

2017-2018 SALMONID SPAWNING AND RELEASE OPERATIONS AT NIMBUS FISH HATCHERY

Background

The Nimbus Fish Hatchery (NIM) conducts an artificial propagation program for fall-run Central Valley (CV) Chinook salmon and steelhead trout on the Lower American River (LAR). CV fall-run Chinook are listed as a Species of Special Concern by the California Department of Fish and Wildlife (CDFW) and a Species of Concern by the National Marine Fisheries Service. Natural origin CV steelhead are listed as a threatened species by the National Marine Fisheries Service. Hatchery origin steelhead trout at NIM are not considered to be part of the steelhead CV evolutionary significant unit (ESU) and for that reason are segregated from natural origin steelhead returning to the hatchery. The potential for replacing NIM steelhead trout with other candidate stocks within the CV ESU is currently being evaluated.

NIM is operated by the CDFW under contract with the United States Bureau of Reclamation (Reclamation). The primary purpose of the hatchery programs is to mitigate for salmon and steelhead spawning and rearing habitat eliminated due to construction of Nimbus Dam in 1955, and secondarily to support river and ocean fisheries. Annual production targets are to release 4 million Chinook smolts (60-90 fish per pound) and 430,000 steelhead yearlings at 4 fish per pound.

During the extreme drought of 2014 and 2015, environmental conditions in the salmonid emigration corridor between Battle Creek and the Pacific Ocean were severely degraded. The U.S. Fish and Wildlife Service (Service) at Coleman National Fish Hatchery (CNFH) was concerned that releasing fall Chinook salmon into Battle Creek could result in very low survival or possibly a complete loss of the year's production of 12-million Fall Chinook salmon (FCS). As a result, the Service transported all FCS smolts to the Bay-Delta for release in 2014. Analysis of Coded Wire tags (CWT) from the 2016 escapement in the lower American River revealed 51 percent of ad-clipped fish were from CNFH. Estimated stray rates for CNFH FCS in 2017 are expected to be as high as 90 percent which would prevent CNFH from achieving production targets. Due to the predicted shortfall of FCS at CNFH, the Service is requesting to collect eggs and milt from stray CNFH salmon trapped at NIM, as well as unmarked FCS, then once the eyed-egg stage is achieved transfer to CNFH for rearing.

1.0 Fall-Run Chinook Broodstock Collection and Spawning Protocol

1.1 Weir and ladder operations

Adult Chinook salmon returning to the LAR are directed into the fish ladder by the fish weir. The weir will be installed on September 21, 2017. The weir will remain in place until December 15, 2017, but may be removed earlier if flows in the LAR are anticipated to exceed 5,000 cfs.

Water will be run through the fish ladder starting October 8, 2017, to attract fish to the ladder entrance. The ladder is typically opened in the first week of November but will be opened earlier to receive the CNFH origin fish, which typically start spawning in early October. The ladder gate will be opened on Monday, October 9, 2017, to allow fish to ascend the ladder in sufficient numbers for trapping. On the following day, fish will be brought into the hatchery in approximate groups of 20 fish at a time for sorting, counting, tagging, and spawning. Water temperatures in and near the hatchery are anticipated to be 60°F or less in October.

1.2 Broodstock collection and spawning

Spawning is planned to occur Monday through Friday or until the weekly egg collection goals for NIM and CNFH have been met. Collection for CNFH is scheduled to start on 10/9. Collection for NIM is scheduled to start on 10/23. In practice, spawn days may change depending on numbers of ripe fish. All fish will be spawned using a true 1X1 cross where one male and one female are combined in one spawning pan unless there are insufficient males or females toward the end of the spawning day. In this circumstance, the remaining fish will be spawned factorially, e.g., 2 males to 3+ females or 2 females to 3+ males, each spawned in individual tubs and combined after fertilization. Fish will be spawned, up to the daily target or weekly target which is approximately double the eyed egg goal. This practice will maximize potential genetic diversity within the two hatchery populations. Excess eyed-eggs will be culled proportionately from the Lots (Lot = spawning day) to shape the run timing.

Due to the likely high proportion of Coleman origin fish in early November, and the desire to limit their inclusion in the NIM broodstock while still incorporating as many natural origin LAR fish as possible, a change in NIM brood stock collection procedures will be put in place for 2017. For 2017, all known NIM origin fish will be spawned with an unmarked fish.

All Chinook entering the hatchery during the trapping period will be sorted by the presence or absence of an adipose fin.

1.2.1 Adipose-intact salmon

All unripe ad-intact Chinook will be tagged with two Hallprint dart tags, one on each side, along with a caudal fin hole punch, and returned to the river. The tag numbers, collection date, sex, and fork length in mm will be recorded. Any fish returning to the hatchery with a Hallprint tag will have the additional collection date(s) recorded and be returned to the river. Ad-intact, unripe grilse will be marked and returned to the river. Fish with suspect or partial ad-clips will be scanned to determine the presence or absence of a CWT. If the fish has a CWT it will be placed with the ad-clipped fish.

From 10/10 to 11/3 ripe, ad-intact fish will be paired and spawned for potential transfer to CNFH as eyed eggs. If the percentage of ad-clipped CNFH salmon that enter the hatchery is at least 75% of the total number of ad-clipped salmon entering the hatchery on that day, then the eggs from the ad-intact fish will be transferred to CNFH. If the percentage of ad-clipped CNFH salmon entering the hatchery is less than 75% the eggs will be discarded.

After 11/3 ripe, ad-intact fish will be paired with a known NIM CWT fish in a 1:1 ratio. If NIM is not able to meet its daily or weekly egg collection goals using a known NIM CWT fish paired with an ad-intact fish, additional fertilized eggs will be collected using only ad-intact fish. Eggs from the ad-intact only fish will be held in separate incubation jars and will be the first eggs to be culled if culling is necessary to get to production goals.

1.2.2 Adipose-clipped salmon

Unripe, adipose-clipped salmon will be sorted into the holding ponds by relative ripeness and checked periodically.

All ripe, ad-clipped salmon will receive an individually numbered jaw tag when they are placed on the spawning table. Males will receive a blue tag and females will receive a red tag. Eggs and milt will be expressed into a bag or cup, labeled with the jaw tag number, then placed on ice until Coded Wire Tag (CWT) information returns.

The carcass with jaw tag will be taken to the CWT shed where the head will be removed and the CWT extracted and read.

When the origin of the fish is determined, the information will be brought back to the spawning room where eggs from CNFH female will be fertilized with milt from a CNFH male with as close to 1:1 sex ratio as practicable. Eggs and/or milt from NIM fish will be combined with an unmarked salmon again using as close to a 1:1 sex ratio as practicable.

- No ad-clipped fish will be returned to the river
- Eggs from ad-clipped salmon missing a CWT will be discarded
- Eggs and milt identified as originating from hatcheries other than NIM and CNFH will be discarded.
- Ad-clipped grilse salmon (less than 68cm FL) will be sorted and held by ripeness with adult fish.
 - Grilse incorporation rate will be roughly 1% for NIM broodstock.
 - The goal for grilse incorporation rate for NCFH is 5%, however if in the very unlikely event there are a significant number of grilse identified as CNFH origin, they will be incorporated into the CNFH broodstock even if it exceeds the 5% target.

If, on the first spawn day, October 10th, there are insufficient numbers of ripe ad-clipped fish to spawn all unripe ad-clipped fish will be ponded (maximum of 400 fish per pond, 4 ponds total). Hatchery staff will assess at the end of the day whether or not to spawn the next day depending on the number of almost ripe fish.

NIM broodstock collection will continue throughout the spawning season in order to collect eggs from the entire run. The daily green egg collection target reflects the bell-shaped curve of the natural run as much as possible. A total egg take target of 8.9 million green eggs has been

established to provide assurances against unforeseen mortality and disease issues in order to achieve the 4 million smolt production goal while also maximizing the available parentage and natural origin incorporation. (Table 1)

Table 1. Proposed egg take table for NIM 2017 fall-run Chinook salmon spawning. Egg take goals for CNFH are not included.

Week	Number of NIM females required						Total Eggs	Proportion of total by week
	Monday	Tuesday	Wednesday	Thursday	Friday	Total		
Oct 23-29	7	8	7	8		30	150,000	2
Oct 30-Nov 5	15	15	15	15		60	300,000	3
Nov 6-12	30	45	45	45	X	165	825,000	9
Nov13-19	45	60	75	75		255	1,275,000	14
Nov20-26	90	105	105	X	X	300	1,500,000	17
Nov27-Dec3	120	135	135	120		510	2,550,000	29
Dec4-10	165	X	X	X	120	285	1,425,000	16
Dec11-17	60	45	45	30		180	900,000	10
Totals						1785	8,925,000	100

After the weir is removed on December 15, the ladder entrance will be kept open to maximize the number of Chinook that might enter the hatchery. All ad-clipped fish will be ponded and identified/spawned on Tuesday and Friday to increase the pool of potential NIM-origin fish. This may be adjusted in December depending on the CWT results throughout the spawning season. Chinook spawning will end when there is a week of insufficient number of ad-clipped fish ascending the ladder.

1.3 Pathology protocols

Following fertilization, eggs and sperm will be mixed with a chilled saline solution to extend sperm motility and aid in the fertilization process. Eggs will then be rinsed with ultraviolet-sterilized (UV) water and disinfected. During the disinfection procedure, eggs will be water-hardened in a 1:400 solution of iodine for 20 minutes, flushed with UV water, then placed into hatching jars.

During spawning, ovarian fluid samples from 60 adult females will be collected by CDFW Fish Pathology Lab staff to monitor for disease including for Infectious Hematopoietic Necrosis Virus (IHN). If disease appears to be present in eggs, pathology lab personnel will plate smears and send samples to a contracted lab for virology testing.

1.4 Egg Incubation

If incoming water temperatures are above 57°F, eggs will be incubated at, or below 57°F in Hatchery Building Two using hatching jars connected to portable tank top recirculating aquaculture systems (RAS) which use ultraviolet light and chillers to sterilize and chill the water. If incoming water is below 57°F eggs will be incubated in hatching jars in Hatchery Building One. Eggs collected for CNFH will be kept separate from NIM eggs and incubated to the eyed stage to limit losses associated with transporting green eggs.

1.5 Egg care, sorting and culling

Eggs will be checked daily to assure they are receiving adequate water flows. Moribund or dead eggs will be removed daily. When eggs become eyed they will be addled, picked and inventoried pursuant to production goals using the procedure below.

- At the eyed stage, eggs will be addled and allowed to rest for one to two days.
 - Dead eggs will be removed and discarded
- After addling, culling of eggs will commence in such a way as to closely mimic the natural bell-shaped curve of the abundance and timing of escapement and to represent as many family groups as possible
 - Eyed eggs in excess of the Lot goal will be discarded (culled) by removing an equal proportion of eggs from each Lot.
- Number of green eggs collected, number of eyed eggs culled and number of eyed eggs kept will be recorded to determine green egg to eyed egg loss
- After addling and picking, all CNFH eggs will be transferred to CNFH to be hatched, reared and released
- After addling and picking, 50% of the NIM eggs will be placed back into jars to hatch and 50% of the eggs will be put in hatching boxes to hatch.
 - Data will be collected on hatch rate, fish size at hatch, and observed fish condition to compare the two hatching methods

1.6 Rearing and feeding strategies

When 80% of the fish in the jars or hatching boxes have hatched, the remaining fish will be dumped into the troughs. After 1600 Thermal Units, the fry will be hand fed Bio-Oregon Bio-Vita to satiation at each feeding, 8 times a day depending on age and size. Once fish reach approximately 250/lb they will be transferred to outdoor concrete raceways. All FCS will be switched to Bio-Pro probiotic diet approximately 2 weeks prior to, and at least five days after coded wire tagging operations. Four to six weeks prior to release, or earlier if possible, all FCS will be switched to Bio-Supreme transfer diet. Bio-supreme transfer diet is specially formulated to help fish ease osmotic regulation when transferring to salt water. Recent studies at other Central Valley Chinook hatcheries with a 2 week prerelease feed time have shown return rates up to 42% higher than control. Medicated and antibiotic feeds will be used if necessary as prescribed by CDFW pathologists.

2.0 Salmon Production Goals

The current mitigation release goal for fall-run Chinook salmon from NIM is 4 million smolts (± 10 percent) at 60 to 90 fish per pound.

To account for mortality, a loss buffer over the production goal will be used for green egg collection. Survival from green to eyed egg stage has been variable by Lot from as high as 88% to as low as 0% for the last three years where survival data have been collected. Figure 3 presents survival from green to eyed for 2015. This buffer allows for potential mortality in egg lots and culling of lots, if necessary, due to differential survival between lots. Culling will be done so the last tally of eyed eggs prior to ponding fish represents an estimated 10 percent

over the release goal to provide a buffer for loss between eyed egg and release.

3.0 Salmon Marking and Tagging

Fish will be marked and tagged (adipose fin clip and a CWT inserted at the standard Constant Fractional Marking rate of twenty-five percent when they reach a minimum of 120 fish per pound. A total of 6 different tag codes will be used to differentiate between brood years and release locations.

4.0 Salmon Release Strategy

In 2017, NIM hatchery personnel will replicate the release strategy that was implemented in 2016. All Chinook will be released in complete CWT groups of approximately 666,667 fish per group at approximately 60-80 fish to the pound.

- Thirty-three percent of Chinook will be released in the lower American River at the Sunrise Boulevard boat launch at approximately 60-80 fish per pound.
- Thirty-three percent will be released in the lower American River at the Jibboom Street Bridge at approximately 60-80 fish per pound.
- Thirty-three percent will be released into the San Pablo Bay acclimation net pens at approximately 60 fish per pound.

A paired release strategy will be used for the two in-river releases, with each release separated by approximately two weeks. A unique CWT group will be released at each in-river site per day, followed by another unique CWT group at each site approximately two weeks later. Two tag codes will also be used for the two days of net pen bay releases. Release dates will be in May and June 2018. Exact dates will be based on fish growth, Delta Cross Channel Gates (DCC) operation, and water conditions at the release sites and downstream.

The NIM Technical Team, a subset of the Hatchery Coordination Team, will meet starting in September and continue meeting through the release season as necessary to discuss specific release dates and logistics.

4.1 Criteria and Contingencies

In coordination with the National Marine Fisheries Service (NMFS) CDFW has developed the following criteria and triggers that will be used to inform decisions on the release strategy to be implemented in 2018. These criteria and triggers were developed based on review of water temperature, river flow, and DCC Gates operations. The criteria identified below are designed to minimize the risk of exposing NIM-produced Chinook salmon to river conditions that could result in extremely low survival. Each of the criteria are intended to be independent of the others, meaning if any one or more of the criteria are anticipated to be met, then NIM-produced Chinook salmon will be transported to the acclimation net pens for release into San Pablo Bay. If none of the triggers are forecast to be met, then juveniles will be released into the American River, as described above.

DCC operations – Survival of juvenile salmon are significantly reduced when gates are open and increased numbers of fish are diverted into the interior Delta.

- DCC Gates are forecast to be open within 7 days of the date when the hatchery salmon are ready to be released.

Water Temperature – Increased water temperatures above 70°F degrees have been shown to be detrimental to juvenile survival.

- Sustained daily average water temperatures are expected to be greater than 74°F at Watt Avenue within 5 days of the date when the hatchery salmon are ready to be released.
- Sustained Daily Average Water temperatures are expected to be greater than 74°F at Freeport within 7 days of the date when the hatchery salmon are ready to be released.

Flow – Decreased flows in the Sacramento River can lead to significantly reduced survival of juvenile salmon because of reduced travel times exposing the fish to increased predation and increased risk of diversion into the interior Delta where survival is significantly reduced.

- An American River flow at Fair Oaks of less than 800 cfs is forecast to occur within days of the date when the hatchery salmon are ready to be released.
- A Sacramento River flow of less than 6,000 cfs at Freeport is forecast to occur within 7 days of the date when the hatchery salmon are ready to be released.
- Delta outflow is forecast to be less than 3,000 cfs within 7 days of the date when the hatchery salmon are ready to be released.

If during any of these assessments, existing/predicted conditions are expected to meet the criteria triggering consideration of the alternative release strategy, then preparations will begin, continue, or be implemented to truck appropriate groups of fish to the acclimation net pens in San Pablo Bay.