Late-fall Chinook Salmon Propagation at Coleman National Fish Hatchery
Program Information and considerations for the Delta Action-8 Studies
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Program Goals

The goal of the Coleman National Fish Hatchery's (Coleman NFH) late-fall Chinook salmon propagation program is to mitigate for the loss of anadromous fish habitat and the consequent reduction in salmonid populations resulting from the construction and operation of the Shasta Dam. Mitigation is conducted for the purpose of contributing to harvest in the Sacramento River sport fishery and the ocean sport and commercial fisheries. Additionally, in order to perpetuate the propagation program it is essential that adequate numbers of adults escape the fishery and return to the hatchery to be collected as broodstock. Supplementation of natural spawning late-fall Chinook salmon is not a current goal of the program.

The U.S. Fish and Wildlife Service conducts the late-fall Chinook propagation program with the intent to achieve program goals while imposing minimal risks to natural spawning populations. This is accomplished by following genetically conscious spawning strategies, releasing fish at the smolt stage to encourage rapid emigration, and releasing production fish on-site to reduce the likelihood of straying.

As many as half the late-fall Chinook juveniles produced from each brood year are released at alternate locations and/or times to accommodate various investigations. Release locations and timing for off-site releases are coordinated with and approved by the National Marine Fisheries Service and the California Department of Fish and Game.

Broodstock Collection

Late-fall Chinook broodstock are collected at the Coleman National Fish Hatchery throughout the duration of run timing. Hatchery origin adults returning to Battle Creek are the primary source of late-fall Chinook brood stock for the propagation program. Up to 10% of the broodstock are natural origin late-fall Chinook collected at the Keswick Dam Fish Trap on the upper Sacramento River. Natural origin late-fall Chinook are spawned at the Coleman NFH to reduce the likelihood of deleterious genetic impacts that may occur to an isolated hatchery stock (e.g., increased domestication and genetic divergence from the natural spawning population). Maintaining genetic similarity of hatchery and natural origin fish is an important goal for the Service's late-fall Chinook propagation program to reduce genetic and ecological risks to natural populations.

Spawning

Spawning of late-fall Chinook begins in late-December and continues through February. Hatchery spawning schedules, including spawn dates and target numbers of broodstock, are developed prior to the onset of each spawning season. Spawning schedules are designed to mimic the hypothetical bell-shaped distribution of natural spawning populations. For example, the number of fish spawned at the tails of the spawning distribution (i.e., beginning and end of the run) are generally smaller and the egg-takes

are less frequent as compared to the middle (mode) of the spawning distribution when egg-takes are generally larger and spawning events occur more frequently.

Annual spawning targets for late-fall Chinook are determined by "working backwards" from a juvenile release target (currently 1-million smolts) and accounting for fecundity and survivability of eggs and juveniles prior to release. Fecundity, the average number of eggs per female, is initially estimated based on data from previous years and adjusted in-season by sampling several female spawners. Survivability estimates of eggs and juveniles at the hatchery are based on data from previous years. Based on these parameters and a pairwise mating strategy (i.e., a single male paired with a single female), the number of late-fall Chinook required to meet current production targets at the Coleman NFH is about 560 – 600 spawners, comprised of half males and half females.

During recent years the Service has spawned about twice the number of late-fall Chinook needed to meet production targets at the Coleman NFH (i.e., about 1,200 spawners or 600 spawning pairs). Prior to hatch, approximately half the eggs produced from hatchery origin broodstock are then culled at the eyed stage. Eggs resulting from matings involving natural origin broodstock are not culled. These protocols are designed to maintain the genomic diversity of the hatchery stock and to prevent genetic divergence from naturally produced late-fall Chinook salmon without exceeding hatchery production targets.

Experimental releases are "built into" the production program during the preparation of hatchery spawning schedules. Meaning that, experimental groups (off site releases or altered release timing) are dedicated from specific spawn 'takes' at the time the eggs are collected at the hatchery. This is done to maintain the genetic diversity of the parent population within the fish that are expected to return to the hatchery as adults while compensating for altered survivability and/or decreased return to the hatchery that is typically associated with experimental release groups. For example, releases of late-fall Chinook associated with the Delta Action-8 study from 1997 to 2001 returned to the hatchery at rates ranging from 1/8 to 1/23 that of the general production release groups. For some experimental release groups, especially those fish released into the inner Delta (e.g., Georgiana Slough) or those released early (e.g., November Spring Chinook Surrogates) decreased return to the hatchery results from reduced survival. However, for groups of fish released at other locations of the lower Sacramento River or Delta (e.g., Ryde-Koket and Port Chicago) the lowered rate of return is associated with substantially increased straying. From 54% to 84 % of the delta releases of late-fall Chinook from 1993 to 1995 associated with the Action-8 study strayed to freshwater locations other than Battle Creek. Straying decreases sport harvest in the upper Sacramento River, decreases escapement of adults to the hatchery, and increases the likelihood of negative impacts associate with the hatchery's propagation program.

Egg Incubation and Juvenile Rearing

Late-fall Chinook salmon eggs are incubated in incubation trays until hatched, when they are transferred into hatchery raceways, or "ponded". Egg takes are ponded separately in

order to help standardize fish size within each raceway. This is necessary to encourage uniform growth. As the fish in any given raceway grow, the total biomass of fish is maintained within acceptable limits by splitting the fish from single raceways into multiple raceways. Initial loading density index[1] for raceways of late-fall Chinook at Coleman NFH average 0.07, and final loading densities average 0.13. Transfers or "splits" of late-fall Chinook to final ponding densities are completed during mid-August to mid-September. Final pond loadings are approximately 70-75,000 yearling smolts per raceway.

Marking and Tagging

Since broodyear 1992 all late-fall Chinook salmon produced at the Coleman NFH have been adipose fin-clipped and coded-wire tagged prior to release (hereafter referred as "marked" and "tagged"). The primary purpose for marking and tagging all hatchery origin late-fall Chinook is to differentiate them during the period of juvenile emigration from naturally-produced, ESA-listed winter Chinook salmon.

Marking and tagging all late-fall Chinook produced at the Coleman NFH requires approximately two months to complete. Marking and tagging typically begins in mid-October, immediately after the marking of hatchery produced steelhead, and continues through mid-December.

Releases of Juvenile Late-fall Chinook

General production late-fall Chinook juveniles are released as yearling smolts. The target release size for late-fall Chinook is about 135 mm, or approximately thirteen fish per pound. Releases occur in Battle Creek in early January.

As many as half the late-fall Chinook juveniles produced at the Coleman NFH are released at alternate locations and/or times to accommodate various investigations (Table 1). Recent and ongoing investigations involving late-fall Chinook from the Coleman NFH include the following:

1) November and December Releases into Battle Creek, designed to serve as surrogates for ESA-listed spring Chinook salmon
2) Evaluations of survival related to delta inflow and exports
3) Evaluations of survival related to operations of the Delta Cross-channel.

[1] **Error! Main Document Only.**Density indices are calculated using the following equation: DI = W/(FL*V), where DI = density index, W = weight of fish in rearing unit (lbs.), FL = average fork length (inches), and V = volume (ft3) of rearing unit.

Table 1. Typical release strategy for juvenile late-fall Chinook salmon produced at the Coleman National Fish Hatchery (NFH).

Release number (x1,000)	Average fork length at release (mm)	Release location	Release timing	Purpose
210	135	Battle Creek @ Coleman NFH	Nov, Dec	Experimental - Spring Chinook Surrogates
290	135	Various Delta Locations	Dec -Jan	Experimental - Delta Survival Evaluations
500	135	Battle Creek @ Coleman NFH	January	General Production

Juvenile releases of experimental groups are linked back to the preseason hatchery spawning schedule so that the temporal distribution of the spawning run is maintained within the broodstock. For example, the release schedule of late-fall Chinook from broodyear (Figure 1) shows general production releases covering the entire distribution of the late-fall spawning season at the Coleman NFH. Experimental release groups (e.g., Action-8 and spring Chinook surrogates) are taken, to the extent possible, from spawning takes that are also represented by general production releases.**Error! No topic specified.**

Transporting Off-site Releases

Two aerated, 1,200-gallon fish distribution trucks are used to transport off-site release groups. Availability of truck drivers for off-site release groups can sometimes be limited. Currently, 3 staff at the hatchery are certified as operators of fish distribution trucks. Motor vehicle operators share this responsibility with several other duties at the hatchery, such as conducting spawning operations, so the ability to transport off-site groups can sometimes be limited as a result of driver unavailability. Occasionally, drivers from other USFWS offices have been enlisted to assist with the transportation of off-site releases for the delta releases.