	No data available
1971	Coleman NFH & Keswick	No data available
1972	Coleman NFH & Keswick	Spawning began on 12/22/1971, no data for the end of spawning
1973	Coleman NFH	No data available
1974	Coleman NFH & Keswick	Spawning began on 12/19/1973, no data for the end of spawning
1975	Coleman NFH	
1976	Coleman NFH	
1977	Coleman NFH & Keswick	
1978	Sac River @ RBDD	No data available
1979	Coleman NFH	No data available
1980	Coleman NFH	No data available
1981	Coleman NFH	No data available
1982	Coleman NFH	
1983	Coleman NFH & Keswick	
1984	Coleman NFH & Keswick	
1985	Coleman NFH & Keswick	
1986	Coleman NFH & Keswick	
1987	Coleman NFH	No data available
1988	Coleman NFH	

Appendix 8C (cont.) Collection locations and spawn timing of steelhead trout at Coleman National Fish Hatchery, brood years 1948-2008.

Brood Year	Collection Location	December	January	February	March	April
1989	Coleman NFH					
1990	Coleman NFH					
1991	Coleman NFH					
1992	Coleman NFH					
1993	Coleman NFH					
1994	Coleman NFH					
1995	Coleman NFH					
1996	Coleman NFH					
1997	Coleman NFH					
1998	Coleman NFH					
1999	Coleman NFH					
2000	Coleman NFH					
2001	Coleman NFH					
2002	Coleman NFH					
2003	Coleman NFH					
2004	Coleman NFH					
2005	Coleman NFH					
2006	Coleman NFH					
2007	Coleman NFH					
2008	Coleman NFH					



Appendix 10A Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008. Data include release date(s), species, race (run), brood year (BY), production lot number, number released, coded-wire tag (CWT) status, CWT code, size at release (fork length [inches] and number per pound, and release location. Information in this table may be cross-tabulated with Coleman NFH spawning data (Appendix 6A) using "CWT code" as an index field.

Distribution Date										Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
			1941				3,761,280	No CWT		ee	ee	
			1941	Fall			501,600	No CWT		1		
			1941	Spring			4,395,000	No CWT		1		
			1941	Fall			508,576	No CWT		1.5		
			1946	Spring		lot 8	87,863	No CWT		1.5		
			1946	Spring		lot 8	24,930	No CWT		6		
12	27		1946	Spring		lot 9	14,769	No CWT		1		
4	8	16	1946	Spring		lot 9	68,629	No CWT		2		
3	27		1946	Spring		lot 9	599,455	No CWT		2.5		
9	6	30	1946	Spring		lot 9	94,286	No CWT		5		
10	2	14	1946	Spring		lot 9	107,729	No CWT		5		
1	9		1946	Fall	1945	lot 10	3,300	No CWT		1		
2	8		1946	Fall	1945	lot 10	16,913,076	No CWT		2		
2	28		1946	Fall	1945	lot 10	2,451,450	No CWT		2		
4	5	22	1946	Fall	1945	lot 10	96,682	No CWT		4		
8	2	23	1946	Fall	1945	lot 10	137,225	No CWT		4.5		Battle Creek
9	20	27	1946	Fall	1945	lot 10	100,250	No CWT		4.5		Battle Creek
10	2	14	1946	Fall	1945	lot 10	453,898	No CWT		5		Battle Creek
2	4	28	1946	Fall	1945	lot 11	3,221,600	No CWT		1.5		
1	21	31	1946	Fall	1945	lot 12	1,700,608	No CWT			1168	Battle Creek
2	1	21	1946	Fall	1945	lot 12	5,001,086	No CWT		1-1.5		Battle Creek
12	3		1946	Spring	1946	lot 13	1,800	No CWT		1		
1	16		1947	Spring	1946	lot 12	157,782	No CWT		1		
2	1	20	1947	Spring	1946	lot 12	888,334	No CWT		1.5 & 2		
9	15	29	1947	Spring	1946	lot 12	297,338	No CWT		5 & 5.5		
1	3		1947	Spring	1946	lot 13	2,650	No CWT		1.5		
2	1	20	1947	Spring	1946	lot 13	802,427	No CWT		1.5 & 2		
3	4		1947	Spring	1946	lot 13	16,126	No CWT		2		
10	1	7	1947	Spring	1946	lot 13	277,205	No CWT		5 & 5.5		

Appendix 10A (cont.) Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date										Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
2	16	18	1947	Fall	1946	lot 14	1,357,799	No CWT		1.5		
3	3	17	1947	Fall	1946	lot 14	8,267,539	No CWT		1.5		
10	8	10	1947	Fall	1946	lot 14	301,009	No CWT		5.5		
3	13	28	1947	Fall	1946	lot 15	13,805,801	No CWT		1.5		
4	1		1947	Fall	1946	lot 15	19,449	No CWT		1.5		
10	10	14	1947	Fall	1946	lot 15	289,982	No CWT		4 & 5		
3	26		1948	Spring	1947	lot 17	74,654	No CWT		2		
10	19		1948	Spring	1947	lot 17	43,236	No CWT		5		
3	17	26	1948	Fall	1947	lot 18	8,432,451	No CWT		1.5 & 2		
4	8		1948	Fall	1947	lot 18	104,650	No CWT		1.5 & 2		
9	13	29	1948	Fall	1947	lot 18	796,763	No CWT		5		
10	13	18	1948	Fall	1947	lot 18	750,733	No CWT		5		
			1949	Fall	1948	lot 19	1,607,559	No CWT		2		
			1949	Fall	1948	lot 19	1,915,492	No CWT		5		
4	7		1950	Spring	1949	lot 22	32,000	No CWT		2		
9	22		1950	Spring	1949	lot 22	151,378	No CWT		5		
			1950	Fall	1949	lot 23	10,786,572	No CWT		1.5		
			1950	Fall	1949	lot 23	100,000	No CWT		2		
			1950	Fall	1949	lot 23	1,807,393	No CWT		5		
3	22		1951	Spring	1950	lot 27	630,928	No CWT		2		Sacramento River
10	1		1951	Spring	1950	lot 27	127,801	No CWT		5		Sacramento River
			1951	Fall	1950	lot 28	8,107,405	No CWT		2		Sacramento River
			1951	Fall	1950	lot 28	1,565,837	No CWT		5		Sacramento River
10	29		1952	Fall	1952	lot 38	12,000	No CWT		ee	ee	Mill Creek, CA
1	21		1952	Spring	1951	lot 32	789,949	No CWT		1		
			1952	Fall	1951	lot 33	19,924,340	No CWT		1		
			1952	Fall	1951	lot 33	1,483,764	No CWT		5		
			1953	Fall	1952	lot 38	28,219,705	No CWT		1.5		
			1953	Fall	1952	lot 38	2,754,095	No CWT		4		
			1953	Fall	1953	lot 43	36,000	No CWT		ee	ee	Seattle, WA
			1953	Fall	1953	lot 43	2,700	No CWT		ee	ee	Univ. of Wisconsin
			1953	Fall	1953	lot 43	341,958	No CWT		1		
			1954	Fall	1954	lot 46	151,273	No CWT		fry		Clear Creek
			1954	Fall	1953	lot 43	38,700	No CWT		ee	ee	

Appendix 10A (cont.) Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date										Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
			1955	Fall	1953	lot 43	33,557,600	No CWT		1.5		Sacramento River
			1955	Fall	1953	lot 43	2,238,860	No CWT		4		Sacramento River
			1955	Fall	1953	lot 43	918,210	No CWT		5		Sacramento River
			1955	Fall	1953	lot 43	2,000,000	No CWT		1		Mokelumne River
			1955	Fall	1953	lot 43	100,000	No CWT		2		Clear Creek
			1955	Fall	1953	lot 43	2,500	No CWT		2		Tracy Pumping Plant
			1955	Fall	1953	lot 43	150	No CWT		4		Tracy Pumping Plant
			1955	Fall	1954	lot 46/ 4CM	17,306,733	No CWT		2		Sacramento River
			1955	Fall	1954	lot 46/ 4CM	2,713,173	No CWT		5		Sacramento River
			1955	Fall	1954	lot 46/ 4CM	500,000	No CWT		1		Mokelumne River
10			1956	Fall	1956	6CM	30,000	No CWT		ee	ee	Fisheries Biology
			1956	Fall	1955	5CM	20,599,479	No CWT		2		Sacramento River
			1956	Fall	1955	5CM	257,750	No CWT		3		Sacramento River
			1956	Fall	1955	5CM	115,928	No CWT		4		Sacramento River
			1956	Fall	1955	5CM	2,959,407	No CWT		5		Sacramento River
			1956	Fall	1955	5CM	1,050,000	No CWT		1		Mokelumne River
			1956	Fall	1955	5CM	1,000,000	No CWT		1		Russian River
2			1957	Fall	1956	6CM	650,484	No CWT			513	Sacramento River
3			1957	Fall	1956	6CM	335,000	No CWT			670	Sacramento River
3			1957	Fall	1956	6CM	11,178,133	No CWT			608	Sacramento River
3			1957	Fall	1956	6CM	250,000	No CWT		1		Clear Creek
3			1957	Fall	1956	6CM	500,000	No CWT		1		Mill Creek, CA
4			1957	Fall	1956	6CM	250,000	No CWT			719	Deer Creek, CA
5			1957	Fall	1956	6CM	716,000	No CWT			358	Sacramento River
6			1957	Fall	1956	6CM	367,112	No CWT			355	Sacramento River
7			1957	Fall	1956	6CM	412,000	No CWT			206	Sacramento River
8			1957	Fall	1956	6CM	560,800	No CWT		3		Sacramento River
9			1957	Fall	1956	6CM	1,012,141	No CWT		4		Sacramento River
10			1957	Fall	1956	6CM	2,214,648	No CWT			23	Sacramento River
12			1957	Fall	1956	6CM	20,527	No CWT			12	Sacramento River
3			1958	Fall	1957	7CM-56	889,990	No CWT			426	Sacramento River
4			1958	Fall	1957	7CM-56	9,153,965	No CWT			78	Sacramento River
7			1958	Fall	1957	7CM-56	1,122,644	No CWT			88	Sacramento River
10			1958	Fall	1957	7CM-56	2,912,528	No CWT			36	Sacramento River

Appendix 10A (cont.) Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date										Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
12			1958	Fall	1957	7CM-56	312,508	No CWT			18	Sacramento River
			1958	Fall	1957	7CM-56	1,214,500	No CWT		ee	ee	Nimbus Hatchery
2			1959	Fall	1958	8-CM-62	55,652	No CWT			752	Sacramento River
2			1959	Fall	1958	8-CM-62	296,288	No CWT				Clear Creek
3			1959	Fall	1958	8-CM-62	890,501	No CWT			1272	Sacramento River
4			1959	Fall	1958	8-CM-62	427,758	No CWT			206	Sacramento River
5			1959	Fall	1958	8-CM-62	656,257	No CWT			160	Sacramento River
6			1959	Fall	1958	8-CM-62	2,893,249	No CWT			249	Sacramento River
10			1959	Fall	1958	8-CM-62	922,793	No CWT			24	Sacramento River
11			1959	Fall	1959	9-CM-66	25,000	No CWT		ee	ee	Mill Creek Fish. Res.
12			1959	Fall	1958	8-CM-62	1,344,257	No CWT		4		Sacramento River
12			1959	Fall	1959		165,368	No CWT		ee	ee	Mill Creek Fish. Res.
			1959	Fall	1958	8-CAL-64	28,971	No CWT			281	
			1959	Fall	1958	8-CM-62	14,932,795	No CWT		1		Sacramento River
			1959	Winter	1958	8-CM-60	3,117	No CWT		4		Sacramento River
			1959	Fall	1958	8-CM-62	1,753,750	No CWT		ee	ee	Nimbus Hatchery
			1959	Fall	1959	9-CM-66	1,032,716	No CWT		ee	ee	
2			1960	Fall	1959	9-CM-68	13,580,972	No CWT			964	Sacramento River
3			1960	Fall	1959	9-CM-68	9,309,876	No CWT			1138	Sacramento River
4			1960	Fall	1959	9-CM-68	6,856,595	No CWT			710	Sacramento River
5			1960	Fall	1959	9-CM-68	579,000	No CWT			304	Sacramento River
10			1960	Fall	1959	9-CM-68	4,505,551	No CWT			38	Sacramento River
1			1961	Fall	1960	0-CN-74	254,928	No CWT			1128	Clear Creek
2			1961	Fall	1960	0-CN-74	7,110,080	No CWT			613	Sacramento River
3			1961	Fall	1960	0-CN-74	14,203,927	No CWT			457	Sacramento River
3			1961	Fall	1960	0-CN-74	34,400	No CWT			800	Mill Creek Fish. Res.
4			1961	Fall	1960	0-CN-74	5,195,425	No CWT			450	Sacramento River
5			1961	Fall	1960	0-CN-74	764,236	No CWT			170	Sacramento River
6			1961	Fall	1960	0-CN-74	1,328,136	No CWT			104	Sacramento River
7			1961	Fall	1960	0-CN-74	234,900	No CWT			87	Sacramento River
10			1961	Fall	1960	0-CN-74	4,089,140	No CWT			30	Sacramento River
12			1961	Fall	1961	1-CN-78	500,000	No CWT		ee	ee	Mill Creek Fish Res.
12			1961	Fall	1961	1-CN-78	3,649,940	No CWT		7	1128	Sacramento River
			1961	Fall	1960	0-CAL-75	36,750	No CWT		2		Sacramento River

Appendix 10A (cont.) Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date										Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
			1961	Fall	1960	0-CAL-75	59,831	No CWT		2		Sacramento River
			1961	Fall	1960	0-SC-73	285,847	No CWT		2		Sacramento River
1			1962	Fall	1961	1-CN-78	4,049,852	No CWT		7	1287	
2			1962	Fall	1961	1-CN-78	750,000	No CWT		7		Shasta Lake
3			1962	Fall	1961	1-CN-78	6,904,374	No CWT			644	Sacramento River
3			1962	Fall	1961	1-CN-78	760,611	No CWT			325	Transfer to CA Fish & Game
4			1962	Fall	1961	1-CN-78	691,756	No CWT			306	Transfer to CA Fish & Game
5			1962	Fall	1961	1-CN-78	164,655	No CWT			125	Transfer to CA Fish & Game
5			1962	Fall	1961	1-CAL-79	50,000	No CWT			125	Sacramento River
5			1962	Fall	1961	1-CAL-79	58,330	No CWT			124	Sacramento River
10			1962	Fall	1961	1-CN-78	3,970,470	No CWT			37	Sacramento River
10			1962	Fall	1961	1-CN-78	27,750	No CWT			37	Corp. of Eng.
1			1963	Fall	1962	2-CN-83	250,000	No CWT		ee	ee	Mill Creek Fish. Res.
1			1963	Fall	1962	2-CN-83	283,000	No CWT		ee	ee	Fish. Res. - Woodall
1			1963	Fall	1962	2-CN-83	463,100	No CWT		ee	ee	Fish Res. - Parisot
2			1963	Fall	1962	2-CN-83	54,000	No CWT			1227	Mill Creek Fish. Res.
2			1963	Fall	1962	2-CN-83	1,467,622	No CWT			794	Sacramento River
3			1963	Fall	1962	2-CN-83	12,187,679	No CWT			1062	Sacramento River
4			1963	Fall	1962	2-CN-83	10,530,255	No CWT			460	Sacramento River
4			1963	Fall	1962	2-CN-83	1,008,000	No CWT			899	Transfer to CA Fish & Game
5			1963	Fall	1962	2-CN-83	5,571,807	No CWT			933	Sacramento River
5			1963	Fall	1962	2-CN-83	509,000	No CWT			1000	Russian River
6			1963	Fall	1962	2-CN-83	1,058,598	No CWT			475	Sacramento River
7			1963	Fall	1962	2-CN-83	503,120	No CWT			380	Sacramento River
7			1963	Winter	1963	3-CN-88	50,000	No CWT		ee	ee	Australia
8			1963	Fall	1962	2-CN-83	278,029	No CWT			39	Sacramento River
9			1963	Fall	1962	2-CN-83	604,835	No CWT			39	Sacramento River
10			1963	Fall	1962	2-CN-83	3,198,076	No CWT			39	Sacramento River
11			1963	Fall	1962	2-CN-83	1,113,750	No CWT			41	Sacramento River
11			1963	Fall	1962	2-CN-83	63,000	No CWT			26	Russian River
12			1963	Winter	1962	1-CN-82	34,516	No CWT		5		Sacramento River
12			1963	Fall	1962	2-CN-83	357,000	No CWT			32	Sacramento River
12			1963	Fall	1962	2-CN-83	112,000	No CWT			28	Clear Creek
1			1964	Fall	1963	4-CN-89	60,000	No CWT		ee	ee	Mill Creek Fish. Res.

Appendix 10A (cont.) Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date										Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
2			1964	Winter	1963	3-CN-88	73,000	No CWT			88	Sacramento River
3			1964	Fall	1963	4-CN-89	1,000,000	No CWT			1000	Sacramento River
5			1964	Fall	1963	4-CN-89	368,000	No CWT				Russian River
7			1964	Fall	1963	4-CN-89	605,500	No CWT			48	Sacramento River
8			1964	Fall	1963	4-CN-89	1,134,000	No CWT			36	Sacramento River
10			1964	Fall	1963	4-CN-89	3,300	No CWT			33	Fish. Res. - Tiburon
10			1964	Fall	1963	4-CN-89	1,452,300	No CWT			34	Sacramento River
11			1964	Fall	1963	4-CN-89	59,400	No CWT			54	Russian River
11			1964	Fall	1963	4-CN-89	557,400	No CWT			38	Sacramento River
12			1964	Fall	1963	4-CN-89	2,076,600	No CWT			73	Sacramento River
2			1965	Fall	1964	5-CN-93	1,229,000	No CWT			95	Sacramento River
3			1965	Fall	1964	5-CN-93	8,500,000	No CWT			669	Sacramento River
4			1965	Fall	1964	5-CN-93	3,149,000	No CWT			605	Sacramento River
6			1965	Fall	1964	5-CN-93	30,000	No CWT			500	Trans. Calif. Fish & Game
6			1965	Fall	1964	5-CN-93	331,000	No CWT			99	Sacramento River
8	4	10	1965	Fall	1964	5-CN-93	240,000	No CWT		3-4	38	Sacramento River
8	5	9	1965	Fall	1964	5-CAL-94	220,000	No CWT		3	42	Sacramento River
8	11		1965	Fall	1964	5-CN-93	65,000	No CWT		4	41	Red Bluff - Sacramento River
9	1	10	1965	Fall	1964	5-CN-93	412,000	No CWT		4	32	Princeton - Sacramento River
9	10		1965	Fall	1964	5-CN-93	36,000	No CWT		4	36	Red Bluff - Sacramento River
10	4	21	1965	Fall	1964	5-CN-93	1,183,900	No CWT		3-4	41	Jelly's Ferry - Sacramento River
10	4	11	1965	Fall	1964	5-CN-93	134,500	No CWT		3	42	Ball's Ferry - Sacramento River
11	2	30	1965	Fall	1964	5-CN-93	3,083,600	No CWT		3-5	41	Jelly's Ferry - Sacramento River
3	24		1966	Fall	1965	6-CN-1	222,000	No CWT		1	1,110	Clear Creek
5	5	13	1966	Fall	1965	6-CN-1	360,300	No CWT		2	313	Princeton - Sacramento River
5	13	20	1966	Winter	1965	5-CN-98	53,000	No CWT		4	30	Princeton - Sacramento River
7	20	29	1966	Fall	1965	6-CN-1	570,800	No CWT		3	106	Jelly's Ferry - Sacramento River
7	21	22	1966	Fall	1965	6-CN-1	239,800	No CWT		3	79	Princeton - Sacramento River
8	2		1966	Fall	1965	6-CN-1	56,000	No CWT		3	56	Red Bluff - Sacramento River
8	8	25	1966	Fall	1965	6-CN-1	746,900	No CWT		3	37	Jelly's Ferry - Sacramento River
8	17	30	1966	Fall	1965	6-CN-1	516,450	No CWT		3	48	Princeton - Sacramento River
8	30		1966	Fall	1965	6-CN-1	106,250	No CWT		3	106	Battle Creek
9	1		1966	Fall	1965	6-CN-1	47,500	No CWT		3	95	Red Bluff - Sacramento River
9	2		1966	Fall	1965	6-CAL-2	178,000	No CWT		3	89	Battle Creek

Appendix 10A (cont.) Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date										Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
9	6	21	1966	Fall	1965	6-CN-1	697,600	No CWT		3	75	Sacramento River @ Battle Creek
9	6	19	1966	Fall	1965	6-CN-1	871,100	No CWT		3	80	Jelly's Ferry - Sacramento River
9	6	16	1966	Fall	1965	6-CN-1	1,163,750	No CWT		4	48	Princeton - Sacramento River
9	7	21	1966	Fall	1965	6-CN-1	1,078,550	No CWT		3-4	42	Battle Creek
9	23		1966	Fall	1965	6-CAL-2	153,000	No CWT		3	85	Sacramento River @ Battle Creek
10	17	28	1966	Fall	1965	6-CAL-2	100,800	No CWT		4	32	Sacramento River @ Battle Creek
10	31		1966	Fall	1965	6-CN-1	2,409,300	No CWT		3-4	69	Sacramento River @ Battle Creek
11	1	3	1966	Fall	1965	6-CN-1	783,000	No CWT		3	60	Sacramento River @ Battle Creek
2	9		1967	Winter	1966	6-CN-6	4,300	No CWT		3	72	Jelly's Ferry - Sacramento River
6	2		1967	Fall	1966	7-CN-9	125,190	No CWT		3	78	Battle Creek
8	16	28	1967	Fall	1966	7-CN-9	1,135,744	No CWT		4	45	Sacramento River @ Battle Creek
8	28	31	1967	Fall	1966	7-CN-9	1,276,021	No CWT		3	74	Sacramento River @ Battle Creek
9	1	20	1967	Fall	1966	7-CN-9	3,206,445	No CWT		3	70	Sacramento River @ Battle Creek
9	6	8	1967	Fall	1966	7-CN-9	538,790	No CWT		4	49	Sacramento River @ Battle Creek
11	1		1967	Fall	1967	8-CN-15	18,000	No CWT		ee	ee	Research - Kimberly Clark Corp.
2	1		1968	Winter	1967	7-CN-13	16,176	No CWT		3	139	Sacramento River @ Battle Creek
5	27	28	1968	Fall	1967	8-CN-15	424,500	No CWT		3	85	Sacramento River @ Battle Creek
6	4	28	1968	Fall	1967	8-CN-15	1,870,060	No CWT		3	89	Sacramento River @ Battle Creek
7	1	17	1968	Fall	1967	8-CN-15	681,292	No CWT		3	97	Sacramento River @ Battle Creek
8	1	27	1968	Fall	1967	8-CN-15	4,442,931	No CWT		3	85	Sacramento River @ Battle Creek
9	6	12	1968	Fall	1967	8-CN-15	2,581,217	No CWT		3	88	Sacramento River @ Battle Creek
9	12		1968	Fall	1967	8-CN-15	339,000	No CWT		3	70	Sacramento River
4	21		1969	Fall	1968	9-CN-20	508,037	No CWT		3	80	Sacramento River @ Battle Creek
4	21		1969	Fall	1968	9-CN-20	388,143	No CWT		3	74	Rio Vista
5	22	23	1969	Fall	1968	9-CN-20	193,727	No CWT		3	86	Rio Vista
5	22	23	1969	Fall	1968	9-CN-20	185,537	No CWT		3	86	Sacramento River @ Battle Creek
6			1969	Fall	1968	9-CN-20	4,703	No CWT		3	157	Research - Tiburon Marine Lab.
7	5		1969	Fall	1968	9-CN-20	2,500	No CWT		3	100	Red Bluff - Sacramento River
8	1	14	1969	Fall	1968	9-CN-20	2,875	No CWT		3	192	Research - Kimberly Clark Corp.
9	2		1969	Fall	1968	9-CN-20	120	No CWT		4	60	Research - Kimberly Clark Corp.
9	2	12	1969	Fall	1968	9-CN-20	1,301,317	No CWT		3-4	64	Sacramento River @ Battle Creek
9	3	5	1969	Fall	1968	9-UC-23	414,569	No CWT		3	52	Rio Vista
9	4	12	1969	Fall	1968	9-CN-20	871,081	No CWT		3-4	65	Rio Vista
9	4		1969	Fall	1968	9-CN-20	108,876	No CWT		3		Rio Vista

Appendix 10A (cont.) Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date										Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
10	21		1969	Fall	1969	9-CN-26	15,600	No CWT		ee	ee	Research - Kimberly Clark Corp.
11	21		1969	Fall	1969	9-CN-26	8,000	No CWT		ee	ee	Research - Tehama Colusa Fish Facilities
2	27		1970	Fall	1969	9-CN-26	18,000	No CWT		ee	ee	Research - Kimberly Clark Corp.
2	27		1970	Fall	1969	9-CN-26	250	No CWT		2	250	Research - Kimberly Clark Corp.
3	19		1970	Fall	1969	9-CN-26	1,500	No CWT		2	375	Research - Tiburon Marine Lab.
3	24		1970	Fall	1969	9-CN-26	25,000	No CWT		1	1,316	Battle Creek
3	26		1970	Fall	1969	9-CN-26	140	No CWT		2	375	Research - Kimberly Clark Corp.
4	1		1970	Fall	1969	9-CN-26	180	No CWT		2	90	Research - Kimberly Clark Corp.
4	13	14	1970	Fall	1969	9-CN-26	1,031,406	No CWT		ee	ee	Transferred to State of Cal. - Oroville Hatchery
4	16		1970	Fall	1969	9-CN-26	600	No CWT		2	300	Research - Tiburon Marine Lab.
4	27	30	1970	Fall	1969	9-CN-26	703,242	No CWT		4	81	Rio Vista
4	27	30	1970	Fall	1969	9-CN-26	648,448	No CWT		4	84	Sacramento River @ Battle Creek
4	29		1970	Fall	1969	9-CN-26	2,591	No CWT		5	50	Research - Tiburon Marine Lab.
5	13	14	1970	Fall	1969	9-CN-26	361,151	No CWT		4	97	Sacramento River @ Battle Creek
6	1	12	1970	Fall	1969	9-CN-26	734,065	No CWT		4	124	Rio Vista
6	2	18	1970	Fall	1969	9-CN-26	475,546	No CWT		4	98	Sacramento River @ Battle Creek
6	2	30	1970	Fall	1969	9-CN-26	14,502	No CWT		2-4	264	Research - Tiburon Marine Lab.
7	20		1970	Fall	1969	9-CN-26	150	No CWT		3	150	Research - Kimberly Clark Corp.
9	14	30	1970	Fall	1969	9-CN-26	2,375,473	No CWT		3	57	Princeton - Sacramento River
9	15		1970	Fall	1969	9-CN-26	668	No CWT		3	45	Battle Creek
10	1	7	1970	Fall	1969	9-CN-26	581,558	No CWT		3	52	Princeton - Sacramento River
10	12		1970	Fall	1969	9-CN-26	150	No CWT		3	50	Research - Kimberly Clark Corp.
10	22		1970	Fall	1969	9-CN-26	63,000	No CWT		3	50	Sacramento River @ Battle Creek
1	19		1971	Fall	1970	0-CN-31	4,500	No CWT		ee	ee	Research - Diamond International Corp.
1	20		1971	Fall	1970	0-CN-31	200	No CWT		1		Research - Kimberly Clark Corp.
2	2		1971	Fall	1969	9-CN-26	150	No CWT		6	19	Research - Kimberly Clark Corp.
2	10		1971	Fall	1969	9-CN-26	35,598	No CWT		6	19	Sacramento River @ Battle Creek
2	16		1971	Fall	1970	0-CN-31	3,000	No CWT		ee	ee	Display - Arroyo Grande H.S.
3	4		1971	Fall	1970	0-CN-31	3,000	No CWT		ee	ee	Display - Arroyo Grande H.S.
3	18		1971	Fall	1970	0-CN-31	200	No CWT		3	67	Research - Kimberly Clark Corp.
3	19		1971	Fall	1970	0-CN-31	4,000	No CWT		ee	ee	Research - Diamond International Corp.
5	10	28	1971	Fall	1970	0-CN-31	1,886,819	No CWT		4	77	Rio Vista

Appendix 10A (cont.) Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date										Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
5	17	19	1971	Fall	1970	0-CN-31	1,056,577	No CWT		4	74	Sacramento River @ Battle Creek
6	1	10	1971	Fall	1970	0-CN-31	527,425	No CWT		3	85	Rio Vista
6	2	10	1971	Fall	1970	0-CN-31	1,658,081	No CWT		3	90	Battle Creek
9	15	27	1971	Fall	1970	0-CN-31	1,448,674	No CWT		4-5	40	Princeton - Sacramento River
9	28		1971	Fall	1970	0-CN-31	1,170,587	No CWT		4	49	Battle Creek
1	20		1972	Fall	1971	1-CM-37	2,755	No CWT		1	1,378	Research - Tehama Colusa Fish Facilities
3	15		1972	Fall	1971	1-CM-37	4,000	No CWT		3	200	Display - Steinhart Aquarium
3	24		1972	Fall	1971	1-CM-37	298,800	No CWT		3	166	Battle Creek
4	5		1972	Fall	1971	1-UCA-38	120,000	No CWT		1	1,000	Battle Creek
4	5		1972	Fall	1971	1-CM-37	1,863,351	No CWT		3	121	Sacramento River @ Battle Creek
4	10		1972	Fall	1971	1-CM-37	300	No CWT		3	150	Research - Simpson Lee Corp.
4	13		1972	Fall	1971	1-UCA-38	551,600	No CWT		3	131	Battle Creek
4	25		1972	Fall	1971	1-UCA-38	146,575	No CWT		3	143	Rio Vista
4	30		1972	Fall	1971	1-UCA-38	64,500	No CWT		2	430	Battle Creek
5	2	19	1972	Fall	1971	1-UCA-38	783,429	No CWT		3	68	Battle Creek
5	3	16	1972	Fall	1971	1-CM-37	700	No CWT		3	100	Research - Tiburon Marine Lab.
5	5	24	1972	Fall	1971	1-CM-37	615,669	No CWT		2	919	Balls Ferry - Sacramento River
5	12	26	1972	Fall	1971	1-UCA-38	960,500	No CWT		3	117	Rio Vista
5	19	24	1972	Fall	1971	1-CM-37	631,190	No CWT		3	90	Battle Creek
5	22		1972	Fall	1971	1-CM-37	200	No CWT		3	100	Research - Simpson Lee Corp.
5	25		1972	Fall	1971	1-CM-37	266,770	No CWT		3	103	Rio Vista
6	1		1972	Fall	1971	1-CM-37	188,000	No CWT		3	94	Rio Vista
6	1	28	1972	Fall	1971	1-UCA-38	1,575,811	No CWT		3	114	Battle Creek
6	1	28	1972	Fall	1971	1-UCA-38	1,239,942	No CWT		3	101	Rio Vista
6	16		1972	Fall	1971	1-UCA-38	426,189	No CWT		3	107	Knights Landing - Sacramento River
7	5		1972	Fall	1971	1-UCA-38	1,060	No CWT		3	106	Research - Tiburon Marine Lab.
7	11	12	1972	Fall	1971	1-UCA-38	513,520	No CWT		3	98	Rio Vista
7	11	12	1972	Fall	1971	1-UCA-38	203,500	No CWT		3	98	Battle Creek
7	11	12	1972	Fall	1971	1-CM-37	2,062,183	No CWT		3	106	Battle Creek
7	19		1972	Fall	1971	1-CM-37	200	No CWT		3	100	Research - Kimberly Clark Corp.
8	1	9	1972	Fall	1971	1-CM-37	325,048	No CWT		3	107	Battle Creek
8	9		1972	Fall	1971	1-CM-37	942,990	No CWT		3	98	Balls Ferry - Sacramento River
10	13	17	1972	Fall	1972	2-CM-43	7,100	No CWT		ee	ee	Research - Diamond International Corp.

Appendix 10A (cont.) Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date										Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
3	29		1973	Fall	1972	2-CM-43	1,000	No CWT		2	333	Display - Steinhart Aquarium
4	2		1973	Fall	1972	2-UCA-44	100	No CWT		1		Research - Diamond International Corp.
4	6		1973	Fall	1972	2-CM-43	100	No CWT		3		Research - Diamond International Corp.
4	9	27	1973	Fall	1972	2-CM-43	600	No CWT		2-3	120	Research - Simpson Lee Corp.
4	18		1973	Fall	1972	2-UCA-44	5,085	No CWT		2	339	Battle Creek
4	19	27	1973	Fall	1972	2-CM-43	573,774	No CWT		2-4	81	Battle Creek
5	3	29	1973	Fall	1972	2-CM-43	2,395,201	No CWT		3	89	Battle Creek
5	4	21	1973	Fall	1972	2-UCA-44	12,795	No CWT		2	298	Battle Creek
5	4	31	1973	Fall	1972	2-CM-43	550	No CWT		3	110	Research - Simpson Lee Corp.
6	1		1973	Fall	1972	2-CM-43	307,843	No CWT		4	77	Battle Creek
6	6		1973	Fall	1972	2-UCA-44	117,912	No CWT		4	102	Lake Redding Park - Sacramento River
6	8	29	1973	Fall	1972	2-CM-43	1,003,333	No CWT		3	89	Battle Creek
6	18	29	1973	Fall	1972	2-UCA-44	1,077,925	No CWT		3	101	Battle Creek
6	19	27	1973	Fall	1972	2-UCA-44	780,690	No CWT		3	112	Rio Vista
6	20	27	1973	Fall	1972	2-UCA-44	1,500	No CWT		3	100	Research - Tiburon Marine Lab.
6	26		1973	Fall	1972	2-CM-43	198,653	No CWT		3	91	Lake Redding Park - Sacramento River
6	28		1973	Fall	1972	2-UCA-44	230,000	No CWT		3	100	Balls Ferry - Sacramento River
6	29		1973	Fall	1972	2-CM-43	216,000	No CWT		3	90	Rio Vista
1	11		1974	Fall	1973	3-CM-50	60	No CWT		1		Display - Shasta College
1	22		1974	Fall	1973	3-CM-50	357,850	No CWT		2	850	Research - Tehama Colusa Fish Facilities
1	23	29	1974	Fall	1973	3-CM-50	140,400	No CWT		2	836	Battle Creek
1	28		1974	Fall	1973	3-UCA-51	412,270	No CWT		2	1,220	Research - Tehama Colusa Fish Facilities
2	11		1974	Fall	1973	3-CM-50	20,000	No CWT		2	667	Battle Creek
2	21		1974	Fall	1973	3-CM-50	250	No CWT		2		Research - Simpson Lee Corp.
3	4	22	1974	Fall	1973	3-CM-50	750	No CWT		2	250	Research - Simpson Lee Corp.
3	4	15	1974	Fall	1973	3-CM-50	2,700	No CWT		2-3	193	Research - Simpson Lee Corp.
3	15		1974	Fall	1973	3-UCA-51	5,000	No CWT		2	556	Battle Creek
3	16	17	1974	Fall	1973	3-UCA-51	20,804	No CWT		2	520	Battle Creek
3	28		1974	Fall	1973	3-UCA-52	11,875	No CWT		2	475	Battle Creek
5	7	17	1974	Fall	1973	3-CM-50	2,901,493	No CWT		2-4	85	Battle Creek
5	9		1974	Fall	1973	3-CM-50	500	No CWT		3	100	Research - Simpson Lee Corp.
5	17		1974	Fall	1973	3-UCA-51	293,595	No CWT		3	88	Battle Creek

Appendix 10A (cont.) Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date											Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
5	30		1974	Fall	1973	3-UCA-51	500	No CWT		4	63	Research - Simpson Lee Corp.
6	4	13	1974	Fall	1973	3-UCA-52	1,471,356	No CWT		3	89	Rio Vista
6	5	13	1974	Fall	1973	3-UCA-52	1,182,878	No CWT		3	89	Battle Creek
6	6	17	1974	Fall	1973	3-UCA-51	1,025,480	No CWT		3	95	Rio Vista
6	7		1974	Fall	1973	3-UCA-51	255,061	No CWT		4	69	Battle Creek
6	13	17	1974	Fall	1973	3-UCA-51	556,493	No CWT		3	90	Battle Creek
6	13	28	1974	Late-fall	1974	3-CM-55	1,686,593	No CWT		2	304	Battle Creek
6	14	27	1974	Late-fall	1974	3-CM-55	1,100	No CWT		3	110	Research - Simpson Lee Corp.
6	24	28	1974	Fall	1973	3-CM-50	1,502,317	No CWT		3	94	Battle Creek
11	12		1974	Fall	1974	4-CM-56	6,000	No CWT		ee	ee	Research - Simpson Lee Corp.
12	15		1974	Fall	1974	4-CM-56	1,000	No CWT		ee	ee	Display - San Jose School
4	3	18	1975	Fall	1974	4-CM-56	650	No CWT		2	325	Research - Simpson Lee Corp.
4	24	30	1975	Fall	1974	4-CM-56	179,840	No CWT		2-3	118	Battle Creek
4	30		1975	Late-fall	1975	4-CM-57	15,600	No CWT		2	600	Battle Creek
5	6		1975	Fall	1974	4-CM-56	246,315	No CWT		3	81	Battle Creek
5	8	29	1975	Fall	1974	4-UCA-58	900	No CWT		3	150	Research - Simpson Lee Corp.
5	13		1975	Late-fall	1975	4-CM-57	3,500	No CWT		2	500	Battle Creek
5	30		1975	Fall	1974	4-UCA-58	100,000	No CWT		3	100	Battle Creek
6	3		1975	Fall	1974	4-CM-56	288,600	No CWT		3-4		Red Bluff Diversion Dam
6	3		1975	Fall	1974	4-UCA-58	168,650	No CWT		3		Red Bluff Diversion Dam
6	3	9	1975	Fall	1974	4-UCA-58	319,068	No CWT		3		Battle Creek
6	3	9	1975	Fall	1974	4-CM-56	1,194,807	No CWT		3		Battle Creek
6	9		1975	Late-fall	1975	4-CM-57	7,500	No CWT		3		Battle Creek
6	12		1975	Late-fall	1975	4-CM-57	1,070	No CWT		3	214	Research - Simpson Lee Corp.
6	25		1975	Late-fall	1975	4-CM-57	5,000	No CWT		2		Battle Creek
7	18	31	1975	Late-fall	1975	4-CM-57	1,250	No CWT		2-4	179	Research - Simpson Lee Corp.
8	7		1975	Late-fall	1975	4-CM-57	300	No CWT		3	150	Research - Simpson Lee Corp.
9	2	18	1975	Late-fall	1975	4-CM-57	1,883,988	Partial	060301	3-4	58	Battle Creek
10	3		1975	Late-fall	1975	4-CM-57	120	No CWT		4	60	Display - Shasta College
10	21		1975	Fall	1975	5-CM-63	6,000	No CWT		ee	ee	Research - Simpson Lee Corp.
12	2	3	1975	Fall	1975	5-CM-63	24,000	No CWT		ee	ee	Transfer - California Dept. Fish and Game
1	8		1976	Late-fall	1975	4-CM-57	10,085	No CWT		5	24	Balls Ferry - Sacramento River
2	13		1976	Late-fall	1976	5-CM-65	6,000	No CWT		ee	ee	Research - Simpson Lee Corp.

Appendix 10A (cont.) Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date										Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
2	18		1976	Fall	1975	5-CM-63	3,000	No CWT		2	500	Battle Creek
3	1	15	1976	Fall	1975	5-CM-63	700	No CWT		2-3	140	Research - Simpson Lee Corp.
3	19		1976	Fall	1975	5-CM-63	10,000	No CWT		2	714	Battle Creek
3	19		1976	Fall	1975	5-UCA-64	5,000	No CWT		2	714	Battle Creek
4	2		1976	Fall	1975	5-UCA-64	10,950	No CWT		2	438	Battle Creek
4	13		1976	Fall	1975	5-CM-63	105,723	No CWT		4	74	Battle Creek
4	19		1976	Fall	1975	5-CM-63	450	No CWT		3	150	Research - Simpson Lee Corp.
5	5		1976	Fall	1975	5-CM-63	13,500	No CWT		3	90	Battle Creek
5	14	28	1976	Fall	1975	5-CM-63	433,090	Partial	060303, 060304, 060305	3	156	Lake Red Bluff - Sacramento River
5	14	28	1976	Fall	1975	5-CM-63	403,232	Partial	060303, 060304, 060305	3	137	Above Red Bluff Diversion Dam - Sacramento River
5	14	28	1976	Fall	1975	5-CM-63	401,018	Partial	060303, 060304, 060305	3	131	Below Red Bluff Diversion Dam - Sacramento River
5	25		1976	Fall	1975	5-CM-63	600	No CWT		3	200	Research - Simpson Lee Corp.
6	1	7	1976	Fall	1975	5-CM-63	1,205,384	No CWT		3	100	Battle Creek
6	1		1976	Fall	1975	5-CM-63	124,230	No CWT		3	120	Above Red Bluff Diversion Dam - Sacramento River
6	1		1976	Fall	1975	5-CM-63	39,270	No CWT		3	102	Below Red Bluff Diversion Dam - Sacramento River
6	1		1976	Fall	1975	5-CM-63	49,770	No CWT		3	121	Lake Red Bluff - Sacramento River
6	7	25	1976	Fall	1975	5-UCA-64	478,284	No CWT		3	101	Battle Creek
6	7	25	1976	Late-fall	1976	5-CM-65	950	No CWT		3	119	Research - Simpson Lee Corp.
6	24	28	1976	Fall	1975	5-UCA-64	938,300	No CWT		3	115	Rio Vista
7	30		1976	Late-fall	1976	5-CM-65	500	No CWT		3	100	Research - Simpson Lee Corp.
9	10		1976	Fall	1975	5-UCA-64	161,000	No CWT		4	55	Battle Creek
9	10		1976	Fall	1975	5-CM-63	716,000	No CWT		4	50	Battle Creek
9	22		1976	Fall	1975	5-UCA-64	87,000	No CWT		5	35	Battle Creek
9	22		1976	Fall	1975	5-CM-63	117,000	No CWT		5	28	Battle Creek
10	7	20	1976	Late-fall	1976	5-CM-65	397,483	Partial	060307	3-4	49	Battle Creek
10	12		1976	Fall	1975	5-CM-63	7,573	No CWT		5	26	Clifton Court Forebay
10	18		1976	Fall	1975	5-CM-63	58,766	No CWT		5		Sacramento River at Battle Creek
10	18	20	1976	Fall	1975	5-CM-63	126,904	No CWT		4	39	South Fork Mokelumne River
10	18		1976	Fall	1975	5-CM-63	39,396	No CWT		5	33	North Fork Mokelumne River
10	18	20	1976	Late-fall	1976	5-CM-65	106,392	No CWT		4	48	Ryde - Sacramento River

Appendix 10A (cont.) Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date										Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
10	18	20	1976	Late-fall	1976	5-CM-65	125,733	No CWT		4	48	Steamboat Slough - Sacramento River
10	20		1976	Fall	1975	5-CM-63	45,962	No CWT		5	33	Mokelumne River - Georgiana Slough
2	20		1977	Fall	1976	6-CM-72	300	No CWT		1	150	Research - Simpson Lee Corp.
3	14		1977	Fall	1976	6-CM-72	262	No CWT		3	175	Research - Simpson Lee Corp.
4	15		1977	Fall	1976	6-CM-72	600	No CWT		3	200	Research - Simpson Lee Corp.
4	15		1977	Fall	1976	6-CM-72	2,000	No CWT		1	1,230	Research - Tehama Colusa Fish Facilities
4	21	28	1977	Fall	1976	6-CM-72	1,597,000	No CWT		3	93	Battle Creek
5	6	24	1977	Fall	1976	6-CM-72	932,312	Partial	066008, 066009, 066010, 066011	3-4	86	Red Bluff - Sacramento River
5	9		1977	Fall	1976	6-CM-72	500	No CWT		2	250	Research - Simpson Lee Corp.
5	12	31	1977	Fall	1976	6-CM-72	4,072,980	No CWT		2-3	95	Battle Creek
5	24		1977	Fall	1976	6-CM-74	800	No CWT		2	400	Research - Simpson Lee Corp.
5	31		1977	Fall	1976	6-UCA-73	869,905	No CWT		3	115	Battle Creek
6	15	21	1977	Fall	1976	6-UCA-73	1,096,809	No CWT		3	91	Rio Vista
7	8		1977	Fall	1976	6-CM-74	500	No CWT		3	125	Research - Simpson Lee Corp.
8	15		1977	Fall	1976	6-CM-74	300	No CWT		3	100	Research - Simpson Lee Corp.
9	16	30	1977	Fall	1976	6-CM-74	600	No CWT		4	60	Research - Simpson Lee Corp.
10	14		1977	Fall	1976	6-CM-74	60	No CWT		5	15	Display - Shasta College
11	3	7	1977	Fall	1976	6-CM-72	302,373	No CWT		6	17	Red Bluff - Sacramento River
12	11	19	1977	Fall	1976	6-CM-72	177,358	No CWT		6-7	13	Battle Creek
12	11	19	1977	Fall	1976	6-CM-74	175,695	No CWT		5-6	23	Battle Creek
12	14		1977	Fall	1976	6-CM-74	200,124	No CWT		5-6	24	Red Bluff - Sacramento River
12	14	19	1977	Fall	1976	6-CM-72	115,318	No CWT		6	14	Red Bluff - Sacramento River
12	16		1977	Fall	1977	7-CM-78	983,776	No CWT		ee	ee	Transfer - Feather River SFH
1	3	5	1978	Fall	1977	7-CM-82	586,993	Partial	066015	5-6	25	Battle Creek
1	8	9	1978	Fall	1977	7-CM-82	225,680	Partial	066014	5	23	Red Bluff - Sacramento River
1	24		1978	Fall	1976	6-CM-74	251,968	Complete	066012	4-6	23	Battle Creek
1			1978	Fall	1977	7-CM-78	25,300	No CWT		2	843	Battle Creek
3			1978	Fall	1977	7-CM-78	100,000	No CWT		2	1,000	Battle Creek
4	28		1978	Fall	1977	7-UCA-84	284,800	No CWT		3	94	Battle Creek
5	5	26	1978	Fall	1977	7-CM-78	1,607,000	No CWT		3	87	Battle Creek
5	11	18	1978	Fall	1977	7-UCA-84	1,244,000	No CWT		3	91	Battle Creek
6	1	9	1978	Fall	1977	7-CM-78	1,546,000	No CWT		3	94	Battle Creek
6	6	12	1978	Fall	1977	7-CM-83	1,425,908	No CWT		3	151	Rio Vista

Appendix 10A (cont.) Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date										Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
6	9		1978	Fall	1977	7-CM-79	625,000	No CWT		3	90	Battle Creek
6	12		1978	Fall	1977	7-CM-82	450	No CWT		2	225	Research - Simpson Lee Corp.
7	17		1978	Fall	1977	7-CM-82	800	No CWT		3	133	Research - Simpson Lee Corp.
10	2	24	1978	Fall	1977	7-CM-82	941,450	Partial	066013	4	48	Battle Creek
1	9		1979	Fall	1977	7-CM-82	30,600	No CWT		6	22	Battle Creek
2	13	14	1979	Winter	1978	8-CM-86	9,942	Complete	050453	5	21	Battle Creek
2	14		1979	Winter	1978	8-CM-86	308	No CWT		5	21	Tehama Colusa Fish Facilities
2	28		1979	Fall	1978	8-UCA-88	400	No CWT		1	1,143	Research - California Dept. Fish and Game
4	13		1979	Fall	1978	8-CM-87	500	No CWT		3	125	Tehama Colusa Fish Facilities
4	20	30	1979	Fall	1978	8-UCA-88	3,405,975	No CWT		2-3	157	Redding - Sacramento River
4	20	30	1979	Fall	1978	8-UCA-88	190,975	No CWT		2-3	186	Battle Creek
4	30		1979	Fall	1978	8-CM-87	490,000	No CWT		3	128	Battle Creek
5	9		1979	Fall	1978	8-CM-87	42,275	No CWT		3-4	99	Battle Creek
5	16		1979	Fall	1978	8-CM-87	500	No CWT		3	83	Tehama Colusa Fish Facilities
6	19		1979	Fall	1978	8-CM-87	275	No CWT		4	46	Tehama Colusa Fish Facilities
9	4	7	1979	Fall	1978	8-UCA-91	522,575	No CWT		5	23	Red Bluff - Sacramento River
10	19	25	1979	Fall	1978	8-CM-87	1,013,462	No CWT		6	17	Battle Creek
12	3		1979	Late-Fall	1979	8-CM-90	827,504	No CWT		4-5	36	Battle Creek
2	4		1980	Fall	1978	8-CM-87	39,300	No CWT		6	13	Battle Creek
2	4	6	1980	Late-Fall	1979	8-CM-90	104,000	Partial	066023	5	25	Battle Creek
2	11		1980	Late-Fall	1979	8-CM-90	50,200	Complete	066022	5	24	Red Bluff - Sacramento River
2	20		1980	Fall	1979	9-CM-91	51,640	Complete	H50204, H50205	2	420	Berkeley Pier - San Francisco Bay
2	26		1980	Fall	1979	9-CM-91	53,893	Complete	H50206, H50207	2	359	Clarksburg - Sacramento River
2	29		1980	Fall	1979	9-CM-91	54,410	Complete	H50301, H50302	2	419	Red Bluff - Sacramento River
3	7		1980	Fall	1979	9-CM-91	53,518	Complete	H50303, H50304	2	541	Clarksburg - Sacramento River
3	12		1980	Fall	1979	9-CM-91	51,284	Complete	H50305, H50306	2	518	Red Bluff - Sacramento River
3	13	15	1980	Fall	1979	9-CM-91	190,000	No CWT		2	704	Battle Creek
4	17	28	1980	Fall	1979	9-CM-91	3,515,605	No CWT		3	107	Battle Creek
5	7	27	1980	Fall	1979	9-CM-91	7,101,883	No CWT		3	127	Battle Creek
6	6	17	1980	Late-Fall	1980	9-CM-93	490,263	No CWT		2-3	227	Battle Creek
9	22		1980	Late-Fall	1980	9-CM-93	886,591	No CWT		4	62	Battle Creek
9	22		1980	Fall	1979	9-CM-91	613,309	No CWT		5-6	21	Battle Creek
9	22		1980	Fall	1979	9-CM-91	1,600	No CWT		6	20	Research - Red Bluff FAO

Appendix 10A (cont.) Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date										Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
12	9		1980	Late-Fall	1980	9-CM-93	41,146	No CWT		5	34	Balls Ferry - Sacramento River
2	3		1981	Late-Fall	1980	9-CM-93	52,008	Complete	066018	5	25	Battle Creek
2	5		1981	Late-Fall	1980	9-CM-93	51,200	Complete	066019	5	24	Red Bluff - Sacramento River
2	6	27	1981	Fall	1980	0-CM-96	111,186	Complete	H60101, H60105	2	537	Red Bluff - Sacramento River
2	12		1981	Fall	1980	0-CM-96	55,068	Complete	H60102	2	441	Isleton - Sacramento River
2	20		1981	Fall	1980	0-CM-96	52,673	Complete	H60103	2	522	Mokelumne River & San Joaquin River
2	25		1981	Fall	1980	0-CM-96	57,796	Complete	H60104	2	525	Berkeley Pier - San Francisco Bay
3	4		1981	Fall	1980	0-CM-96	51,628	Complete	H60106	2	555	Isleton - Sacramento River
3	6		1981	Fall	1980	0-CM-96	50,884	Complete	H60107	2	599	Mokelumne River & San Joaquin River
3	11		1981	Fall	1980	0-CM-96	53,175	Complete	H60201	2	604	Berkeley Pier - San Francisco Bay
5	14	29	1981	Fall	1980	0-CM-96	13,857,806	Partial	066016	3	110	Battle Creek
5	18		1981	Fall	1980	0-CM-96	101,477	Complete	066017	3	82	Red Bluff - Sacramento River
5	18		1981	Fall	1980	0-CM-96	102,998	Complete	066020, 066021	3	89	Knights Landing - Sacramento River
11	3		1981	Late-Fall	1981	0-CM-97	327,017	No CWT		4	41	Battle Creek
12	2		1981	Late-Fall	1981	0-CM-97	1,708,447	No CWT		4.5	38	Battle Creek
1	27		1982	Late-Fall	1981	0-CM-97	488,301	Partial	066025	5	34	Battle Creek
1	27		1982	Late-Fall	1981	0-CM-97	51,757	Complete	066024	5	35	Red Bluff - Sacramento River
2	5	25	1982	Fall	1981	1-CM-99	101,421	Complete	H60202, H60206	2	502	Red Bluff - Sacramento River
2	11		1982	Fall	1981	1-CM-99	49,257	Complete	H60203	2	498	Isleton - Sacramento River
2	17		1982	Fall	1981	1-CM-99	49,999	Complete	H60204	2	500	San Joaquin River
2	22		1982	Fall	1981	1-CM-99	49,876	Complete	H60205	2	499	Berkeley Pier - San Francisco Bay
3	2		1982	Fall	1981	1-CM-99	48,982	Complete	H60207	2	500	Isleton - Sacramento River
3	8		1982	Fall	1981	1-CM-99	50,671	Complete	H60301	2	502	Berkeley Pier - San Francisco Bay
3	10		1982	Fall	1981	1-CM-99	52,163	Complete	H60302	2	502	Mokelumne River & San Joaquin River
3	26		1982	Fall	1981	1-CM-99	800	No CWT		2	200	Research - Simpson Lee Corp.
5	5	26	1982	Fall	1981	1-CM-99	7,938,225	Partial	066026, 066027	3	96	Battle Creek
5	5		1982	Fall	1981	1-CM-99	99,240	Complete	066028, 066029	3	73	Red Bluff - Sacramento River
5	5		1982	Fall	1981	1-CM-99	100,652	Complete	066030, 066031	3	77	Knights Landing - Sacramento River
5	12		1982	Fall	1981	1-CM-99	101,676	Complete	066218	3	78	Discovery Park - Sacramento River
5	17		1982	Fall	1981	1-CM-99	98,501	Complete	066219	3	71	Port Chicago
5	28		1982	Fall	1981	1-CM-99	1,000	No CWT		3	250	Research - Simpson Lee Corp.
6	2		1982	Fall	1981	1-CM-99	250,000	No CWT		3	173	Battle Creek
8	2		1982	Late-Fall	1982	2-CM-02	350	No CWT		3	175	Research - Simpson Lee Corp.
10	1		1982	Late-Fall	1982	2-CM-02	777,516	No CWT		4	36	Battle Creek

Appendix 10A (cont.) Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date										Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
12	1		1982	Fall	1982	2-CM-04	799,200	No CWT		ee	ee	Tehama Colusa Fish Facilities
12	28		1982	Fall	1982	2-CM-04	219,040	No CWT		2	1,360	Antelope Creek
1	3		1983	Late-Fall	1982	2-CM-02	909,308	No CWT		4.5	40	Battle Creek
1	17		1983	Fall	1982	2-CM-04	538,720	No CWT		1.5	1,189	Tehama Colusa Fish Facilities
1	18	25	1983	Fall	1982	2-CM-04	805,420	No CWT		1.5	1,239	Antelope Creek
1	18	27	1983	Fall	1982	2-CM-04	2,101,920	No CWT		1.5	1,201	Posse Grounds - Sacramento River
2	4	18	1983	Fall	1982	2-CM-04	1,136,090	No CWT		1.5	1,190	Battle Creek
2	23		1983	Fall	1982	2-CM-04	545,720	No CWT		1.5	1,111	Posse Grounds - Sacramento River
3	17		1983	Winter	1982	2-CM-03	11,548	Complete	050429	4.5	39	Battle Creek
4	1	29	1983	Fall	1982	2-CM-04	950	No CWT		3	190	Research - Simpson Lee Corp.
4	28	29	1983	Fall	1982	2-CM-04	3,114,000	No CWT		3	89	Battle Creek
5	3		1983	Fall	1982	2-CM-04	200	No CWT		3	200	Display - NEED Camp, Clear Creek
5	4	27	1983	Fall	1982	2-CM-04	3,671,312	No CWT		3	94	Battle Creek
5	13		1983	Fall	1982	2-CM-04	500	No CWT		3	125	Research - UC Davis
5	13	26	1983	Fall	1982	2-CM-04	600	No CWT		3	150	Research - Simpson Lee Corp.
5	24	27	1983	Fall	1982	2-CM-04	1,173,350	No CWT		3	103	Red Bluff - Sacramento River
6	1	9	1983	Fall	1982	2-CM-04	1,258,400	Partial	066034,066035	3	109	Red Bluff - Sacramento River
6	1	9	1983	Fall	1982	2-CM-04	2,448,595	Partial	066036, 066037	3	104	Battle Creek
6	2		1983	Fall	1982	2-CM-04	99,938	Complete	066032, 066033	3	98	Knights Landing - Sacramento River
6	2		1983	Late-Fall	1983	2-CM-06	400	No CWT		1	400	Tehama Colusa Fish Facilities
6	8		1983	Fall	1982	2-CM-04	300	No CWT		3	100	Research - UC Davis
6	8		1983	Fall	1982	2-CM-04	21,000	No CWT		3	97	Transfer - CDFG, Redding CA
6	9		1983	Fall	1982	2-CM-04	100	No CWT		3	100	Research - FAO Red Bluff
6	10	24	1983	Fall	1982	2-CM-04	700	No CWT		3	175	Research - Simpson Lee Corp.
9	15	22	1983	Fall	1982	2-CM-04	441,178	No CWT		5	32	Battle Creek
11	16		1983	Late-Fall	1983	2-CM-06	100	No CWT		4-4.5	50	Research - UC Davis
11	17	21	1983	Late-Fall	1983	2-CM-06	287,475	No CWT		4.5	37	Red Bluff - Sacramento River
11	22		1983	Late-Fall	1983	2-CM-06	13,542	No CWT		4.5	36	Battle Creek
1	12	17	1984	Late-Fall	1983	2-CM-06	406,267	No CWT		4-5	33	Battle Creek
1	17	19	1984	Late-Fall	1983	2-CM-06	651,083	No CWT		4-4.5	38	Red Bluff - Sacramento River
3	1	23	1984	Fall	1983	3-CM-08	102,740	Complete	H60404, H60504	2	447	Red Bluff - Sacramento River
3	2		1984	Fall	1983	3-CM-08	3,000	No CWT		2	429	Research - FAO Red Bluff
3	5	21	1984	Fall	1983	3-CM-08	101,866	Complete	H60405, H60503	2	445	Courtland - Sacramento River
3	8	19	1984	Fall	1983	3-CM-08	101,241	Complete	H60406, H60502	2	444	Walnut Grove - Sacramento River

Appendix 10A (cont.) Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date										Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
3	12		1984	Fall	1983	3-CM-08	50,679	Complete	H60407	2	452	North Fork Mokelumne River
3	14		1984	Fall	1983	3-CM-08	51,765	Complete	H60501	2	454	S. Fork, Mokelumne River
4	13		1984	Fall	1983	3-CM-08	300	No CWT		2	300	Research - Simpson Lee Corp.
4	23		1984	Fall	1983	3-CM-08	1,787,312	No CWT		3.5	76	Battle Creek
4	26		1984	Fall	1983	3-CM-08	300,000	No CWT		3	102	Red Bluff - Sacramento River
5	3	14	1984	Fall	1983	3-CM-08	3,606,923	Partial	066042, 066043	3-4	113	Battle Creek
5	3		1984	Fall	1983	3-UCA-09	564,450	No CWT		3.5	84	Red Bluff - Sacramento River
5	9		1984	Fall	1983	3-CM-08	100,766	Complete	066038, 066039	4	56	Knights Landing - Sacramento River
5	9	17	1984	Fall	1983	3-CM-08	3,199,490	Partial	066040, 066041	3	109	Red Bluff - Sacramento River
5	17		1984	Late-Fall	1984	3-CM-12	250	No CWT		2.5	250	Research - Simpson Lee Corp.
6	4	29	1984	Fall	1983	3-CM-08	23,921	No CWT		3-3.5	95	Research - FAO Red Bluff
6	8		1984	Late-Fall	1984	3-CM-12	250	No CWT		2	250	Research - Simpson Lee Corp.
7	5	10	1984	Fall	1983	3-CM-08	7,460	No CWT		3.5-4	75	Research - FAO Red Bluff
7	10		1984	Fall	1983	3-CM-08	19,480	No CWT		4	4	Battle Creek
10	18		1984	Fall	1984	4-CM-13	8,000	No CWT		ee	ee	Research - Diamond International Corp.
11	20		1984	Late-Fall	1984	3-CM-12	88,900	No CWT		5	26	Battle Creek
11	20		1984	Late-Fall	1984	3-CM-12	154,575	No CWT			35	Red Bluff - Sacramento River
1	7		1985	Fall	1984	4-CM-13	700	No CWT		2	117	Research - Simpson Lee Corp.
1	8		1985	Late-Fall	1984	3-CM-12	65,992	No CWT		4	49	Battle Creek
1	8		1985	Fall	1984	4-CM-13	2,400	No CWT		1.5	800	Research - FAO Red Bluff
1	10		1985	Late-Fall	1984	3-CM-12	65,380	No CWT		4	47	Red Bluff - Sacramento River
1	24	31	1985	Fall	1984	4-CM-13	4,141,440	No CWT		1.5	1,280	Posse Grounds - Sacramento River
1	25	29	1985	Fall	1984	4-CM-13	656,640	No CWT		1.5	1,283	Balls Ferry - Sacramento River
1	25	31	1985	Fall	1984	4-CM-13	2,937,600	No CWT		1.5	1,278	North Street Bridge - Sacramento River
1	25		1985	Fall	1984	4-CM-13	169,040	No CWT		1.5	801	Battle Creek
2	1	4	1985	Fall	1984	4-CM-13	656,640	No CWT		1.5	1,293	Lake Redding Park - Sacramento River
2	1	5	1985	Fall	1984	4-CM-13	1,546,560	No CWT		1.5	1,308	North Street Bridge - Sacramento River
2	1	5	1985	Fall	1984	4-CM-13	1,211,040	No CWT		1.5	1,302	Balls Ferry - Sacramento River
2	4	5	1985	Fall	1984	4-CM-13	665,280	No CWT		1.5	1,315	Posse Grounds - Sacramento River
2	13		1985	Fall	1984	4-CM-13	250	No CWT		2.5	3	Research - Simpson Lee Corp.
2	14		1985	Fall	1984	4-CM-13	56,500	Complete	H60505	2	401	Red Bluff - Sacramento River
2	19		1985	Fall	1984	4-CM-13	57,400	Complete	H60506	2	361	Courtland - Sacramento River
2	21		1985	Fall	1984	4-CM-13	55,700	Complete	H60507	2	404	Koket - Sacramento River
2	26		1985	Fall	1984	4-CM-13	52,850	Complete	H60601	2.5	370	S. Fork, Mokelumne River

Appendix 10A (cont.) Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date											Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
2	28		1985	Fall	1984	4-CM-13	53,000	Complete	H60602	2	421	North Fork Mokelumne River
3	5		1985	Fall	1984	4-CM-13	54,900	Complete	H60603	2	389	Koket - Sacramento River
3	7		1985	Fall	1984	4-CM-13	53,100	Complete	H60604	2	382	Courtland - Sacramento River
3	8		1985	Fall	1984	4-CM-13	199,280	No CWT		2.5	376	Clear Creek
3	11		1985	Fall	1984	4-CM-13	201,770	No CWT		2.5	376	Antelope Creek
3	12		1985	Fall	1984	4-CM-13	204,660	No CWT		2.5	376	Cow Creek
3	12	13	1985	Fall	1984	4-CM-13	57,060	Partial	H50307	2.5	363	Battle Creek
3	14		1985	Fall	1984	4-CM-13	53,600	Complete	H60605	2.5	362	Red Bluff - Sacramento River
3	15		1985	Fall	1984	4-CM-13	6,450	No CWT		1.5	1,290	Research - FAO Red Bluff
3	29		1985	Fall	1984	4-CM-13	250	No CWT		2.5	250	Research - Simpson Lee Corp.
4	3	22	1985	Fall	1984	4-CM-13	1,458,082	No CWT		3-4	91	Battle Creek
4	17		1985	Fall	1984	4-CM-13	5,145	No CWT		3	147	Research - FAO Red Bluff
4	18	22	1985	Fall	1984	4-CM-13	2,007,000	No CWT		3.5	73	Red Bluff - Sacramento River
4	19		1985	Fall	1984	4-CM-13	250	No CWT		2.5	250	Research - Simpson Lee Corp.
5	7	15	1985	Fall	1984	4-CM-13	13,000	No CWT		3	125	Research - FAO Red Bluff
5	10		1985	Fall	1984	4-CM-13	250	No CWT		3	250	Research - Simpson Lee Corp.
5	13		1985	Fall	1984	4-CM-13	500	No CWT		3.5	83	Research - UC Davis
5	14	15	1985	Fall	1984	4-CM-13	4,320,341	Partial	054104, H5+K6120105, 054005, 053904, 050616	3-4	83	Battle Creek
5	14	15	1985	Fall	1984	4-CM-13	2,482,237	Partial	054304, 054204, 050947, H50106	3-4	98	Red Bluff - Sacramento River
5	15		1985	Fall	1984	4-CM-13	66,790	Complete	050948, 050949, H50107	4	59	Princeton - Sacramento River
6	5	28	1985	Fall	1984	4-CM-13	27,100	No CWT		3.5	100	FAO Red Bluff
6	13		1985	Fall	1984	4-CM-13	610,227	Partial	050950, 050951	3.5	97	Tehama Colusa Fish Facilities
6	13		1985	Fall	1984	4-CM-13	5,820	No CWT		3.5	97	Battle Creek
7	5		1985	Fall	1984	4-CM-13	21,280	No CWT		3.5	80	FAO Red Bluff
10	16		1985	Late-Fall	1985	5-CM-15	100	No CWT			50	Research - CA Dept. Fish and Game
10	17		1985	Fall	1985	5-CM-16	10,000	No CWT		ee	ee	Research - Diamond International Corp.
11	23		1985	Fall	1984	4-CM-13	729,600	No CWT		ee	ee	Tehama Colusa Fish Facilities
12	6		1985	Late-Fall	1985	5-CM-15	210,408	No CWT			24	Battle Creek
12	9		1985	Late-Fall	1985	5-CM-15	103,704	No CWT			28	Red Bluff - Sacramento River
1	29		1986	Fall	1985	5-CM-16	800	No CWT			400	Research - CA Dept. Fish and Game
2	12		1986	Fall	1985	5-CM-16	100	No CWT			100	Research - CA Dept. Fish and Game
2	27		1986	Fall	1985	5-CM-16	53,000	Complete	H60607		445	Courtland - Sacramento River
3	4	12	1986	Fall	1985	5-CM-16	108,056	Complete	H60702, H60704		343	Koket - Sacramento River

Appendix 10A (cont.) Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date												
										Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
3	7	25	1986	Fall	1985	5-CM-16	550	No CWT			275	Research - Simpson Lee Corp.
3	10		1986	Fall	1985	5-CM-16	55,345	Complete	H60703		337	Courtland - Sacramento River
3	18	31	1986	Fall	1985	5-CM-16	581,210	Partial	H50707		341	Battle Creek
3	19		1986	Fall	1985	5-CM-16	1,583,676	Partial	H60705		330	Red Bluff - Sacramento River
3	31		1986	Fall	1985	5-CM-16	20,000	No CWT			333	FAO Red Bluff
4	4	21	1986	Fall	1985	5-CM-16	2,044,279	No CWT			250	Battle Creek
4	14		1986	Fall	1985	5-CM-16	608,140	No CWT			159	Red Bluff - Sacramento River
4	17		1986	Fall	1985	5-CM-16	350	No CWT			117	Research - Simpson Lee Corp.
5	1	23	1986	Fall	1985	5-CM-16	500	No CWT			125	Research - Simpson Lee Corp.
5	9	13	1986	Fall	1985	5-CM-16	3,419,026	Partial	H50404, H50405		106	Red Bluff - Sacramento River
5	12	27	1986	Fall	1985	5-CM-16	5,800,066	Partial	H50402, H50403		90	Battle Creek
5	13		1986	Fall	1985	5-CM-16	46,537	Complete	H50406, H50407		64	Princeton - Sacramento River
5	21		1986	Fall	1985	5-CM-16	10,027	No CWT			98	FAO Red Bluff
5	27		1986	Fall	1985	5-CM-16	603,000	No CWT			90	Tehama Colusa Fish Facilities
6	2	10	1986	Fall	1985	5-CM-16	89,863	No CWT			65	FAO Red Bluff
11	4		1986	Late-Fall	1986	6-CM-18	317,988	No CWT			29	Red Bluff - Sacramento River
11	12		1986	Late-Fall	1986	6-CM-18	392,012	No CWT			28	Battle Creek
2	4	20	1987	Fall	1986	6-CM-19	1,494,700	No CWT			374	Battle Creek
3	5		1987	Fall	1986	6-CM-19	51,789	Complete	H60706		339	Courtland - Sacramento River
3	12	27	1987	Fall	1986	6-CM-19	403,869	Partial	B50413		203	Battle Creek
3	13		1987	Fall	1986	6-CM-19	54,280	Complete	H60707		310	Red Bluff - Sacramento River
4	20		1987	Fall	1986	6-CM-19	5,312,900	No CWT			100	Battle Creek
4	20		1987	Fall	1986	6-CM-19	1,051,309	Partial	B50205		103	Tehama Colusa Fish Facilities
4	24	28	1987	Fall	1986	6-CM-19	27,700	No CWT			73	FAO Red Bluff
5	1		1987	Fall	1986	6-CM-19	200	No CWT			200	Research - Simpson Lee Corp.
5	3	13	1987	Fall	1986	6-CM-19	269,365	Partial	051840		68	Red Bluff - Sacramento River
5	12		1987	Fall	1986	6-CM-19	4,124,174	Partial	051839		77	Battle Creek
5	13		1987	Fall	1986	6-CM-19	18,100	No CWT			93	FAO Red Bluff
5	14		1987	Fall	1986	6-CM-19	51,581	Complete	051841		68	Princeton - Sacramento River
6	5		1987	Fall	1986	6-CM-19	11,800	No CWT			60	Battle Creek
7	22		1987	Late-Fall	1987	7-CM-22	110	No CWT			55	Research - Humboldt State University
10	27		1987	Fall	1987	7-CM-23	15,000	No CWT		ee	ee	Research - Diamond International Corp.
11	20		1987	Late-Fall	1987	7-CM-21	629,100	No CWT			24	Battle Creek
11	20		1987	Late-Fall	1987	7-CM-22	435,600	No CWT			25	Battle Creek

Appendix 10A (cont.) Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date										Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
12	22		1987	Fall	1987	7-CM-23	507,000	No CWT			1,213	Battle Creek
1	4	22	1988	Fall	1987	7-CM-23	4,500,719	No CWT			1,211	North Street Bridge - Sacramento River
2	16	24	1988	Fall	1987	7-CM-23	959,666	No CWT			728	North Street Bridge - Sacramento River
2	19		1988	Fall	1987	7-CM-23	55,325	Complete	B50206		457	Battle Creek
2	22		1988	Fall	1987	7-CM-23	54,247	Complete	B61401		350	Red Bluff - Sacramento River
2	22		1988	Fall	1987	7-CM-23	250	No CWT			250	Research - Simpson Lee Corp.
3	11	25	1988	Fall	1987	7-CM-23	600	No CWT			300	Research - Simpson Lee Corp.
4	1	15	1988	Fall	1987	7-CM-23	725,187	No CWT			103	Red Bluff - Sacramento River
4	5	12	1988	Fall	1987	7-CM-23	1,157,100	No CWT			159	Tehama Colusa Fish Facilities
4	11	19	1988	Fall	1987	7-CM-23	514,910	No CWT			114	Battle Creek
4	15		1988	Fall	1987	7-CM-23	350	No CWT			350	Research - Simpson Lee Corp.
5	6		1988	Fall	1987	7-CM-23	250	No CWT			250	Research - Simpson Lee Corp.
5	9	13	1988	Fall	1987	7-CM-23	4,573,025	Partial	051940		75	Red Bluff - Sacramento River
5	9	13	1988	Fall	1987	7-CM-23	6,155,967	Partial	051939		84	Battle Creek
5	11		1988	Fall	1987	7-CM-23	53,036	Complete	051941		67	Princeton - Sacramento River
5	17		1988	Fall	1987	7-CM-23	52,921	Complete	051842		60	Benicia
12	8		1988	Late-Fall	1988	8-CM-25	510,890	No CWT			22	Battle Creek
12	8		1988	Late-Fall	1988	8-CM-26	24,510	No CWT			11	Battle Creek
1	12		1989	Late-Fall	1988	8-CM-25	100	No CWT			25	FAO Red Bluff
1	19		1989	Late-Fall	1988	8-CM-25	126,679	No CWT			20	Battle Creek
2	3	24	1989	Fall	1988	8-CM-27	5,678,534	No CWT			610	Red Bluff - Sacramento River
2	16		1989	Fall	1988	8-CM-27	200,000	No CWT			500	Stillwater Creek
2	16		1989	Fall	1988	8-CM-27	100,500	No CWT			500	Anderson Creek
3	6	23	1989	Fall	1988	8-CM-27	3,824,520	No CWT			627	Balls Ferry - Sacramento River
3	23		1989	Fall	1988	8-CM-27	684,193	No CWT			635	Red Bluff - Sacramento River
3	28		1989	Fall	1988	8-CM-27	53,950	No CWT			650	Battle Creek
4	12		1989	Fall	1988	8-CM-89	250	No CWT			250	Research - Simpson Lee Corp.
5	3		1989	Fall	1988	8-CM-27	250	No CWT			250	Research - Simpson Lee Corp.
5	8		1989	Fall	1988	8-CM-27	6,001,147	Partial	052037		136	Battle Creek
5	9	10	1989	Fall	1988	8-CM-27	5,537,520	Partial	052038		118	Red Bluff - Sacramento River
5	10		1989	Fall	1988	8-CM-27	51,356	Complete	052039		111	Princeton - Sacramento River
5	15		1989	Fall	1988	8-CM-27	40,934	Complete	052040		107	Benicia
12	19		1989	Late-Fall	1989	KEW-89-COL	118,117	No CWT		5	23	Battle Creek
1	5	89	1990	Late-Fall	1989	KEW-89-COL	277,183	No CWT		5	25	Sacramento River

Appendix 10A (cont.) Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date										Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
1	8		1990	Late-Fall	1989	BCW-89-COL	61,105	No CWT				Battle Creek
1	8	26	1990	Late-Fall	1989	KEW-89-COL	452,341	Partial	052053	5.5	20	Battle Creek
1	25		1990	Winter	1989	9-CM-32	3,203	No CWT		3.7	68	Sacramento River
2	26		1990	Late-Fall	1990	BCW-90-COL	568	No CWT		ee	ee	Research - FAO Red Bluff
2	26		1990	Late-Fall	1990	KEW-90-COL	2,749	No CWT		ee	ee	Research - FAO Red Bluff
3	5	23	1990	Fall	1989	BCW-89-COL	3,919,302	No CWT		2	453	Sacramento River
3	30		1990	Fall	1989	BCW-89-COL	769,343	No CWT		2	400	Battle Creek
4	27		1990	Fall	1989	BCW-89-COL	9,000	No CWT		3	118	Research - Glenn-Colusa Irrigation District
5	2	10	1990	Fall	1989	BCW-89-COL	19,000	No CWT		3	229	Research - Glenn-Colusa Irrigation District
5	4	14	1990	Fall	1989	BCW-89-COL	6,313,300	Partial	052057	3.5	74	Princeton - Sacramento River
5	10	11	1990	Fall	1989	BCW-89-COL	154,643	Partial	052055			Battle Creek
5	12		1990	Fall	1989	BCW-89-COL	52,212	Complete	052056	3.5	73	Red Bluff - Sacramento River
5	13	22	1990	Fall	1989	BCW-89-COL	5,661,126	Partial	052058	3.5	88	Benicia
10	30		1990	Fall	1990	BCW-90-COL	719,186	No CWT		ee	ee	Transfer - Feather River SFH
11	1		1990	Fall	1990	BCW-90-COL	540,750	No CWT		ee	ee	Transfer - Feather River SFH
1	15		1991	Winter	1990	SRW-90-COL	1,286	No CWT		3.5	76	Caldwell Park - Sacramento River
1	18	31	1991	Late-Fall	1990	BCW-90-COL	129,351	No CWT		6-6.5	13	Battle Creek
1	18	31	1991	Late-Fall	1990	KEW-90-COL	74,036	No CWT		6	15	Battle Creek
2	15		1991	Fall	1990	BCW-90-COL	369	No CWT		2		Research - Simpson Lee Corp.
2	26		1991	Fall	1990	BCW-90-COL	100,194	No CWT		2	370	North Fork Battle Creek
2	26		1991	Fall	1990	BCW-90-COL	99,824	No CWT		2	370	South Fork Battle Creek
2	28		1991	Fall	1990	BCW-90-COL	271,156	No CWT		2	339	Anderson Cottonwood Irrigation District Dam - Sacramento River
2	28		1991	Fall	1990	BCW-90-COL	550,045	No CWT		2	341	Anderson River Park - Sacramento River
2	28		1991	Fall	1990	BCW-90-COL	672,559	No CWT		2	385	Balls Ferry - Sacramento River
2	28		1991	Fall	1990	BCW-90-COL	307,819	No CWT		2	374	Bend Bridge - Sacramento River
2	28		1991	Fall	1990	BCW-90-COL	680,214	No CWT		2	405	Sacramento River @ Battle Creek
2	28		1991	Fall	1990	BCW-90-COL	324,679	No CWT		2	402	Posse Grounds - Sacramento River
3	1	25	1991	Fall	1990	BCW-90-COL	4,518,601	Partial	0501010111	2	550	Red Bluff - Sacramento River
3	1		1991	Fall	1990	BCW-90-COL	666,834	No CWT		2	420	Woodson Bridge - Sacramento River
4	8		1991	Fall	1990	BCW-90-COL	400	No CWT		2		Research - Simpson Lee Corp.

Appendix 10A (cont.) Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date										Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
3	4	11	1991	Fall	1990	BCW-90-COL	2,442,889	Partial	0501010110	2	473	Battle Creek
4	15		1991	Fall	1990	BCW-90-COL	21,000	No CWT		2		Research - Glenn-Colusa Irrigation District
4	22	29	1991	Fall	1990	BCW-90-COL	6,349,775	No CWT		2	93	Princeton - Sacramento River
4	23	26	1991	Fall	1990	BCW-90-COL	19,656	No CWT		2.5	234	Research - Glenn-Colusa Irrigation District
4	29	30	1991	Fall	1990	BCW-90-COL	901,820	No CWT		2	149	Benicia
4	30		1991	Fall	1990	BCW-90-COL	64,698	Complete	0501010113	2	86	Battle Creek
5	1		1991	Fall	1990	BCW-90-COL	64,700	Complete	0501010112	2	91	Red Bluff - Sacramento River
5	1	13	1991	Fall	1990	BCW-90-COL	5,098,734	Partial	0501010104	3-3.5	111	Benicia
5	3	6	1991	Fall	1990	BCW-90-COL	273,150	Partial	051845, 051847, 051848	2	156	Princeton - Sacramento River
5	3		1991	Fall	1990	BCW-90-COL	295	No CWT		3	98	Research - Simpson Lee Corp.
5	7		1991	Fall	1990	BCW-90-COL	13,675	No CWT		3	149	Research - Glenn-Colusa Irrigation District
7	23		1991	Late-Fall	1991	BCW-91-COL	1,189	No CWT		2	297	Transfer - Red Bluff FRO
1	3	6	1992	Late-Fall	1991	LFS-91-COL	302,982	Partial	0501010308, 0501010309	6.5	13	Battle Creek
1	21		1992	Winter	1991	SRW-91-COL	11,153	Complete	0501010403, 0501010404, 0501010405, 0501010406	3.5	58	Caldwell Park - Sacramento River
9	16		1992	Winter	1991	SRW-91-COL	746			6.9		Bodega Bay Marine Lab - Captive Broodstock Program
2	13	28	1992	Fall	1991	BCW-91-COL	4,761,200	No CWT		2	452	Red Bluff - Sacramento River
2	25		1992	Fall	1991	BCW-91-COL	25,369	Complete	0601110206	2	518	Verona
3	3	19	1992	Fall	1991	BCW-91-COL	6,318,720	Partial	0501010310, B50203	2	406	Red Bluff - Sacramento River
3	3	10	1992	Fall	1991	BCW-91-COL	53,143	Complete	0601110207, 601110208	2	436	Verona
3	16		1992	Fall	1991	BCW-91-COL	24,350	Complete	0601110209	2	343	Miller Park - Sacramento River
3	23		1992	Fall	1991	BCW-91-COL	10,234	No CWT		2	445	Battle Creek
4	6	21	1992	Fall	1991	BCW-91-COL	13,839,767	Partial	052819	3	133	Princeton - Sacramento River
4	14	21	1992	Fall	1991	BCW-91-COL	200,317	Partial	052812, 052813, 052814	3	111	Battle Creek
4	15		1992	Fall	1991	BCW-91-COL	54,556	Complete	052818	3	113	Red Bluff - Sacramento River
4	28		1992	Fall	1991	BCW-91-COL	54,878	Complete	052830	3.5	80	Benicia
11	19		1992	Late-Fall	1992	B&K-92-COL	100	Complete	053120	5	20	Research - NCVFRO, Red Bluff
11	20		1992	Late-Fall	1992	B&K-92-COL	15,002	Complete	053120	5	22	Research - SSJFRO-Clifton Ct. Forebay
1	4		1993	Late-Fall	1992	B&K-92-COL	325,244	Complete	052859, 052862, 053122, 053121	5.5	14	Battle Creek
1	27		1993	Winter	1992	SRW-92-COL	26,433	Complete	0501010607-0501010615, 0501010701-0501010710, 0501010712-0501010714	3	74	North Street Bridge - Sacramento River

Appendix 10A (cont.) Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date										Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
2	17	18	1993	Winter	1992	SRW-92-COL	971	Complete	0501010607-0501010615, 0501010701-0501010710, 0501010712-0501010714	3	74	Bodega Bay Marine Lab. - Captive Broodstock Program
2	23		1993	Fall	1992	BCW-92-COL	5,750	No CWT		1-1.5	1,150	Research - UC Davis
3	10		1993	Fall	1992	BCW-92-COL	123,743	Complete	0501010801, 0501010802	2	273	Red Bluff - Sacramento River
3	23	30	1993	Fall	1992	BCW-92-COL	3,460,081	No CWT		2.5	172	Battle Creek
4	6		1993	Fall	1992	BCW-92-COL	250	No CWT		2	250	Research - Glenn-Colusa Irrigation District
4	13	26	1993	Fall	1992	BCW-92-COL	8,354,884	Partial	0501010803-0501010805, 0601141101, 0601141102	3	109	Battle Creek
5	14		1993	Fall	1992	BCW-92-COL	10,580	No CWT		3.5-4	46	Research - NCVFRO, Red Bluff
11	18		1993	Late-Fall	1993	B&K-93-COL	15,577	Complete	053417	5	19	Research - CDFG, Byron, CA
12	2		1993	Late-Fall	1993	B&K-93-COL	33,668	Complete	064521	5	22	Georgiana Slough
12	2		1993	Late-Fall	1993	B&K-93-COL	34,929	Complete	064522	5	19	Research - SSJFRO- Ryde-Koket
12	28		1993	Late-Fall	1993	B&K-93-COL	238	Complete	064521, 064522	5	14	Research- Nimbus SFH
1	3	5	1994	Late-Fall	1993	B&K-93-COL	676,131	Complete	053316, 053317, 053408-053415	5.5	14	Battle Creek
1	27		1994	Winter	1993	SRW-93-COL	18,723	Complete	0501010810-0501010812, 0501010814, 0501010815, 0501010901-0501010907	3	70	Caldwell Park - Sacramento River
2	7	16	1994	Fall	1993	BCW-93-COL	2,226,597	No CWT		1.5-2	579	Red Bluff - Sacramento River
2	28		1994	Winter	1993	SRW-93-COL	998	Complete	0501010810-0501010815, 0501010901-0501010903, 0501010905-0501010907	4	37	Bodega Bay Marine Lab
3	1	10	1994	Fall	1993	BCW-93-COL	2,287,347	Partial	0501010908, 0501010909	1.5-2	451	Red Bluff - Sacramento River
3	10		1994	Fall	1993	BCW-93-COL	34,775	No CWT		2	419	Battle Creek
3	28		1994	Fall	1993	BCW-93-COL	2,557	No CWT		2	8	Research - NBS, Columbia, MO.
4	14	15	1994	Fall	1993	BCW-93-COL	12,129,576	Partial	053427, 053428, 053429	2-3	103	Battle Creek
5	9		1994	Fall	1993	BCW-93-COL	21,940	No CWT		3	94	Research - NCVFRO, Red Bluff
11	10		1994	Late-Fall	1994	B&K-94-COL	64,919	Complete	053622			Battle Creek
11	20		1994	Late-Fall		B&K-95-COL	2,073	No CWT		5.5	17	Research - CDFG, Byron, CA
12	5		1994	Late-Fall	1994	B&K-94-COL	32,176	Complete	053425	4.5-5	23	Georgiana Slough
12	5		1994	Late-Fall	1994	B&K-94-COL	30,525	Complete	053426	4.5-5	23	Walnut Grove - Sacramento River
12	7		1994	Late-Fall	1994	B&K-94-COL	63,629	Complete	053742			
1	26		1995	Winter	1994	SRW-94-COL	43,346	Complete	0501011002-0501011015, 0501011101-0501011115, 0501011201-0501011203	3	74	Bonneyview Boat Ramp- Sacramento River
3	16		1995	Winter	1994	SRW-94-COL	330	Complete	0501011013, 0501011014, 0501011101-0501011106, 0501011112-0501011115, 0501011201-0501011203, 0501011108	4	37	Steinhart Aquarium - Captive Broodstock Program

Appendix 10A (cont.) Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date										Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
5	10		1995	Winter	1994	SRW-94-COL	333	Complete	0501011002-0501011012, 0501011015, 0501011107, 0501011109-0501011111	4.5	27	Steinhart Aquarium - Captive Broodstock Program
1	4	11	1995	Late-Fall	1994	B&K-94-COL	378,098	Complete	053620, 053546, 053621, 053743	5.5-6	14	Battle Creek
1	4		1995	Late-Fall	1994	B&K-94-COL	31,644	Complete	062525	5.5	15	Georgiana Slough
1	5		1995	Late-Fall	1994	B&K-94-COL	31,876	Complete	062524	5.5-6	13	SSJFRO
2	13	23	1995	Fall	1994	BCW-94-COL	1,482,415	No CWT		2.0	410	Red Bluff - Sacramento River
3	10		1995	Fall	1994	BCW-94-COL	101,331	Complete	05111205, 05111204	2	349	Red Bluff - Sacramento River
3	14	23	1995	Fall	1994	BCW-94-COL	1,317,557	No CWT		2	418	Balls Ferry - Sacramento River
3	23	29	1995	Fall	1994	BCW-94-COL	1,141,830	No CWT		2-2.5	205	Battle Creek
3	24		1995	Fall	1994	BCW-94-COL	5,030	No CWT		2	210	Research - Bureau of Reclamation, Red Bluff
4	5	19	1995	Fall	1994	BCW-94-COL	303,302	No CWT		2.5	158	Research - NCVFRO, Red Bluff
4	6	25	1995	Fall	1994	BCW-94-COL	11,842,260	Partial	05111208, 05111207, 05111206	2.5-3	122	Battle Creek
4	20		1995	Fall	1994	BCW-94-COL	9,969	No CWT		2.5	158	Research - Bureau of Reclamation, Red Bluff
6	16		1995	Late-Fall	1995	B&K-95-COL	4,747	No CWT		2	264	Research - Bureau of Reclamation, Red Bluff
8	22		1995	Late-Fall	1995	B&K-95-COL	3,876	No CWT				Research - Bureau of Reclamation, Red Bluff
11	9		1995	Late-Fall	1995	B&K-95-COL	126,584	Complete	053627, 054116	5-5.5	17	Battle Creek
11	20		1995	Late-Fall	1995	B&K-95-COL	2,073	No CWT		5.33	17	Research -CDFG,Byron
12	8		1995	Late-Fall	1995	B&K-95-COL	140,814	Complete	054107, 054109	5-5.5	18	Battle Creek
12	21		1995	Winter	1995	SRW-95-COL	51,267	Complete	0501011301-0501011315, 0501011401-0501011415, 0501011501, 0501011502, 0501011505, 0501011506	2-2.5	183	Caldwell Park - Sacramento River
1	2	10	1996	Late-Fall	1995	B&K-95-COL	529,845	Complete	053416, 053618, 053628, 054108, 054117-054119	5-6	14	Battle Creek
1	9	16	1996	Late-Fall	1995	B&K-95-COL	133,721	Complete	054111-054114	5.5-6	13	Delta Study-Port Chicago, Courtland, Georgiana Slough, Ryde-Koket
1	17		1996	Fall	1995	BCW-95-COL	2,085	No CWT		1.5-2	521	Research - Bureau of Reclamation, Red Bluff
1	29		1996	Fall	1995	BCW-95-COL	1,319,814	No CWT		1.5-2	527	Red Bluff - Sacramento River
2	8	28	1996	Fall	1995	BCW-95-COL	5,222,300	No CWT		1.5-2	457	Red Bluff - Sacramento River
3	5	15	1996	Fall	1995	BCW-95-COL	1,001,507	No CWT		1.5-2	432	Red Bluff - Sacramento River

Appendix 10A (cont.) Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date										Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
3	13		1996	Fall	1995	BCW-95-COL	4,840	No CWT		1.5-2	372	Research - Bureau of Reclamation, Red Bluff
3	14	29	1996	Fall	1995	BCW-95-COL	8,210,230	Partial	0501020114, 0501020115	2.5-3	131	Battle Creek
4	24		1996	Winter	1995	SRW-95-COL	332	Complete	0501011301-0501011314, 0501011401-0501011415, 0501011501, 0501011506	4.31	31	Steinhart Aquarium - Captive Broodstock Program
3	27		1996	Winter	1995	SRW-95-COL	316	Complete	0501011301-0501011314, 0501011401-0501011415, 0501011501, 0501011506	3.5-4	45	Bodega Bay Marine Lab. - Captive Broodstock Program
4	15		1996	Fall	1995	BCW-95-COL	7,044	No CWT		2.5	156	Research - Bureau of Reclamation, Red Bluff
4	22	23	1996	Fall	1995	BCW-95-COL	4,144,723	Partial	0501020201	2.5-3.0	147-69	Battle Creek
8	27		1996	Late-Fall	1996	B&K-96-COL	500	No CWT		4.1	37	Research- Bureau of Reclamation
9	23		1996	Late-Fall	1996	B&K-96-COL	4,556	No CWT		4.5	27	Research- Bureau of Reclamation
11	7		1996	Late-Fall	1996	B&K-96-COL	127,460	Complete	054232, 054233	3.9-4.1	40-37	Battle Creek
12	2		1996	Late-Fall	1996	B&K-96-COL	55,425	Complete	054231	4	38	Miller Park - Sacramento River
12	10		1996	Late-Fall	1996	B&K-96-COL	123,015	Complete	054234, 054235	4.2	33	Battle Creek
12	30		1996	Late-Fall	1996	B&K-96-COL	51,049	Complete	054229	4.1	36	Benicia
1	9	17	1997	Late-Fall	1996	B&K-96-COL	676,113	Complete	054123-054127, 054236-054241	4.5-6.4	27-9	Battle Creek
1	14		1997	Late-Fall	1996	B&K-96-COL	48,046	Complete	054230	4.6	25	Miller Park - Sacramento River
1	30		1997	Winter	1996	CAP-96-BML	2,365	Complete	0501020207	2.3	208	Caldwell Park - Sacramento River
2	4	13	1997	Fall	1996	BCW-96-COL	1,970,072	No CWT		1.6-1.7	568-480	Hunters MHP - Sacramento River
2	20	27	1997	Fall	1996	BCW-96-COL	3,097,705	No CWT		1.7-1.9	480-390	Bow River Boat Ramp - Sacramento River
2	5	26	1997	Fall	1996	BCW-96-COL	5,306	No CWT		1.3	758	Research - Bureau of Reclamation, Red Bluff
3	4	12	1997	Fall	1996	BCW-96-COL	2,915,824	No CWT		1.7-1.8	480-416	Bow River Boat Ramp - Sacramento River
3	12		1997	Winter	1996	CAP-96-BML	2,353	Complete	0501020207	2.2-2.4	231-178	Caldwell Park - Sacramento River
3	19		1997	Fall	1996	BCW-96-COL	2,914	No CWT		1.9	367	Research - Bureau of Reclamation, Red Bluff
3	26	27	1997	Late-Fall	1997	BCW-97-COL	2,066	No CWT		1.1-1.3	1,515-1,037	Research - Misc.
3	27		1997	Fall	1996	BCW-96-COL	34	No CWT		2.2	219	Research - Misc.

Appendix 10A (cont.) Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date										Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
4	1	16	1997	Fall	1996	BCW-96-COL	11,260,314	Partial	0501020208-0501020215, 0501020301-0501020315, 0501020401, 0501020402	2.7-3.1	125-78	Battle Creek
4	7	10	1997	Late-Fall	1997	BCW-97-COL	7,652	No CWT		1.1	1,515	Research - Misc.
5	2		1997	Fall	1996	BCW-96-COL	50	No CWT		2.7	131	Research - Misc.
5	2		1997	Late-Fall	1997	BCW-97-COL	200	No CWT		1.7	500	Research - Misc.
5	5	22	1997	Late-Fall	1997	BCW-97-COL	3,040	No CWT		2.1	255	Research - Bureau of Reclamation, Red Bluff
5	6		1997	Fall	1996	BCW-96-COL	1,181,661	Partial	0501020403, 0501020404, 0501020405	2.9-3.0	100-89	Battle Creek
6	10		1997	Late-Fall	1997	BCW-97-COL	822	No CWT		2.7	125	Research - UC Davis
6	25		1997	Late-Fall	1997	BCW-97-COL	1,907	No CWT		3.1	80	Research - Bureau of Reclamation, Red Bluff
8	17		1997	Late-Fall	1997	BCW-97-COL	3,010	No CWT				Research - Bureau of Reclamation, Red Bluff
9	16		1997	Late-Fall	1997	BCW-97-COL	962	No CWT				Research - Bureau of Reclamation, Red Bluff
11	10		1997	Late-Fall	1997	BCW-97-COL	141,769	Complete	055040, 055041	4.7	24	Battle Creek
12	4		1997	Late-Fall	1997	BCW-97-COL	64,501	Complete	055050	4.1	35	Georgiana Slough
12	5		1997	Late-Fall	1997	BCW-97-COL	49,740	Complete	055060	4.0	37	Ryde
12	9		1997	Late-Fall	1997	BCW-97-COL	130,405	Complete	055042, 055048	4.2	34	Battle Creek
12	29		1997	Late-Fall	1997	BCW-97-COL	50,611	Complete	055061	4.1	35	Port Chicago
1	12	22	1998	Late-Fall	1997	BCW-97-COL	582,175	Complete	055051-055059	5.4-5.6	16-15	Battle Creek
1	13		1998	Late-Fall	1997	BCW-97-COL	68,962	Complete	055049	5.5	15	Georgiana Slough
1	14		1998	Late-Fall	1997	BCW-97-COL	50,060	Complete	055062	5.6	14	Ryde
1	14		1998	Late-Fall	1997	BCW-97-COL	315	Complete	055062	5.6	14	Research - to CDFG
1	8		1998	Fall	1997	BCW-97-COL	2,501	No CWT		1.3	1,131	Research - Bureau of Reclamation, Red Bluff
2	4	26	1998	Fall	1997	BCW-97-COL	8,203,920	No CWT		1.7	500	Below RBDD
3	4	6	1998	Fall	1997	BCW-97-COL	2,700,864	Partial	0501020508-0501020513	2.3	205	Battle Creek
3	12		1998	Fall	1997	BCW-97-COL	2,000	No CWT		2.1	272	Research - Bureau of Reclamation, Red Bluff
3	31		1998	Fall	1997	BCW-97-COL	3,570,654	Partial	0501020514-0501020515, 0501020601-0501020606	2.5-2.7	156-125	Battle Creek
4	7	23	1998	Fall	1997	BCW-97-COL	6,503,681	Partial	0501020607-0501020615, 0501020701-0501020705	2.3-2.9	205-104	Battle Creek

Appendix 10A (cont.) Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date										Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
4	8		1998	Fall	1997	BCW-97-COL	2,040	No CWT		2.3	205	Research - Bureau of Reclamation, Red Bluff
4	24		1998	Winter	1997	CAP-97-BML	21,271	Complete	0501011512	3.1	86	Caldwell Park - Sacramento River
8	5		1998	Winter	1997	CAP-97-BML	5,042	No CWT		5.4	16	Steinhart Aquarium - Display
9	16		1998	Winter	1997	CAP-97-BML	5,024	No CWT		6.5	9	Steinhart Aquarium - Display
4	23		1998	Late-Fall	1998	BCW-98-COL	4,407	No CWT		1.3	1,131	Research - Bureau of Reclamation, Red Bluff
6	3		1998	Late-Fall	1998	BCW-98-COL	2,167	No CWT		2.0	313	Research - Bureau of Reclamation, Red Bluff
6	26		1998	Late-Fall	1998	BCW-98-COL	5,104	No CWT		2.3	205	Research-NCVFWO
7	8		1998	Late-Fall	1998	BCW-98-COL	125,892	No CWT				CNFH - Abatement Pond (44,137 escaped into Battle Creek)
8	7		1998	Late-Fall	1998	BCW-98-COL	2,696	No CWT		3.0	93	Research - Bureau of Reclamation, Red Bluff
8	13		1998	Late-Fall	1998	BCW-98-COL	632	No CWT		3.2	76	Research - Misc.
9	14		1998	Late-Fall	1998	BCW-98-COL	2,088	No CWT		3.8	45	Research - Bureau of Reclamation, Red Bluff
11	12		1998	Late-Fall	1998	BCW-98-COL	140,038	Complete	052309, 052311	4.4	29	Battle Creek
12	1	29	1998	Late-Fall	1998	BCW-98-COL	141,568	Complete	052308, 052312	4.7-4.8	24-22	Georgiana Slough
12	2	30	1998	Late-Fall	1998	BCW-98-COL	101,053	Complete	052320, 052321	4	40	Ryde
12	15		1998	Late-Fall	1998	BCW-98-COL	131,852	Complete	052316, 052317	4.1	36	Battle Creek
12	22		1998	Late-Fall	1998	BCW-98-COL	50,217	Complete	052322	4	40	Port Chicago
1	4		1999	Late-Fall	1998	BCW-98-COL	537,812	Complete	052310, 052313-052315, 052318, 052319, 054128, 054129	4.7-5.1	24-19	Battle Creek
1	28		1999	Winter	1998	WCS-SRW-98-LIV	153,908	Complete	0501020811-0501020815, 0501020901-0501020915, 0501021001	2.8-3.5	119-58	Caldwell Park - Sacramento River
3	18		1999	Winter	1998	WCS-SRW-98-LIV	503	Complete	0501020811-0501020815, 0501020901-0501020915, 0501021001	3.1	94	Bodega Bay Marine Lab. - Captive Broodstock Program
3	18		1999	Winter	1998	WCS-SRW-98-LIV	504	Complete	0501020811-0501020815, 0501020901-0501020915, 0501021001	3.0	97	Steinhart Aquarium - Captive Broodstock Program
3	18		1999	Winter	1998	WCS-SRW-98-LIV	211	Complete	0501020811-0501020815, 0501020901-0501020915, 0501021001	3.1	89	Livingston Stone NFH - Captive Broodstock Program
1	12		1999	Fall	1998	BCW-98-COL	3,205	No CWT		1.5	735	Research - Bureau of Reclamation, Red Bluff

Appendix 10A (cont.) Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date										Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
1	29		1999	Fall	1998	BCW-98-COL	384,882	No CWT		1.4	833	Bow River Boat Ramp - Sacramento River
1	29		1999	Fall	1998	BCW-98-COL	370,191	No CWT		1.4	833	Woodson Bridge - Sacramento River
3	1		1999	Fall	1998	BCW-98-COL	3,371	No CWT		1.4	833	Research - Bureau of Reclamation, Red Bluff
3	3		1999	Fall	1998	BCW-98-COL	481,715	Partial	0501021006	2	290	Battle Creek
3	23		1999	Fall	1998	BCW-98-COL	3,093	No CWT		1.6	625	Research - Bureau of Reclamation, Red Bluff
3	31		1999	Fall	1998	BCW-98-COL	926,018	Partial	0501021015	2.3	192	Battle Creek
4	9		1999	Fall	1998	BCW-98-COL	3,510	No CWT		2.2	231	Research - Battle Creek
4	20	28	1999	Fall	1998	BCW-98-COL	11,623,260	Partial	0501021007-0501021014, 0501021101-0501021115	3.2-3.5	76-58	Battle Creek
4	23		1999	Fall	1998	BCW-98-COL	221	No CWT		2.9	100	Research - CDFG
5	6		1999	Fall	1998	BCW-98-COL	3,100	No CWT				Research - Bureau of Reclamation, Red Bluff
6	9		1999	Fall	1998	BCW-98-COL	1,000	No CWT				Research - Bureau of Reclamation, Red Bluff
5	11		1999	Late-Fall	1999	BCW-99-COL	2,001	No CWT		1.4	833	Research - Bureau of Reclamation, Red Bluff
10	14		1999	Late-Fall	1999	BCW-99-COL	5,137	Complete	0501020412	4.5	27	Research - NCVFWO, Red Bluff
11	10		1999	Late-Fall	1999	BCW-99-COL	74,211	Complete	055140	4.8	22	Battle Creek
12	9		1999	Late-Fall	1999	BCW-99-COL	80,796	Complete	055141	5.2	18	Battle Creek
12	10		1999	Late-Fall	1999	BCW-99-COL	69,699	Complete	055130	6.0	11	Georgiana Slough
12	11		1999	Late-Fall	1999	BCW-99-COL	53,966	Complete	055132	5.5	15	Ryde
12	20		1999	Late-Fall	1999	BCW-99-COL	69,371	Complete	055131	5.5	15	Georgiana Slough
12	21		1999	Late-Fall	1999	BCW-99-COL	83,383	Complete	055214	5.4	16	Battle Creek
12	21		1999	Late-Fall	1999	BCW-99-COL	50,348	Complete	055133	6.6	12	Ryde
12	29		1999	Late-Fall	1999	BCW-99-COL	52,349	Complete	055134	5.5	15	Port Chicago
1	4		2000	Late-Fall	1999	BCW-99-COL	500,085	Complete	055207-055212	5-5.6	19-15	Battle Creek
1	14		2000	Late-Fall	1999	BCW-99-COL	230	Complete	055213	5.7	13	Research - Stockton
1	14		2000	Late-Fall	1999	BCW-99-COL	83,117	Complete	055213	5.7	13	Battle Creek
1	27		2000	Winter	1999	WCS-SRW-99-LIV	26,522	Complete	0501021205-0501021215, 0501021301-0501021306	3.8	46	Caldwell Park - Sacramento River
1	27		2000	Winter	1999	WCS-BML/SRW-99-LIV	4,318	Complete	0501021307	2.7	123	Caldwell Park - Sacramento River

Appendix 10A (cont.) Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date										Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
1	20		2000	Winter	1999	WCS-SRW-99-LIV	211	Complete	0501021205-0501021215, 0501021301-0501021306	3.6	65	Livingston Stone NFH - Captive Broodstock Program
1	20		2000	Winter	1999	WCS-SRW-99-LIV	503	Complete	0501021205-0501021215, 0501021301-0501021306	3.6	65	Bodega Bay Marine Lab. - Captive Broodstock Program
1	20		2000	Winter	1999	WCS-SRW-99-LIV	504	Complete	0501021205-0501021215, 0501021301-0501021306	3.6	66	Steinhart Aquarium - Captive Broodstock Program
3	6	14	2000	Fall	1999	FCS-BCW-99-COL	195,133	Complete	0501011514, 0501011515, 0501020101, 0501020102	2.2	227	Red Bluff Diversion Dam, Clarksburg
3	22		2000	Fall	1999	FCS-BCW-99-COL	9,932	No CWT		2.2		Los Molinos
4	4		2000	Fall	1999	FCS-BCW-99-COL	1,150	No CWT		2.4		Los Molinos
4	14		2000	Fall	1999	FCS-BCW-99-COL	6,426,237	Partial	0501021313-0501021315, 0501021401-0501021411	3.0	91	Battle Creek
4	21		2000	Fall	1999	FCS-BCW-99-COL	5,276,300	Partial	0501021412-0501021415, 0501021501-0501021509	3.0	84	Battle Creek
11	3		2000	Late-Fall	2000	LFS-BCW-00-COL	60,156	Complete	050397	4.4	25	Battle Creek
11	9	21	2000	Late-Fall	2000	LFS-BCW-00-COL	113,419	Complete	050479-050482	4.7	29	Walnut Grove
12	8		2000	Late-Fall	2000	LFS-BCW-00-COL	56,547	Complete	050398	5.9	15	Battle Creek
1	2		2001	Late-Fall	2000	LFS-BCW-00-COL	370,023	Complete	050465-050470	4.5	14	Battle Creek
1	9		2001	Late-Fall	2000	LFS-BCW-00-COL	67,305	Complete	050399	5.6	12	Battle Creek
1	18		2001	Winter	2000	WCS-SRW-00-LIV	216	Complete	0501030109, 0501030201-0501030209, 0501030301-0501030304, 0501030308, 0501030309, 0501030401-0501030408	3.1	95	Livingston Stone NFH - Captive Broodstock Program
1	18		2001	Winter	2000	WCS-SRW-00-LIV	504	Complete	0501030109, 0501030201-0501030209, 0501030301-0501030304, 0501030308, 0501030309, 0501030401-0501030408	3.1	93	Bodega Bay Marine Lab. - Captive Broodstock Program
1	18		2001	Winter	2000	WCS-SRW-00-LIV	504	Complete	0501030109, 0501030201-0501030209, 0501030301-0501030304, 0501030308, 0501030309, 0501030401-0501030408	3.1	94	Steinhart Aquarium - Captive Broodstock Program
1	20	22	2001	Late-Fall	2000	LFS-BCW-00-COL	158,700	Complete	054110, 055129, 055137	5.6	14	Steamboat Slough, Sutter Slough, Walnut Grove
1	21		2001	Late-Fall	2000	LFS-BCW-00-COL	300	Complete	050492	6.9		Research - Old River
2	1		2001	Winter	2000	WCS-SRW-00-LIV	166,207	Complete	0501030107-0501030109, 0501030201-0501030209, 0501030301-0501030309, 0501030401-0501030409	3.1	81	Caldwell Park - Sacramento River
2	26		2001	Fall	2000	FCS-BCW-00-COL	99,749	Complete	0501030105, 0501030502	1.7	454	Red Bluff Diversion Dam, Clarksburg
3	5	8	2001	Fall	2000	FCS-BCW-00-COL	100,926	Complete	0501021515, 0501030502	1.9	454	Red Bluff Diversion Dam, Clarksburg

Appendix 10A (cont.) Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date										Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
4	13		2001	Fall	2000	FCS-BCW-00-COL	6,159,159	Partial	050497-050499, 050564, 050567, 050569, 0501030503-0501030509, 0501030601	2.9	101	Battle Creek
4	27		2001	Fall	2000	FCS-BCW-00-COL	6,304,751	Partial	050565, 050566, 050568, 050570-050573, 0501030602-0501030608	2.9	105	Battle Creek
10	28	31	2001	Late-Fall	2001	LFS-BCW-01-COL	118,109	Complete	050695-050698	3.5	45	Walnut Grove
11	14		2001	Late-Fall	2001	LFS-BCW-01-COL	88,039	Complete	050699	4.0	27	Battle Creek
12	12		2001	Late-Fall	2001	LFS-BCW-01-COL	74,602	Complete	050764	4.1	16	Battle Creek
12	23		2001	Late-Fall	2001	LFS-BCW-01-COL	1,430	Complete	054115	8.7	7	Delta Cross Channel
1	3	10	2002	Late-Fall	2001	LFS-BCW-01-COL	178,985	Complete	050767-050768, 050776	4.9	14	Ryde-Koket, Port Chicago, Georgianna Slough
1	4		2002	Late-Fall	2001	LFS-BCW-01-COL	65,571	Complete	050766	5.0	17	Battle Creek
1	8		2002	Late-Fall	2001	LFS-BCW-01-COL	540,369	Complete	050769-050775, 055135	4.9	15	Battle Creek
1	23		2002	Winter	2001	WCS-SRW-01-LIV	208	Complete	0501030707-0501030709, 0501030801-0501030809, 0501030901-0501030909, 0501040101-0501040104, 0501020507	3.0	107	Livingston Stone NFH - Captive Broodstock Program
1	23		2002	Winter	2001	WCS-SRW-01-LIV	208	Complete	0501030707-0501030709, 0501030801-0501030809, 0501030901-0501030909, 0501040101-0501040104, 0501020507	3.0	110	Bodega Bay Marine Lab. - Captive Broodstock Program
1	30		2002	Winter	2001	WCS-SRW-01-LIV		Complete	0501030706-0501030709, 0501030801-0501030809, 0501030901-0501030909, 0501040101-0501040104, 0501020507	3.0	90	Caldwell Park - Sacramento River
1	30		2002	Winter	2001	WCS-BML/SRW-01-LIV	61,952	Complete	0501030705	3.0	98	Caldwell Park - Sacramento River
2	19	21	2002	Fall	2001	FCS-BCW-01-COL	100,341	Complete	0501040303, 0501040304	2.1	227	Red Bluff Diversion Dam, Clarksburg
3	11	12	2002	Fall	2001	FCS-BCW-01-COL	100,668	Complete	0501040301, 0501040302	2.2	227	Red Bluff Diversion Dam, Clarksburg
4	18		2002	Fall	2001	FCS-BCW-01-COL	5,859,280	Partial	050874-050879, 050880, 0501040204-0501040209	3.0	91	Battle Creek
4	25		2002	Fall	2001	FCS-BCW-01-COL	5,257,739	Partial	050881-050887, 0501040105-0501040107, 0501040201-0501040203	2.9	92	Battle Creek
11	5		2002	Late-Fall	2002	LFS-BCW-02-COL	71,032	Complete	051097	4.0	28	Battle Creek
12	2		2002	Late-Fall	2002	LFS-BCW-02-COL	60,324	Complete	051165	5.3	15	Battle Creek
12	3	9	2002	Late-Fall	2002	LFS-BCW-02-COL	260,502	Complete	051098, 051166, 051167, 051168, 055138	4.7	18	Georgianna Slough, Port Chicago, Ryde-Koket, West Sacramento
1	2		2003	Late-Fall	2002	LFS-BCW-02-COL	539,910	Complete	051091-051095, 051099, 051164, 055139	4.9	15	Battle Creek

Appendix 10A (cont.) Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date										Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
1	15		2003	Late-Fall	2002	LFS-BCW-02-COL	76,677	Complete	051096	5.2	13	Battle Creek
1	30		2003	Winter	2002	WCS-SRW-02-LIV	164,805	Complete	051276-051296, 051299, 051364-051373	3.1	82	Caldwell Park - Sacramento River
1	30		2003	Winter	2002	WCS-BML/SRW-02-LIV	68,807	Complete	051297, 051298, 053737	2.6	122	Caldwell Park - Sacramento River
2	6		2003	Winter	2002	WCS-SRW-02-LIV	201	Complete	051276-051289, 051292, 051293, 051296, 051299, 051364-051370, 051372, 051373	3.6	79	Livingston Stone NFH - Captive Broodstock Program
2	6		2003	Winter	2002	WCS-SRW-02-LIV	201	Complete	051276-051289, 051292, 051293, 051296, 051299, 051364-051370, 051372, 051373	3.5	88	Bodega Bay Marine Lab. - Captive Broodstock Program
2	20	21	2003	Fall	2002	FCS-BCW-02-COL	100,245	Complete	0501020103, 0501020104	2.1	227	Red Bluff Diversion Dam, Clarksburg
3	6	7	2003	Fall	2002	FCS-BCW-02-COL	100,587	Complete	0501020105, 0501020106	2.4	227	Red Bluff Diversion Dam, Clarksburg
4	4		2003	Fall	2002	FCS-BCW-02-COL	1,685,414	No CWT		3.0	91	Battle Creek
4	8		2003	Late-Fall	2002	LFS-BCW-02-COL	450	No CWT				Research - Buckley Cove Marina
4	18		2003	Fall	2002	FCS-BCW-02-COL	5,214,104	No CWT		3.1	91	Battle Creek
4	25		2003	Fall	2002	FCS-BCW-02-COL	6,937,627	No CWT		2.9	102	Battle Creek
11	28		2003	Late-Fall	2003	LFS-BCW-03-COL	138,213	Complete	051767, 051769	4.7	20	
12	5	20	2003	Late-Fall	2003	LFS-BCW-03-COL	286,371	Complete	051771-051774, 051778-051783	4.9	17	West Sacramento, Sherman Island, Georgianna Slough, Ryde-Koket, Benicia, Vorden
12	31		2003	Late-Fall	2003	LFS-BCW-03-COL	354,100	Complete	051699, 051764, 051765, 051768, 051775	5.2	13	Battle Creek
1	2		2004	Late-Fall	2003	LFS-BCW-03-COL	200,685	Complete	051770, 051776, 051777	5.1	13	Battle Creek
1	28		2004	Winter	2003	WCS-SRW-03-LIV	217	Complete	051679, 051964, 051967-051986, 051991, 051992	3.3	79	Livingston Stone NFH - Captive Broodstock Program
1	30		2004	Late-Fall	2003	LFS-BCW-03-COL	68,403	Complete	051766	5.7	10	Battle Creek
2	5		2004	Winter	2003	WCS-SRW-03-LIV	151,911	Complete	051679, 051964-051993	3.3	68	Caldwell Park - Sacramento River
2	5		2004	Winter	2003	WCS-BML/SRW-03-LIV	66,606	Complete	051994-051997	3.0	84	Caldwell Park - Sacramento River
2	17		2004	Fall	2003	FCS-BCW-03-COL	100,368	Complete	0501021513, 0501021514	1.9		Red Bluff Diversion Dam, Clarksburg
3	2		2004	Fall	2003	FCS-BCW-03-COL	100,261	Complete	0501030103, 0501030104	2.0		Red Bluff Diversion Dam, Clarksburg
4	16		2004	Fall	2003	FCS-BCW-03-COL	6,286,896	Partial	0501040108, 0501040109	3.0	88	Battle Creek
4	23		2004	Fall	2003	FCS-BCW-03-COL	6,614,040	No CWT		2.9	105	Battle Creek
7	4		2004	Late-Fall	2004	LFS-BCW-04-COL	57,652	Complete	0501021203, 0501021204			Research - GCID
11	5		2004	Late-Fall	2004	LFS-BCW-04-COL	87,836	Complete	052275	4.8	21	Battle Creek
11	29		2004	Late-Fall	2004	LFS-BCW-04-COL	69,996	Complete	052276	4.6	20	Battle Creek

Appendix 10A (cont.)   Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date										Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
12	6	10	2004	Late-Fall	2004	LFS-BCW-04-COL	296,338	Complete	052280-052285, 052290-052293	4.8	18	Ryde-Koket, Port Chicago, Sherman Island, West Sacramento, Vorden, Georgianna Slough
1	4		2005	Late-Fall	2004	LFS-BCW-04-COL	413,196	Complete	052273, 052274, 052277, 052279, 052286, 052287, 052294	5.3	14	Battle Creek
1	13		2005	Late-Fall	2004	LFS-BCW-04-COL	69,768	Complete	052278	5.3	12	Battle Creek
2	3		2005	Winter	2004	WCS-SRW-04-LIV	148,384	Complete	051681, 051683-051696, 052476	3.3	67	Caldwell Park - Sacramento River
2	3		2005	Winter	2004	WCS-LSNFH/SRW-04-LIV	19,876	Complete	052477	2.8	111	Caldwell Park - Sacramento River
2	18		2005	Fall	2004	FCS-BCW-04-COL	99,926	Complete	0501020107, 0501020108	1.9	337	Red Bluff Diversion Dam, Clarksburg
3	7		2005	Fall	2004	FCS-BCW-04-COL	46,876	Complete	0501020109, 0501020110	2.1	340	Red Bluff Diversion Dam, Clarksburg
4	15		2005	Fall	2004	FCS-BCW-04-COL	6,097,731	No CWT		2.9	89	Battle Creek
4	29		2005	Fall	2004	FCS-BCW-04-COL	5,609,155	No CWT		3.0	83	Battle Creek
6	7		2005	Late-Fall	2005	LFS-BCW-05-COL	86,874	Complete	0501021510, 0501021511	4.9	19	Research - GCID
12	2		2005	Late-Fall	2005	LFS-BCW-05-COL	125,489	Complete	052780, 052781	4.6	19	Battle Creek
12	8	14	2005	Late-Fall	2005	LFS-BCW-05-COL	172,014	Complete	052784-052795	4.9	19	Georgianna Slough, Ryde-Koket, Sherman Island, Port Chicago
1	3		2006	Late-Fall	2005	LFS-BCW-05-COL	553,317	Complete	052783, 052864-052870	5.2	16	Battle Creek
1	19		2006	Late-Fall	2005	LFS-BCW-05-COL	65,444	Complete	052782	5.6	16	Battle Creek
2	2		2006	Winter	2005	WCS-SRW-05-LIV	160,272	Complete	052478-052488, 052774-052777, 053072, 053074	3.4	58	Caldwell Park - Sacramento River
2	2		2006	Winter	2005	WCS-LSNFH/SRW-05-LIV	13,071	Complete	053073	2.9	94	Caldwell Park - Sacramento River
2	16		2006	Fall	2005	FCS-BCW-05-COL	98,333	Complete	0501040702-0501040705	2.0	384	Red Bluff Diversion Dam, Clarksburg
2	24		2006	Fall	2005	FCS-BCW-05-COL	99,848	Complete	0501040706-0501040709	2.0	361	Red Bluff Diversion Dam, Clarksburg
4	14		2006	Fall	2005	FCS-BCW-05-COL	6,600,075	No CWT		3.0	89	Battle Creek
4	28		2006	Fall	2005	FCS-BCW-05-COL	4,193,388	No CWT		3.0	84	Battle Creek
5	1		2006	Late-fall	2006	LFS-BCW-06-COL	51,719	Complete	0501011511, 0501021512			Research - GCID
5	5		2006	Fall	2005	FCS-BCW-05-COL	2,363,701	No CWT		2.9	90	Battle Creek
11	29		2006	Late-fall	2006	LFS-BCW-06-COL	176,143	Complete	053381, 053382	4.9	16	Battle Creek
12	4	11	2006	Late-fall	2006	LFS-BCW-06-COL	120,239	Complete	053371-053378	5.3	14	Ryde-Koket, Benicia, West Sacramento
1	3		2007	Late-fall	2006	LFS-BCW-06-COL	630,035	Complete	053383-053387, 053389, 053390	5.2	14	Battle Creek
1	16	19	2007	Late-fall	2006	LFS-BCW-06-COL	104,037	Complete	052988-052993, 053379, 053380	5.6	12	Ryde-Koket, Benicia, Discovery Park
1	22		2007	Late-fall	2006	LFS-BCW-06-COL	82,856	Complete	053388	5.4	13	Battle Creek

Appendix 10A (cont.) Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date										Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
2	8		2007	Winter	2006	WCS-SRW-06-LIV	161,192	Complete	051680, 051682, 051697, 051698, 052490-052493, 053399, 053466-053473, 053867	3.6	51	Caldwell Park - Sacramento River
2	8		2007	Winter	2006	WCS-LSNFH/SRW-06-LIV	35,076	Complete	053073	3.3	68	Caldwell Park - Sacramento River
3	15		2007	Fall	2006	FCS-BCW-06-COL	100,145	Complete	0501040801-0501040804	2.2	231	Red Bluff Diversion Dam, Clarksburg
3	22		2007	Fall	2006	FCS-BCW-06-COL	102,447	Complete	0501040805-0501040808	2.3	222	Red Bluff Diversion Dam, Clarksburg
4	12		2007	Fall	2006	FCS-BCW-06-COL	5,103,834	Partial	053794	3.0	90	Battle Creek
4	23		2007	Fall	2006	FCS-BCW-06-COL	7,009,767	Partial	053795-053799, 053864, 053865	2.9	103	Battle Creek
9	13		2007	Late-fall	2007	LFS-BCW-07-COL	78,392	Complete	0501010914, 0501010915	2.0	241	Research - GCID
11	26		2007	Late-fall	2007	LFS-BCW-07-COL	161,323	Complete	053994, 053996	4.9	18	Battle Creek
12	6	11	2007	Late-fall	2007	LFS-BCW-07-COL	122,877	Complete	052796-052799, 053685-053688	4.7	20	Ryde-Koket, Port Chicago, Georgiana Slough
1	2		2008	Late-fall	2007	LFS-BCW-07-COL	496,305	Complete	053988-053990, 053992, 053995, 053997	5.1	17	Battle Creek
1	14		2008	Late-fall	2007	LFS-BCW-07-COL	83,569	Complete	053993	5.0	18	Battle Creek
1	17	22	2008	Late-fall	2007	LFS-BCW-07-COL	118,841	Complete	052994, 052995, 053674-053677, 053683, 053684	5.1	15	Ryde-Koket, Port Chicago, Georgiana Slough
1	31		2008	Winter	2007	WCS-SRW-07-LIV	71,883	Complete	054553, 054554, 054604-054610	3.5	62	Caldwell Park - Sacramento River
3	3		2008	Fall	2007	FCS-BCW-07-COL	100,519	Complete	0501040901-0501040904	2.1	286	Red Bluff Diversion Dam, Clarksburg
3	10		2008	Fall	2007	FCS-BCW-07-COL	100,606	Complete	0501040905-0501040908	2.1	285	Red Bluff Diversion Dam, Clarksburg
4	23		2008	Fall	2007	FCS-BCW-07-COL	3,559,697	Partial	054391, 054393, 054465-054467	3.0	87	Battle Creek
4	29		2008	Fall	2007	FCS-BCW-07-COL	7,672,804	Partial	054395, 054398, 054399, 054464, 054468-054472	2.9	103	Battle Creek
5	19		2008	Fall	2007	FCS-BCW-07-COL	367,583	Partial	054392	3.2	61	Conoco Phillips
5	27		2008	Fall	2007	FCS-BCW-07-COL	455,378	Partial	054394	3.5	58	San Pablo Bay at Mare Island
6	2		2008	Fall	2007	FCS-BCW-07-COL	443,988	Partial	054397	3.3	61	Conoco Phillips
12	16		2008	Late-fall	2008	LFS-BCW-08-COL	156,153	Complete	054288,054296	5.3	16	Battle Creek
12	30		2008	Late-fall	2008	LFS-BCW-08-COL	414,536	Complete	054286, 054287, 054289-054291	5.2	16	Battle Creek
1	6		2009	Late-fall	2008	LFS-BCW-08-COL	461,919	Complete	053991-054294, 054297, 054298	5.3	15	Battle Creek
1	23		2009	Late-fall	2008	LFS-BCW-08-COL	75,932	Complete	054295	5.6	11	Battle Creek
1	29		2009	Winter	2008	WCS-SRW-08-LIV	146,211	Complete	053464,0 53465, 053474, 054024-054026, 054028, 054029, 054167, 054171-054174	3.6	57	Lake Redding Park
4	9		2009	Fall	2008	FCS-BCW-08-COL	4,538,510	Partial	054874-054877, 054878, 054880-054884	3.0	95	Battle Creek

Appendix 10A (cont.) Distribution of Chinook salmon from Coleman National Fish Hatchery (NFH) from 1941 through July 2008.

Distribution Date										Size		
Month	First Date	Last Date	Year	Race	BY	Lot No.	Number Released	CWT Status	CWT Code	(inches)	(No.)/lb	Release Location
4	16		2009	Fall	2008	FCS-BCW-08-COL	3,263,230	Partial	054872, 054885-054889, 054891	3.0	93	Battle Creek
4	23		2009	Fall	2008	FCS-BCW-08-COL	4,727,718	Partial	054873, 054890, 054892-054899	2.9	94	Battle Creek
5	12	13	2009	Fall	2008	FCS-BCW-08-COL	432,485	Partial	054879	3.5	59	Conoco Phillips
5	13	15	2009	Fall	2008	FCS-BCW-08-COL	554,218	Partial	054871	3.5	59	Mare Island Net pen
5	14	15	2009	Fall	2008	FCS-BCW-08-COL	504,965	Partial	054870	3.5	55	Mare Island Net pen

Appendix 10B Broodstock source and distribution summary of steelhead and non-anadromous rainbow trout at Coleman National Fish Hatchery. STT, RBT, and KAM denote steelhead trout, non-anadromous rainbow trout, and Kamloops (Gerrard strain rainbow trout), respectively.

Brood Year	Release Date	Stock	Source of Eggs or Broodstock	Lot Number	Number Released	Approx. Size (in.)	Release Location	Coded-wire Tagged Releases	
								Number	Tag Codes
1948	1948	STT	Keswick Trap	16	11,211	4	Sacramento River		
1948	1951	STT	Keswick Trap	16	27	"ADULTS"	Sacramento River		
1949	1949	STT	Coleman Broodstock (Lot 16)	20	41,291	3-4	Sacramento River		
1949	1950	STT	Coleman Broodstock (Lot 16)	20	1,590	6	Sacramento River		
1949	1950	STT	Coleman Broodstock (Lot 16)	20	24	"ADULTS"	Sacramento River		
1949	1951	STT	Coleman Broodstock (Lot 16)	20	83	"ADULTS"	Sacramento River		
1950	1950	KAM	British Columbia, Canada	21	934	6	Shasta Lake		
1950	1950	STT	Coleman Broodstock (Lot 16)	24	136,414	3	Sacramento River		
1950	1950	STT	Coleman Broodstock (Lot 16)	24	3,971	4	Sacramento River		
1951	1951	KAM	British Columbia, Canada	26	25,232	4	Shasta Lake		
1951	1950	RBT	Pocatello, ID	25	94,000	2			
1951	1951	STT	Coleman Broodstock	29	110,197	1	Sacramento River		
1952	1952	KAM	British Columbia, Canada	31	71,654	4	Shasta Lake		
1953	1953	KAM	British Columbia, Canada	37	51,778	5	Shasta Lake		
1953	1952	KAM	Greenough, MT	36	28,493	6	Shasta Lake		
1953	1953	STT	Battle Creek	35	63,662	6	Sacramento River		
1953	1954	STT	Battle Creek	40	153,025	5-6	Sacramento River		
1954	1954	KAM	Missoula, MT	41 & 42	84,091	5-6	Shasta Lake		
1954	1955	STT	Battle Creek	44	178,259	5-6	Sacramento River		
1956	1956	STT	Battle Creek and Keswick	5CM	206,071	6	Sacramento River		
1956	1956	STT	Battle Creek and Keswick	5CM	79,804	5-6	Sacramento River		
1956	1955	STT	Battle Creek and Keswick	5CM	47,627	EYED EGGS	Nimbus Hatchery		
1956	1956	RBT	Hagarman, ID	5H	16,419	5-6			
1956	1955	STT	Battle Creek	5CM	67,141	7-8	Sacramento River		
1956	Oct-57	STT	Battle Creek and Keswick	6CM	18,285	2	Sacramento River		
1956	1957	STT	Battle Creek and Keswick	6CM	121,899	6	Sacramento River		
1956	Jan-57	STT	Battle Creek and Keswick	6CM	109,762	4	Mill Creek-Sacramento River		
1956	Apr-57	STT	Battle Creek and Keswick	6CM	2,190	6	Indian Springs Creek-Sacramento River		
1956	Apr-57	STT	Battle Creek and Keswick	6CM	2,250	6	Upper Dry Creek-Sacramento River		
1956	Apr-57	STT	Battle Creek and Keswick	6CM	560	6	Lower Dry Creek-Sacramento River		
1956	Aug-57	STT	Battle Creek and Keswick	6CM	783	6-7	Sacramento River		
1957	Dec-57	STT	Battle Creek and Keswick	7-CM-54	33,531	6	Sacramento River		
1957	Jan-58	STT	Battle Creek and Keswick	7-CM-54	94,970	5-6	Sacramento River		
1957	Apr-58	STT	Battle Creek and Keswick	7-CM-54	5,037	7-8	Sacramento River		
1957	1956	RBT	Hagarman, ID	6H	42,000	EYED EGGS	CA Dept. of Fish and Game		
1958	Jul-58	STT	Battle Creek and Keswick	8-CM-59	6,987	1-2	Sacramento River		
1958	1957	KAM	Coleman Broodstock	7-CM	2,456	8	Sacramento River		
1958	1957	KAM	Fort Klamath, OR	7-ORE-55	23,804	3	Shasta Lake		
1958	May-58	KAM	Fort Klamath, OR	7-ORE-55	3,172	3-4	Big Spring/NV		
1958	May-58	KAM	Fort Klamath, OR	7-ORE-55	37,952	3-4	Shasta Lake		
1959	Mar-59	STT	Battle Creek and Keswick	8-CM-59	131,712	5	Sacramento River		

Appendix 10B (cont.) Broodstock source and distribution summary of steelhead and non-anadromous rainbow trout at Coleman National Fish Hatchery.

Brood Year	Release Date	Stock	Source of Eggs or Broodstock	Lot Number	Number Released	Approx. Size (in.)	Release Location	Coded-wire Tagged Releases Number	Tag Codes
1959	Mar-59	STT	Battle Creek and Keswick	8-CM-59	84,171	6	Sacramento River		
1959	Mar-59	STT	Battle Creek and Keswick	8-CM-59	25,861	5	Feather River		
1959	Mar-59	STT	Battle Creek and Keswick	8-CM-59	24,451	6	Clear Creek-Sacramento River		
1959	Mar-59	STT	Battle Creek and Keswick	8-CM-59	1,414	6	Mill Creek-Sacramento River		
1959	Mar-59	STT	Battle Creek and Keswick	8-CM-59	15,051	6	Chico Creek-Sacramento River		
1959	Apr-59	STT	Battle Creek and Keswick	8-CM-59	6,318	6	Upper Dry Creek-Sacramento River		
1959	Mar-60	KAM	Coleman Broodstock	8-CM-65	14,964	8	Shasta Lake		
1959	Jan-59	KAM	Coleman Broodstock	8-CM-65	502	6-7	Shasta Lake		
1959	Apr-59	KAM	Coleman Broodstock	8-CM-65	9,207	5-6	Shasta Lake		
1959	1958	RBT	Mount Shasta, CA	8-CAL-58	18,991	2			
1959	1959	KAM	Diamond Lake, OR	8-ORE-61	19,438	5-6			
1960	1960	STT	Battle Creek and Keswick	9-CM-66	30,069	4	Sacramento River		
1960	Feb-60	STT	Battle Creek and Keswick	9-CM-66	50,076	4	Clear Creek-Sacramento River		
1960	1960	STT	Battle Creek and Keswick	9-CM-66	221,356	5	Sacramento River		
1960	Mar-60	STT	Battle Creek and Keswick	9-CM-66	25,091	4	Feather River		
1960	Mar-60	STT	Battle Creek and Keswick	9-CM-66	30,228	5	Mill Creek-Sacramento River		
1960	Mar-60	STT	Battle Creek and Keswick	9-CM-66	15,348	6	Chico Creek-Sacramento River		
1960	Mar-61	STT	Battle Creek and Keswick	9-CM-71	5,015	5	Chico Creek-Sacramento River		
1960	Mar-61	STT	Battle Creek and Keswick	9-CM-71	10,018	5	Feather River		
1960	Mar-61	STT	Battle Creek and Keswick	9-CM-71	97,344	5	Sacramento River		
1960	Apr-60	KAM	Diamond Lake, OR	9-ORE-67	27,372	5	Shasta Lake		
1960	Feb-61	KAM	Battle Creek	9-CM-70	17,684	8	Shasta Lake		
1960	Oct-61	STT	Battle Creek and Keswick	1-CN-77	62,889	6	Sacramento River		
1960	Nov-61	STT	Battle Creek and Keswick	1-CN-77	56,250	6	Sacramento River		
1960	Dec-61	STT	Battle Creek and Keswick	1-CN-77	58,840	6	Sacramento River		
1960	Jan-62	STT	Battle Creek and Keswick	1-CN-77	35,217	6-7	Feather River		
1960	Jan-62	STT	Battle Creek and Keswick	1-CN-77	12,192	6	Chico Creek-Sacramento River		
1960	Jan-62	STT	Battle Creek and Keswick	1-CN-77	7,270	6-7	Research-Army Corp of Eng.		
1960	Jan-62	STT	Battle Creek and Keswick	1-CN-77	152,130	6-7	Sacramento River		
1960	Feb-62	STT	Battle Creek and Keswick	1-CN-77	64,036	5-6	Sacramento River		
1960	Mar-62	STT	Battle Creek and Keswick	1-CN-77	35,084	5-6	Mill Creek-Sacramento River		
1960	Mar-62	STT	Battle Creek and Keswick	1-CN-77	25,228	5-6	Deer Creek-Sacramento River		
1960	Mar-62	STT	Battle Creek and Keswick	1-CN-77	43,763	5-6	Sacramento River		
1961	Feb-61	KAM	Diamond Lake, OR	0-ORE-72	17,684	4	Shasta Lake		
1962	Nov-62	STT	Battle Creek and Keswick	2-CN-81	86,150	6-7	Sacramento River		
1962	Dec-62	STT	Battle Creek and Keswick	2-CN-81	160,650	6-7	Sacramento River		
1962	Jan-63	STT	Battle Creek and Keswick	2-CN-81	29,220	6-7	Sacramento River		
1962	Feb-63	STT	Battle Creek and Keswick	2-CN-81	243,730	6-7	Sacramento River		
1962	Feb-53	STT	Battle Creek and Keswick	2-CN-81	35,210	6-7	Feather River		
1962	Feb-63	STT	Battle Creek and Keswick	2-CN-81	9,980	6-7	Chico Creek-Sacramento River		
1962	Mar-63	STT	Battle Creek and Keswick	2-CN-81	366,146	5-6	Sacramento River		
1962	Apr-63	STT	Battle Creek and Keswick	2-CN-81	21,252	5	Deer Creek-Sacramento River		
1962	Apr-63	STT	Battle Creek and Keswick	2-CN-81	42,966	5	Mill Creek-Sacramento River		

Appendix 10B (cont.) Broodstock source and distribution summary of steelhead and non-anadromous rainbow trout at Coleman National Fish Hatchery.

Brood Year	Release Date	Stock	Source of Eggs or Broodstock	Lot Number	Number Released	Approx. Size (in.)	Release Location	Coded-wire Tagged Releases Number	Coded-wire Tagged Releases Tag Codes
1962	Apr-63	STT	Battle Creek and Keswick	2-CN-81	218,257	5	Sacramento River		
1962	Oct-61	KAM	Coleman Broodstock	1-CN-76	50,031	7	Sacramento River		
1962	Jan-62	KAM	Coleman Broodstock	1-CN-76	35,217	6	Shasta Lake		
1962	Nov-62	KAM	Coleman Broodstock	2-CN-80	34,302	6-7	Sacramento River		
1962	Nov-62	KAM	Coleman Broodstock	2-CN-80	53,340	6-7	Shasta Lake		
1962	Dec-63	KAM	Coleman Broodstock	2-CN-80	40,210	8	Sacramento River		
1962	Apr-63	KAM	Coleman Broodstock	2-CN-80	9,850	8	Military Bases		
1963	Oct-63	STT	Battle Creek and Keswick	3-CN-86	6,300	6-7	Sacramento River		
1963	Jan-64	STT	Battle Creek and Keswick	3-CN-86	22,200	7-8	Sacramento River		
1963	Feb-64	STT	Battle Creek and Keswick	3-CN-86	181,000	6-7	Sacramento River		
1963	Feb-64	STT	Battle Creek and Keswick	3-CN-86	25,000	6-7	Feather River		
1963	Mar-64	STT	Battle Creek and Keswick	3-CN-86	10,000	6-7	Sacramento River		
1963	Mar-64	STT	Battle Creek and Keswick	3-CN-86	222,400	6-7	Sacramento River		
1963	1963	KAM	Coleman Broodstock	3-CN-84	86,132	7			
1963	Nov-63	KAM	Coleman Broodstock	3-CN-84	37,600	8	Sacramento River		
1963	Dec-63	KAM	Coleman Broodstock	3-CN-84	33,300	7	Shasta Lake		
1963	Nov-64	KAM	Coleman Broodstock	3-CN-84	26,000	6	Engle Lake		
1963	Nov-64	KAM	Coleman Broodstock	3-CN-84	1,000	8	Military Bases		
1963	Nov-64	KAM	Coleman Broodstock	3-CN-84	25,000	7	Whiskeytown Reservoir		
1963	Nov-64	KAM	Coleman Broodstock	3-CN-84	95,500	7	Shasta Lake		
1963	Nov-64	KAM	Coleman Broodstock	3-CN-84	87,400	6-7	Sacramento River		
1963	Feb-65	KAM	Coleman Broodstock	3-CN-84	7,000	10	Shasta Lake		
1964	Oct-64	STT	Battle Creek and Keswick	4-CN-91	1,400	10	Sacramento River		
1964	Nov-64	STT	Battle Creek and Keswick	4-CN-91	25,600	7	Feather River		
1964	Nov-64	STT	Battle Creek and Keswick	4-CN-91	20,400	6-7	Clear Creek-Sacramento River		
1964	Dec-64	STT	Battle Creek and Keswick	4-CN-91	177,800	6-7	Sacramento River		
1964	Jan-65	STT	Battle Creek and Keswick	4-CN-91	67,000	6-7	Sacramento River		
1964	Jan-65	STT	Battle Creek and Keswick	4-CN-91	25,000	6-7	Feather River		
1964	Feb-65	STT	Battle Creek and Keswick	4-CN-91	231,200	6-7	Sacramento River		
1964	Mar-65	STT	Battle Creek and Keswick	4-CN-91	413,000	6-7	Sacramento River		
1964	Apr-65	STT	Battle Creek and Keswick	4-CN-91	5,000	8-9	Military Bases		
1964	Apr-65	STT	Battle Creek and Keswick	4-CN-91	565,000	5-6	Sacramento River		
1964	Jun-65	STT	Battle Creek and Keswick	4-CN-91	500	1 / LB	Sacramento River		
1965	Mar-Apr 65	STT	Battle Creek and Keswick	5-CN-96	785,000	EYED EGGS	CA Dept. of Fish and Game		
1964	Jan-64	KAM	Coleman Broodstock	4-CN-90	20,000	EYED EGGS	NV Dept. of Fish and Game		
1964	1965	KAM	Coleman Broodstock	4-CN-90	241,900	7			
1964	Jan-65	KAM	Battle Creek	4-CN-90 or 5-CN-90	8,800	EYED EGGS	(Korea) CA Dept. of Fish and Game		
1964	Jan-65	KAM	Battle Creek	4-CN-90 or 5-CN-90	26,000	EYED EGGS	WY Dept. of Fish and Game		
1964	Jan-65	KAM	Battle Creek	4-CN-90 or 5-CN-90	50,000	EYED EGGS	NV Dept. of Fish and Game		
1965	Dec-65	STT	Battle Creek and Keswick	5-CN-96	40,600	6	Sacramento River		

Appendix 10B (cont.) Broodstock source and distribution summary of steelhead and non-anadromous rainbow trout at Coleman National Fish Hatchery.

Brood Year	Release Date	Stock	Source of Eggs or Broodstock	Lot Number	Number Released	Approx. Size (in.)	Release Location	Coded-wire Tagged Releases Number	Tag Codes
1965	Jan-66	STT	Battle Creek and Keswick	5-CN-96	25,000	6-7	Mill Creek-Sacramento River		
1965	Jan-66	STT	Battle Creek and Keswick	5-CN-96	25,000	6-7	Deer Creek-Sacramento River		
1965	Jan-66	STT	Battle Creek and Keswick	5-CN-96	64,000	6-7	Sacramento River		
1965	Feb-66	STT	Battle Creek and Keswick	5-CN-96	50,000	6-7	Feather River		
1965	Feb-66	STT	Battle Creek and Keswick	5-CN-96	180,000	6-7	Sacramento River		
1965	Mar-66	STT	Battle Creek and Keswick	5-CN-96	423,700	6-7	Sacramento River		
1965	Apr-66	STT	Battle Creek and Keswick	5-CN-96	304,751	6-7	Sacramento River		
1965	Apr-66	STT	Battle Creek and Keswick	5-CN-96	3,200	8-9	Military Bases		
1965	May-66	STT	Battle Creek and Keswick	5-CN-96	3,000	9	Military Bases		
1965	May-66	STT	Battle Creek and Keswick	5-CN-96	197,900	6-7	Sacramento River		
1965	Jun-66	STT	Battle Creek and Keswick	5-CN-96	10,000	10	Military Bases		
1965	Jun-66	STT	Battle Creek and Keswick	5-CN-96	167,400	6-7	Sacramento River		
1965	1965	STT	Battle Creek and Keswick	-CN-92	1,900	1.6 / LB			
1965	Nov-65	KAM	Battle Creek	5-CN-95	26,000	8	Shasta Lake		
1965	Dec-65	KAM	Battle Creek	5-CN-95	117,100	7	Shasta Lake		
1965	Jan-66	KAM	Battle Creek	5-CN-95	85,200	6	Shasta Lake		
1965	Jan-66	KAM	Battle Creek	5-CN-95	30,000	6	Whiskeytown Reservoir		
1965	Mar-66	KAM	Battle Creek	5-CN-95	1,000	9	Shasta Lake		
1966	Feb-66	KAM	Battle Creek	6-CN-3	97,000	EYED EGGS	CA Dept. of Fish and Game		
1966	Mar-66	KAM	Battle Creek	6-CN-3	25,000	EYED EGGS	CA Dept. of Fish and Game		
1966	Feb-66	KAM	Battle Creek	6-CN-3	50,000	EYED EGGS	NV Dept. of Fish and Game		
1965	Jan-Mar, Jun 66	STT	Battle Creek and Keswick	5-CN-96	650,600	6	Sacramento River-Jelly's Ferry		
1965	Jan-66	STT	Battle Creek and Keswick	5-CN-96	25,000	6	Mill Creek-Sacramento River		
1965	Jan-66	STT	Battle Creek and Keswick	5-CN-96	25,000	6	Deer Creek-Sacramento River		
1965	Jan-Mar 66	STT	Battle Creek and Keswick	5-CN-96	70,700	6	Sacramento River-Redding		
1965	Feb-66	STT	Battle Creek and Keswick	5-CN-96	50,000	6	Feather River		
1965	Apr-Jun 66	STT	Battle Creek and Keswick	5-CN-96	405,550	3	Sacramento River-Princeton		
1965	Apr-Jun 66	STT	Battle Creek and Keswick	5-CN-96	16,200	11	Military Bases		
1965	Apr-66	STT	Battle Creek and Keswick	5-CN-96	177,000	6	Battle Creek-Sacramento River		
1965	Feb-Mar 66	STT	Battle Creek and Keswick	5-CN-96	75,300	6	Sacramento River-Balls Ferry		
1967	Feb-67	KAM	Coleman Broodstock	7-CN-10	179,600	EYED EGGS	CA Dept. of Fish and Game		
1967	Feb-67	KAM	Coleman Broodstock	7-CN-10	50,000	EYED EGGS	NV Dept. of Fish and Game		
1967	Feb-67	KAM	Coleman Broodstock	7-CN-10	92,000	EYED EGGS	Quilcene NFH, WA		
1966	Mar-67	KAM	Coleman Broodstock	6-CN-3	41,890	7	Whiskeytown Reservoir		
1966	Dec 66 - Mar 67	KAM	Coleman Broodstock	6-CN-3	302,680	7-8	Shasta Lake		
1966	May-Jun 67	RBT	Winthrop, WA	6-WP-5	21,960	9-11	Military Bases		
1966	May-Jun 67	RBT	Winthrop, WA	6-WP-5	10,020	11	Tule River Indian Res.		
1966	Jun-67	RBT	Winthrop, WA	6-WP-5	3,500	9	Sacramento River		
1965	Aug-66	STT	Spillway	6-CN-8	3,750	12	Sacramento River-Balls Ferry		
1966	Dec 66 - Mar 67	STT	Battle Creek	6-CN-4	569,600	7	Sacramento River-Battle Creek		
1966	Jan-67	STT	Battle Creek	6-CN-4	125,150	7	Sacramento River-Redding		
1966	Feb-67	STT	Battle Creek	6-CN-4	48,000	7	Feather River		
1966	Feb-67	STT	Battle Creek	6-CN-4	214,100	7	Sacramento River-Balls Ferry		

Appendix 10B (cont.) Broodstock source and distribution summary of steelhead and non-anadromous rainbow trout at Coleman National Fish Hatchery.

Brood Year	Release Date	Stock	Source of Eggs or Broodstock	Lot Number	Number Released	Approx. Size (in.)	Release Location	Coded-wire Tagged Releases	
								Number	Tag Codes
1966	Mar-67	STT	Battle Creek	6-CN-4	27,190	7	Deer Creek-Sacramento River		
1966	Mar-67	STT	Battle Creek	6-CN-4	27,190	7	Mill Creek-Sacramento River		
1966	Apr-67	STT	Battle Creek	6-CN-4	99,890	7	Sacramento River-Jelly's Ferry		
1967	Jan-May 68	KAM	Coleman Broodstock	7-CN-10	377,500	9	Shasta Lake		
1967	Feb-68	KAM	Coleman Broodstock	7-CN-10	30,500	9	Whiskeytown Reservoir		
1967	Mar-68	KAM	Coleman Broodstock	7-CN-10	3,500	8	Berryessa Lake		
1967	Apr-68	KAM	Coleman Broodstock	7-CN-10	3,500	8	West Valley Indian Res.		
1968	Aug-67	RBT	Ennis, MT	7-DS-14	3,003	9	Military Bases		
1967	Feb, Jun 68	RBT	Ennis, MT	7-E-12	12,000	11-13	Whiskeytown Reservoir		
1967	Apr-Jun 68	RBT	Ennis, MT	7-E-12	8,000	11	La Jolla Indian Res.		
1967	Apr-May 68	RBT	Ennis, MT	7-E-12	25,333	10-11	Military Bases		
1967	Apr-Jun 68	RBT	Ennis, MT	7-E-12	15,000	11	Tule River Indian Res.		
1968	May-68	KAM	Coleman Broodstock	8-CM-16	126,076	2	CA Dept. of Fish and Game		
1967	Sep 67 - Mar 68	STT	Battle Creek	7-CN-11	798,000	7	Sacramento River-Jelly's Ferry		
1967	Jan-Mar 68	STT	Battle Creek	7-CN-11	400,000	6-7	Sacramento River-Balls Ferry		
1967	Jan-Mar 68	STT	Battle Creek	7-CN-11	200,000	7	Sacramento River-Battle Creek		
1967	Mar-68	STT	Battle Creek	7-CN-11	20,000	6	Mill Creek-Sacramento River		
1967	Mar-68	STT	Battle Creek	7-CN-11	25,000	7	Deer Creek-Sacramento River		
1968	Aug-68	KAM	Coleman Broodstock	8-CM-16	10,000	4	Blue Lake Indian Res.		
1968	Jan-May 69; Aug 69	KAM	Coleman Broodstock	8-CM-16	374,265	4-9	Shasta Lake		
1968	Feb-69	KAM	Coleman Broodstock	6-CN-7	881	17	Shasta Lake		
1968	Jan-69	RBT	Ennis, MT	8-E-19	40,000	9	Whiskeytown Reservoir		
1968	Apr-Jun 69	RBT	Ennis, MT	8-E-19	9,738	9-10	La Jolla Indian Res.		
1968	Apr-Jun 69	RBT	Ennis, MT	8-E-19	14,326	10	Tule River Indian Res.		
1968	May-Jun 69	RBT	Ennis, MT	8-E-19	25,181	8-11	Military Bases		
1968	Oct 68 - May 69	STT	Battle Creek	8-CN-18	1,022,845	4-7	Sacramento River-Balls Ferry		
1968	Jan-Jun 69	STT	Battle Creek	8-CN-18	399,734	7-8	Sacramento River-Battle Creek		
1969	Sep-69	KAM	Coleman Broodstock	9-CN-21	128	7	Steinhart Aquarium		
1969	Sep 69; Apr-May 70	KAM	Coleman Broodstock	9-CN-21	517,310	5-9	Shasta Lake		
1969	Sep-69	KAM	Coleman Broodstock	9-CN-21	61,650	5	Keswick Reservoir		
1969	Feb-70	KAM	Winthrop, WA	9-WP-24	1,437	10	Shasta Lake		
1969	May-70	KAM	Coleman Broodstock	6-CN-7X	4,911	12-14	Shasta Lake		
1968	Jul-70	RBT	Ennis, MT	8-E-19	9,506	11	Tule River Indian Res.		
1968	Jul-Aug 70	RBT	Ennis, MT	8-E-19	5,405	11	La Jolla Indian Res.		
1968	Sep-69	RBT	Ennis, MT	8-E-19	1,898	12	Keswick Reservoir		
1969	Sep-69	RBT	Winthrop, WA	9-WP-24	31,008	6	Keswick Reservoir		
1969	Nov 69; Jan-May 70	RBT	Winthrop, WA	9-WP-24	30,128	7-9	Military Bases		
1969	Feb-Apr 70	RBT	Winthrop, WA	9-WP-24	7,200	8	La Jolla Indian Res.		
1969	Feb-Jun 70	RBT	Winthrop, WA	9-WP-24	53,405	8-9	Whiskeytown Reservoir		
1969	Sep-69	RBT	Mt Whitney SFH, CDFG	9-UC-25	32,932	4	Keswick Reservoir		

Appendix 10B (cont.) Broodstock source and distribution summary of steelhead and non-anadromous rainbow trout at Coleman National Fish Hatchery.

Brood Year	Release Date	Stock	Source of Eggs or Broodstock	Lot Number	Number Released	Approx. Size (in.)	Release Location	Coded-wire Tagged Releases Number	Coded-wire Tagged Releases Tag Codes
1969	Feb, Apr 70	STT	Battle Creek	9-CN-22	325,853	7	Sacramento River-Rio Vista		
1969	Feb, Apr 70	STT	Battle Creek	9-CN-22	329,717	7	Sacramento River-Battle Creek		
1971	Apr-70	KAM	Coleman Broodstock	1-CN-33	1,311,000	Fry	Destroyed due to detection of IHN		
1970	Mar-Jun 71	KAM	Coleman Broodstock	0-CN-27	60,759	9-10	Whiskeytown Reservoir		
1970	Apr-Jun 71	KAM	Coleman Broodstock	0-CN-27	404,771	9-10	Shasta Lake		
1970	Apr-May 71	KAM	Coleman Broodstock	0-CN-27	17,480	9	Military Bases		
1968	Jul-Aug 71	RBT	Winthrop, WA	9-WP-24	42,388	9-11	Whiskeytown Reservoir		
1970	Mar-71	RBT	Ennis, MT	0-E-29	6,057	12	Whiskeytown Reservoir		
1970	Jul-70	RBT	Ennis, MT	0-E-29	150	5	San Francisco State Univ.		
1970	Nov-Dec 70; Jan-Mar 71	RBT	Ennis, MT	0-E-29	5,004	9	Military Bases		
1970	Jun-71	RBT	Ennis, MT	0-UC-30	5,193	8	Whiskeytown Reservoir		
1970	Nov-70	STT	Battle Creek and Keswick	9-CN-28	77,927	4	Yuba River		
1970	Feb-Mar 71	STT	Battle Creek and Keswick	9-CN-28	705,383	7	Sacramento River-Rio Vista		
1970	Feb-Apr 71	STT	Battle Creek and Keswick	9-CN-28	822,191	6-7	Sacramento River-Battle Creek		
1971	Feb-71	STT	Battle Creek and Keswick	0-CN-32	100,656	EE	Nimbus Hatchery		
1971	Jan, Apr 72	KAM	Clark Fork Hatchery, ID	1-UID-34	24,558	9-11	Shasta Lake		
1971	Apr-72	KAM	Clark Fork Hatchery, ID	1-UID-34	1,370	8-11	Military Bases		
1970	Jul-Aug 71	RBT	CA Dept. of Fish and Game	0-UC-30	20,885	11	Whiskeytown Reservoir		
1970	Nov-Dec 71; Jan-Mar 72	RBT	CA Dept. of Fish and Game	0-UC-30	5,010	8-9	Two Rocks Ranch, Sonoma City		
1970	Jan, Apr 72	RBT	CA Dept. of Fish and Game	0-UC-30	78,589	9-11	Shasta Lake		
1970	Mar-Apr 72	RBT	CA Dept. of Fish and Game	0-UC-30	15,376	9	Whiskeytown Reservoir		
1972	Jun-72	RBT	Ennis, MT	2-EN-39	5,054	3	Whiskeytown Reservoir		
1971	Apr-May 72	RBT	CA Dept. of Fish and Game	1-UC-36	20,909	7	Military Bases		
1971	Jan-72	RBT	CA Dept. of Fish and Game	1-UC-36	100	6	Research-Simpson Lee Corp.		
1971	Mar-May 72	RBT	CA Dept. of Fish and Game	1-UC-36	184,533	7-8	Shasta Lake		
1971	May-Jun 72	RBT	CA Dept. of Fish and Game	1-UC-36	52,879	7-8	Whiskeytown Reservoir		
1971	Sep 71; Apr 72	STT	Battle Creek and Keswick	0-CN-32	266,130	4	Yuba River		
1971	Oct-71	STT	Battle Creek and Keswick	0-CN-32	62,685	4-5	Sacramento River-Lake Redding Park		
1971	Oct 71; Jan-Feb 72	STT	Battle Creek and Keswick	0-CN-32	316,678	5	Battle Creek-Sacramento River		
1971	Mar-72	STT	Battle Creek and Keswick	0-CN-32	300	7	Steinhart Aquarium		
1971	Oct-71	STT	Battle Creek and Keswick	0-CN-32	97,978	5	Sacramento River-Jelly's Ferry		
1971	Oct 71; Jan-Apr 72	STT	Battle Creek and Keswick	0-CN-32	1,216,993	5-7	Sacramento River-Balls Ferry		
1971	Jan-72	STT	Battle Creek and Keswick	0-CN-32	20,794	7	Shasta Lake		
1971	Jan-Feb 72	STT	Battle Creek and Keswick	0-CN-32	63,571	7	Sacramento River-Ord Bend		
1971	Feb-72	STT	Battle Creek and Keswick	0-CN-32	201,783	7	Sacramento River-Rio Vista		
1972	Feb-72	STT	Battle Creek and Keswick	1-CM-40	3,000	EYED EGGS	Arroyo Grande H.S.-exhibit		
1971	Mar-73	KAM	Clark Fork Hatchery, ID	1-UID-34	945	16	Shasta Lake		
1971	Jul-Aug 72	RBT	CA Dept. of Fish and Game	1-UC-36	32,428	8	Whiskeytown Reservoir		
1971	Jul-72	RBT	CA Dept. of Fish and Game	1-UC-36	4,080	9	Tule River		
1972	Apr-Jun 73	RBT	Ennis, MT	2-EN-39	267,036	8-9	Shasta Lake		
1972	Oct-72	RBT	Ennis, MT	2-EN-39	30	6	Shasta College		

Appendix 10B (cont.) Broodstock source and distribution summary of steelhead and non-anadromous rainbow trout at Coleman National Fish Hatchery.

Brood Year	Release Date	Stock	Source of Eggs or Broodstock	Lot Number	Number Released	Approx. Size (in.)	Release Location	Coded-wire Tagged Releases	
								Number	Tag Codes
1972	Jan, Apr-May 73	RBT	Ennis, MT	2-EN-39	25,273	8-10	Military Bases		
1972	Apr-May 73	RBT	Ennis, MT	2-EN-39	64,509	8-9	Whiskeytown Reservoir		
1972	Nov 72; Feb-Mar 73	RBT	Ennis, MT	2-EN-39 or 1-EN-39	2,000	9	Military Bases		
1972	Mar-73	RBT	Ennis, MT	2-EN-39 or 1-EN-39	71,818	9	Shasta Lake		
1972	Aug-Sep 72; Feb-Mar 73	STT	Nimbus Hatchery, CA	1-UCA-41	1,275	4	Research-Simpson Lee Corp.		
1972	Jul-72	STT	Nimbus Hatchery, CA	1-UCA-41	40	4	Diamond National		
1972	Mar-Apr 73	STT	Nimbus Hatchery, CA	1-UCA-41	490,441	6	Sacramento River-Balls Ferry		
1972	Dec 72; Feb 73	STT	Nimbus Hatchery, CA	1-UCA-41	1,000	5	Tiburon Research Station		
1972	Dec 72; Mar-Apr 73	STT	Nimbus Hatchery, CA	1-UCA-41	104,945	6	Sacramento River-Battle Creek		
1972	Oct-Nov 72; Feb 73	STT	Battle Creek and Keswick	1-CM-40	300	3	Research-Simpson Lee Corp.		
1972	Nov 72; Jan-Mar 73	STT	Battle Creek and Keswick	1-CM-40	533,751	6-8	Sacramento River-Battle Creek		
1972	Jan, Mar 73	STT	Battle Creek and Keswick	1-CM-40	319,473	7-8	Sacramento River-Balls Ferry		
1972	Feb-73	STT	Battle Creek and Keswick	1-CM-40	300	6	Tiburon Research Station		
1972	Feb-73	STT	Battle Creek and Keswick	1-CM-40	100,785	7	Sacramento River-Red Bluff		
1973	Jun-73	STT	Battle Creek and Keswick	2-CM-45	252,400	2	Sacramento River-Lake Redding Park		
1973	Jun-73	STT	Battle Creek and Keswick	2-CM-45	19,562	2	Sacramento River-Battle Creek		
1973	Jun-73	STT	Battle Creek and Keswick	2-CM-45	163,280	2	Sacramento River-Balls Ferry		
1973	May-74	KAM	Coleman Broodstock	3-UID-47	225,310	7	Shasta Lake		
1973	Jul 73; May 74	KAM	Coleman Broodstock	3-UID-47	59,443	3-5	Whiskeytown Reservoir		
1973	Oct-73	KAM	Coleman Broodstock	3-UID-47	38,280	5	Keswick Reservoir		
1973	Oct 73; Jan 74	KAM	Coleman Broodstock	3-UID-47	110	5	Shasta College		
1973	May-74	KAM	Coleman Broodstock	3-UID-47	13,008	8	Military Bases		
1973	May-74	KAM	Hot Springs Hatchery, CA	3-UCA-46	126,653	8	Shasta Lake		
1973	Sep 73; Apr 74	KAM	Hot Springs Hatchery, CA	3-UCA-46	4,980	4-9	Whiskeytown Reservoir		
1973	Nov 73; Jan-Apr 74	KAM	Hot Springs Hatchery, CA	3-UCA-46	16,570	7	Military Bases		
1973	Apr-74	KAM	Hot Springs Hatchery, CA	3-UCA-46	8,000	8	Whiskeytown Reservoir		
1971	Feb-74	KAM	Clark Fork Hatchery, ID	1-UID-34 or 3-UID-34	654	21	Keswick Reservoir		
1971	Feb-74	KAM	Clark Fork Hatchery, ID	1-UID-34	3	20	Shasta College		
1971	Jan-74	KAM	Clark Fork Hatchery, ID	1-UID-34	552	21	Keswick Reservoir		
1971	Jun-74	KAM	Clark Fork Hatchery, ID	1-UID-34	2	23	Shasta Lake		
1974	Jun-74	KAM	Clark Fork Hatchery, ID	4-UID-53	264,069	3-11	Shasta Lake		
1972	Jul-Aug 73	RBT	Ennis, MT	2-EN-39	38,796	9	Whiskeytown Reservoir		
1973	Nov-73	RBT	Mount Shasta Hatchery, CA	3-UCA-48	205,530	5	Shasta Lake		
1973	Feb-74	STT	Battle Creek and Keswick	2-CM-45	118,475	6	Sacramento River-Red Bluff		
1973	Dec 73; Mar 74	STT	Battle Creek and Keswick	2-CM-45	258,662	6	Sacramento River-Balls Ferry		

Appendix 10B (cont.) Broodstock source and distribution summary of steelhead and non-anadromous rainbow trout at Coleman National Fish Hatchery.

Brood Year	Release Date	Stock	Source of Eggs or Broodstock	Lot Number	Number Released	Approx. Size (in.)	Release Location	Coded-wire Tagged Releases	
								Number	Tag Codes
1973	Aug 73; Apr 74	STT	Battle Creek and Keswick	2-CM-45	223,070	3-4	Yuba River		
1973	Jul-Dec 73; Jan-Feb 74	STT	Battle Creek and Keswick	2-CM-45	3,075	2-4	Research-Simpson Lee Corp.		
1973	Aug 73; Jan-Apr 74	STT	Battle Creek and Keswick	2-CM-45	574,259	3-6	Battle Creek-Sacramento River		
1973	Oct-73	STT	Battle Creek and Keswick	2-CM-45	500	5	Tiburon Research Station		
1973	Mar-74	STT	Battle Creek and Keswick	2-CM-45	127,593	7	Sacramento River-Colusa		
1973	Apr-74	STT	Battle Creek and Keswick	2-CM-45	253,344	6-7	Sacramento River-Butte City		
1973	Apr-74	STT	Battle Creek and Keswick	2-CM-45	102,607	7	Sacramento River-Princeton		
1974	Mar-74	STT	Battle Creek and Keswick	3-CM-54	5,000	EYED EGGS	Arroyo Grande H.S.		
1973	Jun 74; Jan, Apr 75	KAM	Coleman Broodstock	3-UID-47	600	15	Shasta Lake		
1973	Jun-Aug 74; Jan, Mar 75	KAM	Coleman Broodstock	3-UID-47	20,375	8	Whiskeytown Reservoir		
1973	Feb-Mar 75	KAM	Coleman Broodstock	3-UID-47	30	15	Military Bases		
1974	Sep-74	KAM	Coleman Broodstock	4-UID-53	50	6	Shasta College		
1974	Sep-74	KAM	Coleman Broodstock	4-UID-53	105,234	5	Keswick Reservoir		
1974	Nov-Dec 74; Jan-May 75	KAM	Coleman Broodstock	4-UID-53	31,198	9-11	Military Bases		
1974	Apr-Jun 75	KAM	Coleman Broodstock	4-UID-53	25,475	9-11	Whiskeytown Reservoir		
1974	May-75	KAM	Coleman Broodstock	4-UID-53	477,524	8-11	Shasta Lake		
1975	May-75	KAM	Coleman Broodstock	5-UID-61	354,316	2	Shasta Lake		
1971	Jan-75	KAM	Clark Fork Hatchery, ID	1-UID-34	437	25	Shasta Lake		
1975	Feb-75	KAM	Clark Fork Hatchery, ID	5-UID-61	3,000	EYED EGGS	Arroyo Grande H.S.		
1974	Dec-75	STT	Battle Creek and Keswick	3-CM-54	101,551	7	Sacramento River-Balls Ferry		
1974	Sep-74	STT	Battle Creek and Keswick	3-CM-54	50	4	Shasta College		
1974	Jul-Sep 74	STT	Battle Creek and Keswick	3-CM-54	3,295	3-4	Research-Simpson Lee Corp.		
1974	Feb-75	STT	Battle Creek and Keswick	3-CM-54	101,334	7	Sacramento River-Red Bluff		
1974	Feb-Apr 75	STT	Battle Creek and Keswick	3-CM-54	653,317	7	Battle Creek-Sacramento River		
1974	Mar-75	STT	Battle Creek and Keswick	3-CM-54	239,547	7	Sacramento River-Princeton		
1974	Mar-Apr 75	STT	Battle Creek and Keswick	3-CM-54	259,461	6-7	Sacramento River-Ord Bend		
1974	Mar-75	STT	Battle Creek and Keswick	3-CM-54	50,803	7	Yuba River		
1975	May-75	STT	Nimbus Hatchery, CA	4-UCA-60	15,000	1	Battle Creek-Sacramento River		
1974	Jul-75	KAM	Coleman Broodstock	4-UID-53	17,710	9	Whiskeytown Reservoir		
1975	Oct-75	KAM	Coleman Broodstock	5-UID-61	45	5	Shasta College		
1975	Sep 75; Jan-Jun 76	KAM	Coleman Broodstock	5-UID-61	390,287	5	Shasta Lake		
1975	Nov-Dec 75; Jan-Mar 76	KAM	Coleman Broodstock	5-UID-61	21,064	8	Military Bases		
1975	Jun-76	KAM	Coleman Broodstock	5-UID-61	15,075	8	Whiskeytown Reservoir		
1975	Feb-76	KAM	Coleman Broodstock	5-UID-61 or 5-CM-61	14,715	7	Shasta Lake		
1975	Apr-76	KAM	Coleman Broodstock	5-UID-61 or 4-CM-61	5,138	8	Whiskeytown Reservoir		

Appendix 10B (cont.) Broodstock source and distribution summary of steelhead and non-anadromous rainbow trout at Coleman National Fish Hatchery.

Brood Year	Release Date	Stock	Source of Eggs or Broodstock	Lot Number	Number Released	Approx. Size (in.)	Release Location	Coded-wire Tagged Releases	
								Number	Tag Codes
1975	Apr-76	KAM	Coleman Broodstock	5-UID-61 or 4-CM-61	9,573	8	Military Bases		
1976	Jun-76	KAM	Coleman Broodstock	6-UID-68 or 6-CM-68	352,542	2	Keswick Reservoir		
1976	Jun-76	KAM	Coleman Broodstock	6-CM-69	71,750	2	Keswick Reservoir		
1976	Jun-76	STT	Battle Creek and Keswick	5-CM-66	48,440	2	Battle Creek-Sacramento River		
1976	Mar-76	STT	Battle Creek and Keswick	5-CM-66	6,000	EYED EGGS	Arroyo Grande H.S.		
1975	Mar-76	STT	Battle Creek and Keswick	4-CM-59	53,460	7	Yuba River		
1975	Oct-75	STT	Battle Creek and Keswick	4-CM-59	115,250	4	Sacramento River-Anderson River Park		
1975	Oct-75	STT	Battle Creek and Keswick	4-CM-59	70	4	Shasta College		
1975	Mar-Apr 76	STT	Battle Creek and Keswick	4-CM-59	263,393	7	Sacramento River-Los Molinos		
1975	Feb-Mar 76	STT	Nimbus Hatchery, CA	4-UCA-60	156,940	7	Sacramento River-Los Molinos		
1976	Jul-Aug 76	KAM	Coleman Broodstock	5-UID-61	18,095	9	Whiskeytown Reservoir		
1976	Dec 76; Jan 77	KAM	Coleman Broodstock	5-UID-61	1,800	12-14	Military Bases		
1976	Oct 76; May 77	KAM	Coleman Broodstock	6-UID-68	360,311	8-9	Shasta Lake		
1976	Feb, Apr-May 77	KAM	Coleman Broodstock	6-UID-68	23,334	9	Military Bases		
1973	Jan-77	KAM	Coleman Broodstock	3-UID-47	715	24	Shasta Lake		
1976	May-77	KAM	Coleman Broodstock	6-UID-68	1,980	9	Shasta College		
1976	May-77	KAM	Coleman Broodstock	6-CM-69	89,295	9	Shasta Lake		
1977	Jun-77	KAM	Clark Fork Hatchery, ID	7-UID-77	353,072	3	Shasta Lake		
1976	May-77	KAM		6-UCA-71	33,488	7	Shasta Lake		
1976	Apr-77	STT	Battle Creek and Keswick	5-CM-66	200,000	7	Battle Creek-Sacramento River		
1976	Jan-Feb 77	STT	Battle Creek and Keswick	5-CM-66	241,494	8	Sacramento River-Tehama		
1976	Nov-76	STT	Battle Creek and Keswick	5-CM-66	178,535	4-6	Sacramento River-Balls Ferry		
1976	Sep-76	STT	Battle Creek and Keswick	5-CM-66	55,800	4	Sacramento River-Redding		
1976	Jun-76	STT	Battle Creek and Keswick	5-CM-66	300	3	Research-Simpson Lee Corp.		
1976	Mar-Apr 77	STT	Battle Creek and Keswick	5-CM-66	477,475	6	Sacramento River-Woodson Bridge		
1977	Jun-77	STT	Battle Creek and Keswick	6-CM-75	540	2	Research-Simpson Lee Corp.		
1976	Mar-77	STT	Battle Creek and Keswick	5-CM-66	49,867	7	Yuba River		
1976	Mar-77	STT	Nimbus Hatchery, CA	5-UCA-67	58,967	7	Sacramento River-Woodson Bridge		
1976	Aug-78	KAM	Coleman Broodstock	6-UID-68	2,700	12	Whiskeytown Reservoir		
1976	Aug-78	KAM	Coleman Broodstock	6-UID-68	2,170	12	Clear Creek-Sacramento River		
1977	Mar, May 78	KAM	Coleman Broodstock	7-UID-77	159,013	9	Shasta Lake		
1977	Dec 77; Feb-May 78	KAM	Coleman Broodstock	7-UID-77	25,878	8-9	Military Bases		
1977	Aug-77	KAM	Coleman Broodstock	7-UID-77	104,570	4	Keswick Reservoir		
1977	Mar-78	KAM	Coleman Broodstock	7-UID-77	164,702	8	Shasta Lake		
1976	Oct-Nov 78	KAM	Coleman Broodstock	5-UID-61	3,454	14	Whiskeytown Reservoir		
1977	Mar-Apr 78	STT	Battle Creek and Keswick	6-CM-75	510,806	8-10	Sacramento River-Los Molinos		
1977	Oct-77	STT	Battle Creek and Keswick	6-CM-75	60	5	Shasta College		
1977	Jul-Aug 78	STT	Battle Creek and Keswick	6-CM-75	1,200	3	Research-Simpson Lee Corp.		
1977	Aug-78	STT	Battle Creek and Keswick	6-CM-75	114,312	4	Sac. River-Posse Grounds, Redding		
1977	Aug 77; Mar 78	STT	Battle Creek and Keswick	6-CM-75	106,091	4-8	Yuba River		

Appendix 10B (cont.) Broodstock source and distribution summary of steelhead and non-anadromous rainbow trout at Coleman National Fish Hatchery.

Brood Year	Release Date	Stock	Source of Eggs or Broodstock	Lot Number	Number Released	Approx. Size (in.)	Release Location	Coded-wire Tagged Releases Number	Coded-wire Tagged Releases Tag Codes
1977	Apr-78	STT	Battle Creek and Keswick	6-CM-75	368,129	6	Battle Creek-Sacramento River		
1977	Sep-77	STT	Nimbus Hatchery, CA	6-UCA-76	300	4	Research-Simpson Lee Corp.		
1977	Mar-78	STT	Nimbus Hatchery, CA	6-UCA-76	106,119	7	Sacramento River-Los Molinos		
1978	Mar-Apr 79	STT	Mad River	7-UCA-85	374,651	5-8	Sacramento River-Redding		
1978	Aug-78	STT	Mad River	7-UCA-85	400	3	Research-Simpson Lee Corp.		
1978	Mar, May 79	STT	Mad River	7-UCA-85	500	6	Tehama Colusa Fish Fac.-Sac. R.		
1978	Apr-79	STT	Mad River	7-UCA-85	283,652	8	Sacramento River-RBDD		
1978	Jun-79	STT	Mad River	7-UCA-85	13,100	9	Merced Lake		
1978	Feb-79	STT	Sacramento River at RBDD	7-CM-80	293	7	Tehama Colusa Fish Fac.-Sac. R.		
1978	Feb-79	STT	Mad River	8-UCA-85 or 7-UCA-85	300	5	Tehama Colusa Fish Fac.-Sac. R.		
1978	Mar-79	STT	Sacramento River at RBDD	7-CM-80	200	7	Tehama Colusa Fish Fac.-Sac. R.		
1978	Mar-79	STT	Sacramento River at RBDD	7-CM-80	132,875	6	Battle Creek-Sacramento River		
1978	Mar-79	STT	Sacramento River at RBDD	7-CM-80	133,220	7-8	Sacramento River-RBDD		
1978	Jul-Aug 79	STT	Mad River	7-UCA-85	46,205	8-10	Merced Lake		
1978	Aug-79	STT	Mad River	7-UCA-85	27,270	6-7	Yuba River		
1980	Jan-80	STT	Battle Creek	9-CM-92 or 9-CM-93	400,050	EYED EGGS	Nimbus Hatchery		
1979	Apr-80	STT	Battle Creek	8-CM-89	107,024	8	Sacramento River-RBDD		
1979	Mar-Apr 80	STT	Battle Creek	8-CM-89	445,735	8	Battle Creek-Sacramento River		
1980	Mar-80	STT	Battle Creek	9-CM-92	35,000	2	Antelope Creek, Sacramento River		
1980	Apr-80	STT	Battle Creek	9-CM-92	629,465	2	Antelope Creek, Sacramento River		
1980	Jun-80	STT	Battle Creek	9-CM-92	199,184	3	Battle Creek-Sacramento River		
1980	Oct 80; Mar 81	STT	Battle Creek	9-CM-92	802,268	5	Battle Creek-Sacramento River		
1980	Feb-81	STT	Battle Creek	9-CM-92	349,545	7	Sacramento River-RBDD		
1981	Feb-Mar 82	STT	Battle Creek	0-CM-98	266,496	7	Battle Creek-Sacramento River		
1981	Feb-82	STT	Battle Creek	0-CM-98	250	7	Bodega Marine Laboratory		
1981	Mar-82	STT	Battle Creek	0-CM-98	7,600	7	Sacramento River-Lake California		
1981	Mar-82	STT	Battle Creek	0-CM-98	50,000	7	Sacramento River-RBDD		
1982	Mar-83	STT	Battle Creek	2-CM-01	1,108,084	7-8	Battle Creek-Sacramento River		
1983	Dec-83	STT	Battle Creek and Keswick	2-CM-05	248,577	7-8	Sacramento River-RBDD		
1983	Jan, Mar 84	STT	Battle Creek and Keswick	2-CM-05	584,410	8	Battle Creek-Sacramento River		
1983	Feb-Apr 84	STT	Feather River Hatchery, CA	2-UCA-07	158,129	7-9	Sacramento River-RBDD		
1983	Apr-84	STT	Feather River Hatchery, CA	2-UCA-07	30,951	9	Sacramento River-Princeton		
1983	Apr-84	STT	Feather River Hatchery, CA	2-UCA-07	41,171	9	Battle Creek-Sacramento River		
1984	Jun-84	STT	Nimbus Hatchery, CA	3-UCA-11	232	2.5	Research-Simpson Lee Corp.		
1984	Jun-84	STT	Nimbus Hatchery, CA	3-UCA-11	100	2	Research-PG&E		
1984	Jan-Feb 85	STT	Battle Creek and Keswick	3-CM-10	144,513	8-9	Battle Creek-Sacramento River	93,066	050550, 050551, 050552, 050553, 050554, 050555, 050428, 050540, 050541, 050542, 050543
1984	Jan-85	STT	Battle Creek and Keswick	3-CM-10	130	8-9	Research-FAO, Red Bluff		
1984	Jan-85	STT	Battle Creek and Keswick	3-CM-10	8,620	8-9	Sacramento River-RBDD		

Appendix 10B (cont.) Broodstock source and distribution summary of steelhead and non-anadromous rainbow trout at Coleman National Fish Hatchery.

Brood Year	Release Date	Stock	Source of Eggs or Broodstock	Lot Number	Number Released	Approx. Size (in.)	Release Location	Coded-wire Tagged Releases	
								Number	Tag Codes
1984	Feb-85	STT	Battle Creek and Keswick	3-CM-10	135,644	7-9	Sacramento River-Princeton	107,778	050544, 050545, 050546, 050547, 050548, 050549
1984	Jan, Mar 85	STT	Nimbus Hatchery, CA	3-UCA-11	196,135	6-8	Battle Creek-Sacramento River		
1984	Jan-Mar 85	STT	Nimbus Hatchery, CA	3-UCA-11	107,443	8-9	Sacramento River-RBDD		
1985	May-85	STT	Battle Creek	5-CM-14	550	2-3	Research-Simpson Lee Corp.		
1985	Jun-85	STT	Battle Creek	5-CM-14	104,412	2	S. FK. Cow Creek-Sacramento River		
1985	Jun-85	STT	Battle Creek	5-CM-14	100,005	2	Clear Creek-Sacramento River		
1985	Jun-85	STT	Battle Creek	5-CM-14	182,721	2	Sacramento River-RBDD		
1986	Jun-86	STT	Battle Creek	6-CM-17	86,555	6	Sacramento River-Balls Ferry		
1986	Aug-86	STT	Battle Creek	6-CM-17	225,401	3	Sacramento River-Balls Ferry		
1986	May-86	STT	Battle Creek	6-CM-17	80,086	3	Battle Creek-Sacramento River		
1986	Aug-86	STT	Battle Creek	6-CM-17	43,981	6	Battle Creek-Sacramento River		
1986	Jan-86	STT	Battle Creek	6-CM-17	972,072	EYED EGGS	Tehama Colusa Fish Fac.-Sac. R.		
1985	May, Jul 86	STT	Battle Creek	5-CM-14	500	2.5	Research-Simpson Lee Corp.		
1986	Oct-87	STT	Battle Creek	6-CM-17	167,231	4-7	Sacramento River-Princeton		
1986	Oct-87	STT	Battle Creek	6-CM-17	9,237	6	Sacramento River-Woodson Bridge		
1986	Oct-87	STT	Battle Creek	6-CM-17	200	7	Research-FAO, Red Bluff		
1987	Nov-87	STT	Battle Creek	7-CM-17	200	4	Research-FAO, Red Bluff		
1987	Jun-87	STT	Battle Creek	7-CM-20	600	2	Research-Simpson Lee Corp.		
1987	Dec-Feb 88	STT	Battle Creek	7-CM-20	600,512	4-5	Battle Creek-Sacramento River	34,703	B50404, B50415
1988	May-88	STT	Battle Creek	8-CM-24	250	2-3	Research-Simpson Lee Corp.		
1988	Jan-89	STT	Battle Creek	8-CM-24	590,741	7-9	Battle Creek-Sacramento River		
1988	Jan-89	STT	Battle Creek	8-CM-24	100	8-9	Research-FAO, Red Bluff		
1988	Jan-89	STT	Battle Creek	8-CM-27	29,739	5	Battle Creek-Sacramento River		
1988	Feb-89	STT	Battle Creek	8-CM-25	134,000	5	Battle Creek-Sacramento River		
1989	Feb-90	STT	Feather River Hatchery, CA	SBW-89-CA	29,400	8	Battle Creek-Sacramento River		
1989	Feb-Mar 90	STT	Battle Creek	SBW-89-COL	41,994	11	Battle Creek-Sacramento River	27,393	0501010109
1989	Feb-90	STT	Battle Creek	BCW-89-COL	2,846	11	Battle Creek-Sacramento River		
1990	Jan-90	STT	Battle Creek	SBW-90-COL	463,573	EYED EGGS	Mokelumne Hatchery		
1990	Aug-90	STT	Battle Creek	SBW-90-COL	421,769	4-5	Feather River at Yuba City		
1990	Aug-90	STT	Battle Creek	SBW-90-COL	151,470	4-5	Feather River Hatchery		
1990	Jan-Feb 91	STT	Battle Creek	SBW-90-COL	698,847	10	Battle Creek-Sacramento River		
1991	Jun-91	STT	Battle Creek	SBW-91-COL	97,056	3	Clear Creek-Whiskeytown		
1991	Jun-91	STT	Battle Creek	SBW-91-COL	103,728	3	Clear Creek-Whiskeytown		
1991	Jun-91	STT	Battle Creek	SBW-91-COL	25,113	3	Clover Creek-Sacramento River		
1991	Jun-91	STT	Battle Creek	SBW-91-COL	24,991	3	S. FK. Cow Creek-Sacramento River		
1991	Jun-91	STT	Battle Creek	SBW-91-COL	24,870	3	Old Cow Creek-Sacramento River		
1991	Jun-91	STT	Battle Creek	SBW-91-COL	24,991	3	Oak Run Creek-Sacramento River		
1991	Jun-91	STT	Battle Creek	SBW-91-COL	31,057	3	Sacramento River-above Intake #3		
1991	Jun-91	STT	Battle Creek	SBW-91-COL	51,439	3	Battle Creek at Jelly's Ferry Bridge		
1991	Jun-91	STT	Battle Creek	SBW-91-COL	1,091	3	Glen-Colusa Irrigation District		
1991	Jan-Feb 92	STT	Battle Creek	SBW-91-COL	747,014	6-10	Sacramento River-Battle Creek	202,441	050101011, 050101030, 052059, 052060
1991	Jan-92	STT	Battle Creek	SBW-91-COL	148,099	6-9	Battle Creek at Hatchery		

Appendix 10B (cont.) Broodstock source and distribution summary of steelhead and non-anadromous rainbow trout at Coleman National Fish Hatchery.

Brood Year	Release Date	Stock	Source of Eggs or Broodstock	Lot Number	Number Released	Approx. Size (in.)	Release Location	Coded-wire Tagged Releases	
								Number	Tag Codes
1992	Jan-93	STT	Battle Creek	SBW-92-COL	107,229	7-9	Battle Creek-Sacramento River	105,141	052741, 052743
1992	Mar-93	STT	Battle Creek	SBW-92-COL	147,713	9-11	Battle Creek at Hatchery	110,832	052742, 052744
1992	Jan-93	STT	Battle Creek	SBW-92-COL	640,988	7-9	Sacramento River-Balls Ferry		
1993	May-93	STT	Battle Creek	SRW-93-COL	19,886	1.8	Glen-Colusa Irrigation District		
1993	May-93	STT	Battle Creek	SRW-93-COL	198,217	2.4	Clear Creek-Sacramento River		
1993	May-93	STT	Battle Creek	SRW-93-COL	198,120	2.1-2.3	S. FK. Battle Creek-Sacramento River		
1993	May-93	STT	Battle Creek	SRW-93-COL	99,990	2.0-2.1	S. FK. Cow Creek-Sacramento River		
1993	Jun-93	STT	Battle Creek	SRW-93-COL	5,109	3.0	Research-FRO, Red Bluff		
1993	Jan-94	STT	Battle Creek	SBW-93-COL	604,570	8-9	Sacramento River-Balls Ferry	213,366	053312, 053313, 053314, 053315
1993	Feb-94	STT	Battle Creek	SBW-93-COL	151,538	8-9	Battle Creek at Hatchery		
1994	May-Jun 94	STT	Battle Creek	SBW-94-COL	267,718	2-3	Sacramento River-Battle Creek		
1994	May-Jun 94	STT	Battle Creek	SBW-94-COL	203,772	2.5	Cow Creek-Sacramento River		
1994	Jun-94	STT	Battle Creek	SBW-94-COL	100,286	2.5	Clear Creek-Sacramento River		
1994	Aug-94	STT	Battle Creek	SBW-94-COL	516	4.3	Research-FRO, Red Bluff		
1994	Jan-95	STT	Battle Creek	SBW-94-COL	385,322	7-8.5	Sacramento River-Balls Ferry	236,866	053544,053545,053547,064519,064520
1994	Jan-95	STT	Battle Creek	SBW-94-COL	316,535	8.5-9.0	Battle Creek-Sacramento River		
1995	May-95	STT	Battle Creek	SBW-95-COL	232,758	2.5	Clear Creek-Sacramento River		
1995	Jun-95	STT	Battle Creek	SBW-95-COL	208,021	2.3	Cow Creek-Sacramento River		
1995	Jun-95	STT	Battle Creek	SBW-95-COL	67,372	2.5	S. FK. Battle Creek-Sacramento River		
1995	Jun-95	STT	Battle Creek	SBW-95-COL	66,122	3.0	Sacramento River-RBDD		
1995	Jan-96	STT	Battle Creek	SBW-95-COL	380,993	9.0	Sacramento River-Balls Ferry	125,764	053744, 053745
1995	Jan-96	STT	Battle Creek	SBW-95-COL	150,141	9.0	Battle Creek-Sacramento River		
1996	May-96	STT	Battle Creek	SRW-96-COL	105,230	2.3	S. FK. Battle Creek-Sacramento River		
1996	May-96	STT	Battle Creek	SRW-96-COL	101,355	2.3	N. FK. Battle Creek-Sacramento River		
1996	Jun-96	STT	Battle Creek	SBW-96-COL	102,585	2.5-3.0	S. FK. Cow Creek-Sacramento River		
1996	Jun-96	STT	Battle Creek	SBW-96-COL	90,158	3.0	N. FK. Cow Creek-Sacramento River		
1996	Jan-97	STT	Battle Creek	SBW-96-COL	540,287	9.0	Sacramento River-Balls Ferry		
1997	Mar-97	STT	Battle Creek	SBW-97-COL	100	1.0-1.4	Misc. Researchers		
1997	May-97	STT	Battle Creek	SBW-97-COL	100	1.8	Misc. Researchers		
1997	Jun-97	STT	Battle Creek	SBW-97-COL	81,585	2.8-3.2	N. FK. Battle Creek-Sacramento River		
1997	Jun-97	STT	Battle Creek	SBW-97-COL	35,849	3.0	S. FK. Battle Creek-Sacramento River		
1997	Jan-98	STT	Battle Creek	SBW-97-COL	401,062	8.8-9.0	Sacramento River-Balls Ferry		
1997	Jan-98	STT	Battle Creek	SBW-97-COL	143,517	8.7	Battle Creek-Sacramento River		
1998	Jun-98	STT	Battle Creek	SBW-98-COL	49,928	2.4	N. FK. Battle Creek-Sacramento River		
1998	Jan-99	STT	Battle Creek	SBW-98-COL	366,081	8.4-8.7	Sacramento River-Balls Ferry		
1998	Jan-99	STT	Battle Creek	SBW-98-COL	130,444	7.5	Battle Creek-Sacramento River		
1999	Aug-99	STT	Battle Creek	SBW-99-COL	1,297	3.8	Research-UC Davis		
1999	Jan-00	STT	Battle Creek	SBW-99-COL	389,953	8.7-9.0	Sacramento River-Bend Bridge	146,893	055127, 055128, 054136
1999	Jan-00	STT	Battle Creek	SBW-99-COL	130,250	9.0	Battle Creek-Sacramento River		
1999	Jan-00	STT	Battle Creek	SBW-99-COL	42	8.8	Shasta Wildlife Refuge		
2000	Jan-01	STT	Battle Creek	SBW-00-COL	596,343	8.0	Sacramento River-Bend Bridge	205,170	055217. 055218, 055219, 055220
2001	Jan-02	STT	Battle Creek	SBW-01-COL	689,852	7.3	Sacramento River-Bend Bridge	243,714	050677,050678,050679,050680,050681
2002	Jan-03	STT	Battle Creek	SBW-02-COL	529,364	6.6	Sacramento River-Bend Bridge	166,580	053014, 053015, 050680, 050681

Appendix 10B (cont.) Broodstock source and distribution summary of steelhead and non-anadromous rainbow trout at Coleman National Fish Hatchery.

Brood Year	Release Date	Stock	Source of Eggs or Broodstock	Lot Number	Number Released	Approx. Size (in.)	Release Location	Coded-wire Tagged Releases	
								Number	Tag Codes
2003	Jan-04	STT	Battle Creek	SBW-03-COL	357,918	4.3	Sacramento River-Bend Bridge	127,265	051568, 051569, 054942, 054247
2004	Jan-05	STT	Battle Creek	SBW-04-COL	689,800	7.6	Sacramento River-Bend Bridge	103,927	053738, 053739, 053740, 053741
2005	Jan-06	STT	Battle Creek	SBW-05-COL	606,967	8.2	Sacramento River-Bend Bridge		
2006	Jan-07	STT	Battle Creek	SBW-06-COL	672,686	8.5	Sacramento River-Bend Bridge		
2007	Jan-08	STT	Battle Creek	SBW-07-COL	641,085	8.3	Sacramento River-Bend Bridge		

13.3 ATTACHMENTS

Attachment 3-1: Interagency Agreement between U.S. Fish and Wildlife Service and U.S. Bureau of Reclamation concerning the funding and operation of the Coleman National Fish Hatchery, Anderson, California.

INTERAGENCY AGREEMENT

between

U S FISH AND WILDLIFE SERVICE

and

U S BUREAU OF RECLAMATION

concerning

the funding and operation of the

COLEMAN NATIONAL FISH HATCHERY
Anderson, California

a feature of the
CENTRAL VALLEY PROJECT

March 19 1993

COPY FOR YOUR INFORMATION

U S DEPARTMENT OF THE INTERIOR INTERAGENCY AGREEMENT BETWEEN BUREAU OF RECLAMATION AND FISH AND WILDLIFE SERVICE CONCERNING COLEMAN NATIONAL FISH HATCHERY A MITIGATION FEATURE OF THE CENTRAL VALLEY PROJECT

This Interagency Agreement (Agreement) is made and entered into between the Bureau of Reclamation hereinafter Reclamation and the Fish and Wildlife Service hereinafter the Service to establish general principles and describe the responsibilities of both agencies concerning the custody responsibility and the funding for Coleman National Fish Hatchery (Hatchery)

This Agreement is made under the authority of the Fish and Wildlife Coordination Act as amended (16 U S C 661 et seq) and Federal Reclamation law consisting of the Reclamation Act of 1902 (32 Stat 388) and acts amendatory thereof and supplementary thereto including but not limited to section 2 of the Act of August 26 1937 (50 Stat 844) as amended and supplemented the Act of August 4 1939 (53 Stat 1187) as amended and supplemented Title II of the Act of October 12 1982 (96 Stat 1263) as amended and Title XXXIV of the Act of October 30 1992 (Public Law No 102 575)

WHEREAS the Hatchery was constructed by Reclamation in 1943 as a part of the Central Valley Project (Project) facilities for the salvage protection and preservation of the fish which spawned in the upper Sacramento River Basin prior to construction of Shasta and Keswick Dams and

WHEREAS the Service and Reclamation entered into a Memorandum of Agreement approved September 21 1948 whereby Reclamation transferred to and the Service accepted the full custody and responsibility for the Hatchery and thereafter sought and received directly appropriated funds for this purpose and

WHEREAS the parties further entered into a supplementary Memorandum of Agreement approved on December 5 1951 which states in part that the operation of the Hatchery is a continuing responsibility of both parties and any special problems arising but not provided for in the 1948 Agreement as amended shall be the subject of further agreement and

WHEREAS there is a need for the Hatchery to be operated as a mitigation facility of the Project to partially offset associated anadromous fish losses and that the future costs associated with its operation maintenance and evaluation should be properly allocated among Project beneficiaries and recovered in accordance with Federal Reclamation law and

WHEREAS the Service desires to continue its operation maintenance and evaluation of the Hatchery program and

WHEREAS Reclamation has the authority and is willing to continue to provide Project power and energy needed to operate Hatchery mitigation facilities

NOW THEREFORE RECLAMATION AND THE SERVICE AGREE AS FOLLOWS:

1 This Agreement supersedes the agreements approved on July 11 1947 September 21 1948 December 5 1951 April 27 1953 and September 9 1987 between Reclamation and the Service specific to the Hatchery by consolidating applicable and pertinent elements of said agreements It further describes future funding custody and responsibilities of each agency

2 The Hatchery shall be managed operated evaluated and maintained in accordance with a mutually agreed upon hatchery management plan prepared by the Service

3 Meet not less than annually to coordinate and review the ongoing operation of the Hatchery to ensure appropriate mitigation objectives as identified in a mutually agreed upon hatchery management plan are being met and to identify and plan for future activities including funding needs

RECLAMATION RESPONSIBILITIES:

1 Commencing October 1 1993 Reclamation shall

(a) Pay all applicable Hatchery costs including the costs of appropriate rehabilitation of existing Hatchery facilities and equipment and the costs of any appropriate additional mitigation facilities and

(b) Arrange for the recovery of such costs from Project beneficiaries in accordance with Federal Reclamation law

2 Establish an annual transfer fund contract with the Service for implementing provisions in 1(a) above utilizing the On line Payment and Collection (OPAC) system for invoicing and payment

3 As the action agency responsible for mitigation actions required to offset fishery resource losses associated with the Project Reclamation shall provide necessary oversight and review to ensure that the Hatchery meets objectives of the hatchery management plan

4 Reclamation shall retain administrative responsibility for and shall operate and maintain the Keswick Dam Fish Trap and the present fish collecting devices

5 In its operation of the Project Reclamation shall make every effort to maintain flows and temperatures in the Sacramento River which are necessary

for fishery maintenance and shall consult with the Service when critical fishery conditions are anticipated

6 Reclamation shall provide Project power and energy to the Hatchery at no cost to the Service as required by mutual agreement for mitigation purposes up to a maximum of 2200 kilowatts

IT IS THE RESPONSIBILITY OF THE SERVICE TO:

1 Prepare and submit to Reclamation a hatchery management plan for mitigating fishery resources impacted by the Project

2 Have full operational custody and program responsibility for the Hatchery related facilities and appurtenances and to manage operate evaluate and maintain the Hatchery in accordance with the current hatchery management plan

3 Operate the Hatchery as a unit of the Service s Fishery Resources Program activity and National Fish Hatchery System

4 Provide an annual report to Reclamation on Hatchery activities and expenditures associated with the operation maintenance and evaluation of the Hatchery including estimates for future funding needs in implementing the hatchery management plan

5 Perform biological studies and investigations as may be needed pursuant to Fish and Wildlife Coordination Act requirements

6 Collect adult fish at the Keswick Dam Fish Trap and transfer them to the Hatchery for spawning and release of the progeny into the Sacramento River system or such other locations as may be agreed

7 Provide Reclamation on a quarterly basis the 5 year power and energy use projections for the Hatchery to facilitate Project power and energy planning

8 Provide Reclamation with at least an eight month advance notice of any proposed changes in the voltage of the transmission lines to the Hatchery to facilitate electrical metering changes

9 Maintain at least a 95 percent overall electrical power factor for the Hatchery load served by Project power and energy

GENERAL

1 Amendments hereto may be proposed by either Reclamation or the Service and shall become effective through a written agreement between the parties

2 No member of or delegate to Congress or resident commissioner shall be admitted to any share or part of this agreement or to any benefit that may arise from it

3 This agreement shall become effective upon the latest date written or printed below It shall be reviewed by both parties no later than July 1 1995 and every 5 years thereafter for adequacy compliance necessary or desired changes and/or termination

4 This agreement shall remain in force and effect unless terminated by either party upon 1 year s written notice

Marvin L Plenert
Regional Director
Western Region
U S Fish and Wildlife Service

Date March 15, 1993

Roger K Patterson
Regional Director
Mid Pacific Region
U S Bureau of Reclamation

Date 3/19/93

XAF

United States Department of the Interior

BUREAU OF REC LAMATION
Mid-Pacific R gi l Offi
2800 C ttag W
S n t C liforni 95825-1898

IN REPLY REFER TO
MP 401
ENV 4 00

MAR

Memorandum

To Regional Director U S Fish and Wildlife Service Portland OR

From Regional Director Sacramento CA

Subject Interagency Agreement Concerning Coleman National Fish Hatchery Central Valley Project (Fish Hatchery)

Enclosed for your files is an executed copy of the subject agreement describing the responsibilities of both agencies concerning the custody responsibility and the funding for the Coleman National Fish Hatchery (CNFH) Per this agreement the hatchery will once again become a mitigation feature of the Central Valley Project (CVP) while continuing to be operated by the U S Fish and Wildlife Service (Service) as a unit of the National Fish Hatchery System

Execution of this agreement on behalf of Reclamation represents a significant step towards assisting Reclamation in offsetting fishery impacts associated with the construction and operation of the CVP and is consistent with the intent and direction of Public Law 102 575 the Central Valley Project Improvement Act

Per the agreement Reclamation will become fully responsible for funding all mitigation costs including rehabilitation costs associated with the hatchery beginning in fiscal year 1994 We will be working with your staff soon on the preparation of specific agreements that will enable the transfer of funds to the Service for your mitigation activities at the hatchery

The development of this agreement was the result of important negotiations our staffs held over the last several years We appreciate the efforts and dedication of Mr Jerry Grover who contributed significantly to this agreement

We look forward to your continued operation of CNFH and to the preparation of the mutually agreed upon hatchery management plan that will provide the overall direction for the management operation and evaluation of the hatchery as a integral mitigation feature of the CVP

Should you have any further questions concerning this agreement please contact Mr Gary Sackett at (916) 978 4933

Enclosure

Updated February 1 1992

CENTRAL VALLEY PROJECT FISHERY MITIGATION COST
SHASTA/KESWICK DAM

Coleman NFH CVP Costs	Funding Estimates 1991	1992	1993	1994	1995
Personnel Salaries	$523 400	$557 900	$592 700	$629 700	$669 000
Personnel Benefits	143 600	150 300	172 600	183 400	194 800
Other Personnel Costs	10,800	10,800	15,200	16,100	17,200
Sub total Personnel Costs	$677 800	$719 000	$780 500	$829 200	$881 000
Transportation	$ 13 000	$ 13 500	$ 14 300	$ 15 100	$ 16 000
Utilities 1/	4 300	4 400	4 500	4 600	4 700
Contractual Services	32 400	37 800	40 000	42 300	44 800
Fish Feed and Supplies	287,200	343,100	365,400	389,200	414,500
Sub total Services and Supplies	$336 900	$398 800	$424 200	$451 200	$480 000
Equipment	$ 59 400	$ 91 800	$ 73 600	$ 51 800	$ 93 700
Maintenance 2/	103,600	110,000	140,000	242,000	178,200
Sub total Maintenance	$163 000	$201 800	$213 600	$293 800	$271 900
Fish Health 3/	$ 47 100	$ 50 000	$ 70 000	$ 74 600	$ 79 400
Hatchery Evaluation	150,700	159,900	170,300	181,400	193,200
Sub total Technical Support	$197 800	$209 900	$240 300	$256 000	$269 600
Grand Totals	$1 375 500	$1 529 500	$1 658 600	$1 830 200	$1 902 500

1/ Does not include project power costs
2/ Excludes major rehabilitation and construction
3/ In 1993 includes additional costs associated with monitoring the threatened winter run chinook salmon

Attachment 3-2: Amendment to the Interagency Agreement between U.S. Fish and Wildlife Service and U.S. Bureau of Reclamation to include the funding and operation of the Livingston Stone National Fish Hatchery, Shasta Lake City, California

United States Department of the Interior

BUREAU OF RECLAMATION
Mid-Pacific Regional Office
2800 Cottage Way
Sacramento, California 95825-1898

IN REPLY
REFER TO:
NC-447
LND-6.00

AUG 2 6 2008

MEMORANDUM

To: Acting Regional Director
California and Nevada Region
U.S. Fish and Wildlife Service

From: Donald R. Glaser
Regional Director

Subject: Amendment Number One to Interagency Agreement Between the Bureau of Reclamation and the U.S. Fish and Wildlife Service - Livingston Stone National Fish Hatchery - Central Valley Project, California

On March 19, 1993, an Interagency Agreement (Agreement) between Reclamation and the U.S. Fish and Wildlife Service (Service) was executed to establish general principles and describe the responsibilities of both agencies concerning the Coleman National Fish Hatchery (Coleman). A copy of the 1993 Agreement is attached for your reference.

On February 2, 1998, a Finding of No Significant Impact (FONSI) was signed which established and approved the winter-run Chinook salmon project known as Livingston Stone National Fish Hatchery (LSNFH). According to the FONSI, LSNFH was to be located on Reclamation-owned land, while the facilities would be owned, operated, and maintained by the Service.

Due to the extremely tight construction schedule, a formal agreement outlining roles, responsibilities, and transfer of Reclamation-constructed facilities was not put in place prior to construction of the LSNFH structures and facilities.

In order to comply with their funding requirements, the Service requires title to the LSNFH and has requested Reclamation complete the title transfer. Therefore, we have prepared an amendment as provided for in Article 3 of the general terms of the Agreement.

Three originals of the amendment, which authorizes the transfer of title to the LSNFH with Reclamation retaining fee ownership of the underlying land, are attached for your review.

If the amendment is acceptable, please sign all three originals on behalf of the Service; retain one for your files; and return the remaining two to this office.

If you have any further questions, please contact Mr. Brian Person, Area Manager, Northern California Area Office, at 530-275-1554.

Attachments – 4

U.S. DEPARTMENT OF THE INTERIOR

AMENDMENT ONE INTERAGENCY AGREEMENT BETWEEN BUREAU OF RECLAMATION AND U.S. FISH AND WILDLIFE SERVICE CONCERNING LIVINGSTON STONE NATIONAL FISH HATCHERY A MITIGATION FEATURE OF THE CENTRAL VALLEY PROJECT

On March 19, 1993, an Interagency Agreement (Agreement) was made and entered into between the Bureau of Reclamation, hereinafter "Reclamation", and the U.S. Fish and Wildlife Service, hereinafter the "Service", to establish general principles and describe the responsibilities of both agencies concerning the custody responsibility and the funding for Coleman National Fish Hatchery (Coleman), a mitigation feature of the Central Valley Project (Project).

Amendment One to the Agreement is made and entered into by Reclamation and the Service, to establish general principles and describe the responsibilities of both agencies concerning the custody and responsibility for Livingston Stone National Fish Hatchery (LSNFH), which is an extension of and is being funded as part of Coleman. Authorization to amend the Agreement is provided for in Article 3 under general terms.

WHEREAS, a Finding of No Significant Impact was signed on February 2, 1998, which established and approved the LSNFH winter-run Chinook salmon propagation; and

WHEREAS, the LSNFH was constructed by Reclamation in 1998 as a part of the Project facilities for the salvage, protection, and preservation of the winter-run Chinook salmon, which spawned in the upper Sacramento River Basin prior to the construction of Shasta and Keswick Dams; and

WHEREAS, there is a need for the LSNFH to be operated as a mitigation facility of the Project to partially offset associated anadromous fish losses and that the future cost associated with its operation, maintenance, and evaluation should be properly allocated among Project beneficiaries and recovered in accordance with Federal Reclamation Law; and

WHEREAS, the Service desires to continue its operation, maintenance, and evaluation of the LSNFH and the Hatchery program; and

WHEREAS, both parties agree there is a need to provide for the transfer of title, for the buildings that comprise the LSNFH, Shasta Lake, California, to the Service. The transfer of title shall include the following structures: the hatchery building, the spawning building, the shop/garage, and the living quarters/house. This transfer does not include the land or real property improvements, such as underground pipelines, which shall remain under Reclamation ownership.

NOW THEREFORE RECLAMATION AND THE SERVICE AGREE AS FOLLOWS: This amendment supplements the March 19, 1993, Interagency Agreement between Reclamation and the Service, and authorizes the transfer of title to the Service of the Livingston Stone National Fish hatchery building, the spawning building, the shop/garage, and the living quarters/house which comprise LSNFH. This transfer does not include the land or real property improvements, such as underground pipelines, which shall remain under Reclamation ownership.

RECLAMATION RESPONSIBILITIES: Reclamation shall execute a transfer of title to the Service for the buildings that comprise LSNFH.

IT IS THE RESPONSIBILITY OF THE SERVICE TO:

1. Accept the transfer of title and jurisdiction for the buildings that comprise the LSNFH.

2. Manage, operate, evaluate, and maintain the LSNFH as a unit of the National Fish Hatchery System.

3. Provide notification to Reclamation in the event LSNFH is no longer required or needed by the Service.

4. Seek prior Reclamation approval prior to construction of any additional structures or improvements.

GENERAL

1. Additional amendments hereto may be proposed by either Reclamation or the Service and shall become effective through a written agreement between the parties.

2. No member of or delegate to Congress or resident commissioner shall be admitted to any share or part of this agreement or to any benefit that may arise from it.

[signature]
Regional Director
California and Nevada Region
U.S. Fish and Wildlife Service

Date 2/19/2009

[signature]
Regional Director
Mid-Pacific Region
Bureau of Reclamation

Date 3/13/09

Attachment 3-3 Revised Position Paper on the Battle Creek Watershed, Shasta and Tehama Counties, California.

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Sacramento Fish and Wildlife Office
3310 El Camino Avenue Suite 130
Sacramento California 95821 6340

April 3 1998

To Battle Creek Restoration Interested Parties

Subject Revised Position Paper on the Battle Creek Watershed Shasta and Tehama Counties California

The enclosed revised Position Statement was developed to clarify the Fish and Wildlife Service s (Service) activities in restoring Battle Creek for anadromous fish It incorporates comments received at the March 4 1998 Battle Creek Working Group Meeting The position statement indicates how the Service will fulfill its mission and work with all stakeholders in restoration of anadromous fish to the watershed and maintain the Coleman National Fish Hatchery operations

If you have any questions about this matter please contact Patricia Parker at (530) 527 3043 or Steve Hirsch at (916) 979 2129

Sincerely

Wayne S White
Geographic Assistant Regional Director
Central Valley/San Francisco Bay Ecoregion

Enclosure

April 3 1998

USFWS POSITION PAPER
BATTLE CREEK WATERSHED

The mission of the USFWS is:

To conserve, protect and enhance the Nation s fish and wildlife and their habitats for the continuing benefit of people.

Purpose: This document describes how the USFWS will fulfill its mission in the Battle Creek watershed through implementation of the Anadromous Fish Restoration Program The USFWS through its stewardship responsibilities and its role as operator of the Coleman National Fish Hatchery (CNFH) will continue to play a leadership role in Battle Creek watershed activities to ensure that both Battle Creek and CNFH improvements occur in a timely manner

USFWS Goal: Restore the Battle Creek watershed for naturally produced anadromous salmonids while integrating CNFH operations

USFWS Objectives:

Maximize habitat potential
Conduct monitoring & assessment of natural and hatchery fish populations
Maximize CNFH operational flexibility
Ensure stakeholder involvement
Negotiate a long term operations agreement

Habitat objective: Maximize habitat to benefit naturally produced anadromous salmonid populations.

The USFWS fully supports the February 27 1998 version of the Time for Action proposal or its biological equivalent The current proposal s habitat improvement measures will provide a high degree of certainty to benefit anadromous fish populations All of these habitat restoration measures will assist population recovery efforts for steelhead winter and spring chinook These measures should also benefit fall and late fall chinook once populations of the more sensitive species are protected In the future all reaches of the creek below the natural barrier falls should be made available for anadromous fish production

Fish assessment objective: Conduct monitoring & assessment of natural and hatchery fish populations

The USFWS believes an essential component of the Battle Creek fishery restoration effort is to monitor and assess fish populations before during and after restoration actions (e g redd carcass and outmigrant studies) The USFWS supports attaining long term funding for these efforts

Hatchery production objective: Maintain and enhance CNFH s operational flexibility with a view towards future hatchery production obligations and responsibilities.

The USFWS s CNFH plays an important role in mitigating the Central Valley Project impacts to anadromous fish CNFH s operations need to be integrated with natural production in Battle Creek in a timely manner Completion of the ozone water treatment system alleviates disease concerns associated with upstream passage of anadromous salmonids To further facilitate restoration, USFWS is also actively pursuing 1) modifications to the intake structures to ensure adequate water supply (quality and quantity) and 2) installation of state of the art fish screens to exclude naturally produced fish from the hatchery s water intake

The CNFH barrier weir has long been operated to provide broodstock to the hatchery USFWS is exploring improvements to the weir that will better allow the weir to be operated in a manner that complements and even enhances the restoration of natural spawning populations

Stakeholder objective: Ensure stakeholder involvement.

USFWS supports engaging all stakeholders in the Battle Creek restoration effort and believes that the Battle Creek Working Group and Battle Creek Watershed Conservancy meetings are successfully serving this purpose USFWS believes that a pro active outreach program including frequent updates on the restoration effort and accompanying the NEPA/CEQA/ESA processes is a key factor for continued successful restoration efforts

Long term operations objective: Negotiate a long term operations package.

USFWS appreciates the constructive participation of Pacific Gas & Electric Company (PG&E) staff in ongoing discussions to identify fish friendly improvements to PG&E s facilities that would facilitate the restoration effort USFWS recognizes that restoration planning has been ongoing for some time and is anxious to continue discussions with PG&E California Department of Fish & Game (CDFG) U S Bureau of Reclamation (USBR) and National Marine Fisheries Service (NMFS) to develop a long term operations package that could accompany the restoration effort This package would reduce conflicts between listed species and PG&E s hydropower operations In the near future USFWS will convene a meeting with CDFG USBR and NMFS to outline the respective resource agency s roles responsibilities timelines and parameters that will be included in this package This package could form the basis of a comprehensive plan that the resource agencies and PG&E could submit to the Federal Energy Regulatory Commission (FERC) to support PG&E s license modifications

Attachment 4-1: Adopted waste discharge requirements for Coleman National Fish Hatchery (Order No. R5-2004-0123 as adopted by the California Regional Water Quality Control Board).

California Regional Water Quality Control Board
Central Valley Region

Katherine Hart, Chair

Linda S. Adams
Secretary for Environmental Protection

415 Knollcrest Drive, Suite 100, Redding, California 96002
(530) 224-4845 • Fax (530) 224-4857
http://www.waterboards.ca.gov/centralvalley

Arnold Schwarzenegger
Governor

31 August 2010

CERTIFIED MAIL
7009 2250 0002 9885 3514

Scott Hamelberg
U.S. Fish and Wildlife Service
Coleman National Fish Hatchery
24411 Coleman Fish Hatchery Road
Anderson, CA 96007

NOTICE OF APPLICABILITY; WASTE DISCHARGE REQUIREMENTS FOR COLD WATER CONCENTRATED AQUATIC ANIMAL PRODUCTION FACILITY DISCHARGES TO SURFACE WATERS; U.S. DEPARTMENT OF INTERIOR, FISH AND WILDLIFE SERVICE, COLEMAN NATIONAL FISH HATCHERY, SHASTA COUNTY

The U. S. Department of Interior, Fish and Wildlife Service (hereafter Discharger), owns and operates the Coleman National Fish Hatchery (hereafter Facility). The California Regional Water Quality Control Board, Central Valley Region (Central Valley Water Board) has reviewed the Report of Waste Discharge (ROWD) dated 30 October 2009 for renewal of existing Order No. R5-2004-0123 (NPDES No. CA0004201) for the Facility. The ROWD was deemed complete on 30 November 2009.

On 29 January 2010, General Order No. R5-2010-0018, (NPDES No. CAG135001), Waste Discharge Requirements for Cold Water Concentrated Aquatic Animal Production Facility Discharges to Surface Waters (General Order) was adopted by the Central Valley Water Board. The General Order regulates the discharge of pollutants from Cold Water Concentrated Aquatic Animal Production facilities (CAAP facilities) to surface waters in the Central Valley Region. The Facility discharge meets the conditions for coverage under the General Order. The Central Valley Water Board has determined that discharges from your CAAP facility are more appropriately regulated under the General Order than by the existing individual permit. Therefore, the existing Order No. R5-2004-0123 (NPDES No. CA0004201) is scheduled for rescission by a separate action of the Central Valley Water Board at a future regularly scheduled Board meeting.

The Discharger has been assigned an enrollee number of R5-2010-0018-002. Administrative information for the Facility is provided in Attachment A, a part of this Notice of Applicability (NOA).

The CAAP facility operations and discharge shall be managed in accordance with the requirements contained in the General Order, this NOA, and with the information submitted by the Discharger. The General Order (enclosed) may also be viewed at the following web address:
http://www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/general_orders/r5-2010-0018_npdes.pdf.

You are urged to familiarize yourself with the contents of the entire document. Mandatory monitoring requirements are prescribed in Attachment C of the General Order.

FACILITY INFORMATION/DISCHARGE DESCRIPTION

The Facility is located along the north bank of Battle Creek in Section 1, T29N, R3W, MDB&M, as shown on Attachment A, a part of this NOA. The Facility is located within the Ash Creek Hydrologic Subarea (HAS) No. 507.21. The property is owned by the Discharger and is on Assessor's Parcel Nos. 057-540-03 and 057-540-04. The Facility raises salmon and steelhead for release to mitigate for the loss of historical spawning areas where access was blocked by the construction of Shasta Dam on the Sacramento River. Based on information in the ROWD the maximum annual production of the Facility is approximately 355,000 pounds (lbs).

The Facility consists of an administration building, five residences, spawning and maintenance buildings, an ozone treatment facility, 58 raceways, and seven adult holding ponds. The Discharger has a water right to divert 109 cubic feet per second (cfs) [70.48 million gallons per day (mgd)] for use in the Facility, plus 13 cfs (8.4 mgd) for downstream water users. Therefore the maximum water intake for the Facility is 78.9 mgd. The Facility has the ability to divert intake water from Battle Creek from three separate intake structures. The entire 122 cfs inflow to the Facility is diverted at Intake No. 1 from the Coleman Powerhouse Tailrace. Intakes Nos. 2 and 3 divert water from the water supply canal and are only used as a backup source when Intake No. 1 is not supplying water.

To remove silt, sediment, and bacteria the intake water is treated with at least one of the following prior to distribution through the Facility:

- **Settling Basins:** A portion of the intake water (50 cfs) is treated in two asphalt lined settling basins, each with a capacity of 1.2 million gallons and a retention time of approximately 1.5 to 2 hours. The additional inflow is either routed to the adult holding ponds or routed to the sand/anthracite filters. The settling basins are dewatered and cleaned annually (generally during the summer) to remove accumulated sediment.

- **Sand/Anthracite Filters.** There are four sand/anthracite filter basins with a total retention time of 15 to 30 minutes and a flow rate of 45,000 gallons per minute (gpm) [65 mgd]. The dual media filters are used year round and filter cleaning backwash cycles are automated, with cleaning frequency dependent on turbidity. All backwash water is piped to the pollution abatement pond. In addition, the dual media filters are cleaned with hypochlorite once or twice a year. The hypochlorite is retained for 48 to 96 hours prior to discharge to the pollution abatement pond.

- **Ozone Treatment Facility.** A portion of the treated water from the sand/anthracite filters is routed to the ozone treatment facility. The ozone remains in contact with the water for 15 minutes which is sufficient time to kill all viral, bacterial, and protozoan organisms that could affect fish reared at the Facility. The ozone treatment facility has a maximum design capacity of 30,000 gpm (43.2 mgd). The entire process is automated and computer controlled.

Treated intake water is routed throughout the Facility and wastewater is discharged back to Battle Creek at four discharge locations, as shown in Attachment C (Facility Schematic), a part of this NOA. Wastewater is discharged to the four discharge locations as described below:

- **Discharge Point 001** - In the event of a power loss a minimum flow is required through the Facility to prevent stagnant conditions. Overspill water is routed through the untreated water canal and discharged to Battle Creek at Discharge Point 001. Since no wastes are introduced into the waste stream from this process, the water quality of this discharge is similar to the water quality of Battle Creek. Flow rates from Discharge Point 001 have not been quantified.

- **Discharge Point 002** - Single pass flow through water from the raceways and the hatchery building, when chemicals are not being used, is discharged to Battle Creek at Discharge Point 002. However, because oxytetracycline is added to feed, and fish are fed in the raceways, oxytetracycline has the potential to be introduced to the Discharge Point 002 waste stream. Maximum daily and 30-day average flow rates at Discharge Point 002 are 33.5 mgd and 31.9 mgd, respectively.

- **Discharge Point 003** - Waters from the raceways and hatchery building during any cleaning operations, medication application, or chemical use is routed to the pollution abatement pond prior to discharge to Battle Creek (Discharge Point 003). The 4-acre unlined, earthen embankment abatement pond has a retention time of approximately 12 hours to several days depending on the volume of water discharged during cleaning operations. Maximum daily and 30-day average flow rates at Discharge Point 003 are 3.3 mgd and 2.3 mgd, respectively.

- **Discharge Point 004** - Single pass flow through water from the spawning building adult holding ponds is discharged to Battle Creek through the fish ladder (Discharge Point 004). The source of water in the adult holding ponds is overspill water, and continuous flow-through water from the raceways and the pre-release pond. The pre-release pond is currently used to hold steelhead trout after spawning. Mature fish swim upstream through the fish ladder against the discharge flow and are collected in the adult holding ponds to be harvested for eggs and milt. No feed or medication is applied in the adult holding ponds. The fish ladder is only used during October to February during spawning. The Discharger estimates approximately 14,000 gpm of untreated water and 10,000 gpm of raceway/pre-release pond water is routed to the adult spawning ponds. Water from the raceways and pre-release ponds is used only when no medication or cleaning is being conducted in the raceways or pre-release pond. Flow rates from Discharge Point 004 have not been quantified.

During the spawning season, wash water from the spawning building, which generally contains eggs and blood, is pumped to a 0.5-acre evaporation/percolation pond on the east side of the Facility. There is no direct discharge from the evaporation/percolation pond to surface water.

Based on information in the ROWD, chemicals currently used at the Facility are summarized in the table below.

Chemical	Month(s) of Use	Application
Formalin	October to July (peak October to December)	Applied in hatchery building to prevent fungus in eggs and infection in fingerlings.
Iodophor	Year round (peak October to February)	Disinfect eggs prior to incubation. Disinfect raceway cleaning equipment (brooms, boots).
Enteric Redmouth Bacterin (vaccine)	April to June	Vaccinate Juvenile late fall Chinook Salmon and steelehead.
Sodium Chloride	January to July	Used to reduce stress during medicating or moving fish. Applied in the raceways.
Hypochlorite (chlorine)	May and June	Annual 48 to 96 hour static bath to remove bacteria and algae from sand/anthracite filter beds.
Oxytetracycline as TM-200	April to August	Applied in raceways with fish feed to control columnaris disease.
Florfenicol	April to June	Antibiotic used as Investigational New Animal Drug (INAD).
MS-222	Year round (peak October to February)	Applied in raceways as an anesthetic when handling fish during tagging and inventory.
Carbon Dioxide	March to April and during spawning	Used as an anesthetic during monitoring activities at barrier weir on Battle Creek and in the spawning building during spawning.

Based on information in the ROWD the Discharger has not used Chloramine-T since 1997. However, the Discharger states Chloramine-T would be used in the event of an outbreak of bacterial gill disease at the Facility. Additional chemicals, antibiotics and other therapeutic drugs listed in the General Permit may be used during periods of disease outbreaks.

Potable water is supplied by an on-site domestic well and disinfected using ultraviolet light. The Facility discharges domestic wastes to a septic tank/leachfield system. In addition, each of the five residences has its own septic tank which discharges to a common leachfield system.

Returning excess adult salmon that are not needed for egg take are provided to a seafood processing company and/or to the Bureau of Indian Affairs to be distributed to Native Americans. All other carcasses and dead eggs are sent to a rendering company for processing.

The Facility has backup power capability of 2500 kilowatts (KW), requiring fuel storage in three tanks with a total capacity of 9,000 gallons (gals) of diesel fuel. In addition, the Facility has one gasoline tank (500 gals) and one waste oil tank (500 gals). All tanks have double walls, with tertiary containment. Waste oil from equipment oil changes is periodically collected by an outside vendor. The current Spill Prevention Control and Countermeasure (SPCC) Plan was prepared by a registered engineer in August 2006. Formaldehyde is stored in a 110 gallon stainless steel pressure tank within a containment tank.

MONITORING REQUIREMENTS

The General Order requires that dischargers comply with the Monitoring and Reporting Program that is incorporated as Attachment C to the General Order. Influent, effluent, and receiving water monitoring requirements are based on the pounds of fish produced. This Facility is in the category of production greater than 100,000 lbs of fish.

The Discharger conducted priority pollutant metals monitoring on 14 October 2009. The data show that there is no reasonable potential for priority pollutant metals to cause or contribute to an exceedance of water quality objectives. The Discharger reports that the Facility does not use copper sulfate or chelated copper compounds. The receiving waters are not listed under the Clean Water Act 303(d) List of impaired water bodies; therefore, no additional monitoring requirements will be required.

Site specific monitoring locations for influent, effluent and receiving water monitoring are shown in Attachment C to this NOA (Facility Schematic), and as described in the following table:

Monitoring Location Descriptions

Point Name	Monitoring Location Name	Monitoring Location Description
Intake No. 1	INF-001	At a location where a representative sample can be obtained at Intake No. 1 of the raw water supply from the Coleman Powerhouse Tailrace.
Intake No. 2	INF-002	At a location where a representative sample can be obtained of the raw water supply when water is being diverted at Intake No. 2.
Intake No. 3	INF-003	At a location where a representative sample can be obtained of the raw water supply when water is being diverted at Intake No. 3.
Discharge Point 001	EFF-001	At a location where a representative sample can be obtained of the discharge from Discharge Point 001 prior to entering Battle Creek.
Discharge Point 002	EFF-002	At a location where a representative sample can be obtained of the discharge from Discharge Point 002 prior to entering Battle Creek.
Discharge Point 003	EFF-003	At a location where a representative sample of the discharge from Discharge Point 003 can be obtained prior to entering Battle Creek.

Point Name	Monitoring Location Name	Monitoring Location Description
Discharge Point 004	EFF-004	At a location where a representative sample can be obtained of the discharge from Discharge Point 004 prior to entering Battle Creek.
Receiving Water Upstream	RSW-001	Located 25 feet upstream from the point where Discharge Point 001 flows into Battle Creek.
Receiving Water Downstream	RSW-002	Located 25 feet downstream from the point where Discharge Point 002 flows into Battle Creek.
Receiving Water Downstream	RSW-003	Located 25 feet downstream from the point where Discharge Point 003 flows into Battle Creek.

NOTICE OF APPLICABILITY REQUIREMENTS

Based on the information provided in the ROWD, the Discharger is hereby authorized to discharge to Battle Creek under the terms and conditions of General Order No. R5-2010-0018. In addition to the requirements contained in the General Order, the following shall also apply:

1. The discharge from the Facility shall not exceed 78.9 mgd during the effective period of the General Order.

2. The Discharger is required to comply with all the Monitoring and Reporting Requirements contained in Attachment C to the General Order for facilities with production greater than 100,000 pounds of fish.

3. The Discharger shall electronically submit Self-Monitoring Reports (SMRs) using the State Water Board's California Integrated Water Quality System (CIWQS) Program website (http://www.waterboards.ca.gov/ciwqs/index.html). The CIWQS website will provide additional directions for SMR submittal in the event there will be service interruption for electronic submittal.

4. The State Water Resources Control Board (State Water Board) has determined that individual or general permits for aquaculture activities defined in 40 CFR 122.25(b) will be subject to the same annual fee, which currently is $1,000 (State Water Board Resolution 2002-0150), but may be subject to change.

5. The General Order expires on 1 January 2015, and enrollees will continue to be authorized to discharge until coverage becomes effective under a reissued Order or until Central Valley Water Board staff formally terminates your coverage. Only those CAAP facilities authorized to discharge and who submit a Notice of Intent at least 180 days prior to the expiration date of General Order No. R5-2010-0018 will remain authorized to discharge under administratively continued permit conditions.

Failure to comply with the General Order and this NOA may result in enforcement actions, which could include administrative civil liability. Effluent limitation violations and some late reporting violations are subject to a Mandatory Minimum Penalty (MMP) of $3,000 per violation [California Water Code Sections 13385(h) and (i)]. If you have no discharge during a monitoring period, you must submit a report indicating that no discharge occurred. You must notify the Central Valley Water Board staff within 24 hours of noncompliance or anticipated noncompliance.

Please reference your enrollee number, R5-2010-0018-002, in your correspondence and submitted documents.

If you have any questions regarding this NOA, monitoring reports submittals, discharge notifications, compliance and enforcement; please contact, Kevin Kratzke at (530) 224-4850, or kkratzke@waterboards.ca.gov.

Robert A. Crandall

(for) PAMELA C. CREEDON
Executive Officer

KEK: knr

NOA Attachments: Attachment A - Administrative Information
Attachment B – Location Map
Attachment C – Facility Schematic

Enclosure: General Order No. R5-2010-0018 (Discharger only)

Distribution List: Mr. David Smith, U.S. EPA, Region IX, San Francisco
Mr. Phil Isorena, State Water Resources Control Board, Sacramento
Mr. Mike Keeler, U.S. Fish and Wildlife Service, Anderson

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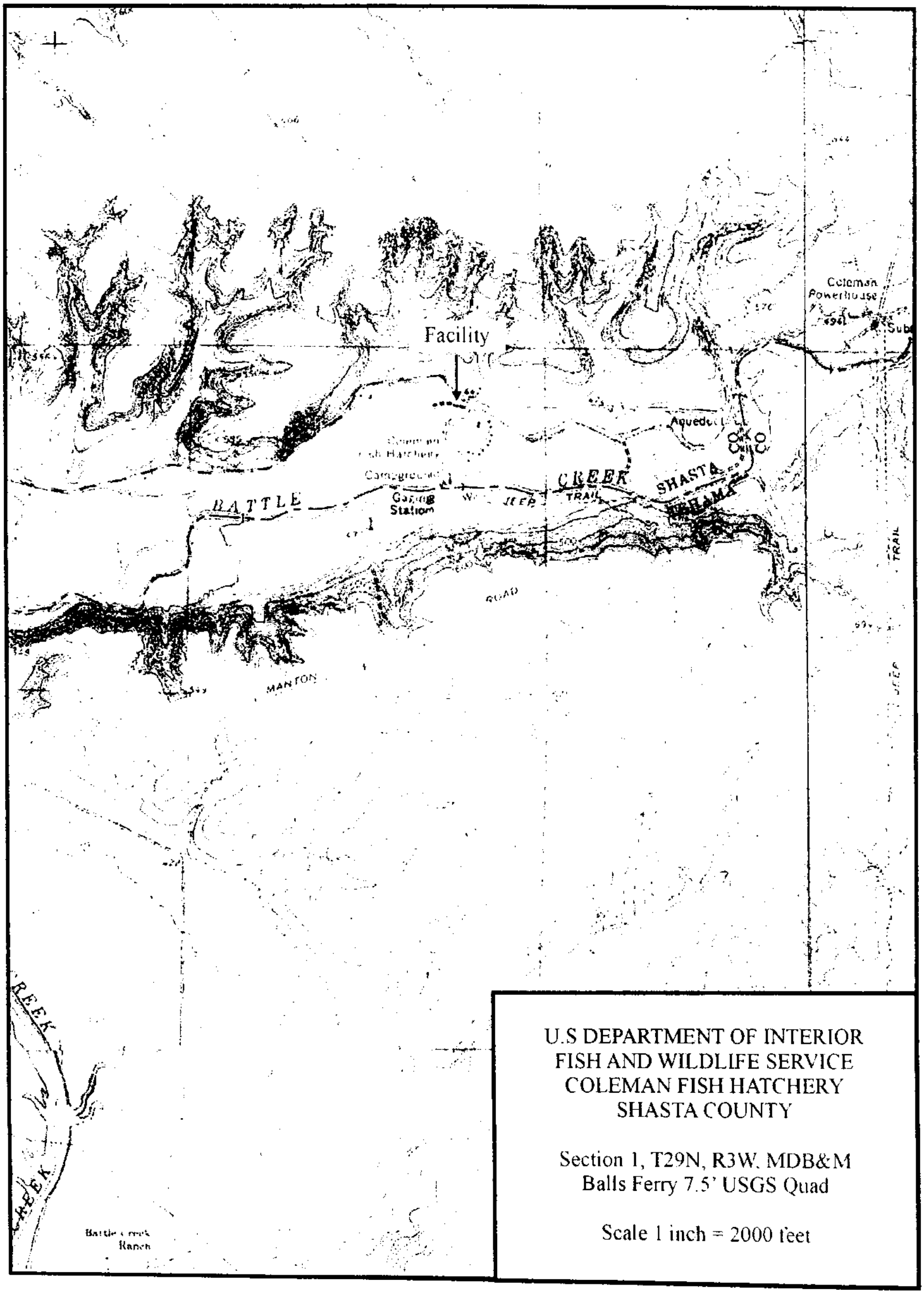
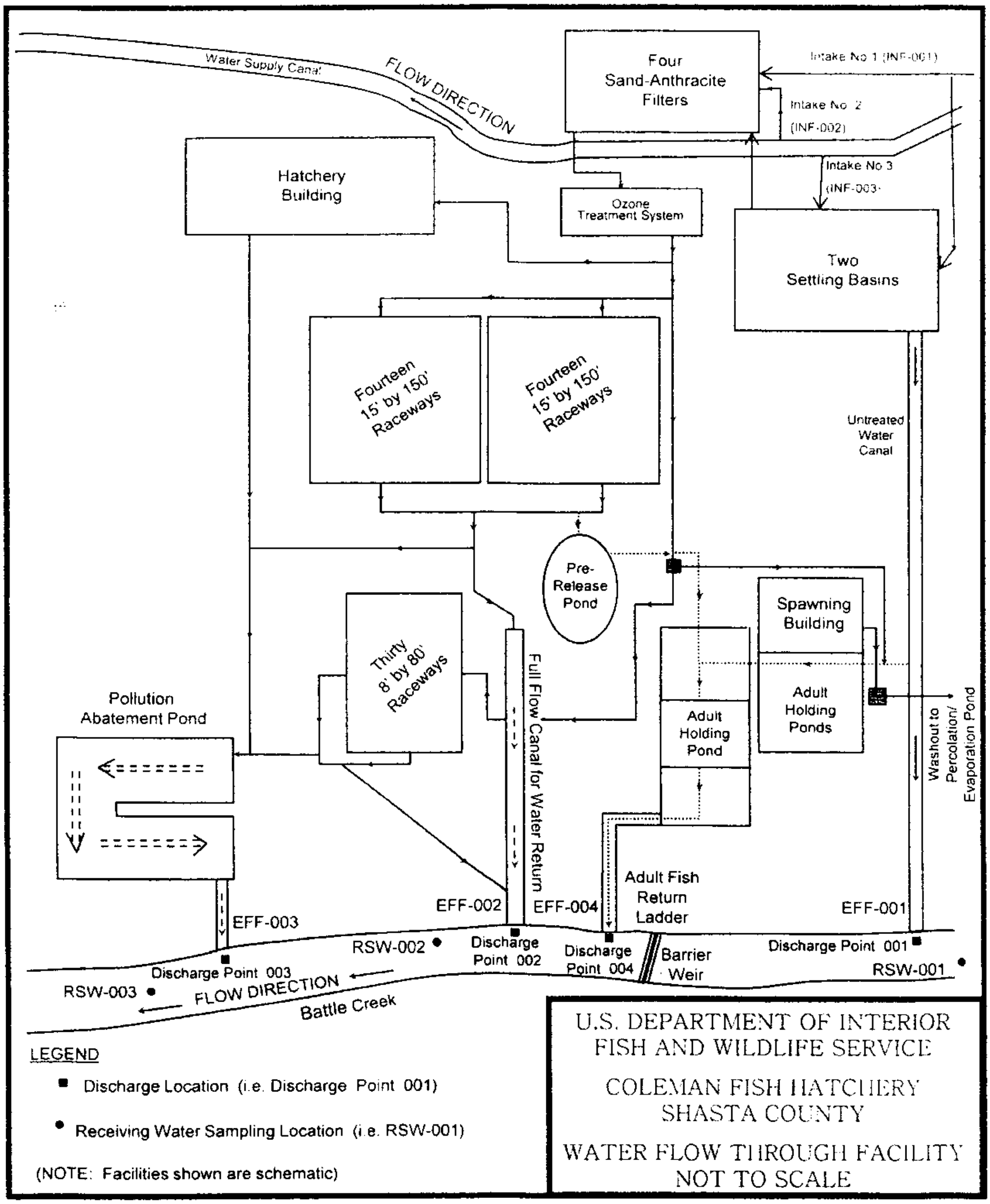
ATTACHMENT A – FACILITY ADMINISTRATIVE INFORMATION

Name of Facility	Coleman National Fish Hatchery
Type of Facility	Cold Water Aquaculture Facility, SIC Code 0921
WDID	5A450707001
General Order NOA Enrollee Number	R5-2010-0018-002
Discharger	U.S. Fish and Wildlife Service (Operator and Facility Owner)
Facility Address	24411 Coleman Fish Hatchery Road Anderson, CA 96007
Land Owner (Address)	24411 Coleman Fish Hatchery Road Anderson, CA 96007
Facility Contact, Title and Phone	Mike Keeler, (530) 365-8622
Authorized Person to Sign and Submit Reports	Scott Hamelberg, Project Leader (530) 365-8622
Mailing Address	24411 Coleman Fish Hatchery Road Anderson, CA 96007
Billing Address	24411 Coleman Fish Hatchery Road Anderson, CA 96007
Total Weight Produced (Annual)	355,000 lbs
Major or Minor Facility	Minor
Threat to Water Quality	2
Complexity	B
Facility Permitted Flow	78.9 mgd
Watershed	Sacramento River Basin
Receiving Water	Battle Creek
Receiving Water Type	Inland surface water

ATTACHMENT B – LOCATION MAP



ATTACHMENT C – FACILITY SCHEMATIC



Attachment 4-2: Waste discharge requirements for Livingston Stone National Fish Hatchery (Winter Run Rearing facility), Shasta County (NPDES No. CAG135001).

California Regional Water Quality Control Board
Central Valley Region
Katherine Hart, Chair

Linda S. Adams
Secretary for
Environmental Protection

415 Knollcrest Drive, Suite 100, Redding, California 96002
(530) 224-4845 • Fax (530) 224-4857
http://www.waterboards.ca.gov/centralvalley

Arnold Schwarzenegger
Governor

31 August 2010

CERTIFIED MAIL
7009 2250 0002 9885 3538

Scott Hamelberg
U.S. Fish and Wildlife Service
Coleman National Fish Hatchery
24411 Coleman Fish Hatchery Road
Anderson, CA 96007

CERTIFIED MAIL
7009 2250 0002 9885 3521

Brian Person
U.S. Bureau of Reclamation
16349 Shasta Dam Blvd.
Shasta Lake, CA 96019

NOTICE OF APPLICABILITY; GENERAL WASTE DISCHARGE REQUIREMENTS FOR COLD WATER CONCENTRATED AQUATIC ANIMAL PRODUCTION FACILITY DISCHARGES TO SURFACE WATERS U.S. DEPARTMENT OF INTERIOR, FISH AND WILDLIFE SERVICE AND U.S. BUREAU OF RECLAMATION, LIVINGSTON STONE NATIONAL FISH HATCHERY, SHASTA COUNTY

The U. S. Department of Interior, Fish and Wildlife Service, operates the Livingston Stone National Fish Hatchery, also known as the Winter Run Rearing Facility (hereafter Facility). The property is owned by the U.S. Bureau of Reclamation. The Fish and Wildlife Service, and Bureau of Reclamation are hereafter designated as the Discharger. The California Regional Water Quality Control Board, Central Valley Region (Central Valley Water Board) has reviewed the Report of Waste Discharge (ROWD) dated 24 July 2009 and supplemental information dated 15 September 2009 for renewal of your existing individual Order No. R5-2005-0013 (NPDES No. CA0084298) for the Facility. The ROWD was deemed complete on 15 October 2009.

On 29 January 2010, General Order No. R5-2010-0018, (NPDES No. CAG135001), Waste Discharge Requirements for Cold Water Concentrated Aquatic Animal Production Facility Discharges to Surface Waters (General Order) was adopted by the Central Valley Water Board. The General Order regulates the discharge of pollutants from Cold Water Concentrated Aquatic Animal Production facilities (CAAP facilities) to surface waters in the Central Valley Region. The Facility discharge meets the conditions for coverage under the General Order. The Central Valley Water Board has determined that discharges from your CAAP facility are more appropriately regulated under the General Order than by the existing individual permit. Therefore, the existing Order No. R5-2005-0013 (NPDES No. CA0084298) is scheduled for rescission by a separate action of the Central Valley Water Board at a future regularly scheduled Board meeting.

The Discharger has been assigned an enrollee number of R5-2010-0018-003. Administrative information for the Facility is provided in Attachment A, a part of this Notice of Applicability (NOA).

The CAAP facility operations and discharge shall be managed in accordance with the requirements contained in the General Order, this NOA, and with the information submitted by the Discharger. The General Order (enclosed) may also be viewed at the following web address:

http://www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/general_orders/r5-2010-0018_npdes.pdf

You are urged to familiarize yourself with the contents of the entire document. Mandatory monitoring requirements are prescribed Attachment C of the General Order.

FACILITY INFORMATION/DISCHARGE DESCRIPTION

The Facility is located 0.5 miles downstream of the Shasta Dam powerhouse and approximately 3 miles northwest of the City of Shasta Lake in Section 15, T33N, R5W, MDB&M, latitude N 40° 43' 00" and longitude W 122° 25' 26", as shown on Attachment A, a part of this NOA. The property is owned by the U. S. Bureau of Reclamation and is on Assessor's Parcel Nos. 065-510-01-11. The Facility is a salmon spawning/rearing operation that raises endangered winter-run Chinook salmon for release to the Sacramento River. A Delta Smelt rearing facility was added to the hatchery in 2007. Based on information in the ROWD the Discharger reported a total maximum annual harvestable weight of Chinook salmon of 3,400 pounds (lbs), and delta smelt of 200 lbs. The Discharger reported 1,148 lbs of food fed during the month of maximum feeding. This facility does not meet the 20,000 lb harvest weight or 5,000 lb food criteria for a flow-through CAAP facility requiring an NPDES permit; however, the Central Valley Water Board has designated the Facility as a CAAP facility because of the chemical additives that are part of the waste stream.

The Facility consists of two wild salmon brood stock holding tanks, 30 salmon rearing tanks, 10 salmon brood stock tanks, and one hatchery building containing 60 circular 30-inch diameter tanks for early rearing of salmon fry. The smelt rearing facility consists of a food preparation building and a main smelt rearing building. The main smelt rearing building contains thirty 29 gallon tanks and twenty-two 106 gallon tanks. There are five 265 gallon adult holding tanks for smelt outside the main building. All the water for used in the smelt rearing facility passes through the existing water lines that were used for ten 12-ft diameter brood stock tanks that were removed.

The Discharger utilizes water diverted from the Shasta Dam penstocks with a current maximum daily flow of 6.24 cubic feet per second [4.03 million gallons per day (mgd)]. The design flow for the Facility is 7.2 mgd. Supply water is aerated by packed towers and routed to a head tank for distribution to the Facility. Overflow water from the supply water head tank is discharged to the Sacramento River at one location. The Facility does not add pollutants to the overflow water which, if not diverted, would normally have passed through the penstocks to the Sacramento River. Wastewater is discharged to the Sacramento River at two locations as shown in the Facility Schematic (Attachment C), a part of this NOA, and as described below:

- **Discharge Point 001** – Wastewater from the salmon hatchery building and the two salmon wild brood stock tanks is discharged to the Sacramento River at Discharge Point 001.

- **Discharge Point 002** – Wastewater from the rectangular salmon rearing, circular salmon brood stock, and delta smelt rearing tanks is discharged to the Sacramento River at Discharge Point 002. Prior to discharge, wastewater from two of the circular salmon brood tanks and several smelt tanks can be directed through a series of ultraviolet (UV) sterilizers.

- **Discharge Point 003** – Overflow water from the supply water head tank is discharged to the Sacramento River at Discharge Point 003. The Facility does not add pollutants to the overflow water which, if not diverted, would normally have passed through the penstocks to the Sacramento River.

Chemicals currently used at the Facility include formalin, (as a 37% formaldehyde, methanol-free solution), malachite green, sodium chloride (salt), providone –iodine (Argentine), chloramine-T, tricaine methanesulfonate (MS-222), carbon dioxide, Pond Poly Aqua, vibrio vaccine, erythromycin (injected), Liquamycin LA-200, and Luteninizing Hormone-Releasing analogue ($LH\text{-}RH_3$). Chemicals not currently used but may be used in the future include oxytetracycline (Terramycin 100D), SLICE (Emamectin benzoate) and Ivermectin.

Malachite green is used as a fungicide treatment for adult salmon in the wild brood stock tanks. During treatment the wastewater is routed through two 2,000 lb granular activated carbon filters (GAC filters) operated in series to remove malachite green. In addition, wastewater containing formalin used to treat eggs for fungus infections is routed through the GAC filters prior to discharge. GAC filter effluent is routed to Discharge Point 001.

Glucose, dimethyl sulfoxide, chicken egg yolk, sodium chloride trizma base buffer, glycine, and theophylline are used in the cryoperservation of sperm and sperm activators. These chemicals are not discharged to surface waters.

The Facility discharges domestic wastes to a septic tank/leachfield system.

MONITORING REQUIREMENTS

The General Order requires that dischargers comply with the Monitoring and Reporting Program (MRP) that is incorporated as Attachment C to the General Order. Influent, effluent, and receiving water monitoring requirements are based on the pounds of fish produced. This Facility is in the category of production less than 100,000 lbs of fish.

The Discharger conducted priority pollutant metals monitoring on 27 July 2009. The data show that there is no reasonable potential for priority pollutant metals to cause or contribute to an exceedance of water quality objectives. The Discharger reports that the Facility does not use copper sulfate or chelated copper compounds. The receiving waters are not listed under the Clean Water Act 303(d) List of impaired water bodies; therefore, no additional monitoring requirements will be required.

Site specific monitoring locations for influent, effluent and receiving water monitoring are shown in Attachment C to this NOA (Facility schematic) and as described in the following table:

Monitoring Location Descriptions

Point Name	Monitoring Location Name	Monitoring Location Description
Influent	**INF-001**	Located where a representative sample of the raw water supply can be obtained.
Effluent	**EFF-001**	Effluent samples shall be collected from Discharge Point 001 downstream of the salmon hatchery building, wild brood stock tanks, and GAC filters after the last point at which wastes are introduced prior to discharge to the Sacramento River.
GAC Filter Effluent	**INT-001**	Effluent samples shall be collected from the outflow from the GAC filters prior to the point where GAC effluent enters the Discharge Point 001 effluent stream.
Discharge 002	**EFF-002A**	To address safety concerns, the Discharger may use a sampling location from the rectangular rearing tanks, designated EFF-002A, to characterize the wastewater discharge from Discharge Point 002. However, exceedance of an effluent limitation for EFF-002A shall be considered and exceedance of the effluent limitation for the entire discharge from Discharge Point 002.
Discharge 002	**EFF-002B**	To address safety concerns, the Discharger may use a sampling location from the brood stock tanks and delta smelt rearing tanks, designated EFF-002B, to characterize the wastewater discharge from Discharge Point 002. However, exceedance of an effluent limitation for EFF-002B, shall be considered and exceedance of the effluent limitation for the entire discharge from Discharge Point 002.
Discharge 003	**EFF-003**	Effluent samples shall be collected from Discharge Point 003 prior to discharge to the Sacramento River.
Receiving Water Upstream	**RSW-001**	To address safety concerns with access to the Sacramento River above Discharge Point 001, the upstream receiving water samples shall be collected from the influent water supply at INF-001.
Receiving Water Downstream	**RSW-002**	Located at the CDEC station, 1/8 mile downstream from the point where Discharge Point 002 flows into the Sacramento River.

NOTICE OF APPLICABILITY REQUIREMENTS

Based on the information provided in the ROWD, the Discharger is hereby authorized to discharge to the Sacramento River under the terms and conditions of General Order R5-2010-0018. In addition to the requirements contained in the General Order, the following shall also apply:

1. The combined maximum daily discharge from Discharge Point 001 and Discharge Point 002 shall not exceed 7.2 mgd during the effective period of the General Order.

2. The by-pass of wastewater containing malachite green around the Granular Activated Carbon (GAC) filters or the overflow of untreated wastewater containing malachite green into Discharge Point 001 is prohibited. The analytical method for determining active malachite green shall be approved by the Executive Officer. The method for

malachite green shall have a reporting limit no greater than 10 µg/L. Samples shall be collected from the outflow from the GAC filters at INT-001 during malachite green treatment. Prior to discharging wastewater generated as a result of backwashing the GAC filters, the Discharger shall contain the wastewater and sample for malachite green and formaldehyde. If malachite green is detected or if formaldehyde exceeds the effluent limitations in Table V.A.1, of the General Order, the wastewater cannot be discharged.

3. The Discharger is required to comply with all the Monitoring and Reporting Requirements contained in Attachment C to the General Order for facilities with production less than 100,000 pounds of fish.

4. The Discharger shall electronically submit Self-Monitoring Reports (SMRs) using the State Water Board's California Integrated Water Quality System (CIWQS) Program website (http://www.waterboards.ca.gov/ciwqs/index.html).The CIWQS website will provide additional directions for SMR submittal in the event there will be service interruption for electronic submittal.

5. The State Water Resources Control Board (State Water Board) has determined that individual or general permits for aquaculture activities defined in 40 CFR 122.25(b) will be subject to the same annual fee, which currently is $1,000 (State Water Board Resolution 2002-0150), but may be subject to change.

6. The General Order expires on 1 January 2015, and enrollees will continue to be authorized to discharge until coverage becomes effective under a reissued Order or until Central Valley Water Board staff formally terminates your coverage. Only those CAAP facilities authorized to discharge and who submit a Notice of Intent at least 180 days prior to the expiration date of General Order No. R5-2010-0018 will remain authorized to discharge under administratively continued permit conditions.

7. The U.S. Bureau of Reclamation, as owner of the real property at which the discharge will occur, is ultimately responsible for ensuring compliance with the General Order. The U.S. Fish and Wildlife Service retains primary responsibility for compliance with the General Order, including day to day operations and monitoring. Enforcement actions will be taken against the U.S. Bureau of Reclamation only in the event that enforcement actions against the U.S. Fish and Wildlife Service are ineffective or would be futile.

Failure to comply with the General Order and this NOA may result in enforcement actions, which could include administrative civil liability. Effluent limitation violations and some late reporting violations are subject to a Mandatory Minimum Penalty (MMP) of $3,000 per violation [California Water Code Sections 13385(h) and (i)]. If you have no discharge during a monitoring period, you must submit a report indicating that no discharge occurred. You must notify the Central Valley Water Board staff within 24 hours of noncompliance or anticipated noncompliance.

Please reference your enrollee number, R5-2010-0018-003, in your correspondence and submitted documents.

If you have any questions regarding this NOA, monitoring reports submittals, discharge notifications, compliance and enforcement; please contact, Kevin Kratzke at (530) 224-4850, or kkratzke@waterboards.ca.gov.

Robert A. Crandall

(for) PAMELA C. CREEDON
Executive Officer

KEK: knr

NOA Attachments: Attachment A - Administrative Information
Attachment B – Location Map
Attachment C – Facility Schematic

Enclosure: General Order No. R5-2010-0018 (Discharger only)

Distribution List: Mr. David Smith, U.S. EPA, Region IX, San Francisco
Mr. Phil Isorena, State Water Resources Control Board, Sacramento
Mr. John Reuth, U.S. Fish and Wildlife Service, Shasta Lake

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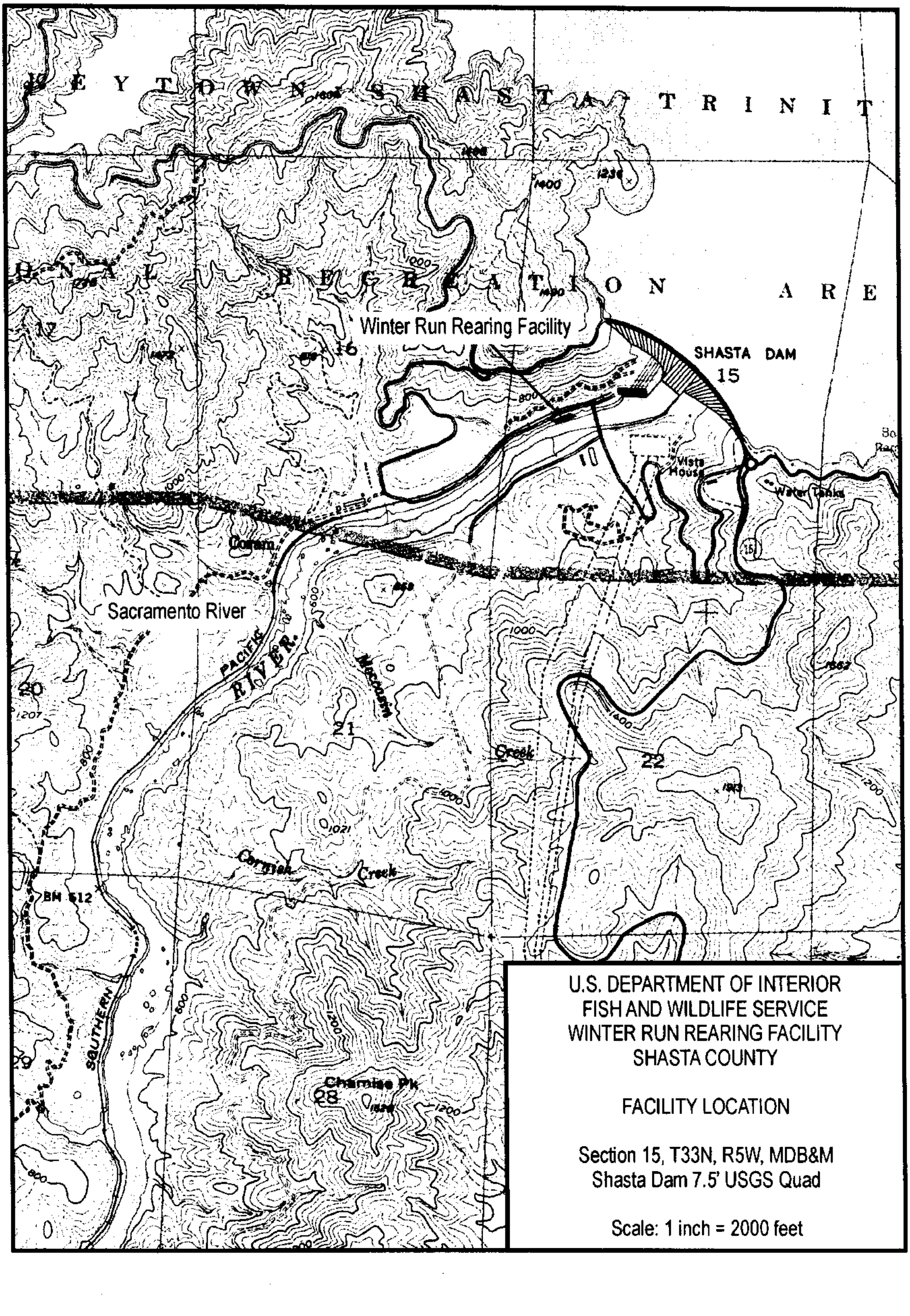
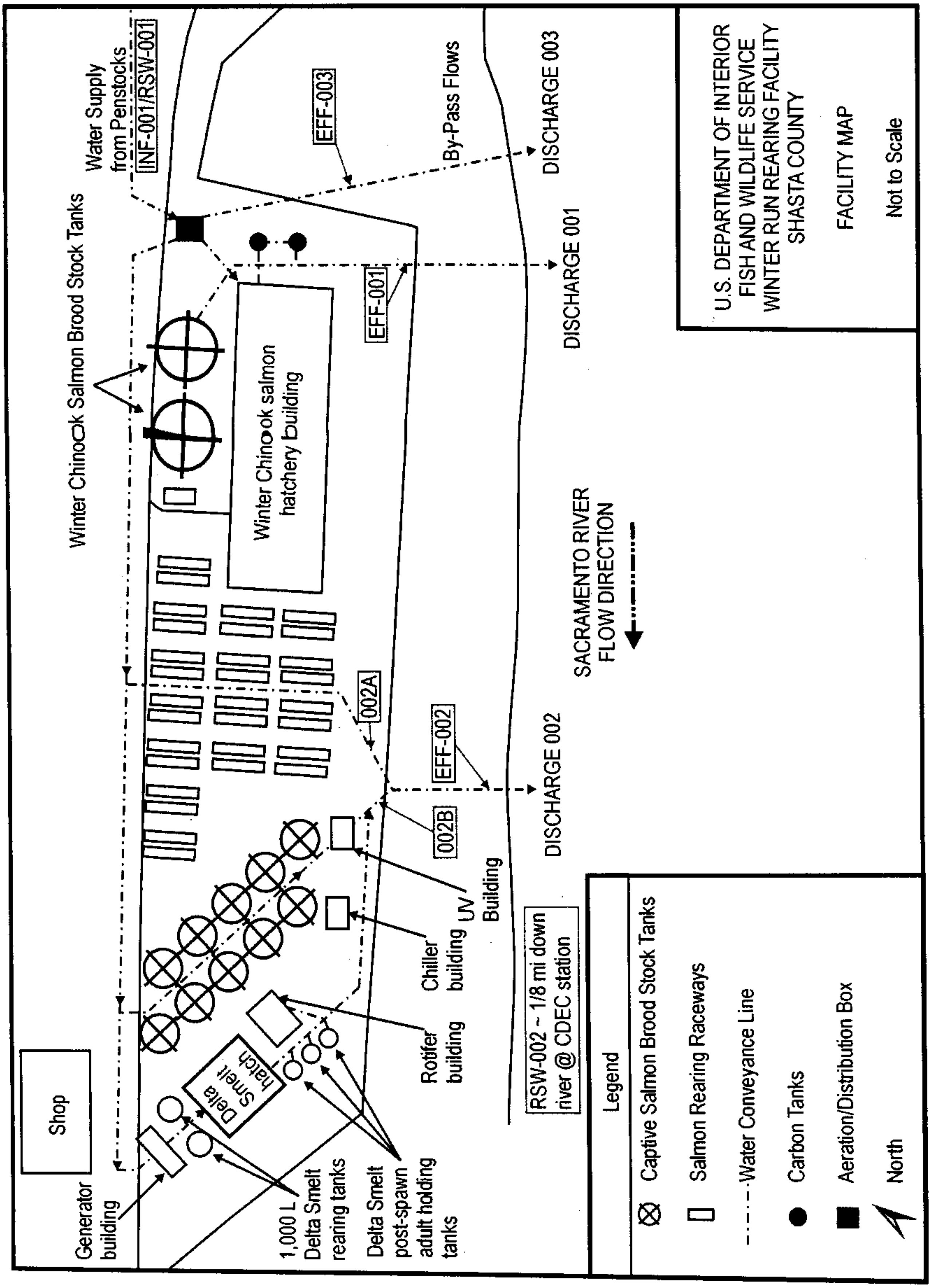
ATTACHMENT A – FACILITY ADMINISTRATIVE INFORMATION

Name of Facility	Livingston Stone National Fish Hatchery
Type of Facility	Cold Water Aquaculture Facility, SIC Code 0921
WDID	5A450704010
General Order NOA Enrollee Number	R5-2010-0018-003
Discharger	U.S. Fish and Wildlife Service (Operator) and U.S. Bureau of Reclamation (Site Owner)
Facility Address	16349 Shasta Dam Blvd. Shasta Lake, CA 96019
Land Owner (Address)	U.S. Bureau of Reclamation 16349 Shasta Dam Blvd. Shasta Lake, CA 96019
Facility Contact, Title and Phone	John Rueth, (530) 275-0549
Authorized Person to Sign and Submit Reports	Scott Hamelberg, Project Leader (530) 365-8622
Mailing Address	Livingston Stone National Fish Hatchery 16349 Shasta Dam Blvd. Shasta Lake, CA 96019
Billing Address	U.S. Fish and Wildlife Service 24411 Coleman Fish Hatchery Road Anderson, CA 96007
Total Weight Produced (Annual)	3600 lbs
Major or Minor Facility	Minor
Threat to Water Quality	2
Complexity	B
Facility Permitted Flow	7.2 mgd
Facility Design Flow	7.2 mgd
Watershed	Sacramento River Basin
Receiving Water	Sacramento River
Receiving Water Type	Inland surface water

ATTACHMENT B – LOCATION MAP



ATTACHMENT C – FACILITY SCHEMATIC



14 CERTIFICATION AND SIGNATURE OF RESPONSIBLE PARTY

"I hereby certify that the foregoing information is complete, true, and correct to the best of my knowledge and belief. I understand that the information provided in this Biological Assessment is submitted for the purpose of receiving limits from take prohibitions specified under the Endangered Species Act of 1973 (16 U.S.C. 1531-1543) and regulations promulgated thereafter for the proposed hatchery program, and that any false statement may subject me to the criminal penalties of 18 U.S.C. 1001, or penalties provided under the Endangered Species Act of 1973."

Scott Hamelberg
Project Leader
Coleman National Fish Hatchery Complex