HATCHERY AND GENETIC MANAGEMENT PLAN

Hatchery Program:	Livingston Stone National Fish Hatchery
Species or Hatchery Stock:	Sacramento River Winter Chinook Salmon (*Oncorhynchus tshawytscha*)
Agency/Operator:	U.S. Fish and Wildlife Service
Watershed and Region:	Sacramento River
Date Submitted:	July 03, 2013
Date Last Updated:	Initial Submission

SECTION 1. GENERAL PROGRAM DESCRIPTION

1.1) Name of hatchery or program.

Winter Chinook are propagated at the Livingston Stone National Fish Hatchery (NFH). Together with the Coleman NFH, these two facilities comprise the Coleman NFH Complex

1.2) Species and population (or stock) under propagation, and ESA status.

Sacramento River Winter Chinook Salmon (*Oncorhynchus tshawytscha*) are listed as endangered under the Endangered Species Act of 1973.

1.3) Responsible organization and individuals

Indicate lead contact and on-site operations staff lead.

Primary Contact

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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 U.S. Fish and Wildlife Service (Service) and funded by the U.S. Bureau of Reclamation (Reclamation).

Reclamation Contact
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U.S. Bureau of Reclamation
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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 operations and maintenance of the Coleman National Fish Hatchery Complex. Additional dedicated funding, such as for construction, facility rehabilitation, research and monitoring, or other projects, may be secured from other sources (e.g., Central Valley Project Improvement Act [CVPIA] and State funding).

The Coleman NFH has approximately 20 employees, including seasonal staff. A portion (approx. $250,000) of the budget provided to the Service is allocated to the Livingston Stone NFH for the winter Chinook propagation program. Total staff for the Livingston Stone NFH is four and occasionally, during periods of increased workload, additional staff are temporarily transferred from the Coleman NFH. The Livingston Stone NFH is also used to house a refugial population of delta smelt. The delta smelt conservation program is operated by staff of the Livingston Stone NFH and funding for the delta smelt conservation program is provided through the Service's Fisheries Program.

A portion of the annual funding provided by Reclamation for operations and maintenance of the Coleman NFH Complex are used to fund programs that support hatchery operations. Approximately $700,000 annually is transferred to the Red Bluff Fish and Wildlife Office (FWO) to conduct evaluations, monitoring, research, and permitting related to hatchery operations. The Hatchery Evaluation Program at the RBFWO consists of eight to ten employees. Another portion of the total annual funding from the Reclamation is transferred to the California-Nevada Fish Health Center (CA-NV FHC) for technical expertise associated with fish health, including the prevention, diagnosis, and treatment of disease.

1.5) Location(s) of hatchery and associated facilities.
Livingston Stone NFH is located in the upper Sacramento River basin in the northern Central Valley of northern California. The hatchery is located at the base of Shasta Dam (Keswick Reservoir) on the west side of the Sacramento River. The stock location code recognized by the Pacific States Marine Fisheries Commission (PSMFC) Regional Mark Processing Center for Livingston Stone NFH is 6FCSASAF LVNH.

1.6) Type of program.
The winter Chinook salmon propagation program is an *integrated-recovery* 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 enhancement to aid in the rebuilding and *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 spawning population.

1.7) Purpose (Goal) of program.
The primary goal of the Service's propagation program at Livingston Stone NFH is to provide a demographic enhancement to the natural spawning component of the winter Chinook population in the upper Sacramento River, assisting in the recovery of that population. Additionally, the program provides a source of marked and tagged winter Chinook that are used to monitor and assess impacts resulting from the commercial and sport ocean salmon fishery.

1.8) Justification for the program.
Livingston Stone NFH, a substation of Coleman NFH, was constructed by Reclamation in 1997. The facility was constructed for the explicit purpose of propagating ESA-listed winter Chinook salmon to supplement natural production and assist in the recovery of that population. All or nearly all of the historic spawning and rearing habitat of Sacramento River Winter Chinook salmon is blocked by Shasta Dam. The winter Chinook supplementation program is supported in NMFS's draft Recovery Plan for winter Chinook salmon.

1.9) List of program "Performance Standards".
The following performance standards have been designed to evaluate the benefits and risks of fish propagation at the Livingston Stone NFH. Performance standards have been classified as either "benefits" or "risks." Performance standards categorized as "benefits" measure the benefits resulting from an 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 the naturally reproducing component of the populations. Performance standards designed to assess benefits (B) are listed first, with performance standards designed to assess risks (R) following.

Performance Standards to Evaluate Benefits

Benefit Number	Standard / Guideline
B1.	Provide a demographic benefit to the abundance of winter Chinook
B2.	Maintain stock integrity and conserve genetic and life history diversity
B3.	Provide fish for experimental purposes
B4.	Conduct research to monitor and evaluate hatchery operations and practices
B5.	Improve survival using appropriate incubation, rearing, and release strategies

B6. Improve survival by preventing disease introduction, spread, or amplification

B7. Provide a source of winter Chinook to be coded-wire tagged for purpose of informing decisions related to harvest management

Performance Standards to Evaluate Risks

Risk Number	Standard / Guideline
R1.	Reduce harmful interactions between hatchery- and natural-origin fish
R2.	Do not introduce, spread, or amplify pathogens
R3.	Reduce the potential for negative genetic effects to natural stocks
R4.	Conduct research to evaluate potential effects on natural stocks and adaptively manage hatchery operations and activities
R5.	Minimize harmful effects of program operations on the ESA-listed population

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 winter Chinook propagation at the Livingston Stone NFH. Performance indicators have been separated into two categories: benefits (B) that the hatchery program will provide to the listed population by meeting program objectives; and risks (R) that the hatchery program may be pose to the listed population.

1.10.1) "Performance Indicators" addressing benefits.

<u>Performance Standard B1:</u> Provide a demographic benefit to the abundance of winter Chinook

Restoration and recovery of native fish and aquatic ecosystems are 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.

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

- Rear fish using the water where the fish are intended to imprint to enhance homing abilities and promote integration with naturally produced winter Chinook in the upper Sacramento River
- Developed a hatchery facility designed specifically for supplementing Sacramento River winter Chinook salmon

- Constrain the collection of broodstock (maximum of 15% of estimated total run) to lower the demographic and genetic risks to the naturally spawning population
- Use only natural-origin winter Chinook as broodstock to lower the degree of fitness reduction caused by domestication
- Implement strategies to effectively identify and spawn only target broodstock
- Use factorial-type mating strategy to avoid decreasing the effective population size
- Mark and tag 100% 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
- Conducted a parentage type analysis to confirm reproductive success of the winter Chinook salmon from the propagation program at Livingston Stone NFH

Performance Standard B2: Maintain stock integrity and conserve genetic and life history diversity

Fish culture practices at the 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 and age. In addition, only natural-origin adults are used as hatchery broodstock. These practices of broodstock selection are believed to help maintain the fitness of the hatchery stock by reducing the risks of domestication selection and decreasing divergence between hatchery and natural stocks.

Relevant fish culture practices:

- Use locally-collected, natural-origin adults for broodstock
- Conduct spawning in a manner that minimizes genetic drift and conserves genetic variability of the stock
- Collect adults throughout the duration of run timing, modeling the collection schedule upon historic run timing of naturally produced winter Chinook past the Red Bluff Diversion Dam
- Employ a factorial type mating strategy, using at least two males (if possible) to fertilize a separate portion of eggs from each female. Spawn each male with preferably two but no more than four females
- Use phenotype and mark status to effectively identify and spawn only winter Chinook
- Use natal stream water at the hatchery to reinforce genetic compatibility with local environments and promote homing
- Use genetic techniques to effectively identify target broodstock

Performance Indicators:

- Monitor population trends in fecundity, return rates, return timing, spawn timing, adult size and age composition, survival for different life stages, effective population size, and other parameters

<u>Performance Standard B3:</u> Provide fish for approved experiments

Investigators from government agencies, academic institutions, and the private sector request fish or fish tissues from fish propagation programs at the Livingston Stone NFH to study a variety of issues. In these investigations, fishes propagated at Coleman and Livingston Stone NFHs can be used as surrogates for natural-origin fish, which may not be available for research purposes.

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

- Spawn and rear fish in a manner that will support the needs of NMFS-approved research projects
- Mark and CWT experimental fish prior to release

<u>Performance Indicators:</u>

- As appropriate for specific experimental design

<u>Constraints:</u>

- The size and configuration of rearing units limits flexibility of lot sizes
- The potential for reduced survival of experimental groups limits the use of ESA-listed fish for experimental purposes

<u>Performance Standard B4:</u> Conduct research, monitoring and evaluations of hatchery operations and practices

Standard and proven fish culture practices are used at the Livingston Stone NFH to produce fish necessary to accomplish program goals (supplementation), while reducing the potential for negative effects resulting from the program. Research and monitoring are conducted on- and off-site. Knowledge gained through experimentation and research is used to modify fish culture practices, when appropriate, to better accomplish program goals.

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

- All existing fish culture practices at the Livingston Stone NFH
- The existing Monitoring and Evaluation Program conducted from the Red Bluff FWO

<u>Performance Indicators:</u>

- Marking and tagging of 100% hatchery-origin winter Chinook
- Mark screening and tag recovery efforts of adults collected on the Sacramento River Winter Chinook Carcass Survey
- Periodically review and summarize ocean harvest data
- Analyze and summarize information collected during mainstem Sacramento River carcass surveys to evaluate program operations

<u>Constraints:</u>

- ESA-status as endangered limits the extent that winter Chinook can be used in research

<u>Performance Standard B5:</u> Improve survival of propagated species/stock using appropriate incubation, rearing, and release strategies

The Service will continue to work to achieve a high level of survival of fish produced at the Livingston Stone NFH, to ensure that the program is producing a demographic benefit to increase escapement and supplement natural production, while reducing the risks to naturally produced salmonids

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

- Release fish at a time and size that attempts to achieve a balance between high rates of survival and a low level of risk to naturally produced salmonids
- Incubate eggs and rear fish at densities favorable for reducing stress, disease, and mortality
- Use proper disease prevention and control techniques to achieve a high level of survival
- Conduct studies to investigate effects of fish culture practices, such as: food types; rearing densities; ponding strategies; natural-type rearing elements; and size, time, and location of release. Apply knowledge gained through investigations to modify hatchery practices, when appropriate, to achieve a balance between high rates of survival and low potential for detrimental impacts

<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>Performance Standard B6:</u> Improve survival by preventing disease introduction, spread, or amplification

The primary goal of fish health management programs at the Livingston Stone NFH is to produce healthy fish that will contribute to program's conservation goals. 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 and treatment. Fish culture practices at the 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, and reduce the potential to negatively impact naturally produced salmonids. The following list details specific projects or activities undertaken at the Livingston Stone NFH to prevent the introduction, spread, or amplification of fish pathogens.

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

- Maintain sanitary conditions for fish rearing
- Monitor fish behaviors and mortality during incubation and rearing for issues potentially related to fish heath
- Use fencing and/or bird netting to reduce predation and disease transmission into or out of the hatchery
- 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

- Develop and conduct propagation strategies to minimize occurrence of disease in hatchery and natural fish
- Routinely perform examinations of live fish to assess health status and detect problems before they progress into clinical disease or mortality
- 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
- Examine hatchery broodstock for disease organisms (viral, bacterial and parasites)

Performance Indicators:
- Analyze survival trends for different life stages at the hatcheries

Constraints:
- Difficult to control all pathways of disease transmission

Performance Standard B7: Provide a source of winter Chinook salmon to be coded-wire tagged for purpose of informing decisions related to harvest management

Because winter Chinook are protected as an endangered species, harvest regulations are intended to avoid or minimize their harvest in ocean and freshwater commercial or recreational fisheries. To accomplish this, harvest constraints are developed in the Fishery Management Plan that reduce impacts to winter Chinook by implementing harvest restrictions. Winter Chinook originating at the Livingston Stone NFH are the only source of coded-wire-tagged winter Chinook. Data associated with harvest of tagged hatchery winter Chinook are used to inform the development of fishery regulations and provide feedback to evaluate their success.

Relevant fish culture practices:
- All hatchery produced winter Chinook salmon are marked and coded-wire tagged prior to release. Releases and recoveries of CWT winter Chinook are reported to the coast-wide CWT database (RMIS; maintained by the PSMFC), where the data are available to evaluate impacts of harvest.

Performance Indicators:
- Report coded-wire tag releases and recoveries

1.10.2) "Performance Indicators" addressing risks.

<u>Performance Standard R1:</u> Reduce potentially harmful genetic and ecological interactions between hatchery- and natural-origin stocks

Hatchery propagation of winter Chinook at the Livingston Stone NFH is designed to achieve the primary program goal of supplementing the abundance of winter Chinook while reducing the potential for negative effects resulting from the propagation program.

<u>Relevant fish culture practices:</u>
- Propagate only genetically-identified winter Chinook collected from the upper Sacramento River
- Use only natural-origin fish as hatchery broodstock
- Release fish at the area intended for supplementation to promote imprinting and reduce straying

<u>Performance Indicators:</u>
- Monitor and assess characteristics of hatchery-origin winter Chinook in comparison to naturally produced winter Chinook

<u>Constraints:</u>
- Environmental conditions limit field monitoring capabilities

<u>Performance Standard R2:</u> Do not introduce, spread, or amplify pathogens of natural stocks

The primary goal of fish health management programs at the Livingston Stone NFH is to produce healthy fish that will contribute to program goals of supplementation, 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 the 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 reduce potential negative effects that releasing diseased fish may have on natural salmonid populations. The following list identifies specific projects or activities undertaken at the Livingston Stone NFH to prevent the introduction, spread, or amplification of fish pathogens from hatchery stocks into natural populations.

<u>Relevant fish culture practices:</u>
- Employ propagation and rearing strategies that minimize occurrence of disease in hatchery fish and decrease the potential for transmission of diseases to natural fish
- Develop and conduct a disease control protocol for marking and tagging Chinook salmon
- 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 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:
- Routinely monitor on-station mortality of Chinook salmon and conduct examinations when mortality levels exceed normal levels

Constraints:
- It is often difficult to determine the mode of disease transmittance

Performance Standard R3: Reduce the potential for negative genetic effects to natural stocks

Fish propagation practices at the Livingston Stone NFH are conducted so that hatchery fish remain genetically similar to naturally produced winter Chinook in the upper Sacramento River. Maintaining a high level of genetic similarity between fish of hatchery- and natural-origins decreases the possibility of hatchery-origin fish having deleterious genetic effects. Hatchery broodstocks are screened using phenotypic and genetic criteria to reduce chances of interbreeding between different stocks (e.g., winter and spring or fall and late-fall). Some of the fish culture practices employed at the Livingston Stone NFHs to accomplish this Performance Standard are listed below.

Relevant fish culture practices:
- Use natal stream water to reinforce genetic compatibility with local environments
- Use only native, natural-origin winter Chinook from the upper Sacramento River as hatchery broodstock
- Spawn numbers of adults necessary to minimize genetic drift and to conserve genetic variability
- Collect and spawn adults throughout the duration of run timing
- Use a factorial-type mating (e.g., 1 male to fertilize half eggs from two females) to increase effective population size relative to single pair matings
- Select and pair broodstock randomly from collected broodstock
- Incorporate jacks into the spawning plan.

Performance Indicators:
- 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 estimates of effective population size associated with releases of juvenile hatchery-origin winter Chinook salmon

Other Indicators and Achievements

- Developed genetic techniques to effectively identify winter Chinook broodstock

Performance Standard R4: **Conduct monitoring, evaluations, and research to investigate potential effects on natural stocks and adaptively manage hatchery operations**

Monitoring and evaluation are conducted to evaluate potential negative effects to resulting from the winter Chinook propagation program at the Livingston Stone NFH. Knowledge gained through experimentation and research is used to modify fish culture practices, when appropriate, to maximize program benefits and reduce negative effects.

Relevant fish culture practices:

- Existing fish culture practices at the Livingston Stone NFH
- The existing Hatchery Evaluation program conducted from the Red Bluff FWO

Performance Indicators:

- Investigated mode(s) and potential for IHNV transmission between hatchery- and natural-origin Chinook salmon (inferences gained from research using fall Chinook at Coleman NFH)
- Conducted a survey for IHNV in natural-origin fall Chinook salmon from Battle Creek and the upper Sacramento River (inferences gained from research using fall Chinook)
- Conducted a post-release evaluation of hatchery-origin smolts to examine disease progression during emigration (inferences gained from research using fall Chinook)
- Conducted a grand-parentage analysis to document successful reproduction of hatchery-origin winter Chinook
- Conducting an acoustic tracking study to evaluate effects of broodstock collection and to evaluate the accuracy of existing methods to estimate abundance

Constraints:

- Environmental conditions (e.g., flows, turbidity) may limit field monitoring capabilities
- ESA-status as endangered limits the extent that winter Chinook can be used in research

Performance Standard R5: **Minimize harmful effects of program operations on the ESA-listed population**

The act of conducting propagation activities for winter Chinook could impose negative effects upon the winter Chinook population. For example, trapping of winter Chinook for use as hatchery broodstock could result in mortality, injury or behavioral effects, resulting in decreased natural spawning success. Minimizing such effects is necessary to ensure that the program achieves the intended demographic benefits

Relevant fish culture practices:

- Broodstock collection activities at the Livingston Stone NFH

Performance Indicators:

- Conduct floy/dart tagging of fishes released from trapping activities to gain insights into the fate of released fish
- Planned a study to monitor the movements of winter Chinook released during the course of broodstock collection activities

1.11) Expected size of program.

Unlike typical production-oriented hatchery programs, the winter Chinook program does not have an annual target for juvenile production. Rather, production levels for the winter Chinook propagation program are dictated by the number of broodstock that are collected and spawned annually, which is dependent upon the estimated upriver escapement. The broodstock collection target is limited to a maximum of 15% of the estimated upriver escapement, with an upper limit of 120 broodstock per brood year (i.e., when run sizes >800). To maintain genetic diversity in the event of very low abundance, no less than 20 winter Chinook adults will be collected for broodstock regardless of run size (i.e., when run sizes <135). No hatchery-origin winter Chinook are used as broodstock to reduce the potential for negative effects resulting from domestication selection.

1.11.1) Proposed annual broodstock collection level (maximum number of adult fish).

The broodstock collection target for winter Chinook is 15% of the estimated upriver escapement, with a minimum of 20 and a maximum of 120. These collection targets include any mortality to potential broodstock while being held captive.

1.11.2) Proposed annual fish release levels (maximum number) by life stage and location.

Annual targets for the winter Chinook production are not defined in terms of numbers of juveniles produced, but rather, the program goal is to maximize production from the adults collected and used as hatchery broodstock (as explained above). The annual production level anticipated when broodstock collections are maximized (i.e., n=120 spawners comprised of 60 females and 60 males) is approximately 250,000 smolts.

Table 1.11.2 Proposed release location and maximum release level of winter Chinook from the Livingston Stone National Fish Hatchery

Life Stage	Release Location	Annual Release Level
Eyed Eggs	N/A	0
Unfed Fry	N/A	0
Fry	N/A	0
Fingerling (Smolt)	Sacramento River – RM 298.5	Approx. 250,000 (maximum)
Yearling	N/A	0

1.12) Current program performance, including estimated smolt-to-adult survival rates, adult production levels, and escapement levels. Indicate the source of these data.

For brood years 2000 through 2008, the average estimated rate of total contribution (i.e., ocean harvest plus spawning escapement) for winter Chinook salmon from the Livingston Stone NFH was approximately 0.41% (95% CI, 0.06% - 0.77%) of the total number of juveniles released per brood year. The total contribution includes an average of approximately 854 (95% CI, 11 - 1697) adults returning to the upper Sacramento River.

Table 1.12 Estimated proportion of juvenile winter Chinook salmon produced at the Livingston Stone NFH from 2000 through 2008 returning to spawning areas of the upper Sacramento River. Data presented include progeny produced from cryopreserved semen, which is a standard production strategy at Livingston Stone NFH. Captive broodstock progeny were excluded from tabulated information as these releases were experimental (i.e., a study to evaluate the captive rearing program) and have been discontinued, and may not be representative of general performance of the supplementation program.

Brood Year	Release No.	Return Year	Return No.	% Return
2000	166,206	2003	474	0.285
2001	190,732	2004	633	0.332
2002	165,015	2005	3,092	1.874
2003	152,011	2006	2,382	1.567
2004	148,385	2007	189	0.127
2005	160,274	2008	170	0.106
2006	196,288	2009	467	0.238
2007	71,883	2010	199	0.277
2008	146,211	2011	80	0.055

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

The Service initially attempted to propagate winter Chinook salmon at Coleman NFH in 1955. This attempt, as well as several subsequent efforts from 1958 through 1967, was generally unsuccessful. Similarly, from 1978 through 1985, several additional attempts to propagate winter Chinook salmon at Coleman NFH were met with limited success. High water temperatures at the hatchery on Battle Creek resulted in substantial mortality of broodstock, eggs, and juveniles.

The Service re-committed to developing a successful propagation program for winter Chinook in 1988, with a decline in the natural winter Chinook salmon population and a pending petition to list winter Chinook salmon under the Endangered Species Act. The goal of the resurrected winter Chinook propagation program would be to supplement natural production and assist in recovery of winter Chinook salmon in the upper Sacramento River. Winter Chinook salmon were propagated at the Coleman NFH, located on Battle Creek, from 1989 through 1995. However, despite attempts to imprint juveniles to the Sacramento River, hatchery-origin adults instead returned to the site of the hatchery on Battle Creek, where suitable spawning habitats were not available. Because of this failure to imprint juveniles to the Sacramento River and additional concerns about possible hybridization with spring Chinook, the Service temporarily discontinued collecting winter Chinook broodstock during 1996 and 1997. During these years, hatchery spawning of winter Chinook was limited to very low numbers of fish from a 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. Since that time the winter Chinook propagation program has operated continuously, including the annual collection and spawning of broodstock from the upper Sacramento River.

1.14) Expected duration of program.

Supplementation of winter Chinook salmon using the propagation program at the Livingston Stone NFH is a temporary measure to assist in the recovery of winter Chinook salmon in the upper Sacramento River. Winter Chinook propagation is expected to cease when the population has been recovered, as described in the NMFS' Draft Recovery Plan.

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

1.15) Watersheds targeted by program.

The winter Chinook salmon propagation program at Livingston Stone NFH is operated to supplement natural production in the upper Sacramento River. All natural spawning of Sacramento River Winter Chinook Salmon occurs upstream of the city of Red Bluff, California (PSMFC Recovery Location code: 6FCSASAF ABRB), primarily within the city limits of Redding, California.

Planning is underway to introduce winter Chinook to restored habitats of Battle Creek. The Service is collaborating with the California Department of Fish and Wildlife, NMFS, and others to develop a strategy to introduce winter Chinook to that tributary. The role that the Livingston Stone NFH propagation program has in this effort, if any, has not yet been determined.

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

Several alternative and complementary actions have been implemented to improve environmental conditions and population status of winter Chinook salmon, including habitat restoration activities (including a large-scale restoration project on Battle Creek), flow and water temperature regulation, harvest restrictions, removal of migration impediments, and a myriad of actions to improve survival through the Delta.

SECTION 2. PROGRAM EFFECTS ON NMFS ESA-LISTED SALMONID POPULATIONS

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

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 July, 2011, the Service submitted an updated Biological Assessment and is currently awaiting NMFS' issuance of a Biological Opinion.

Section 10 Permitting History:

Program:	Artificial propagation of ESA-listed 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

Program:	Monitoring projects targeting winter Chinook salmon conducted from the Red Bluff Fish and Wildlife Office
Current Permit:	Section 10 Permit (No. 1,415) authorizing the take of winter Chinook salmon for various monitoring projects
Issue Date:	Permit Application originally submitted 2002 and resubmitted 2005
Expiration Date:	Permit is currently being processed by NMFS

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

2.2.1) <u>Description of NMFS ESA-listed salmonid population(s) affected by the program.</u>

Information presented below briefly summarizes biological information and life history characteristics of Sacramento River Winter Chinook Salmon and Central Valley Spring Chinook Salmon and Central Valley Steelhead, which could be affected by the supplementation program at the Livingston Stone NFH. General information is presented on geographic distribution and life history characteristics.

Sacramento River Winter Chinook Salmon

Spawning habitat for winter Chinook salmon is restricted to downstream of the Keswick Dam, primarily within the city limits of Redding, California. Prior to 2012 spawning migrations of winter Chinook were partially blocked or delayed by the Red Bluff Diversion Dam (RBDD) and limited spawning occurred downstream as far as the city of Red Bluff, California. The RBDD was deactivated in 2012, and is no longer a migration impediment. Migrating winter Chinook salmon generally migrate past the RBDD between mid-December and early August, with most fish passing that point between January and May and numbers peaking in March. Winter Chinook spawning occurs from mid-April through mid-August, with most spawning activity occurring in May and June. Based on data collected in the Sacramento River carcass survey from 2001 through 2010, age structure of hatchery-origin winter Chinook salmon was 6.2% age-2, 91.4% age-3, and 2.4% age-4, with a rare age-5 fish returning. Detailed information on the age structure of natural-origin winter Chinook salmon is not readily available, but proportion of jacks (age-2) and adults (age 3+) from 2001 to 2010 were 5.1% and 94.9%, respectively based on length-frequency distributions. Fisher (1994) reported that most winter Chinook females mature at age-3 (1% age-2, 91% age-3, and 8% age-4).

Size and sex ratio data for spawning winter Chinook salmon are available for adults captured during 1998 through 2011 at the Battle Creek barrier weir, RBDD fish trap, and Keswick Dam fish trap. Adult males ranged between 240 and 1,151 millimeter (mm) fork length (FL), and females ranged between 500 and 980 mm FL. Average male-to-female sex ratio was approximately 1:1. Winter Chinook eggs incubate and hatch in about two months, depending on water temperatures. Juveniles emerge between the end of June and mid-October. Juvenile winter Chinook salmon generally emigrate between August and April, with peak emigration rates in September. Juvenile winter Chinook salmon enter saltwater at approximately 120 mm FL.

Table 2.2.1 Size ranges, means, and sex ratios of winter Chinook salmon captured during broodstock collection activities at the Coleman NFH barrier weir, Red Bluff Diversion Dam, and Keswick Dam Fish Trap for years 1998-20008[a,b].

Return Year	Males				Females				Sex Ratio
		Fork Length (mm)				Fork Length (mm)			
	Number	Min	Max	Mean	Number	Min	Max	Mean	(♂ to ♀)
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
2009	105	550	990	852	163	520	930	776	0.6 to 1
2010	191	240	1010	819	228	560	980	737	0.8 to 1
2011	185	480	1000	641	193	500	980	655	1.0 to 1
Overall	1,659	240	1,151	724	1,629	500	980	743	1.0 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. Changes in timing of migration apparently occurred after the construction of Shasta Dam, and indicate possible hybridization with fall Chinook salmon. 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. 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. Spring Chinook salmon undergo physiological changes that enable transition to saltwater at about 80 mm FL.

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).

- Identify the NMFS ESA-listed population(s) that will be directly affected by the program.
The Sacramento River winter Chinook salmon ESU will be directly affected by the propagation program at the Livingston Stone NFH. Winter Chinook are trapped from the upper Sacramento River for use as hatchery broodstock. Returning hatchery-origin adults are intended to spawn in the upper Sacramento River and integrate into the naturally spawning population.

- Identify the NMFS ESA-listed population(s) that may be incidentally affected by the program.
Central Valley Spring Chinook, Central Valley steelhead, 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 the Livingston Stone NFH.

2.2.2) Status of NMFS ESA-listed salmonid population(s) affected by the program.

- Describe the status of the listed natural population(s) relative to “critical” and “viable” population thresholds (*see definitions in “Attachment 1").*

Sacramento River Winter Chinook Salmon

Sacramento River Winter Chinook Salmon were historically abundant and comprised of populations in the McCloud, Pit, Little Sacramento, and Calaveras rivers. Most of these populations have since been isolated from historic native spawning areas by the construction and operation of Shasta Dam. Currently available spawning habitats are restricted to the mainstem Sacramento River between the Keswick Dam and the city of Red Bluff.

Estimates of winter Chinook abundance have been derived using a combination of methods. From 1967 to 2008, estimates for winter Chinook abundance were derived by counting passage through the fish ladders at the RBDD. However, the ability to estimate winter Chinook passage at the RBDD ended after 2008 with the completion of construction of a pumping plant, which enabled year-round diversion of water without lowering the dam gates. Beginning in 1996, estimates of winter Chinook spawner abundance have been derived by employing daily surveys of winter Chinook spawning areas and a combination of carcass mark-and-recapture estimators, including the Peterson, Schaefer, Jolly-Seber, and Cormack Jolly-Seber.

Abundance of winter Chinook have fluctuated greatly, exhibiting multi-year trends of either increase or decrease. 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. 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. From the early 1990s until 2006 the winter Chinook salmon population steadily increased in abundance, reaching a high of 17,296. Since 2006, the abundance of winter Chinook spawners has consistently declined to an estimate of only 825 in 2011. The cohort replacement rate for winter Chinook salmon returning in 2012 was less than one for the sixth consecutive year, indicating a trend of declining abundance. Estimated number of natural-origin winter Chinook juveniles emigrating past the RBDD 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). In order for winter Chinook to achieve recovery, three viable populations must exist at low risk of extinction.

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.

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.

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, sub-adults 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.

Provide the most recent 12 year (e.g. 1988-present) progeny-to-parent ratios, survival data by life-stage, or other measures of productivity for the listed population. Indicate the source of these data.

For brood years 1999 through 2012, the median estimated cohort replacement rate (CRR) was 0.61 for Sacramento River Winter Chinook salmon. For ten of the twelve recent years the CRR was less than one, indicative of a population experiencing declining abundance.

Table 2.2.2.1 Estimated run sizes and cohort replacement rates for Sacramento River winter Chinook salmon.

Return Year	Estimated Run Size[1]	Cohort Replacement Rate[2]
1999	1,352	
2001	8,224	-
2002	7,441	-
2003	8,218	6.08
2004	7,869	0.96
2005	15,839	2.13
2006	17,296	2.10
2007	2,542	0.32
2008	2,830	0.18
2009	4,537	0.26
2010	1,596	0.63
2011	824	0.29
2012	2676	0.59
Median		0.61

[1] Estimated Run Size from CDFG GRANDTAB file dated February 1, 2011 (http://www.calfish.org/portals/0/Programs/AdditionalPrograms/CDFGFisheriesBranch/tabid/104/Default.aspx).

[2] Cohort Replacement Rate (CRR) calculated by dividing the run size in year "x+3" by the run size in year "x". The predominant age at return for winter Chinook salmon is three years.

- Provide the most recent 12 year (e.g. 1988-1999) annual spawning abundance estimates, or any other abundance information. Indicate the source of these data.

Table 2.2.2.2 Estimated run size of Sacramento River Winter Chinook, 2000-2012

Return Year	Estimated Run Size[1]
2000	1,352
2001	8,224
2002	7,441
2003	8,218
2004	7,869
2005	15,839
2006	17,296
2007	2,542
2008	2,830
2009	4,537
2010	1,596
2011	824
2012	2676

[1] Estimated Run Size from CDFW GRANDTAB file dated February 1, 2011 (http://www.calfish.org/portals/0/Programs/AdditionalPrograms/CDFGFisheriesBranch/tabid/104/Default.aspx).

- Provide the most recent 12 year (e.g. 1988-1999) estimates of annual proportions of direct hatchery-origin and listed natural-origin fish on natural spawning grounds, if known.

Table 2.2.2.3 Sacramento River winter Chinook salmon estimated run size, hatchery-origin run component, carcasses observed, and river miles surveyed for return years 2001 – 2010.

Return Year	Total Estimated Run-size[1]	Hatchery Origin Run-size[2]	% of Run Hatchery Origin
2000	1,352	Not available	-
2001	8,224	513	6.2
2002	7,464	570	7.7
2003	8,218	423	5.1
2004	7,869	636	8.1
2005	15,839	3,056	19.3
2006	17,205	2,380	13.8
2007	2,542	140	5.5
2008	2,830	170	6.0
2009	4,537	467	10.3
2010	1,596	199	12.5
2011	824	80	7
2012	2676	809	30.2
Median	4,537	494	7.9

[1] Estimated Run Size for 2000-2010 from CDFW GRANDTAB file dated February 1, 2011 (http://www.calfish.org/portals/0/Programs/AdditionalPrograms/CDFGFisheriesBranch/tabid/104/Default.aspx). Estimated run size from 2011 from Doug Killam, CDFG Red Bluff (pers. com.).

[2] Hatchery-origin run size from USFWS annual reports of Winter Chinook Spawning Grounds Survey (http://www.fws.gov/redbluff/he_reports.aspx).

2.2.3) Describe hatchery activities, including associated monitoring and evaluation and research programs, that may lead to the take of NMFS listed fish in the target area, and provide estimated annual levels of take

- Describe hatchery activities that may lead to the take of listed salmonid populations in the target area, including how, where, and when the takes may occur, the risk potential for their occurrence, and the likely effects of the take.

Activities associated with winter Chinook propagation at the Livingston Stone NFH will result in direct take of ESA-listed winter Chinook. Estimates of direct take of ESA-listed winter Chinook resulting from the Service's Winter Chinook propagation program are described in the Service's section 10 permit application. Take of winter Chinook resulting from operations at the Livingston Stone NFH is expected to be limited to activities associated with broodstock collection, as described below.

Broodstock Collection
Winter Chinook broodstock are collected from the wild each spawning season. Broodstock collection, using a fish trap at the base of Keswick Dam, begins in mid-February and extends through July. The entrance to the Keswick Dam Fish Trap (KDFT) is opened as frequently as daily during hours of daylight. The trap entrance is closed during hours of darkness to prevent harassment and predation upon trapped fishes by river otters. The KDFT is generally emptied twice a week during the period of collecting winter Chinook broodstock, Tuesdays and Fridays, thus fishes may spend up to four days in the fish trap prior to initial sorting.

All fishes captured at the KDFT are transported to the Livingston Stone NFH for initial sorting. Chinook salmon collected at the KDFT are initially identified and sorted as either winter Chinook or non-winter Chinook based on phenotypic characteristics. Phenotypic natural-origin winter Chinook that are needed to meet monthly collection targets are retained for genetic verification of run assignment prior to use as hatchery broodstock. Phenotypic non-winter Chinook and hatchery-origin winter Chinook collected during trapping activities are tissue sampled, tagged with two anchor-type tags, and released into the Sacramento River at Redding, CA. Fish may spend two to five hours in the transport truck before they are released.

Phenotypically identified natural-origin winter Chinook are tissue sampled and placed in quarantine while a genetically-based run assignment is determined. Genetic run assignment is performed using single nucleotide polymorphism (SNP) markers which provide a high degree of accuracy in differentiating winter Chinook from other co-occurring runs of salmon. Genetic analysis may require three to five days. Quarantined fish that are identified by genetics as non-winter Chinook are transported to the Sacramento River at Redding, CA where they are released. Quarantined fish that are genetically-identified as winter Chinook are retained as broodstock.

All winter Chinook salmon trapped at the KDFT are considered direct take. Take may occur as capture, handling, transport, tissue sample, captivity, stress, injury, and intentional or unintentional lethal take.

Incidental impacts resulting from salmon and steelhead propagation programs at the Coleman NFH Complex to ESA-listed Sacramento River Winter Chinook, Central Valley Spring Chinook, Central Valley Steelhead, Southern DPS of North American Green Sturgeon, and the Southern Resident Killer Whale were evaluated in a section 7 biological assessment submitted to NMFS in July 2011. The Service is currently awaiting NMFS' issuance of a Biological Opinion including an authorization for incidental take.

Research and monitoring activities associated with the Service's ongoing evaluations of anadromous salmonid populations in the Upper Sacramento River basin, including activities associated with evaluating the propagation programs at the Coleman NFH Complex, may also result in take of the following ESA-listed fishes; Sacramento River Winter Chinook, Central Valley Spring Chinook, Central Valley Steelhead, and the Southern DPS of North American Green Sturgeon. The Service's Red Bluff Fish and Wildlife Office has submitted to NMFS an application for a section 10 permit (Permit #1415) to authorize take of listed fish species associated with these research and monitoring projects.

- Provide information regarding past takes associated with the hatchery program, (if known) including numbers taken, and observed injury or mortality levels for listed fish.

Chinook salmon are semelparous and female broodstock at the Livingston Stone NFH are therefore killed at the time of spawning. Male broodstock are used in multiple matings, and spawning events of an individual male may occur over several days, thus males are kept alive until after they are spawned for the final time.

Some of the winter Chinook encountered during the collection of hatchery broodstock may be injured or killed during the process of trapping, transportation, anaesthetization, handling, or during their detention at hatchery prior to spawning. Lethal take of this type, occurring while fish are held captive, is characterized as "pre-spawn mortality" in hatchery records. Pre-spawn mortality is expected to be less than 15% of the number of adults retained as broodstock. Pre-spawn mortality results in losses of genetic information and causes lost productivity. Prespawn mortality resulting from winter Chinook trapping, transportation, handling, sampling, and anaesthetization ranged from 4 to 12 annually from 2000 to 2011.

It is difficult to quantify the non-lethal effects resulting from stress or injuries occurring during the course of broodstock collection. When an injured fish is encountered in the fish trap it is generally unfeasible to ascertain whether an injury occurred while a fish was captive in the trap or if the fish had been previously injured and subsequently entered the trap. If a fish is known to be injured during the course of trapping activities or during handling it is generally retained for broodstock and is considered pre-spawn mortality if it dies prior to spawning. If it cannot be ascertained that an injury resulted from trapping or handling activities, an injured fish will not likely be retained for use as broodstock; natural spawning success of these fish is unknown

Table 2.2.3 Total trapping mortalities 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 2000-2011.

Return Year	Number of Mortalities			Total number collected	% Mortality
	Male	Female	Total		
2000	7	4	11	89	12.4%
2001	3	2	5	102	4.9%
2002	6	2	8	96	8.3%
2003	4	2	6	85	7.1%
2004	7	5	12	84	14.23%
2005	7	5	12	107	11.2%
2006	3	1	4	93	4.30%
2007	6	3	9	54	16.7%
2008	7	5	12	105	11.4%
2009	4	2	6	121	5.0%
2010	6	1	7	63	11.1%
2011	4	4	8	86	9.30%
2012	6	3	9	93	9.6%
Median	6	3	8	93	9.6%

Information are not available to confidently estimate levels of take to fish that are trapped at the Keswick Dam but not retained for use as hatchery broodstock. Lethal take of fishes trapped and released from the Keswick Dam Fish Trap has previously been estimated at 5% the number released; however, data are not available to confidently support or refute that estimate. Fishes not meeting phenotypic and genetic criteria, winter Chinook in excess of monthly collection targets, and all hatchery-origin winter Chinook, are released into the Sacramento River at Redding, California. The intent of releasing these fish is that they integrate and spawn with the naturally reproducing population. Prior to their release, non-retained winter Chinook are tagged with two dart-type tags. Tagging enables these fish to be identified if they are subsequently recaptured at the Keswick Dam Fish Trap or encountered as carcasses on the winter Chinook escapement survey (i.e, carcass survey). It is not uncommon for dart tagged winter Chinook to re-enter the Keswick Dam Fish Trap multiple times during a collection season. Some fish have been trapped at the Keswick Dam Fish Trap as many as six times, with capture dates extending more than four months after the initial collection (USFWS, Red Bluff FWO, unpublished data). This information suggests that trapping and handling of fishes is not necessarily detrimental to survival, at least for some fishes. However, few anchor tagged winter Chinook are observed on the carcass survey. Observations of anchor-tagged fish on the winter Chinook carcass survey occur far less frequently than would be expected given the numbers of tagged fish released and recent estimates of winter Chinook abundance. The lack of observations of anchor tagged winter Chinook on the carcass survey suggests that released fish may not be successfully contributing to the natural spawning population. Considered together, these data are confounding and do not provide the resolution necessary to characterize the effects of broodstock collection activities on the reproductive success of winter Chinook that are not retained as broodstock. The Service is currently studying movements of winter Chinook after they have been trapped at the Keswick Dam Fish Trap and released into the Sacramento River using acoustic telemetry (see Section 12). It is anticipated that these studies will help to elucidate delayed effects of trapping and handling upon released fishes, which can then be used to better quantify estimates of this manner of take.

Provide projected annual take levels for listed fish by life stage (juvenile and adult) quantified (to the extent feasible) by the type of take resulting from the hatchery program (e.g. capture, handling, tagging, injury, or lethal take).

*Complete the appended "take table" (**Table 1**) for this purpose. Provide a range of potential take numbers to account for alternate or "worst case" scenarios.*

Table 1. Projected levels and types of take of winter Chinook salmon resulting from artificial propagation programs at the Livingston Stone National Fish Hatchery. Where a fish may be affected by more than one type of take it is included in the category that would have the greatest detrimental impact; such that the total number of potentially affected individuals of can be estimated by the sum of each column.

Listed species affected: __Winter Chinook Salmon____ ESU/Population:____Sacramento River____ Activity:_Winter Chinook Supplementation				
Location of hatchery activity:_Sacramento River____ Dates of activity:_February through June__ Hatchery program operator:__USFWS_______				
Type of Take	**Annual Take of Listed Fish By Life Stage (*Number of Fish*)**			
	Egg/Fry	Juvenile/Smolt	Adult	Carcass
Observe or harass	0	0	0	0
Collect for transport	0	0	0	0
Capture, handle, and release	0	0	0	0
Capture, transport, handle, tag/mark/tissue sample, and release a)	0	0	824	0
Removal (e.g. broodstock) b)	0	0	102	0
Intentional lethal take	0	0	0	0
Unintentional lethal take c)	0	0	62	0
Other Take (specify)	0	0	50[d]	0

a. Maximum estimate of direct take of winter Chinook salmon from the Sacramento River are for fishes trapped while collecting winter Chinook broodstock at the Keswick Dam Fish Trap (maximum observed during 2012 broodstock collection season). Collections of winter Chinook at the Keswick Dam Fish Trap may also occur while trapping for late-fall Chinook broodstock; however, such *incidental* captures during the late-fall broodstock collection period are covered under the Service's section 7 biological assessment and are not included in this table.

b. Includes intentional mortality of winter Chinook as a result of spawning as broodstock The project take level is the maximum retention number (i.e., 120) minus the maximum level of prespawn mortality (i.e., 15% of 120 = 18).

c. Unintentional mortality of winter Chinook, including loss of fish during transport or holding prior to spawning or prior to release into the wild. The projected take level represents 15% of the maximum adult collection target and does not include juvenile mortalities during incubation and rearing.

d. Other take includes additional handling, gastric tagging, and possible mortality from acoustic telemetry research

Table 2. Projected levels and types of take of spring Chinook salmon resulting from artificial propagation programs at the Livingston Stone National Fish Hatchery. For these take estimates all genetic non-winter Chinook are presumed to be spring Chinook. Where a fish may be affected by more than one type of take it is included in the category that would have the greatest detrimental impact; such that the total number of potentially affected individuals can be estimated by the sum of each column.

Listed species affected: __Spring Chinook Salmon____ ESU/Population:____Central Valley___ Activity:_Winter Chinook Supplementation				
Location of hatchery activity:_Sacramento River______ Dates of activity:___ February through June _ Hatchery program operator:_USFWS_____				
Type of Take	**Annual Take of Listed Fish By Life Stage *(Number of Fish)***			
	Egg/Fry	Juvenile/Smolt	Adult	Carcass
Observe or harass	0	0	0	0
Collect for transport	0	0	0	0
Capture, handle, and release	0	0	0	0
Capture, handle, tag/mark/tissue sample, and release a)	0	0	133	0
Removal (e.g. broodstock)	0	0	0	0
Intentional lethal take b)	0	0	20	0
Unintentional lethal take c)	0	0	9	0
Other Take (specify)	0	0	0	0

a. Request for incidental take of spring Chinook salmon from the Sacramento River are estimated to be equivalent to the maximum annual number of genetic non-winter Chinook trapped at the Keswick Dam Fish Trap while collecting winter Chinook broodstock. Requested take of 171represents maximum observed non-winter Chinook collected during the 2008 broodstock collection season. Collections of spring Chinook at the Keswick Dam Fish Trap may also occur while trapping for late-fall Chinook broodstock; however, collections of spring Chinook during late-fall broodstock collection season are not included in this table.
b. Maximum intentional mortality of listed Central Valley Spring Chinook Salmon captured at the Keswick Dam Fish Trap and culled. Requested take of 28 represents maximum number of spring Chinook from the Feather River Fish Hatchery captured and culled during the course of winter Chinook broodstock collection activities (from the 2010 broodstock collection season).
c. Unintentional mortality of spring Chinook, including loss of fish during transport, handle, mark/tag/tissue sample, and release, prior to release into the wild. The projected take level of one represents does not include juvenile mortalities during incubation and rearing.

Table 3. Projected levels and types of take of steelhead/rainbow trout resulting from the winter Chinook propagation program at the Livingston Stone National Fish Hatchery. For these take estimates all life history types of the species Oncorhynchus mykiss are indicated. Where a fish may be affected by more than one type of take it is included in the category that would have the greatest detrimental impact; such that the total number of potentially affected individuals can be estimated by the sum of each column.

Listed species affected: __Steelhead____ ESU/Population:____Central Valley____ Activity:_Winter Chinook Supplementation				
Location of hatchery activity:_Sacramento River______ Dates of activity:___February through June_ Hatchery program operator:__USFWS_____				
Type of Take	**Annual Take of Listed Fish By Life Stage (*Number of Fish*)**			
	Egg/Fry	Juvenile/Smolt	Adult[a]	Carcass
Observe or harass	0	0	0	0
Collect for transport	0	0	0	0
Capture, handle, and release	0	0	0	0
Capture, transport, handle, tag/mark/tissue sample, and release a)	0	0	102	0
Removal (e.g. broodstock)	0	0	0	0
Intentional lethal take	0	0	0	0
Unintentional lethal take b)	0	0	2	0
Other Take (specify)	0	0	0	0

a. Request for incidental take of steelhead/rainbow trout from the Sacramento River has been estimated to be equivalent to the maximum annual number of steelhead/rainbow trout trapped at the Keswick Dam Fish Trap while collecting winter Chinook broodstock. Requested take of 104represents maximum observed steelhead/rainbow trout collected at the Keswick Dam Fish Trap (during the 2004 broodstock collection season). Collections of steelhead/rainbow trout at the Keswick Dam Fish Trap may also occur while trapping for late-fall Chinook broodstock; however, collections of steelhead/rainbow trout during late-fall broodstock collection season are not included in this table but are counted within the Service's biological assessment for the Coleman NFH (2011).
b. Unintentional mortality of steelhead/rainbow trout, including loss of fish during trapping, transport, handle, mark/tag/tissue sample, and release, prior to release into the wild.

Indicate contingency plans for addressing situations where take levels within a given year have exceeded, or are projected to exceed, take levels described in this plan for the program.

If actual take levels resulting from the winter Chinook supplementation program exceed those described in the section 10 permit, NMFS will be notified and engaged in discussions regarding the reasons for exceeding authorized take levels and possible alternative operating strategies to reduce take levels.

SECTION 3. RELATIONSHIP OF PROGRAM TO OTHER MANAGEMENT OBJECTIVES

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

The winter Chinook hatchery program will be operated consistent with the Recovery Plan for Winter Chinook Salmon. Additionally, operational strategies employed at the Livingston Stone NFH will be reviewed for alignment with the recommendations recently provided by the California Hatchery Scientific Review Group.

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

The Coleman NFH complex is operated to mitigate for the loss of spawning habitat caused by the construction and operation of Shasta Dam. The Coleman NFH complex is operated by the *U.S. Fish and Wildlife Service* through an interagency agreement with the *Bureau of Reclamation,* which funds the maintenance and operation of the Coleman NFH as a mitigation feature of the Central Valley Project. The agreement stipulates that the Service will 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) Relationship to harvest objectives.

Winter Chinook salmon propagated at the Livingston Stone NFH are not intended for harvest, although some are incidentally harvested while targeting non-listed salmon, especially in the ocean recreational fishery south of San Francisco Bay. The primary goal of the Service's artificial production program at Livingston Stone NFH is to provide a demographic enhancement to the natural spawning population in the upper Sacramento River, assisting in the *recovery* of that population. As a source of coded-wire tagged winter Chinook, the winter Chinook supplementation program also benefits harvest management. Recovery of coded-wire tags from winter Chinook originating at the Livingston Stone NFH are used to monitor the effectiveness of harvest regulations and to inform decisions related to harvest management, which are aimed at reducing the harvest of winter Chinook.

3.3.1) Describe fisheries benefitting from the program, and indicate harvest levels and rates for program-origin fish for the last twelve years, if available.

The purpose of the winter Chinook artificial propagation program at the Livingston Stone NFH is to supplement the naturally spawning, ESA-listed population. Harvest regulations have been enacted to reduce impacts to winter Chinook, including restrictions of time-area fisheries and minimum size restrictions. Recovery of coded-wire tags applied to juvenile winter Chinook salmon released from Livingston Stone NFH is the source of empirical data used to monitor impact rates. Ocean harvest estimates of hatchery-origin winter Chinook from 1999 to 2011 are shown below.

Table 3.3.1 Estimated harvest of winter Chinook from Livingston Stone National Fish Hatchery, 1999-2011. Data Source: http://www.rmpc.org.

Harvest Year	Freshwater Sport	Ocean Sport	Ocean Troll	Total Harvest
1999	0	8	0	8
2000	22	118	15	155
2001	84	63	13	160
2002	31	67	34	132
2003	0	47	3	50
2004	0	682	147	829
2005	0	421	91	512
2006	0	37	4	41
2007	0	29	0	29
2008	8	0	0	8
2009	15	0	0	15
2010	0	4	2	6
2011	0	191	31	232

3.4) Relationship to habitat protection and recovery strategies.

Several programs are in place to restore anadromous fish habitats and recover salmonid populations in California's Central Valley. The two largest such programs are the Central Valley Project Improvement Act (CVPIA), along with its associated Anadromous Fish Restoration Program (AFRP), and the Bay-Delta Conservation Plan (BDCP). These programs are designed to address the complex biological, economic, social, and technological issues necessary to support populations of naturally reproducing anadromous salmonids and their Central Valley habitats. Following is a discussion of the relationships between artificial propagation programs conducted at the Livingston Stone NFH and the CVPIA-AFRP, and the BDCP.

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 Central Valley Project (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.

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).

The California Bay-Delta Authority

The California Bay-Delta Authority (CBDA) oversees the implementation of the CALFED Bay-Delta Program for the 25 state and federal agencies working cooperatively to improve the quality and reliability of California’s water supplies while restoring the Bay-Delta ecosystem. The Authority is comprised of state and federal agency representatives, public members, a member of the Bay-Delta Public Advisory Board, ex-officio legislative members and members at large. 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 Ecosystem Restoration Program (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.

Bay-Delta Conservation Program
Program Overview - The BDCP is a department within the government of California, administered under the California Natural Resources Agency. The BDCP is guided by the 2009 Delta Reform Act, which made it state policy to manage the Delta in support of the co-equal goals of water supply reliability and ecosystem restoration in a manner that acknowledges the evolving nature of the Delta as a place for people and communities. The Bay Delta Conservation Plan (BDCP) is being prepared by a group of local water agencies, environmental and conservation organizations, state and federal agencies, and other interest groups. The BDCP is being developed in compliance with the Federal Endangered Species Act (ESA) and the California Natural Communities Conservation Planning Act (NCCPA). When complete, the BDCP will provide the basis for the issuance of endangered species permits for the operation of the state and federal water projects. The heart of the BDCP is a long-term conservation strategy that sets forth actions needed for a healthy Delta. Implementation of the Plan will occur over a 50-year time frame by a number of agencies and organizations with specific roles and responsibilities as prescribed by the Plan. A major part of implementation will be monitoring conservation measures to evaluate effectiveness, and revising actions through the adaptive management decision process.

3.5) Ecological interactions.

Describe salmonid and non-salmonid fishes or other species that could (1) negatively impact program; (2) be negatively impacted by program; (3) positively impact program; and (4) be positively impacted by program. Give most attention to interactions between listed and "candidate" salmonids and program fish.

Ecological effects of releasing juvenile hatchery-origin winter Chinook from the Livingston Stone NFH include predation, competition/displacement, and disease. Deleterious ecological impacts to winter Chinook or other listed salmonids are not anticipated, primarily due to the small size of the winter Chinook program. Production levels in the winter Chinook program are dictated by spawner escapement levels, and limited to a maximum of 120 spawners annually. Therefore, juvenile production levels increase and decrease along with natural production, with a maximum of approximately 250,000 smolts being released annually. The low number of juveniles produced in the winter Chinook program, relative to most propagation programs in the Central Valley, limits the potential for negative ecological impacts to listed fish stocks. More detailed explanations are provided below:

Predation

The average size of hatchery-origin winter Chinook salmon smolts at the time of release in late January or early February is 88 mm fork-length (FL; range 46-123 mm, SD = 8.4). Listed juvenile salmonids present in the river at that time are expected to be equal in size or larger than hatchery-origin winter Chinook, making predation very unlikely. For example, naturally produced juvenile winter Chinook salmon are expected to range in size from 55 to 135 mm on February 1 (Daily length increment chart; DWR). Because hatchery and natural winter Chinook are approximately the same size during their co-residence in the Sacramento River, intraspecific predation is not likely.

Competition/Displacement

An objective of the winter Chinook propagation program is that hatchery-origin fish integrate with naturally produced winter Chinook. Potential negative effects of competition/displacement are not expected to result in deleterious effects for the following reasons: 1) juvenile hatchery-origin winter Chinook are approximately equal in size or smaller than co-occurring listed salmonids; 2) hatchery-origin winter Chinook are released after the vast majority of naturally produced winter Chinook juveniles have left the upper river system and those that remain have established home territories; 3) the number of winter Chinook released from the Livingston Stone NFH is small compared to the number of juveniles produced annually in the upper Sacramento River and the number of juvenile Chinook salmon produced in other hatchery programs, and 4) rearing habitats in the upper Sacramento River are not considered to be limiting the abundance of winter Chinook salmon.

Disease

Increased transmission or amplification of disease is not expected to result from releasing juvenile winter Chinook from the Livingston Stone NFH. Juvenile winter Chinook released from the Livingston Stone NFH have been notably healthy and free of disease problems. Lack of disease outbreaks at the Livingston Stone NFH is attributed to effective prophylactic treatments, good fish culture practices, and supply "clean" source of water from deep in Shasta Lake.

SECTION 4. WATER SOURCE

4.1) Provide a quantitative and narrative description of the water source (spring, well, surface), water quality profile, and natural limitations to production attributable to the water source.

For integrated programs, identify any differences between hatchery water and source, and "natal" water used by the naturally spawning population. Also, describe any methods applied in the hatchery that affect water temperature regimes or quality. Include information on water withdrawal permits, National Pollutant Discharge Elimination System (NPDES) permits, and compliance with NMFS screening criteria.

The source of water for the Livingston Stone NFH is Shasta Lake, which is also the source of water for the only population of naturally reproducing winter Chinook in the upper Sacramento River. Water is delivered to the hatchery by a pipe tapped directly into the penstocks of Shasta Dam. To ensure water availability in the event one or more penstocks become inoperable, the facility has the option to draw water off of alternate penstocks. Water from the penstocks is delivered 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 (e.g., employing computer controlled electronic valves); however, manual overrides, redundancies, and fault securities have been built into the system. In the event of a power outage, a solenoid will trip thus allowing free flow (i.e., approximately 5,000 gpm) to the head tank. The head tank will overflow in this situation, however, the water supply will be uninterrupted and fish production will not be at risk. Any power outages at the Shasta Dam facilities are expected to be of short duration. Since Shasta Dam is the primary electricity generating facility in Northern California electrical grids at the facility are generally restored as a high priority.

Water quality at Livingston Stone NFH is favorable for propagating winter-run Chinook salmon. Suitable water temperature is achieved through operation of the Temperature Control Device (TCD) at Shasta Dam. Turbidity in the hatchery water supply is generally low because most suspended solids settle out of the water column in Lake Shasta reservoir. No water treatment/sterilization by ozonation is required prior to use at the Livingston Stone NFH. Although fish are abundant in Lake Shasta reservoir, water delivered to the hatchery is withdrawn from 270 feet below the crest of Shasta Dam, a depth where fish and fish pathogens are expected to be at low abundance and pose a low risk to fish production at the hatchery.

Water used for winter Chinook production at Livingston Stone NFH is returned to Keswick Reservoir just below Shasta Dam. 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 (see Attachment 4-2 to the Biological Assessment of Artificial Propagation at Coleman National Fish Hatchery and Livingston Stone National Fish Hatchery, July 2011).

4.2) Indicate risk aversion measures that will be applied to minimize the likelihood for the take of listed natural fish as a result of hatchery water withdrawal, screening, or effluent discharge.

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, an area inaccessible to ESA-listed fishes.

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 General Order (No. R5-2010-0018) National Pollution Discharge Elimination (NPDES) (Permit No. CAG135001) issued by the California Regional Water Quality Control Board (WQCB) 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 self-monitoring of the hatchery's water supply and effluent is conducted to ensure that water quality parameters are maintained to be compliant with the General Order of the WQCB.

SECTION 5. FACILITIES

Provide descriptions of the hatchery facilities that are to be included in this plan (see "Guidelines for Providing Responses" Item E), including dimensions of trapping, holding incubation, and rearing facilities. Indicate the fish life stage held or reared in each. Also describe any instance where operation of the hatchery facilities, or new construction, results in destruction or adverse modification of critical habitat designated for listed salmonid species.

Construction of the Livingston Stone NFH was completed in 1998. The Livingston Stone NFH is constructed on a 0.4 acre Reclamation-owned site located approximately 0.5 miles downstream of Shasta Dam on the Keswick Reservoir. The hatchery is situated on the west bank of the Sacramento River, outside the flood plain.

5.1) Broodstock collection facilities

Adult winter Chinook salmon broodstock are collected from the Sacramento River at a fish trap constructed onto the face of the Keswick Dam. The Keswick Dam Fish Trap (KDFT) 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 fish ladder with a 340 cfs jet pump. 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 KDFT and associated structures occurred prior to 2001 and resulted in improved operation and maintenance of the structure and are described in Service 2001b. Modifications to these structures since 2001 include replacement of the hoist motor and brake system and installation of cameras and an automatic gate, which enable the trap to be monitored and operated to eliminate otter predation.

5.2) Fish transportation equipment (description of pen, tank truck, or container used)
Adults collected in the KDFT 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 vehicles are also used for transporting juvenile winter Chinook salmon to the release location.

5.3) Broodstock holding and spawning facilities
Following transport to Livingston Stone NFH, phenotypically identified winter Chinook are placed in a 20-foot circular quarantine tank while awaiting the results of genetic analyses. Results of genetic analysis may require up to three days. Adult salmon genetically identified as winter Chinook salmon are then transferred into another 20-foot circular tank for longer-term holding until ripe. The holding tanks are connected to a carbon filter for removal of malachite green following prophylactic and therapeutic antifungal treatments of broodstock.

5.4 – 5.6) Facilities for incubation, rearing, and acclimation/release
Facilities for incubation, rearing, and release are located in close proximity to each other at the Livingston Stone NFH, and are described here together. The spawning and rearing building at the Livingston Stone NFH 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. The incubation building also contains a large 120 gpm chiller and a 75 kilowatt back-up generator. Larger outdoor tanks are used for juvenile rearing, including Twenty-four 3-feet x 16-feet rectangular tanks and ten 12-feet diameter circular tanks.

The release location for winter Chinook salmon is the upper Sacramento River at Redding, California (RM 299). Juvenile winter Chinook are transported to the release site in two 2,000 gallon insulated fish hauling trucks. The source of water for the Livingston Stone NFH is the same as used by the natural-spawning population in the upper Sacramento River and has similar physical and chemical characteristics; therefore, no acclimation facilities are used.

5.7) Describe operational difficulties or disasters that led to significant fish mortality.
Near the end of the brood year 2004 broodstock collection season the Service discovered that river otters were likely predating on salmonids that were captured in the KDFT. Suspicions of otter depredation were based on observations that several Chinook that had been contained within the trap during the evening were absent when the trap was being emptied the following day. Using video surveillance equipment we confirmed that river otters were entering through the mouth of the trap during periods of darkness and were harassing the captured fishes. It is not possible to determine with confidence how long the otters may have been using the KDFT as a feeding location.

Based on our observations, broodstock collection operations at the KDFT were modified at the end of the 2004 winter Chinook broodstock collection season to reduce the potential for otter predation. Trapping operations were modified in the following manner:

1) the KDFT was "opened" in mornings to allow potential broodstock to enter and “closed” at the end of the regular workday (approximately 4:00-5:00) by blocking the entrance with the trap’s brail structure. Because otters are primarily nocturnal hunters, we believed that closing the trap at night would substantially reduce the incidence of otter predation upon captured fishes.

2) video monitoring was employed to monitor for otter predation inside the fish trap. Video monitoring has been used both inside of the trap (during periods the trap was "open" to capture fishes) and just outside of the trap at the entrance (during periods the trap was "closed"). Video recordings are then reviewed to observe for incidents of otter harassment and/or predation.

Based on video surveillance and direct observations, the strategies put in place during 2004 broodstock collection season were effective at preventing predation by river otters upon fishes within the KDFT. To reduce the risk of otter predation on captured fishes, the Service has adopted these measures into standard protocol for winter Chinook collection. River otters have not since been observed to enter the trap.

5.8) Indicate available back-up systems, and risk aversion measures that will be applied, that 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, which ensures continued supply of water for fish propagation. The facility receives water from three of the five Shasta Dam penstocks (penstocks 2, 3, and 4); a redundancy which promotes an uninterrupted water supply. Additionally, the capability to supply water from penstock 5 is currently being sought. A 75 kilowatt back-up generator is enabled in the event of a power outage.

SECTION 6. BROODSTOCK ORIGIN AND IDENTITY

Describe the origin and identity of broodstock used in the program, its ESA-listing status, annual collection goals, and relationship to wild fish of the same species/population.

6.1) Source.

List all historical sources of broodstock for the program.

Broodstock for the winter Chinook supplementation program are obtained from the mainstem Sacramento River using the KDFT. Prior to 2008, an alternate trapping facility at the Red Bluff Diversion Dam was occasionally used to collect winter Chinook broodstock; however, use of that facility was discontinued due to ineffectiveness of that collection location. The Service is currently pursing development of a secondary trapping facility for winter Chinook at the ACID Dam. This trapping facility, when completed, will benefit from being situated near the center of the distribution of winter Chinook spawning in the City of Redding, CA.

6.2) Supporting information.

6.2.1) History.

Broodstock for the winter Chinook propagation program have been collected only from the Sacramento River. The KDFT, which is an original component of the Shasta Salvage Plan, has always been the primary location, and is currently the only location, for collecting winter Chinook broodstock

6.2.2) Annual size.

Provide estimates of the proportion of the natural population that will be collected for broodstock. Specify number of each sex, or total number and sex ratio, if known. For broodstocks originating from natural populations, explain how their use will affect their population status relative to critical and viable thresholds.

The collection target for natural-origin winter Chinook salmon broodstock is limited to the lesser of 15% of the estimated run-size or 120 fish. A minimum of 20 winter Chinook adults will be targeted for capture during any year regardless of run size (e.g., run size <133). Equal numbers of males and females will be targeted for collection. Under current operational protocols, collections of winter Chinook as broodstock for the conservation hatchery program will be made regardless of identified critical and viable population thresholds.

6.2.3) Past and proposed level of natural fish in broodstock.

From the inception of the winter Chinook supplementation program in the early-1990's, most broodstock have been natural-origin. Prior to 2010, broodstock collection targets allowed up to 10% of the broodstock to be of hatchery-origin. Since 2011 only natural-origin fish have been used as broodstock. Only natural-origin winter Chinook will be used for hatchery broodstock in the future.

Table 6.2.3. Numbers of hatchery-and natural-origin winter Chinook salmon used as broodstock at the Livingston Stone National Fish Hatchery, by year. Data presented include fish used as brood stock and do not include pre-spawn mortalities.

Year	Natural-Origin	Hatchery-Origin	% Hatchery-Origin
2003	70	8	10.3
2004	63	8	11.3
2005	93	3	3.1
2006	86	2	2.3
2007	40	4	9.1
2008	86	7	7.5
2009	109	6	5.2
2010	55	0	0
2011	78	0	0

Tabulated data indicate winter Chinook spawned as hatchery broodstock, and do not include pre-spawn mortalities.

6.2.4) Genetic or ecological differences.

Describe any known genotypic, phenotypic, or behavioral differences between current or proposed hatchery stocks and natural stocks in the target area.

The winter Chinook salmon supplementation program at Livingston Stone NFH is designed to reduce the potential for genetic divergence of the hatchery and natural-origin fish and to manage them as a single integrated population. Fishes selected as hatchery broodstock are naturally produced in the upper Sacramento River and are intended to represent the genotypic, phenotypic, and behavioral characteristics of the natural spawning population. 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 identify winter Chinook salmon. To be selected as hatchery broodstock, adult salmon must satisfy both phenotypic criteria (run/spawn timing, collection location, intact adipose fin, and physical appearance) and genetic criteria (based on 96 single nucleotide polymorphism (SNP) markers) that provide effective discrimination between co-occurring runs in the Sacramento River. Because broodstock are often trapped prior to sexual dimorphism, a GHpsi marker is also used to identify sex of broodstock. In combination, the genetic and phenotypic criteria enable accurate and precise identification of winter Chinook salmon for use in the supplementation program at Livingston Stone NFH.

Currently, the collection of winter Chinook broodstock is limited to a single trapping facility: the KDFT, located at the terminus of the migratory corridor. It is intended that the fishes collected as broodstock represent the full spectrum of genetic and phenotypic diversity found in the natural spawning population; however, the extent to which this is true of fish collected at the KDFT is not known. The Service is currently pursuing funding to develop and construct a secondary trapping facility at the ACID Dam, which is located near to the center of the winter Chinook spawning distribution at Redding, California. If this facility is constructed it would be used to supplement collections at the KDFT.

6.2.5) Reasons for choosing.

Describe any special traits or characteristics for which broodstock was selected. 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 hatchery broodstock, an adult salmon must have an intact adipose fin (indicating it is of natural origin), satisfy phenotypic criteria (run and spawn timing, location of capture, physical appearance indicators), and meet stringent genetic criteria (based on 96 single nucleotide polymorphism (SNP) markers that provide a high-level of discrimination from other stocks). In combination, the phenotypic and genetic criteria used to select winter Chinook broodstock provide an accurate and precise discriminatory tool.

Some fishes may enter the trap with injuries or become injured during the stages of trapping, confinement, loading, transportation, or sorting. Fishes that are believed to have entered the trap seriously injured may be excluded from consideration as broodstock if it is believed that their survival would likely be compromised by the injury. However, if a fish is believed to have been injured during the course of trapping or transportation then it will be considered as "take" and will be retained as broodstock. Other than criteria to identify collected fishes as being winter Chinook, and exclusion of some badly injured winter Chinook, no additional other phenotypic criteria are used to select for broodstock. Jacks are incorporated as hatchery broodstock at their rate of collection.

6.3) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic or ecological effects to listed natural fish that may occur as a result of broodstock selection practices.

(e.g. "*The risk of among population genetic diversity loss will be reduced by selecting the indigenous Chinook salmon population for use as broodstock in the supplementation program.*").

Considerable effort has been made to minimize any adverse genetic or ecological effects from the winter Chinook propagation program. For example, Winter Chinook are collected and spawned throughout the duration of run timing to maintain phenotypic and genetic variability. The program uses only natural-origin broodstock to reduce the perpetuation of traits associated with domestication selection. A factorial-type spawning scheme is used to increase the effective population size of hatchery-produced winter Chinook. Phenotypic and genetic broodstock selection criteria are used to ensure that hybridization with other runs does not occur in the hatchery. Additionally, limits have been established for the collection of winter Chinook broodstock; the lower 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 providing a demographic benefit to a population that exists at a very low level of abundance. The upper limit guards against removing too many fish from the naturally spawning population and places the primary emphasis on maintaining a healthy naturally-reproducing component of the population.

SECTION 7. BROODSTOCK COLLECTION

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

Adult (age-3 and older) and "jack" (age-2) natural-origin winter Chinook salmon are collected for broodstock. Age-2 winter Chinook are spawned at their rate of occurrence in the KDFT.

7.2) Collection or sampling design.

Include information on the location, time, and method of capture (e.g. weir trap, beach seine, etc.) Describe capture efficiency and measures to reduce sources of bias that could lead to a non-representative sample of the desired broodstock source.

Winter Chinook broodstock are collected at the KDFT, located at the upstream terminus of free-flowing Sacramento River. Trapping for winter Chinook broodstock occurs from approximately mid-February to July. Monthly collection targets are established 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 winter Chinook salmon migration timing. The proportion of winter Chinook migrating past the RBDD is multiplied by the total annual collection goal to calculate monthly collection targets. 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.

Hatchery and natural winter Chinook are managed as a single population and natural selection is influenced most heavily by selective pressures in the natural environment. 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. Indigenous winter Chinook salmon are the only source of hatchery broodstock. Naturally spawning winter Chinook are collected at the KDFT, 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 96 single SNP markers that provide effective discrimination of winter Chinook plus another GHpsi marker to identify gender). 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.

Operation of the KDFT varies, depending on broodstock needs and the number of fish volunteering into the trap. Generally, the trap is opened to collect fish on a daily basis. Exceptions occur when broodstock targets are low and/or the number of fish entering the trap is high; in these situations, opening of the trap may be limited to preclude the over-collection of broodstock. The KDFT is generally emptied twice per week during the period of winter Chinook broodstock collection, typically Tuesdays and Fridays. Therefore, the maximum duration any fish could be confined within the trap is four days. For example, if the trap is emptied on a Friday then it would generally be emptied again the following Tuesday, for a maximum duration of four days.

Fin punch samples are collected from captured Chinook. Fin samples from putative broodstock are mailed to the Conservation Genetics Laboratory within a day after the trap is emptied. A genetic run confirmation generally requires less than two days, and genetic results are sent to the Livingston Stone NFH. Confirmed winter Chinook broodstock are transferred from the quarantine tank to a holding tank and non-winter Chinook with an intact adipose fin are transferred to the Sacramento River in Redding where they are released. Non-winter Chinook with a missing adipose fin (i.e., either stray late-fall Chinook from the Coleman NFH or stray spring Chinook from the Feather River FH) are culled and their CWT recovered.

The Service considers that broodstock retained for the winter Chinook supplementation program to be representative of the population. However, due to the KDFT being located at the terminus of winter Chinook spawning habitat, a large component of the population may not reach the trapping location, and therefore, would not have the opportunity to be selected for broodstock. We are not aware of any evidence to show that winter Chinook collected at the Keswick trap are not representative of the winter Chinook population, however, the Service is pursuing an additional broodstock collection location at the Anderson-Cottonwood Irrigation District (ACID) Dam in Redding. This facility, when completed, would be a secondary location for collecting winter Chinook broodstock that benefits from being centrally located to the natural spawning population in the upper Sacramento River. Additionally, the ACID trapping facility will be designed to be operated more selectively than the KDFT, which will reduce any impacts resulting to fish that aren't retained as broodstock.

7.3) Identity.

Describe method for identifying (a) target population if more than one population may be present; and (b) hatchery origin fish from naturally spawned fish.

Method of identifying target population from non-target populations:
Hatchery-origin winter Chinook salmon are marked with an adipose-fin clip at a rate of 100%. Hatchery-and natural-origin winter Chinook are differentiated based on this mark. Only natural-origin winter Chinook are used as broodstock in the supplementation program at Livingston Stone NFH.

Natural-origin Chinook salmon collected at the KDFT are identified to run using a combination of phenotypic and genetic characteristics. Identification of winter Chinook is initially made using phenotypic characteristics, including color (e.g., darkness), degree of ripeness (e.g., firmness), body size, and amount of fungus. Physical characteristics that differentiate winter Chinook from non-target stocks vary throughout the season of broodstock collections. 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, winter Chinook at that time are characterized by firm muscle tone, bright coloration, and clean appearance (i.e., minimal fungus). 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, salmon that are over-ripe, dark coloration, and with a large amount of fungus are selected *against,* as fish with these characteristics are likely to be late-fall Chinook salmon. Winter Chinook at that time tend to be moderately firm with dark coloration and generally clean in appearance. By the end of broodstock collection (late-May through mid-July), phenotypic selection criteria for winter Chinook broodstock include flaccid muscle tone, dark coloration, and very fungussed. Spring and fall Chinook are the only other adult salmon in the Sacramento River late in the broodstock collection period of winter Chinook, and they are characterized as having very firm muscle tone, bright silver coloration, and clean appearance. 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. Marked (adipose fin-clipped) Chinook that do not unambiguously satisfy the phenotypic criteria of winter Chinook are sacrificed for recovery of the CWT.

All fish initially identified by phenotypic characteristics as a potentially being 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 numerically labeled dart-type tag is attached near 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 incorrectly excluding a winter Chinook salmon from the propagation program (false negatives) was less than 6.1%. Recent modifications to the procedure implemented in 2012, including changing from microsatellite markers to SNP markers, provide improved discrimination between winter Chinook and other runs, thus further reducing the rate of error in run assignments. Considered together, phenotypic and genetic criteria for identifying winter Chinook broodstock reduce the genetic risks of the artificial propagation program by preventing hybridization within the hatchery program.

7.4) Proposed number to be collected:

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

The winter Chinook propagation program targets 15% of the estimated run size, with a minimum of 20 and a maximum of 120 winter Chinook to be collected during each spawning season. 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 ratios of males and females for broodstock to increase effective population size of hatchery-produced fish.

7.4.2) Broodstock collection levels for the last twelve years (e.g. 1988-99), or for most recent years available.

Table 7.4.2. Tabulated data include number of males and females collected from the Sacramento River. Numbers of eggs and juveniles produced include all production, including, where applicable, a portion resulting from the use of captive broodstock and cryopreserved semen. Data source: USFWS, Red Bluff FWO, unpublished data

	Females	Males	Eggs	Juveniles
1999	9	14	68,892	30,840
2000	44	34	216,075	166,206
2001	49	47	342,822	252,966
2002	45	40	353,786	233,613
2003	45	33	363,910	218,617
2004	35	36	241,516	168,261
2005	51	43	317,866	173,344
2006	52	36	361,667	196,288
2007	23	20	117,565	71,883
2008	48	45	260,370	146,211
2009	61	54	324,321	198,582
2010	27	28	139,349	123,859
2011	45	33	213,739	194,264

7.5) Disposition of hatchery-origin fish collected in surplus of broodstock needs.

Describe procedures for remaining within programmed broodstock collection or allowable upstream hatchery fish escapement levels, including culling.

Monthly trapping efforts for winter Chinook salmon are frequently adjusted to stay within monthly collection targets. For example, trapping may occur anywhere from seven days a week to only a few hours, depending on broodstock needs and the abundance of fish, as observed in the fish ladder at the Keswick Dam. Winter Chinook collected in excess of year-to-date collection targets are released into the Sacramento River in Redding, CA, near to natural spawning areas.

7.6) Fish transportation and holding methods.

Describe procedures for the transportation (if necessary) and holding of fish, especially if captured unripe or as juveniles. Include length of time in transit and care before and during transit and holding, including application of anesthetics, salves, and antibiotics.

Adult winter Chinook salmon collected at the KDFT require transport to the Livingston Stone NFH. All trapped fishes are transported to Livingston Stone NFH in an insulated 2,000 gallon fish hauling truck. Transport to the Livingston Stone NFH requires less than one hour. At Livingston Stone NFH, temporary baffles are added inside the transport tank and fishes are crowded to one compartment of the truck, where they are either sedated with carbon dioxide or allowed to deplete the oxygen supply through their respiration. Phenotypic characteristics are used to sort collected fish into two groups; one group will be retained for use as potential broodstock and the other group will be transported and released into the Sacramento River.

Fish detained for broodstock must satisfy the following initial selection criteria:

- the fish is needed to meet monthly collection targets
- the fish has phenotypic characteristics consistent with being a winter Chinook,
- the fish has an intact adipose fin (indicative of natural-origin),
- the fish meets gender needs of broodstock (the hatchery attempts to equalize numbers of males and females)
- the fish is in generally good health (the hatchery attempts to avoid collection of broodstock that are in poor health or appear to have been badly injured during migration)

Collected fishes that satisfy these criteria are given a dart-type tag for identification, sampled for a small piece of fin tissue, and placed into a 20-feet diameter tank for quarantine while the phenotypically-based run determination is verified genetically. Tissue samples are sent to the Service's Conservation Genetics Laboratory in Abernathy, Washington, for "rapid-response" genetic analysis. Genetic confirmation of run is accomplished using a panel of 96 SNP markers. Genetic run verification requires approximately two days. Salmon genetically confirmed as being winter Chinook salmon are treated with malachite green as an antifungal treatment and then transferred into a second 20-foot diameter circular adult holding tank. Adipose-intact salmon identified genetically as being other than winter Chinook are transported to the Sacramento River in Redding, California, where they are released.

The disposition of trapped fishes that do not satisfy the criteria to be initially retained as hatchery broodstock varies. Hatchery-origin winter Chinook and natural winter Chinook not needed to meet monthly collection targets, fish not meeting the hatchery's gender needs, and those with severe injuries are transported to the Sacramento River and released on the same day as they are collected from the KDFT. Hatchery-origin non-winter Chinook salmon are sacrificed for recovery of the coded-wire tag. Natural-origin Chinook salmon identified as non-winter Chinook, as well as steelhead, are relocated to the Sacramento River. Releases into the Sacramento River occur at one of two sites in Redding, California, 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. Length of time in transit from the Livingston Stone NFH to the boat ramp in Redding is about an hour.

Samples and data collected during the initial sorting of winter Chinook include the following: length, sex, and visible marks/tags are recorded for each fish. Tissue samples are collected from all Chinook salmon and steelhead, except in cases where the number of fish captured is large and density in the transport truck is high. In this situation, samples and data may not be collected from all trapped salmon if it is determined that collecting samples from the fish may compromise their health and general well-being. Prior to release into the Sacramento River, two color-coded and alphanumeric dart-type tags are attached to Chinook salmon just anterior to the dorsal fin. These tags enable identification of individual fish if they are encountered again at the KDFT or as carcasses in the Sacramento River Winter Chinook Carcass Survey.

7.7) Describe fish health maintenance and sanitation procedures applied.

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. 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 Fish Health Center.

Table 7.7. 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
Eugenol		bath	anesthetic
Luteinizing hormone Releasing hormone analog (LH-RHa)	30 :g/kg solution or 30 :g/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.

Include information for spawned and unspawned carcasses, sale or other disposal methods, and use for stream reseeding.

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

7.9) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic or ecological effects to listed natural fish resulting from the broodstock collection program.

The purpose of the winter Chinook propagation program at Livingston Stone NFH is to increase the number of winter Chinook spawners and assist in the recovery of the endangered population. Considerable effort has been made to reduce adverse genetic or ecological effects resulting from the propagation program. For example, limits have been established for the collection of 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 that the supplementation program is continued with at least a minimum level of genetic variability during years when winter Chinook abundance is very low and would receive the greatest demographic benefit. The upper limit to broodstock collection targets guards against removing too many fish from the naturally spawning population. All broodstock for the winter Chinook program are genetically confirmed to be winter Chinook to eliminate the risk of hybridization in the hatchery. In addition, the Service has recently ceased spawning of hatchery-origin broodstock to reduce the effects of domestication. Until 2009, the proportion of hatchery-origin winter Chinook used as broodstock was limited to 10%. Beginning in 2010, the Service has completely discontinued the spawning of hatchery-origin winter Chinook.

In 2004 the Service modified trapping protocols at the Keswick Dam to eliminate an apparent problem with otter predation. Since that year broodstock trapping has been restricted to daylight hours to prevent the nocturnal otters from predating upon trapped fishes. Additionally, a video monitoring program was established at the same time to monitor the area within the fish trap to observe for signs of otter activities.

SECTION 8. MATING

Describe fish mating procedures that will be used, including those applied to meet performance indicators identified previously.

8.1) Selection method.

All winter Chinook from the KDFT that are retained after initial sorting are intended to be used as broodstock. Pairing of broodstock for mating is accomplished without consideration of phenotypic characteristics, except timing of maturation. 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 wedge-shaped containment area using a hinged crowder constructed of vinyl screens. Tricane methanesulfonate (MS-222) is added to anaesthetize the fish so they can be easily handled while being examined for maturity and overall fish health. Sexually mature female salmon are euthanized at the time of spawning. Male salmon may be returned to the tank for extended holding and use in subsequent spawning events.

8.2) Males.

Specify expected use of backup males, precocious males (jacks), and repeat spawners.

Winter Chinook jacks are incorporated into the spawning matrix at their rate of collection. Backup males are not used.

8.3) Fertilization.

Describe spawning protocols applied, including the fertilization scheme used (such as equal sex ratios and 1:1 individual matings; equal sex ratios and pooled gametes; or factorial matings). Explain any fish health and sanitation procedures used for disease prevention.

Luteinizing Hormone-Releasing Hormone analogue (LH-RH_a) implants are administered, as necessary to synchronize maturation of broodstock. Implants are injected into the dorsal muscle lateral and anterior to the dorsal fin. The LH-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.

Sexually mature salmon are removed from the tank, euthanized, and rinsed in fresh water to remove MS-222. Each female is assigned a number and each male is assigned a letter. The caudal artery of ripe females is severed so that blood does not mix into the eggs during spawning. Eggs are removed from the body cavity 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, depending on their condition, how many times they've been spawned, and the abundance of alternate males. Males are preferred to be spawned twice (i.e., to fertilize the number of eggs equivalent to a single female); however, males may be spawned a maximum of four times if needed to fertilize available females.

8.4) Cryopreserved gametes.

If used, describe number of donors, year of collection, number of times donors were used in the past, and expected and observed viability.

Excess semen is collected and cryopreserved during years when a sufficient number of males have been collected to meet the hatchery's spawning targets. In the event that male broodstock are in short abundance during subsequent years, cryopreserved semen may be used as a secondary source to semen collected from live males, as necessary to prevent winter Chinook eggs from remaining unfertilized. Fertilization using cryopreserved semen is accomplished similarly as to using fresh males. That is, eggs from each female are split into two lots and each egg lot is fertilized using the sperm of a different male. Cryopreserved semen is selected randomly, and no male is used more than 4 times. Viability of cryopreserved semen is highly variable and generally lower than that of fresh semen, with survival from green egg to eye-up ranging from less than one percent to nearly 78%. Milt from live males is used preferentially to cryopreserved semen because fertilization success is higher using live males.

Since 1998 there have been eight matings at the Livingston Stone NFH utilizing cryopreserved semen. Survivorship of winter Chinook matings utilizing cryopreserved semen is shown in the table below. Displayed data *do not* include matings involving the use of captive broodstock females, as the captive broodstock program has is no longer operative and performance of captive broodstock may not be indicative of spawnings using wild-caught females.

Table 8.4. Winter Chinook matings at the Livingston Stone National Fish Hatchery employing cryopreserved sperm

Brood Year	Mating ID	Green Eggs	Eyed Eggs	% eye-up	No. Hatch	No. Tanked	% tanked
1998	194F	1256	202	16.1	15.3	183	14.6
1998	294G	1136	856	75.4	74.7	810	71.3
2000	28-99K	1029	215	20.9	20.7	210	20.4
2000	29-99I	1287	546	42.4	42.3	521	40.5
2003	46CR02G	1202	804	66.9	64.9	250	20.8
2003	46CR02F	1331	992	74.5	72.6	950	71.4
2010	1O07	3232	2511	77.7	77.4	2463	76.2
2010	1Q07	3326	21	0.63	0.63	21	0.63

8.5) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic or ecological effects to listed natural fish resulting from the mating scheme.

A factorial mating scheme is used in the winter Chinook propagation program to increase the effective population size. Egg lots are reared separately and estimates of effective population are calculated. Cryopreserved semen is used as necessary to ensure that eggs are not lost as a result of live males being unavailable.

SECTION 9. INCUBATION AND REARING -

Specify any management *goals* (e.g. "egg to smolt survival") that the hatchery is currently operating under for the hatchery stock in the appropriate sections below. Provide data on the success of meeting the desired hatchery goals.

9.1) Incubation:

9.1.1) Number of eggs taken and survival rates to eye-up and/or ponding.

Provide data for the most recent twelve years (1988-99), or for years dependable data are available.

Table 9.1. Number of eggs, number of eggs surviving to eye-up stage, number of juveniles hatched, number of juveniles tanked, and percent of tanked from the eyed-egg stage of winter Chinook at propagated at the Livingston Stone National Fish Hatchery, 1998-2011.

	Number of Eggs		Number of Juveniles		% Tanked from
Brood Year	Green	Eye-up	Hatched	Tanked	Green Eggs
1999	38,303	34,069	30,777	29,165	76.14%
2000	216,075	197,511	193,363	179,399	83.03%
2001	236,864	225,845	220,998	214,954	90.75%
2002	231,375	220,189	210,933	174,465	75.40%
2003	223,269	195,689	187,860	180,205	80.71%
2004	192,387	177,507	173,319	165,878	86.22%
2005	267,803	243,525	234,982	196,211	73.27%
2006	279,853	259,348	254,927	189,881	67.85%
2007	117,565	111,686	109,589	100,909	85.83%
2008	260,370	235,279	228,495	200,696	77.08%
2009	324,321	302,544	298,835	267,819	82.58%
2010	139,349	129,512	127,749	125,153	89.81%
2011	213,739	206,708	203,442	200,436	93.78%

9.1.2) Cause for, and disposition of surplus egg takes.

Winter Chinook broodstock are not retained in excess of collection targets, therefore, surplus salmon eggs or juveniles are not produced.

9.1.3) Loading densities applied during incubation.

Provide egg size data, standard incubator flows, standard loading per Heath tray (or other incubation density parameters).

Incubation units for winter Chinook salmon are sixteen-tray vertically stacked fiberglass incubators, similar to those used for fall and late-fall Chinook and steelhead at the Coleman NFH. Each female winter Chinook is mated with two males, forming two "family groups". The eggs of each female are incubated in a single egg tray, separated by a partition such that family groupings are maintained separately. Incubating eggs in this manner enables contribution by each parent pair to the release group to be quantified. Loading density of winter Chinook eggs range from about 1,200 to 3,500 eggs per tray. Data on winter Chinook egg size has not been collected.

9.1.4) Incubation conditions.

Describe monitoring methods, temperature regimes, minimum dissolved oxygen criteria (influent/effluent), and silt management procedures (if applicable), and any other parameters monitored.

Immediately after fertilization, winter Chinook eggs are placed in Heath incubator trays and disinfected with a 75 ppm iodophor bath for 15 minutes. Sanitary conditions are maintained during the egg incubation stage by disinfecting all equipment between different egg lots. Standard disinfection protocol for this task is to achieve surface contact of iodophor solution at 500 parts per million for a one minute contact time. Incubating eggs are treated twice per week with a 15- minute flow-through treatment of 1,400 ppm of formalin to prevent excessive fungus. After eye-up, non-viable eggs are separated from healthy eggs and removed from the incubation trays. Initial water flow in the incubator trays is four gallons/minute. Flow is increased to six gallons/minute at eye-up. After eye-up, eggs are physically shocked and non-viable eggs removed. Formalin treatments are discontinued at hatch.

One half of the hatchery's incubation capacity has been modified with a chilled re-use system. Water is pumped through two chillers to achieve a temperature less than 54^{o}f. Chilled water is then passed through a series of filters (100, 25, 10 ug) to reduce fine particulates prior reaching the incubator stacks.

9.1.5) Ponding.

Describe degree of button up, cumulative temperature units, and mean length and weight (and distribution around the mean) at ponding. State dates of ponding, and whether swim up and ponding are volitional or forced.

Winter Chinook sac fry remain 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 where they are started on commercial feed. Data regarding temperature units to hatch are available but have not been summarized. Length and weight measurements are not collected at the time of initial ponding in order to reduce handling. As fish size increases during rearing, it is necessary to combine some family groups due to limitations of tank space.

9.1.6) Fish health maintenance and monitoring.

Describe fungus control methods, disease monitoring and treatment procedures, incidence of yolk-sac malformation, and egg mortality removal methods.

Immediately after fertilization, winter Chinook eggs are placed in Heath incubator trays and disinfected with a 75 ppm iodophor bath for 15 minutes. Sanitary conditions are maintained throughout the period of egg incubation by disinfecting all equipment between uses on different egg lots. Standard disinfection protocol for equipment is surface contact of iodophor solution at 500 parts per million for a one minute contact time. Incubating eggs are treated twice per week with a 15- minute flow-through treatment of 1,400 ppm of formalin to prevent excessive fungus. After eye-up, non-viable eggs are separated and removed from healthy eggs in the incubation trays. Initial water flow in the incubator trays is four gallons/minute and later increased to six gallons/minute at eye-up. After eye-up, eggs are physically shocked and non-viable eggs removed. Formalin treatments are discontinued at hatch.

Fish are observed on a daily basis for mortalities and behavioral irregularities. Dead and moribund fish are removed from rearing units daily. In cases of high levels of mortality, 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.

9.1.7) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic and ecological effects to listed fish during incubation.

(*e.g. "Eggs will be incubated using well water only to minimize the risk of catastrophic loss due to siltation.")*

Eggs are incubated on water from Shasta Lake. Chillers are available for use, if needed. Fine sediments are filtered from the water prior to distribution to the egg incubation stacks.

9.2) <u>Rearing</u>:

9.2.1) Provide survival rate data (*average program performance*) by hatchery life stage (fry to fingerling; fingerling to smolt) for the most recent twelve years (1988-99), or for years dependable data are available.

The goal for propagation of winter Chinook at the Livingston Stone NFH is to maximize survival during incubation and every stage of the hatchery rearing process. From 1999 to 2011, overall (i.e., egg to release) survival of winter Chinook propagated at the Livingston Stone NFH ranged from 58% to 91%.

Table 9.2.1. Survival rates for various life stages of juvenile winter Chinook propagated at the Livingston Stone National Fish Hatchery, 1998-2011.

	Survival Rate			
Brood Year	Green egg to eyed egg	Eyed egg to ponding	Ponding to release	Over-all egg to release
1999	0.89	0.86	0.91	0.69
2000	0.91	0.91	0.93	0.77
2001	0.95	0.95	0.89	0.81
2002	0.95	0.79	0.95	0.71
2003	0.88	0.92	0.84	0.68
2004	0.92	0.93	0.89	0.77
2005	0.91	0.81	0.82	0.60
2006	0.93	0.73	0.85	0.58
2007	0.95	0.90	0.71	0.61
2008	0.90	0.85	0.73	0.56
2009	0.93	0.89	0.74	0.61
2010	0.93	0.97	0.99	0.89
2011	0.97	0.97	0.97	0.91
Median	**0.93**	**0.90**	**0.89**	**0.69**

9.2.2) Density and loading criteria (goals and actual levels).

Include density targets (lbs fish/gpm, lbs fish/ft3 rearing volume, etc).

Winter Chinook sac fry remain in 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. As fish size increases, family groups are combined in rearing tanks due to limitations of space at the Livingston Stone NFH. Rearing densities are variable depending on the size of family group combinations and the limitations of available rearing tanks. Maximum rearing densities are 0.20 to 0.25.

9.2.3) Fish rearing conditions

(Describe monitoring methods, temperature regimes, minimum dissolved oxygen, carbon dioxide, total gas pressure criteria (influent/effluent if available), and standard pond management procedures applied to rear fish).

Fish are observed on a daily basis for mortalities and behavioral irregularities. Dead and moribund fish are removed from rearing units. When unusually high levels of mortality are observed, necropsies are conducted 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.

9.2.4) Indicate biweekly or monthly fish growth information (*average program performance*), including length, weight, and condition factor data collected during rearing, if available.

From February 6 to February 7, 2011, a total of 825 BY2011 WCS juveniles were sampled at LSNFH 2-3 days prior to release. Condition factor was calculated using the equation, C (or K) = W/L^3, where weight (W) and length (L) are measured variables and C (or K) is a calculated value that is specific to a species or population of fish. C is the condition factor for English units (inches and pounds), and can be converted to K, the condition factor for metric units (millimeters and grams), by using the equation C=36.13K (Piper et al. 1982). In this equation, length (L) refers to total length of the fish with its tail spread normally. The condition factor for each run was estimated and compared to the standard values used at LSNFH and CNFH. Condition factor for brood year 2011 winter Chinook was C= 3176E-07.

A linear regression of the relationship of fork length to total length was developed to enable data conversions due to differences in measuring procedures used. This data reflects the total and fork length relationship of WCS during later stages of rearing at the Livingston Stone NFH and up to the time of release.

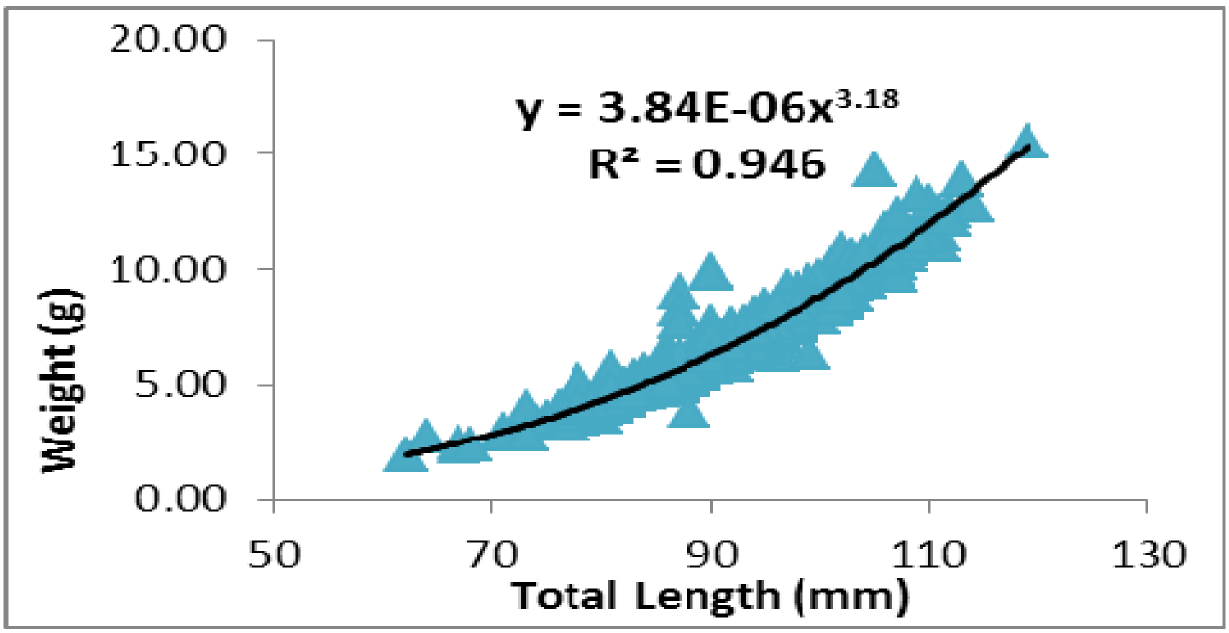

Table 9.2.4 - Length-weight relationships of BY2011 WCS at LSNFH (*n*=823).

Piper, R. G., I. B. McElwain, L. E. Orme, J. P. McCaren, L. G. Fowler, and J. R. Leonard. 1982. Fish Hatchery Management. US Department of the Interior, Fish and Wildlife Service, Washington D.C.

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

Contrast fall and spring growth rates for yearling smolt programs. If available, indicate hepatosomatic index (liver weight/body weight) and body moisture content as an estimate of body fat concentration data collected during rearing.

See section 9.2.4. No additional growth rate and energy reserve data are available.

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

Winter Chinook fry are initially fed a commercial 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 transitioned again to a Soft Moist Starter #2 until release. Feeding rates are determined using manufacturers feeding guidelines, which indicate the appropriate feed rations based on body size and average monthly water temperature.

9.2.7) Fish health monitoring, disease treatment, and sanitation procedures.

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 Fish Health Center conducts applied research on-site to control disease epizootics. Fish are observed on a daily basis for mortalities and behavioral irregularities. 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. Dead and moribund fish are removed from rearing units. Necropsies are conducted when unusually large incidents of disease-caused mortality are observed.

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

Winter Chinook are released at the pre-smolt to smolt stage. Observances of smolts at the rotary-screw traps at the RBDD soon after release indicate that many hatchery-origin winter Chinook emigrate from the upper river system soon after release. Hatchery-origin winter Chinook commonly exhibit residency within the mid- to lower-portion of the river and delta prior to entering saltwater in the spring.

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

Overhead cover is used on outdoor rearing tanks to provide shading, reduce exposure to humans, and decrease the risk of predation. Automated feeder belts are used to reduce habituation to humans.

9.2.10) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic and ecological effects to listed fish under propagation.

(*e.g. "Fish will be reared to sub-yearling smolt size to mimic the natural fish emigration* *strategy and to minimize the risk of domestication effects that may be imparted through rearing to yearling size.")*

Fish will be released during January-February as sub-yearling smolts to provide a balance of increased survival while encouraging transition to saltwater at the same time as naturally produced winter Chinook. Releases will be timed to coincide with storm events resulting in increased flow and turbdity, to the extent possible.

SECTION 10. RELEASE

Describe fish release levels, and release practices applied through the hatchery program. *Specify any management goals (e.g. number, size or age at release, population uniformity, residualization controls) that the hatchery is operating under for the hatchery stock in the appropriate sections below.*

10.1) Proposed fish release levels. *(Use standardized life stage definitions by species presented in **Attachment 1**. "Location" is watershed planted (e.g. "Elwha River").)*

Table 10.1. Maximum fish release level, target size, release date and location for winter Chinook propagated at the Livingston Stone National Fish Hatchery.

Age Class	Maximum Number	Size (fpp)	Release Date	Location
Eggs	0			
Unfed Fry	0			
Fry	0			
Fingerling	250,000	33-205	Late-January/Early-February	Sacramento River
Yearling	0			

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

Stream, river, or watercourse: *Sacramento River*

Release point: Caldwell Park, River Mile 299

Major watershed: Sacramento River

Basin or Region: Sacramento River, CA

10.3) Actual numbers and sizes of fish released by age class through the program.
For existing programs, provide fish release number and size data for the past three fish generations, or approximately the past 12 years, if available.

Table 10.3. Winter Chinook salmon production at Coleman (CNFH) and Livingston Stone (LSNFH) National Fish Hatcheries and Bodega Marine Laboratory (BML), brood years 1996-2011.

Brood Year	Facility Name	Pre-Smolt/Smolt Number	Pre-Smolt/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[b]	31,337[a]
1998	BML, LSNFH	153,912	58-119	1,218[c]	155,130
1999	LSNFH	30,841[d]	46-123	1,204[c]	32,045
2000	LSNFH	166,207	62-112	1,224[c]	167,431
2001	LSNFH	252,685	56-125	416[c]	253,101
2002	LSNFH	233,612	54-144	402[c]	234,014
2003	LSNFH	218,517	49-97	217[c]	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
2008	LSNFH	146,211	42-73	0	146,211
2009	LSNFH	198,582	28-73	0	198,582
2010	LSNFH	123,859	34-67	0	123,859
2011	LSNFH	194,264	47-88	0	194,264
Average		147,152		1,229	153,153

a All production for brood years 1996 and 1997 were from captive-origin broodstock crosses.
b Possible winter-spring hybrids transferred to Steinhart Aquarium for display.
c Withheld from release group for use as captive broodstock
d Includes 4,318 produced from captive x natural broodstock .

10.4) Actual dates of release and description of release protocols.

Provide the recent five year release date ranges by life stage produced (mo/day/yr). Also indicate the rationale for choosing release dates, how fish are released (volitionally, forced, volitionally then forced) and any culling procedures applied for non-migrants.

Table 10.4. Release Dates for winter Chinook salmon reared at the Livingston Stone NFH.

Brood Year	Release Dates
1999	1/27/2000
2000	2/1/2001
2001	1/30/2002
2002	1/30/2003
2003	2/5/2004
2004	2/3/2005
2005	2/2/2006
2006	2/8/2007
2007	1/31/2008
2008	1/29/2009
2009	2/10/2010-2/11/2010
2010	2/3/2011

10.5) Fish transportation procedures, if applicable

Describe fish transportation procedures for off-station release. Include length of time in transit, fish loading densities, and temperature control and oxygenation methods.

Winter Chinook are reared at the hatchery to the sub-yearling pre-smolt/smolt size. Releases occur generally in late-January or early February; however, actual release timing may occur outside of this target window in order to time the release to coincide with a flow and turbidity event, which are believed to decrease predation during the period of acclimation and to stimulate emigration from the upper river. Juvenile winter Chinook are transported to the release site in two groups using aerated and insulated fish distribution trucks. Transportation to the release site in two groups is done to avoid the catastrophic loss of an entire brood of hatchery fish that could be caused by potential difficulties experienced during transport to the release site (e.g., traffic accident). Transportation to the release site requires less than one hour. Releases of hatchery-origin juveniles are conducted at dusk to reduce the risk of predation while juveniles acclimate to the river.

10.6) Acclimation procedures (*methods applied and length of time***)**

Because winter Chinook salmon are reared and released near to their rearing location (i.e., minimal travel time) and using water that has 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. Releases of winter Chinook salmon occur at dusk to reduce the risk of predation while they acclimate to the river environment.

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

All juvenile winter Chinook salmon propagated at the Livingston Stone NFH are marked prior to release by removing (clipping) the adipose fin. Additionally, a coded-wire tag is inserted into their snout.

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

All juvenile winter Chinook salmon propagated at the Livingston Stone NFH will be released. No surplus fish are produced.

10.9) Fish health certification procedures applied pre-release

As its primary responsibility, California-Nevada Fish Health pathologists conduct fish health inspections to observe any indication that disease is present. A pre-release examination 30 days prior to the scheduled release date is conducted at the hatchery. Tissue samples are screened for viral, bacterial, and parasitic fish pathogens. The pre-release examination is conducted by AFS Blue book and USFWS Aquatic Animal Health Handbook methods. The hatchery receives an inspection report that lists what pathogens, if any, were found.

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

The Livingston Stone NFH is not susceptible to flooding and a employs a redundant and virtually fail-safe system of water delivery. Emergency release procedures have not been developed as unplanned releases are not considered necessary.

10.11) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic and ecological effects to listed fish resulting from fish releases

(*e.g. "All yearling coho salmon will be released in early June in the lower mainstem of the Green River to minimize the likelihood for interaction, and adverse ecological effects, to listed natural Chinook salmon juveniles, which rear in up-river areas and migrate seaward as sub-yearling smolts predominately in May").*

Releases of juvenile winter Chinook salmon will be timed to coincide, when practicable, with precipitation events accompanied by increased flow and turbidity in the Sacramento River. These conditions are believed to provide a period to allow for acclimation to the river during which hatchery fish can adjust to the presence of predators. Releases timed to coincide with high flow events are also believed to encourage emigration and decrease ecological interactions in the upper river. Hatchery-origin winter Chinook are believed to exhibit a short-term residency in the lower Sacramento River or delta prior to entering saltwater in the late spring. Due to the small size of the winter Chinook propagation program at the Livingston Stone NFH and the seasonal timing of releases, concerns of ecological effects resulting from the release of hatchery-origin juveniles are minimal.

SECTION 11. MONITORING AND EVALUATION OF PERFORMANCE INDICATORS

This section describes how "Performance Indicators" listed in Section 1.10 will be monitored. Results of "Performance Indicator" monitoring will be evaluated annually and used to adaptively manage the hatchery program, as needed, to meet "Performance Standards".

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

11.1.1) Describe plans and methods proposed to collect data necessary to respond to each "Performance Indicator" identified for the program

Performance indicators are identified for each of the Performance Standards identified in Section1.10.

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

The Service's Hatchery Evaluation (HE) Program at the Red Bluff Fish and Wildlife Office has a staff of approximately eight to ten biologists and technicians dedicated to monitoring, evaluations, and research associated with propagation programs at the Coleman NFH Complex. The HE Program receives annual funding of approximately $0.7M from the USBR, which is included in the Coleman NFH annual funding for operation of the mitigation programs associated with Shasta Dam. Additional funding is secured from outside sources for specific research projects, such as the annual Sacramento River winter Chinook salmon carcass survey.

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

(*e.g. "The Wenatchee River smolt trap will be continuously monitored, and checked every eight hours, to minimize the duration of holding and risk of harm to listed spring Chinook and steelhead that may be incidentally captured during the sockeye smolt emigration period.)"*

Effects of most monitoring and research activities conducted by the Service's HE Program are considered through a separate section 10 permitting process. Detailed descriptions of monitoring and evaluation activities associated with the winter Chinook propagation program, including estimates of take, are included with other monitoring activities conducted out of the Service's Red Bluff Fish and Wildlife Office (Permit #1415). This permitting process is separate from the section 10 process for fish propagation activities at the Coleman NFH Complex.

SECTION 12. RESEARCH

Provide the following information for any research programs conducted in ***direct association with the hatchery program described in this HGMP. Provide sufficient detail to allow for the independent assessment of the effects of the research program on listed fish****. If applicable, correlate with research indicated as needed in any ESU hatchery plan approved by the co-managers and NMFS. Attach a copy of any formal research proposal addressing activities covered in this section. Include estimated take levels for the research program with take levels provided for the associated hatchery program in* ***Table 1****.*

12.1) Objective or purpose

Indicate why the research is needed, its benefit or effect on listed natural fish populations, and broad significance of the proposed project.

The Service is currently involved with two research and monitoring projects directly involved with evaluating the effects of the winter Chinook propagation program at the Livingston Stone NFH; the Upper Sacramento River Winter Chinook Carcass Survey and an Acoustic Telemetry study to monitor the movements of adult winter Chinook that are captured at the Keswick Dam Fish Trap and not retained for broodstock. The winter Chinook Carcass Survey project is permitted through section 10 Permit #1415, which covers most monitoring activities conducted out of the Service's Red Bluff FWO.

Winter Chinook Carcass Survey:

The two primary purposes of the Winter Chinook Carcass Survey project are to estimate the abundance of winter Chinook salmon spawners and to gather information to assist in the evaluation of the winter Chinook propagation program at the Livingston Stone National Fish Hatchery. The estimate of winter Chinook abundance is used by the National Marine Fisheries Service to develop a Juvenile Production Estimate (JPE), which is sued to determine allowable take limits of juvenile winter Chinook salmon at the state and federal pumping facilities in the Sacramento-San Joaquin Delta. Estimates of winter Chinook abundance resulting from this project will also be used by the fishery agencies to assess progress towards Endangered Species Act delisting.

A second objective the winter Chinook carcass survey is to gather information to evaluate the winter Chinook supplementation program at the Livingston Stone National Fish Hatchery. This project is the primary source of information to assess the propagation program and to recommend refinements to increase benefits leading to restoration of a self-sustaining natural population.

Another benefit of this project is that coded-wire tags recovered on this project are used by a multi-agency team to conduct a cohort reconstruction analysis of Sacramento River winter Chinook. This cohort analysis provides the basis for evaluating the effects of ocean harvest upon this endangered species.

Unlike most research and monitoring programs conducted out of the Service's Red Bluff FWO, the Service requests that the ongoing acoustic telemetry study being conducted to monitor the movements of adult winter Chinook released from the Keswick Dam Fish Trap be permitted through the section 10 permit associated with the hatchery supplementation program. Permitting that particular research project through the supplementation program section 10 permit is preferred because that particular research project is highly intertwined with the hatchery production program. The Study Proposal for that research project is attached (Attachment 1).

12.2) Cooperating and funding agencies

The Sacramento River winter Chinook salmon carcass survey is a cooperative project between the Service's Red Bluff FWO and the California Department of Fish and Game. Field sampling for this project also includes personnel from the Pacific States Marine Fisheries Commission

(PSMFC), which is contracted through the CDFG. Approximately half of the field effort for this project is provided by the USFWS and the remainder is provided by CDFG/PSMFC. Funding for this project is currently provided by the CalFed Ecosystem Restoration Program, but is expected to be paid by the U.S. Bureau of Reclamation as a requirement of the OCAP BO beginning in return year 2014.

The winter Chinook adult radio tagging study is conducted by the Service's Red Bluff FWO and funded by the U.S. Bureau of Reclamation as mitigation for Shasta Dam.

12.3) Principle investigator or project supervisor and staff

Principle investigator for the Winter Chinook Carcass Survey and Winter Chinook Adult Acoustic Tagging Study is Mr. Kevin Niemela, Supervisory Fish Biologist and Program Leader of the Hatchery Evaluation Program at the Red Bluff FWO. Principle Investigator for the CDFG is Mr. Doug Killam, CDFW, Red Bluff, Ca.

12.4) Status of stock, particularly the group affected by project, if different than the stock(s) described in Section 2

Stock status is as described in Section 2.

12.5) Techniques: include capture methods, drugs, samples collected, tags applied

Winter Chinook Carcass Survey:

The Winter Chinook Carcass Survey is conducted in the upper Sacramento River from May through August, encompassing the duration of the winter Chinook salmon spawning period. The survey area of this project includes the upper Sacramento River in Shasta County, extending from Keswick Dam at river mile (RM) 301 downstream to near Cottonwood Creek (RM 273). The survey is divided into sections, which are chosen as convenient areas for crews to start or stop the daily surveys. In past years, three (3) to four (4) survey sections have been used to cover the entire survey area. Survey sections will be covered on a rotating basis throughout the survey season.

Field sampling procedures and techniques for the Sacramento River winter Chinook spawning ground surveys are described below and further explained in USFWS Annual Reports for this project (see RBFWO web site at http://www.fws.gov/redbluff/default.html). Most of the survey effort is conducted by boat, utilizing from two to five boats per day, each boat having a driver and an observer. Beginning at the downstream boundary of the reach being surveyed, survey teams slowly maneuver the boats upstream while observing for salmon carcasses. Observers from each boat are responsible for surveying along one shoreline out to the middle of the river. Several short stretches of river may be surveyed on foot, as a result of low-water conditions that could be hazardous to boat navigation. Survey effort is intended to sample all areas where salmon carcasses could be located; however, sampling efforts tend to concentrate in areas where carcasses have been shown to collect through previous surveys. Observed carcasses are collected using a gaff or gig. No live fish are collected during this survey. Most collected carcasses are tagged, except those found in an advanced state of decomposition. Fresh carcasses (those with firm flesh and at least one clear eye) are tagged by attaching a small colored plastic ribbon to the upper jaw with a hog ring. The tag color is used to identify the survey period that the carcass was tagged. Similarly colored tags are applied to the lower jaw of slightly decayed, or non-fresh, carcasses. Carcass condition (fresh or non-fresh) is noted during tagging to accommodate the various population estimators. Carcasses found to be severely decayed are enumerated, cut in half, or "chopped", and disregarded in subsequent surveys. Data and biological samples are collected from non-chopped carcasses, as described below. Following sampling, collected carcasses are returned to a flowing section of the river, near to the location where the carcass was located.

Winter Chinook Adult Radio Tagging Study:

Protocols for techniques employed in the Winter Chinook Acoustic Tagging Study are as described in the study proposal (Attachment 1) and the project description for the winter Chinook propagation program.

12.6) Dates or time period in which research activity occurs.

Winter Chinook Carcass Survey:

The Winter Chinook Carcass Survey is conducted annually from May through August, encompassing the duration of the winter Chinook salmon spawning period.

12.7) Care and maintenance of live fish or eggs, holding duration, transport methods.

Winter Chinook Carcass Survey:

Protocols for the Winter Chinook Carcass Survey do not require observing and sampling carcasses from areas of the river used by spawning winter Chinook. In order to avoid stressing spawning fish, field survey crews avoid boating through sections of the river that where actively spawning fish are congregating. Survey protocols do not involve the collection, handling, or transport of live fish or eggs.

Winter Chinook Acoustic Tagging Study:

Care and maintenance of fish are as described in the study proposal (Attachment 1) and the project description for the winter Chinook propagation program.

12.8) Expected type and effects of take and potential for injury or mortality.

Winter Chinook Carcass Survey:

We anticipate take, in the form of short term and minor "disturbance" will occur to winter Chinook salmon as a result of conducting this monitoring project. This project monitors the abundance of winter Chinook salmon during a time when they are spawning in the upper Sacramento River. Because this project is conducted during this sensitive and critical life stage, and because this project covers the entire spawn timing and spawning distribution, it is potential that any and all fish in the spawning run could be minimally disturbed by project activities; specifically, operating a motor boat in the vicinity of spawning areas. However, the effects of a disruption are expected to be minor and of short duration and are not expected to affect the spawning success of winter Chinook salmon.

Winter Chinook Acoustic Tagging Study:

We anticipate a low level of take in the form of minimal extra handling of fish trapped in the Keswick Dam Fish Trap and possible behavioral modifications and mortality resulting from insertion of radio tags into adult winter Chinook. Potential effects of gastrically applying acoustic tags to winter Chinook may affect the behavior and physiology of Sacramento River winter Chinook salmon including:

- Causing stress and/or physical harm to the fishes during radio tagging using the gastric insertion method;
- Increasing the susceptibility to predation and displacement following the release of adults into the Sacramento River;
- Potential mortality associated with tag antenna snagging on debris, although the tag manufacturer has designed the antenna to minimize this possibility.

We do not anticipate direct or indirect mortality to result from this study but also cannot completely discount the potential occurrence. We request an allowance of 10% mortality (i.e., take) of the total number of fish tagged.

12.9) Level of take of listed fish: number or range of fish handled, injured, or killed by sex, age, or size, if not already indicated in Section 2 and the attached "take table" (Table 1).

Winter Chinook Carcass Survey:

We estimate take resulting from this project, in the form of minimal disturbances to winter Chinook spawners, will potentially affect approximately 100% of the winter Chinook spawners annually. Effects of this disturbance are expected to be negligible, similar to that experienced when a fishing boat passes through a section of river. Additional take in the form of handling dead carcasses of winter Chinook spawners will occur to approximately half the abundance of spawners. This estimate is based on an average handling rate of approximately 50% of total estimated abundance on the carcass survey. Disturbances to winter Chinook are reduced by avoiding areas where active winter Chinook spawning is occurring. We do not anticipate take of other listed species to result from project activities because they are either not expected to be spawning at that time of this survey (steelhead, spring Chinook, green sturgeon) and/or they are not known to in shallow water habitats of the upper Sacramento River, where this survey occurs (green sturgeon).

Winter Chinook Acoustic Tagging Study:

We anticipate take of up to 50 winter Chinook spawners annually from Return Years 2012, 2013, and 2014. Take will be in the form of behavioral modifications resulting from the gastric insertion of a radio tag and an antenna protruding from the mouth. We do not expect any direct or indirect mortality to result from this project but also cannot completely discount its potential. We request an allowance of 10% mortality (i.e., take) of the total number of fish tagged.

12.10) Alternative methods to achieve project objectives.

Winter Chinook Carcass Survey:

This study is the primary method of monitoring the effects of the winter Chinook propagation program and estimating the abundance of winter Chinook. No alternative methods are known to exist that accomplish these objectives with a lower level of impacts.

Winter Chinook Acoustic Tagging Study:
The need for this study has been identified in hatchery evaluation reports for over a decade. No alternative methods have been identified to meet the study objectives with a lower level of impact.

12.11) List species similar or related to the threatened species; provide number and causes of mortality related to this research project.
These projects do not negatively affect other runs of Chinook salmon or steelhead.

12.12) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse ecological effects, injury, or mortality to listed fish as a result of the proposed research activities.
Winter Chinook Carcass Survey:
No live fish are handled during the course of conducting this monitoring activity. Disturbances to actively spawning winter Chinook are reduced by avoiding areas where fish are actively spawning.

Winter Chinook Acoustic Tagging Study:
This study will be conducted concurrently with winter Chinook broodstock collection to minimize or eliminate any additional stress associated with collection, anesthetization, and transport. Gastric insertion of acoustic tags requires minimal additional handling above and beyond that used in normal broodstock collection activities and will not require additional anesthetization or "mutilation" as no surgery will be performed.

SECTION 13. ATTACHMENTS AND CITATIONS

Include all references cited in the HGMP. In particular, indicate hatchery databases used to provide data for each section. Include electronic links to the hatchery databases used (if feasible), or to the staff person responsible for maintaining the hatchery database referenced (indicate email address). Attach or cite (where commonly available) relevant reports that describe the hatchery operation and impacts on the listed species or its critical habitat. Include any EISs, EAs, Biological Assessments, benefit/risk assessments, or other analysis or plans that provide pertinent background information to facilitate evaluation of the HGMP.

Reports and other documents associated with the winter Chinook salmon propagation program can be found at the U.S. Fish and Wildlife Service's Red Bluff Fish and Wildlife Office website: http://www.fws.gov/redbluff/he_reports.aspx

SECTION 14. CERTIFICATION LANGUAGE AND SIGNATURE OF RESPONSIBLE PARTY

"I hereby certify that the information provided is complete, true and correct to the best of my knowledge and belief. I understand that the information provided in this HGMP 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."

Name, Title, and Signature of Applicant:

Certified by: ____________________

Print (Name/Title): SCOTT HAMELBERG / PROJECT LEADER

Date: 7/2/2013

Attachment 1. Study Proposal: Tracking the movements of adult winter Chinook released from the Keswick Dam Fish Trap (March 8, 2013).

Study Proposal:

Tracking the movements of adult winter Chinook released from the Keswick Dam Fish Trap

U.S. Fish & Wildlife Service
Red Bluff FWO: Hatchery Evaluation Program
&
Coleman National Fish Hatchery Complex

March 8, 2013

Background:
In 2012 the U.S. Fish and Wildlife Service (Service) initiated a three year study aimed at tracking the broad-scale movements and eventual spawning locations of winter Chinook salmon collected at the Keswick Dam Fish Trap (KDFT) coincidental with the capture of broodstock for the propagation program at the Livingston Stone National Fish Hatchery (Livingston Stone NFH). Chinook salmon not meeting the broodstock selection criteria and those in excess of monthly collection targets are released into the upper Sacramento River to spawn naturally. A total of 21 winter Chinook from the KDFT were radio tagged during March 2012. Movements of these fish followed three generalized patterns:

1. Three of the 21 radio tagged winter Chinook exhibited localized movements of short duration, with movements ceasing prior to the observed onset of spawning. This movement pattern is presumed to indicate that the radio tags were either regurgitated or the tagged fish died soon after release into the Sacramento River.
2. Six of the 21 tagged fish exhibited successive movements within viable winter Chinook spawning areas of the upper Sacramento River. Movements by these fish extended several weeks after release and ceased during or after the primary spawning period of winter Chinook. This movement pattern is suggestive of spawning behaviors and these fish are presumed to have spawned in naturally the upper Sacramento River.
3. Twelve of the 21 tagged fish remained in the general vicinity of the release site immediately following their release. From two to three weeks after their collection at the KDFT and prior to the onset of the primary spawning period of winter Chinook these 12 fish exhibited sustained downstream movements, taking them far outside of the range of viable winter Chinook spawning areas. Following their downstream migrations, none of these twelve fish were observed to re-enter viable winter Chinook

spawning areas. The extended distance of the downstream movements exhibited by these fish was not indicative of carcass drift.

The observation that the majority of radio tagged winter Chinook released from the KDFT in 2012 moved far downstream and out of viable winter Chinook spawning habitats prior to the onset of spawning was quite unexpected and has raised many questions as to its possible cause(s). At least three possible causes for this behavior have been identified, and are generalized as follows: (1) the observed movement reflects a natural behavior characteristic of Sacramento River winter Chinook; (2) the behavior is atypical of winter Chinook, but results instead from the influence of gastrically-applied radio tags; and (3) the behavior is an incidental effect of the trapping and handling activities associated with the collection and winter Chinook broodstock at the KDFT. It is unlikely that the observed pattern of movement reflects a natural behavior of Sacramento River winter Chinook. Viable spawning habitats for winter Chinook do no occur downstream of Red Bluff, so the movements exhibited by these fish would be maladaptive to their survival and unlikely to be perpetuated within the population. Unfortunately, deciphering the true cause of this observed behavior between the remaining two factors is confounded because the study conducted in 2012 does not provide conclusive evidence to discriminate between the effects of gastrically-applied radio tags versus the incidental effects of trapping and handling winter Chinook at the KDFT.

Modified Study Design for 2013

The design of the study for tracking the broad-scale movements of adult winter Chinook during the 2013 spawning season has been modified from that employed in 2012. The intent of the modifications is to provide additional information that will be helpful to elucidate the effects of gastric tagging on the patterns of movement by fish released into the river. The approach and details of the study design were the focus of a meeting held at the Sacramento office of the National Marine Fisheries Service on February 27, 2013, which included representatives from the Service (Hamelberg, Smith, Null, Niemela), NMFS (Alston, Oppenheim, Cranford), and CDFW (Berry). A general study design was agreed to by participants of that meeting, and has since received minor modifications to improve its performance and execution.

Similar to the study conducted in 2012, fish to be tagged in 2013 will be collected during the course of regular trapping of winter Chinook broodstock for the propagation program at the LSNFH. Fish used for this study will be selected from phenotypic winter Chinook captured at the KDFT during March and early April. Winter Chinook collected at during this time period are sexually immature and, based on tagging trials conducted using late-fall Chinook at the Coleman NFH, capable of being gastrically tagged without a high risk of stomach rupture. A sample of fin tissue will be collected from every trapped fish. Tissue samples will be submitted (either through real-time “rapid response” analysis or at the conclusion of the broodstock collection season) to the Conservation Genetics Laboratory at the Service’s Abernathy Fish Technology Center, Longview, WA, for confirmation of run identity. Trapped fishes will be separated into two groups, as follows, including broodstock for the propagation program at the Livingston Stone NFH and a study group to be tagged and released to spawn naturally.

Hatchery Broodstock: Natural-origin fishes both meeting the phenotypic criteria of winter Chinook and falling within the monthly collection targets of the winter Chinook propagation program will be retained for broodstock at the Livingston Stone NFH. Notwithstanding the exceptions listed in Subset A (below), the protocols for capturing and handling these fish will remain unchanged from standard protocols, as described in the Service's current winter Chinook broodstock collection plan (Attachment A) and the project description contained in the current section 10 permit application, including: the total number of broodstock that will be retained (maximum 120), the schedule for collecting these fish, the criteria for selecting these fish, and the protocols for holding these fish in captivity (including the use of malachite green as anti-fungal treatments).

Broodstock Subset A. A subset of fifteen natural-origin winter Chinook that are retained as hatchery broodstock will be gastrically tagged with either an active (n=5) or inactive (n=10) acoustic tag (VEMCO Ltd, Nova Scotia, Canada, model V13-1X). Gastrically tagged broodstock will be housed together in the same tanks as standard hatchery broodstock and will be handled similarly, with the exception that they will not be given an intraperitoneal injection of the antibiotic oxytetracycline. Withholding this prophylactic antibiotic treatment is being done so that the gastrically tagged broodstock component provide a similar representation of the responses to bacterial loads experienced by the acoustic tagged release group (described below). Gastrically tagged winter Chinook broodstock will be observed daily for morbidity or mortality. Active acoustic tags applied to winter Chinook broodstock will serve a dual purpose of also allowing an assessment of tag life. Information gathered from acoustic tagged hatchery broodstock will be used to infer whether the patterns of movements observed in the river are likely a result of gastric tagging or tag failure.

Acoustic Tagged Release Group: Twenty-five phenotypic winter Chinook that are not selected as hatchery broodstock will be gastrically tagged with an active acoustic tag and released into the Sacramento River to spawn naturally. This group may include either hatchery- or natural-origin winter Chinook; however, we anticipate that the majority of fish in this group will be of hatchery-origin as most natural-origin winter Chinook captured at the KDFT are retained for use as broodstock. Broad scale movements of acoustic tagged winter Chinook in the Sacramento River will be monitored using fixed station acoustic receivers (Attachment B).

All winter Chinook receiving an acoustic tag, including hatchery broodstock and the acoustic tagged release group, will receive two dart tags, as per standard protocol for fish trapped and released from the KDFT. Uniquely coded dart tags will enable the identification of acoustically tagged fish and the association of individual fish to a specific trapping event. Any acoustic tagged fish that are subsequently recovered on a carcass survey will be examined internally and externally to investigate the effects of tagging.

Benefits of the modified study design:

- Similar to the study conducted in 2012, the design of the 2013 study will track the broad-scale movements of winter Chinook salmon following their release from the KDFT. Of particular interest is whether tagged fish exhibit movement patterns similar to those observed in 2012, when a majority of tagged fish exited viable spawning areas prior to spawning. The modified design of the study for the 2013 winter Chinook spawning season offers an improvement over the study conducted in 2012 in that it will elucidate whether the observed patterns of movement likely occurred as a result of morbidity and/or mortality resulting from gastric tagging. Observances of morbidity and/or mortality within the acoustic tagged broodstock at the hatchery, and the timing of these occurrences, will be used to infer whether the process of gastric tagging results in movements observed in the river.