2023 – 2024 Annual Report

Feather River Fish Hatchery

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List of Abbreviations

BKD	Bacterial Kidney Disease
BY	Brood year
CAEP	Classroom Aquarium Education Program
CDFG	California Department of Fish and Game
CDFW	California Department of Fish and Wildlife
cfs	Cubic feet per second
CVFC	Central Valley fall-run Chinook Salmon
CVSC	Central Valley spring-run Chinook Salmon
CVSH	Central Valley steelhead trout
CVTA	Central Valley Tissue Archive
CWT	Coded wire tag
DWR	Department of Water Resources
FHL	CDFW Fish Health Laboratory
FRFH	Feather River Fish Hatchery
FRHOT	Feather River Hatchery Operations Team
HCl	Hydrochloride
IHNV	Infectious hematopoietic necrosis virus
NFFAA	North Fork Feather Above Almanor Reintroduction Feasibility Studies
NMFS	National Marine Fisheries Service
PBT	Parentage-based tagging
PSMFC	Pacific States Marine Fisheries Commission
RM	River mile
SFB	Silverado Fisheries Base
SJRRP	San Joaquin River Restoration Program
TDC	Thiamine deficiency complex

Executive Summary

This report summarizes the operations of the Feather River Fish Hatchery (FRFH) from July 1, 2023, to June 30, 2024 (Figure 1). It details the processes of trapping, broodstock tagging, spawning, rearing, marking, and releasing of Central Valley spring-run Chinook Salmon (*Oncorhynchus tshawytscha*), inland Chinook Salmon (*O. tshawytscha*), Central Valley fall-run Chinook Salmon (*O. tshawytscha*), and Central Valley steelhead trout (*O. mykiss*). It additionally compares the annual operations to those that were outlined in the corresponding spawning and release plans and highlights whether goals and objectives were achieved.

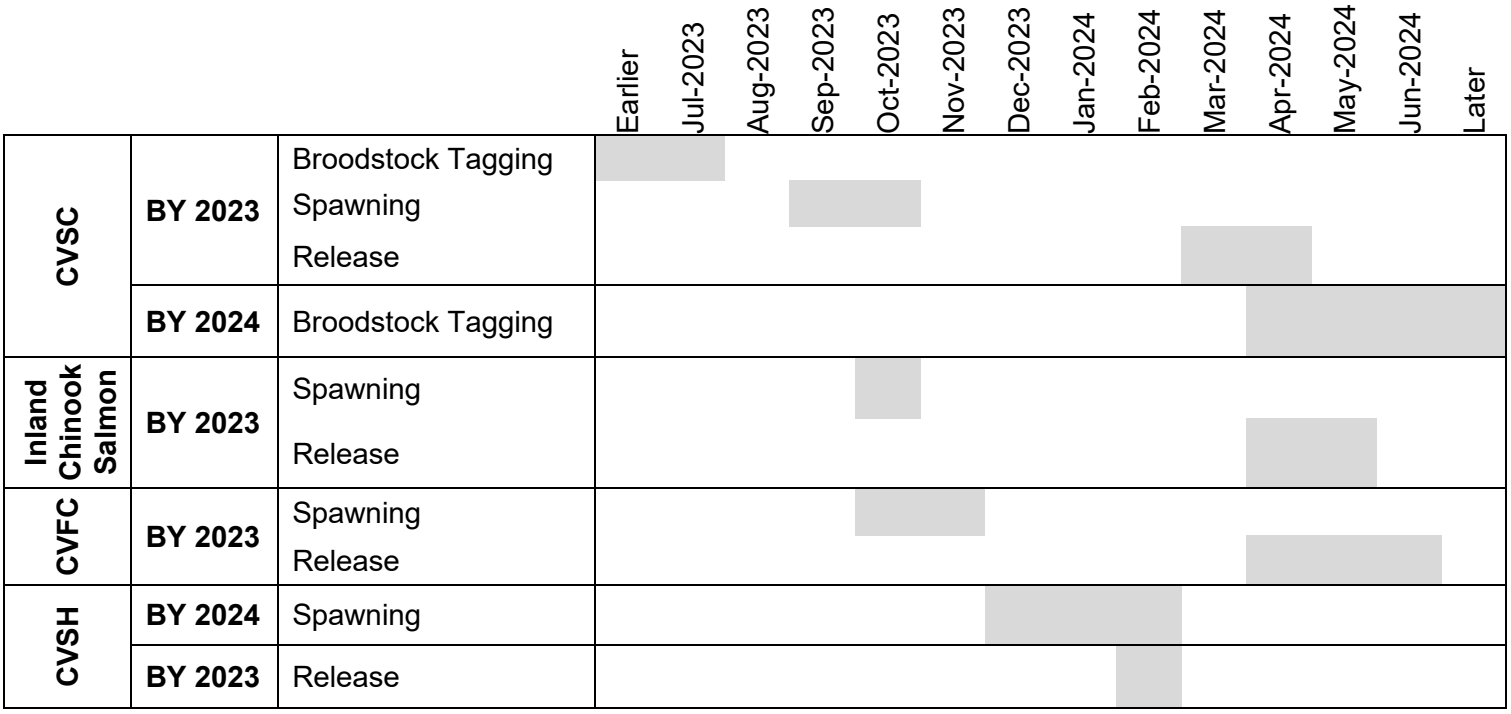

Figure 1. Timeline of broodstock tagging, spawning, and release activities at the FRFH for Central Valley spring-run Chinook Salmon (CVSC), inland Chinook Salmon, Central Valley fall-run Chinook Salmon (CVFC), and Central Valley steelhead (CVSH) by brood year from July 2023 through June 2024.

Central Valley Spring-Run Chinook Salmon Brood Year 2023 Production:

Production goals outlined in the 2023 Spring-Run Chinook Salmon Spawning and Release Plan

- 2,000,000 smolts (± 10%) for the California Department of Water Resources (DWR) mitigation production

Summary

Chinook Salmon are identified as broodstock for the spawning of Central Valley spring-run Chinook Salmon (CVSC) at the FRFH if they were marked with Hallprint tags in the preceding spring. Broodstock collection for brood year (BY) 2023 CVSC began at the FRFH on September 18, 2023, and spawning operations began shortly thereafter on September 20, 2023. A total of 1,394 Chinook Salmon marked with Hallprint tags entered the hatchery between September 18 and October 25, 2023. Through the subsequent analysis of coded wire tags (CWTs) extracted from fish marked with adipose fin clips, it was determined that the 2023 CVSC hatchery escapement was 1,529 fish. A total of 471 Hallprint-tagged females (466 also marked with an adipose fin clip) were spawned between September 20, 2023, and October 2, 2023, to produce a total of 2,353,470 fertilized eggs (i.e., green

eggs). The green eggs collected during BY 2023 CVSC spawning operations accounted for 66.3% of the green egg collection goal outlined in the corresponding Spawning and Release Plan. An 87.3% survival rate during early development resulted in the production of 2,054,998 eyed eggs. Once the eyed eggs hatched into fry, the fry were transferred to the outdoor rearing environment (i.e., ponded) and later processed for tagging 100% of fish with CWTs and marking 100% of fish with adipose fin clips. During the tagging and marking process, 1,960,780 BY 2023 CVSC juveniles were enumerated, indicating that 95.4% of eyed eggs survived to that point. Releases of BY 2023 CVSC aligned with the strategy described in the Spawning and Release Plan for releasing all juveniles into the lower Feather River using three paired releases at the Boyd's Pump Boat Launch and Gridley Boat Launch during the months of March and April in 2024. A total of 1,960,780 CVSC smolts (98% of the 2,000,000 CVSC smolt production goal) were released into the Feather River when they were sized at 61-135 fish per pound.

Central Valley Inland Chinook Salmon Brood Year 2023 Production:

Production goals outlined in the 2023 Fall-Run Chinook Salmon Spawning and Release Plan for production of inland Chinook Salmon

- Inland Chinook Salmon reared at the FRFH:
    - 125,000 triploided fingerlings to support the requisite DWR cold-water fishery in Lake Oroville
    - 125,000 triploided fingerlings to support the CDFW Statewide Inland Salmon Program for release into Lake Spaulding and Pine Flat Reservoir
- Inland Chinook Salmon triploided green eggs transferred to the Silverado Fisheries Base (SFB):
    - 1,200,000 green eggs to support the CDFW Statewide Inland Salmon Program
    - Up to 300,000 green eggs to support the North Fork Feather Above Almanor Reintroduction Feasibility Studies (NFFAA)

Summary

The broodstock used to produce inland Chinook Salmon at the FRFH is composed of Chinook Salmon that return to the FRFH during the CVSC spawning period but are not marked with Hallprint tags. Inland Chinook Salmon spawning at the FRFH began on October 3, 2023, and ended on October 10, 2023. A total of 483 females (212 marked with an adipose fin clip and 271 with an intact adipose fin) were spawned, producing a total of 2,089,967 green eggs. After fertilization, all green eggs were triploided using standard methods, which rendered the fish reproductively sterile. Approximately 1,409,087 of these green eggs were immediately transferred to the SFB to support both the Statewide Inland Salmon Program and the NFFAA. The transferred green triploid eggs accounted for 93.9% of the green egg goal. In support of both the cold-water fishery in Lake Oroville and a portion of the Statewide Inland Salmon Program (Lake Spaulding and Pine Flat Reservoir), approximately 680,880 triploid green eggs were retained and incubated at the FRFH. These eggs accounted for 126.2% of the green egg collection goal to remain at the FRFH for rearing. Due to an unforeseen loss of the first lot of fertilized eggs at the FRFH, only a total of 220,237 eyed eggs were produced, resulting in a 32.3% green-to-eyed egg survival rate. An estimated 203,642 fry were subsequently ponded, resulting in 92.5% eyed egg to fry survival rate. Inland Chinook Salmon are not released with any type of external mark or tag and are therefore not enumerated during tagging operations. Instead, the release estimates are based on the average weight of each fish and the approximate weight of all truckloads of fish being released. In 2024, approximately 138,000 BY 2023 inland Chinook Salmon (110.4% of the production goal) were planted into Lake Oroville on May 6,

2024, at the Loafer Creek Service Ramp. At the time of release, these fish were sized at approximately 46 fish per pound. Additionally, approximately 100,000 juveniles reared at the FRFH and allocated to the Statewide Inland Salmon Program were released into Pine Flat Reservoir on April 5, 2024, resulting in 100.0% of the production goal. These fish were approximately 85 fish per pound at the time of release. The production goal for Lake Spaulding was unable to be met through production at the FRFH due to the unexpected loss of eggs in the first lot. Instead, the allotment goals for Lake Spaulding were achieved through production at SFB, where 33,800 inland Chinook Salmon were released on May 3, 2024.

Central Valley Fall-Run Chinook Salmon Brood Year 2023 Production:

Production goals outlined in the 2023 Fall-Run Chinook Salmon Spawning and Release Plan for production of anadromous fall-run Chinook Salmon

- 6,000,000 smolts (± 10%) for DWR mitigation production
- 2,000,000 smolts (± 10%) for drought production
- 1,500,000 pre-smolts (± 10%) for drought production

Summary

Adult Central Valley fall-run Chinook Salmon (CVFC) began arriving at the FRFH concurrently with the CVSC broodstock; however, only fish that entered the hatchery as early as October 11, 2023, and that were not marked with Hallprint tags, were used as CVFC broodstock. A total of 18,799 Chinook Salmon that returned to the hatchery between September 18, 2023, and December 20, 2023, were originally classified as CVFC during spawning operations due to the absence of Hallprint tags. Subsequent CWT analysis revealed that 465 of those fish contained a CVSC CWT. Additionally, there were eight Hallprint-tagged fish that contained a CVFC CWT. This resulted in a final FRFH CVFC escapement value of 18,342 fish for 2023. Spawning of CVFC began on October 12, 2023, and ended on November 16, 2023. A total of 2,720 females (710 marked with adipose fin clips and 2,010 with their adipose fin intact) were spawned, producing 16,832,847 green eggs. The green eggs collected during BY 2023 CVFC spawning operations exceeded the green egg collection goal outlined in the corresponding Spawning and Release Plan by 21.9%. Of the 16,832,847 green eggs collected, 12,919,025 (79.2%) survived to the eyed egg developmental stage. Once the eyed eggs hatched into fry, the fry were ponded in the outdoor rearing raceways and later tagged and marked at a rate of 25% with CWTs and adipose fin clips. During the tagging and marking process, 10,738,003 BY 2023 CVFC juveniles were enumerated, indicating that 83.1% of eyed eggs survived to that point. Releases of BY 2023 CVFC aligned with the strategy described in the Spawning and Release Plan, and across all production groups, 10,651,965 BY 2023 CVFC (112.1% of the production goal) were released from the FRFH into the Feather River and the San Francisco and San Pablo bays in April, May, and June of 2024. Specifically, 1,712,616 CVFC pre-smolts produced for drought were released into the Feather River at the Gridley Boat Launch. These fish were released as three distinct release groups, with each group being tagged and marked at a rate of 25% with both CWTs and adipose fin clips, and with 100% of fish being tagged through parentage-based tagging (PBT). These fish were released in April 2024, and the average fish size ranged from 90 to 100 fish per pound at the time of release. A total of 2,017,428 CVFC smolts produced for drought were released as two groups, each tagged and marked at a rate of 25% with both CWTs and adipose fin clips, into the San Francisco Bay at the Estuary and Ocean Science Center in Tiburon as nighttime direct releases. These fish were released in May and June 2024, when the average fish size ranged from 63 to 71 fish per pound. The CVFC smolts produced for DWR mitigation objectives, totaling approximately 6,921,921

fish, were released into the Feather River (1,010,515 smolts), the San Francisco Bay at Tiburon (897,262 smolts), the San Pablo Bay at Mare Island (3,973,826 smolts), and the San Pablo Bay at the Cal Maritime Academy (1,040,318 smolts). These fish were all tagged and marked at a rate of 25% with both CWTs and adipose fin clips, and unique CWT codes were assigned to the fish in each release group. The release of CVFC into the Feather River occurred in April 2024, while the other releases of CVFC smolts produced for mitigation objectives occurred from May through June 2024. The average size of fish at release ranged from 56 to 77 fish per pound.

Central Valley Steelhead Brood Year 2024 Production and Brood Year 2023 Release:

Production goals outlined in the 2024 Steelhead Spawning and Release Plan

- 400,000 yearlings (± 10%) for DWR mitigation production
- 50,000 yearlings (± 10%) to support the 1986 Delta Fish Agreement between DWR and the California Department of Fish and Game (CDFG)

Production goals outlined in the 2023 Steelhead Spawning and Release Plan

- 400,000 yearlings (± 10%) for DWR mitigation production
- 50,000 yearlings (± 10%) to support the 1986 Delta Fish Agreement between DWR and CDFG

Summary

Operations at the FRFH regarding Central Valley steelhead (CVSH) pertained to both BY 2023 and BY 2024 during the 2023-2024 annual report period. They included the spawning and rearing of BY 2024 CVSH as well as the rearing and release of BY 2023 CVSH. For BY 2024 CVSH production, broodstock collection began at the FRFH on December 13, 2023. Spawning was initiated shortly thereafter on December 20, 2023, ending on February 7, 2024. During this time, 2,216 adult CVSH (1,149 males and 1,067 females) were trapped for broodstock. In total, 672 females (657 marked with an adipose fin clip and 15 with an adipose fin intact) were spawned, resulting in the collection of 1,958,234 green eggs. Following daily spawning operations, a total of 1,011 adipose fin-clipped adult male CVSH kelts were released into the Thermalito Afterbay to enhance the recreational fishery. The collection of 1,958,234 green eggs exceeded the goal outlined in the 2024 CVSH Spawning and Release Plan by 30.5%. Approximately 1,488,257 eyed eggs developed, resulting in a green-to-eyed egg survival rate of 76.0%. A total of 449,218 eyed eggs were culled to meet fish allotment limits, leading to the retention of 1,039,039 eyed eggs at the hatchery. An estimated 1,009,985 CVSH were ponded into the FRFH raceways, resulting in a 97.2% eyed egg to fry survival rate. These fish are designated to be released as yearlings in 2025. In 2024, BY 2023 CVSH yearlings were released. A total of 445,740 BY 2023 CVSH yearlings were released into the Feather River at the Boyd's Pump Boat Launch starting on February 5, 2024, and ending on February 13, 2024. An additional 23,200 BY 2023 CVSH yearlings were released into the Thermalito Afterbay at the Wilbur Road Boat Launch on February 12, 2024, to contribute to the local fishery in coordination with DWR.

Introduction

This report describes operational activities at the Feather River Fish Hatchery (FRFH) between July 1, 2023, and June 30, 2024. As hatchery operations began in 1967, this annual report details its 56th year of operation. The FRFH is located on the north embankment of the Feather River, about four river miles downstream of the Oroville Dam, in the town of Oroville, in Butte County. The hatchery was constructed by the California Department of Water Resources (DWR) as part of the California State Water Project to mitigate for the loss of spawning habitat for Central Valley spring-run Chinook Salmon (CVSC), Central Valley fall-run Chinook Salmon (CVFC), and Central Valley steelhead

(CVSH) upstream of the Oroville Dam. CVSC are listed as threatened under the California Endangered Species Act, and CVSH and CVSC are both listed as threatened under the Federal Endangered Species Act.

The California Department of Fish and Wildlife (CDFW) operates the FRFH under contract with DWR. The facility consists of eight outdoor raceways which are each 600 feet long, two outdoor raceways which are each 300 feet long, and one rearing channel which is 0.5 miles long. Water is supplied to the hatchery through an intake within the Thermalito Diversion Pool. Water routinely exits the hatchery through two percolation ponds that collect discharged water and filter it back to the Feather River through percolation. In rare events, water from the hatchery may be discharged directly into the Feather River through three emergency overflow pipes. Influent and effluent are permitted through the State Water Resources Control Board order number R5-2014-0161 and abide with mandatory monitoring and reporting requirements.

Annually, Spawning and Release Plans are developed in coordination with the Feather River Hatchery Operations Team (FRHOT), which is a multi-agency team with representatives from CDFW, DWR, and NOAA Fisheries. These plans detail fish production and release objectives for the corresponding brood years (BY), which, for the present reporting period, includes BY 2023 CVSC, BY 2023 inland Chinook Salmon, BY 2023 CVFC, BY 2023 CVSH, and BY 2024 CVSH.

The following mitigation production goals were outlined in the 2023-2024 Spawning and Release Plans to support the requirement of DWR to mitigate for lost fish spawning habitat following the construction of the Oroville Dam:

- BY 2023 CVSC: 2,000,000 smolts (± 10%)
- BY 2023 CVFC: 6,000,000 smolts (± 10%)
- BY 2023 CVSH: 400,000 yearlings (± 10%) (rearing and release)
- BY 2024 CVSH: 400,000 yearlings (± 10%) (spawning and rearing)

In addition to the mitigation requirements, the 2023-2024 Spawning and Release Plans outlined the following supplementary juvenile production and egg transfer goals to support other fisheries programs and reintroduction efforts:

- BY 2023 CVSC: 5,470 eyed eggs to support the San Joaquin River Restoration Program (SJRRP)
- BY 2023 inland Chinook Salmon reared at the FRFH:
    - 125,000 triploided fingerlings to support the requisite DWR cold-water fishery in Lake Oroville
    - 125,000 triploided fingerlings to support the CDFW Statewide Inland Salmon Program for release into Lake Spaulding and Pine Flat Reservoir
- BY 2023 inland Chinook Salmon triploided green eggs transferred to the Silverado Fisheries Base (SFB):
    - 1,200,000 green eggs to support the CDFW Statewide Inland Salmon Program
    - Up to 300,000 green eggs to support the North Fork Feather Above Almanor Reintroduction Feasibility Studies (NFFAA)
- BY 2023 CVSH: 50,000 yearlings in accordance with the 1986 Delta Fish Agreement between DWR and California Department of Fish and Game (CDFG), which was established to aid in offsetting adverse impacts from the diversion of water at the Harvey O. Banks Delta Pumping Plant (rearing and release)

- BY 2024 CVSH: 50,000 yearlings in accordance with the 1986 Delta Fish Agreement between DWR and CDFG (spawning and rearing)

Drought conditions can pose significant challenges to Central Valley Chinook Salmon populations. Lower river flows, increased water temperatures, and decreased dissolved oxygen levels can negatively impact adult and juvenile survival (Notch et al., 2020; Singer et al., 2020). Such conditions can also lead to increased predation, disease transmission, and redd superimposition. To help offset potential impacts associated with multiple years of drought in the California Central Valley, actions were coordinated with the FRHOT and implemented during the 2023-2024 broodstock collection and spawning operations. The drought actions summarized below were intended to address impacts to both adult and juvenile life stages of CVSC and CVFC.

1. Release adult 2023 CVSC adults in excess of those required for broodstock to support mitigation production goals back to the river until the last scheduled day of spawning for the FRFH Inland Chinook Salmon Program. Excise all Hallprint-tagged fish that enter the hatchery after this date following normal practice.
2. Increase BY 2023 CVFC production goals to include an additional 1,500,000 pre-smolts to be released into the Feather River shortly after coded wire tagging, and 2,000,000 smolts to be released at sites along the San Pablo or San Francisco bays.
3. Extend the period of CVSC broodstock tagging to increase the availability of broodstock for spawning in 2024.

Drought actions 1 and 2 described above were completed during the 2023-2024 annual report period. Drought action 3 was not completed because a sufficient number of CVSC broodstock returned to the FRFH for Hallprint tagging in 2024 during the standard tagging window.

Hatchery Operations

Fish Ladder

On September 11, 2023, the installation of a fish ladder gate near the entry point of the fish ladder was successfully completed. This gate was designed to regulate the entry of broodstock into the fish ladder and hatchery. The primary goal of its implementation was to reduce fish handling and the mortality and culling of pre-spawned adult fish in the ladder and hatchery, thereby increasing the number of fish present in the natural spawning area in the Feather River. When the ladder gate is open (i.e., raised), fish can freely pass over the dam boards and under the ladder gate to ascend the fish ladder. When the gate is closed, fish are prevented from ascending the ladder and can volitionally return to the river.

On September 15, 2023, the ladder gate was opened, and a water flow of 16 cubic feet per second (cfs) descending the ladder was initiated to attract the 2023 CVSC broodstock into the hatchery. Ladder gate operations proceeded as described in Table 1 for the spawning of BY 2023 CVSC, BY 2023 inland Chinook Salmon, BY 2023 CVFC, and BY 2024 CVSH, and for the broodstock tagging of 2024 CVSC. Due to high flows in the river, the ladder gate was opened on March 1, and flows in the ladder were reduced to still prevent fish from ascending the ladder. On April 8, 2024, flows in the ladder were increased to allow tagging of 2024 CVSC broodstock. The ladder gate was closed on June 30, 2024, to prevent later migrating Chinook Salmon from ascending the ladder for CVSC broodstock tagging. The ladder was subsequently dewatered and closed on July 18, 2024.

Table 1: Ladder gate operations, 7/1/2023 – 6/30/2024.

Ladder gate opened	Ladder gate closed	Purpose
9/15/2023	9/30/2023	BY 2023 CVSC spawning
10/8/2023	11/13/2023	BY 2023 CVFC spawning
11/30/2023	12/20/2023	BY 2024 CVSH spawning
1/24/2024	1/25/2024	BY 2024 CVSH spawning
3/1/2024	6/21/2024	BY 2024 CVSC broodstock tagging
6/25/2024	6/30/2024	BY 2024 CVSC broodstock tagging

Water Supply

Raw water is supplied to the FRFH from the Thermalito Diversion Pool through an intake just upstream of Thermalito Diversion Dam, which is approximately 4.5 miles downstream of the Oroville Dam. The maximum flow rate of water to the hatchery is 110 cfs; however, normal hatchery operations require approximately 90 cfs. Raw water is gravity-fed to an aeration tower and subsequently delivered throughout the facility. Temperature criteria for water at the FRFH was established in the 1983 interagency agreement between CDFG and DWR and is presented in Table 2. During the reporting period, all necessary water was delivered.

Table 2: FRFH temperature requirements from the 1983 CDFG and DWR Agreement. The water temperature is permitted to deviate from the listed temperature by up to 4 °F, except from December 1 through March 31.

Date	Degrees Fahrenheit
June 16 – August 15	60
August 16 – August 31	58
September 1 – September 30	52
October 1 – November 30	51
December 1 – March 31	No greater than 55
April 1 – May 15	51
May 16 – May 31	55
June 1 – June 15	56

During the reporting period, a temperature exceedance occurred August 8-12, 2023, due to an unexpected issue with the River Valve Outlet System Project. Mean daily average temperature reached a high of 68 °F with instantaneous temperature measurements reaching 69 °F (Table 3). Only juvenile CVSH were in the hatchery at the time, and due to emergency application of water chillers, no unusual fish mortality was observed.

Table 3: Summary of water temperature at the FRFH, 6/16/2023 – 8/15/2024.

Date	Mean Daily Average (°F)	Maximum Daily Average (°F)	Minimum Daily Average (°F)	Maximum Temperature Observed (°F)	Minimum Temperature Observed (°F)
June 16 - August 15, 2023	58.6	68.0	54.0	69.0	53.0
August 16- August 31, 2023	55.8	58.5	53.9	62.2	52.7
September 1 - September 30, 2023	51.0	52.8	48.9	57.1	48.5
October 1 - November 30, 2023	49.0	51.8	47.3	52.3	46.8
December 1, 2023 - March 31, 2024	48.3	50.8	46.2	52.9	45.9
April 1 - May 15, 2024	51.1	54.2	47.8	56.0	47.0
May 16 - May 31, 2024	54.7	56.5	52.4	57.8	51.8
June 1 - June 15, 2024	56.3	57.2	55.7	58.0	55.0
June 16 - August 15, 2024	57.9	61.4	55.2	63.1	54.6

Feeding

The feeding of fish begins once fry have absorbed their yolk sacs. At this point in fish development, fry are transferred to the outdoor raceways (i.e., ponded), and they are hand-fed BioOregon BioPro Starter #0, until fish growth allows for the transition to BioOregon BioPro Starter #2, which can be distributed by a cart-mounted feed blower.

The type of feed given to fish is dependent on fish size and growth. Chinook Salmon and CVSH were fed following the manufacturer's recommendations (Appendix A). A total of 229,547 pounds of various types of feed was purchased to support the Chinook Salmon and steelhead production at FRFH (Table 4).

Table 4: Summary of feed type and amount purchased, 7/1/2023 – 6/30/2024.

Month	BioPro #0	BioPro #1	BioPro #1.2	BioPro #2	BioPro #3	Skretting #1.5	Skretting #2.5	Skretting #3.5	BioVita #1 (Oxytetracycline Medicated)	BioVita #1 (Florfenicol Medicated)	BioVita #2 (Medicated)	Total Pounds
July 2023				1,005		1,232			792			**3,029**
Aug. 2023			4,753			480						**5,233**
Sept. 2023						4,884				6,300		**11,184**
Oct. 2023							6,922					**6,922**
Nov. 2023							600	12,160				**12,760**
Dec. 2023							1,060	24,048				**25,108**
Jan. 2024	2,894	236						29,472				**32,602**
Feb. 2024	5,675	4,533		1,737				6,760				**18,705**
March 2024	2,253	7,170		15,325	6,376							**31,124**
April 2024	1,045	2,730		5,374	35,838							**44,987**
May 2024	1,010	1,188		3,796	25,864					219		**32,077**
June 2024	88	484		2,458	2,640						938	**6,608**
Total Pounds	**12,965**	**16,341**	**4,753**	**29,695**	**70,718**	**6,596**	**8,582**	**72,440**		**6,519**	**938**	**229,547**

Fish Health

Pathology

The CDFW Fish Health Laboratory (FHL) provides the FRFH with pathology diagnostic calls and consultations. Diagnostic calls and consultations include necropsies, collection of specimens (eggs, fish, ovarian fluid, and other fish tissues), and diagnostic analyses for pathogens that may affect fish health. The FHL provides reports of diagnoses with recommendations for treatments and prescriptions for restricted antibiotics or other therapeutics, as necessary. Fish Health Certifications are also provided by the FHL each year for production groups of CVSC, inland Chinook Salmon, CVFC, and CVSH to ensure fish are healthy before they are released.

During spawning operations in 2023, ovarian samples were collected from a subset of CVSC, inland Chinook Salmon, CVFC, and CVSH broodstock and screened for pathogens. A total of 514 samples were collected from adult CVSC, 552 samples were collected from adult CVFC (with 302 of these collected during inland Chinook Salmon spawning), and 192 samples were collected from adult CVSH. Ovarian fluid samples are combined (i.e., pooled) with others collected from additional fish during the same sampling period, with a maximum of five fish contributions per pooled sample. In the 2023-2024 reporting period, two of the pooled samples collected from CVFC and five of the pooled samples collected from CVSH tested positive for presumptive infectious hematopoietic necrosis virus (IHNV). Under the discretion of the FHL, CVFC lot 20 was culled due to the detection of IHNV in the ovarian fluid of female parents, and the CVSH eggs were not culled. A subset of the ovarian fluid samples (70 inland Chinook Salmon, 60 CVFC, and 192 CVSH) were tested for Bacterial Kidney Disease (BKD), and all samples were negative. All other broodstock samples tested negative for pathogens.

Annual Fish Health Certifications were performed on January 1, 2024, for CVSH and on April 23, 2024, for Chinook Salmon. The certificates stated that the fish appeared healthy, were of appropriate shape and size, had no gross external lesions, and were free of any infectious agents (e.g., IHNV, Infectious Pancreatic Necrosis, and BKD).

During the reporting period, FHL was consulted seven times to examine the rearing CVFC and CVSH for infectious diseases. Notable findings included various levels of columnaris disease (*Flavobacterium columnare*), coldwater disease (*F. psychrophilum)*, bacterial gill disease (*F. branchiophilum)*, and parasitic infections such as Costia (*Ichthyobodo necator)*, *Chilodonella,* and *Trichodina*. Treatments prescribed by the FHL included hydrogen peroxide drips, and florfenicol and oxytetracycline medicated feeds. Most issues were resolved after treatment, but some recurrences were observed (Table 5).

Table 5: Diagnostic report for BY 2023 CVSH, BY 2023 CVFC, and BY 2024 CVSH, 7/1/2023 – 6/30/2024.

Examination Date	Production Group	Diagnosis	Treatment
7/11/2023	BY 2023 CVSH	Variable levels of Costia and moderate to high levels of columnaris disease	Oxytetracycline medicated feed and hydrogen peroxide drips
8/4/2023	BY 2023 CVSH	Moderate levels of Costia and mild levels of coldwater disease and columnaris disease	Florfenicol medicated feed, if needed, and hydrogen peroxide drips. Fish health improved and medicated feed was not used.
8/21/2023 (Reexamination)	BY 2023 CVSH	Very minimal levels of Costia, coldwater disease, and columnaris disease	No treatment was warranted
9/13/2023	BY 2023 CVSH	High levels of coldwater disease and columnaris disease	Florfenicol medicated feed
3/27/2024	BY 2024 CVSH	No significant findings	Continue to salt regularly and reduce pond density
3/27/2024	BY 2023 CVFC	No significant findings	Continue to salt regularly and reduce stressors (e.g., keep raceway clean and stocking density low)
4/11/2024	BY 2023 CVFC	Mild to moderate levels of coldwater disease, *Chilodonella,* and *Trichodina*, as well as low levels of bacterial gill disease	Florfenicol medicated feed and hydrogen peroxide drips
4/11/2024	BY 2024 CVSH	Severe coldwater disease	Florfenicol medicated feed
5/29/2024	BY 2024 CVSH	Moderate levels of coldwater disease and mild levels of bacterial gill disease	Florfenicol medicated feed and hydrogen peroxide drips

Thiamine Treatment

Thiamine deficiency complex (TDC) poses a threat to Chinook Salmon in the Central Valley. Juveniles with TDC can experience loss of equilibrium, abnormal swimming patterns, lethargy, and early life-stage mortality (Mantua et al., 2021).

Egg thiamine concentrations can be measured and categorized into four impact levels to assess the

severity of TDC. The four categories are: (1) “not likely impacted” when concentrations are greater than 7.7 nmol/g, (2) “likely impacted” when concentrations range from 5.9 to 7.7 nmol/g, (3) “impacted” when concentrations range from 2.7 to 5.9 nmol/g, and (4) “severely impacted” when concentrations are less than 2.7 nmol/g (Mantua et al., 2025).

Thiamine treatments are administered to Chinook Salmon at the FRFH to alleviate impacts of TDC. The FRFH employs three different treatment methods, depending on the life stage of the fish being treated. Adults can be treated by thiamine hydrochloride (HCl) injections; eggs can be treated by mixing with a thiamine mononitrate solution during fertilization; and hatched fry can be treated through submersion in a thiamine bath prior to ponding in the outdoor rearing raceways (Appendix B). Almost all CVSC spawned at the FRFH are treated via thiamine injection during the broodstock identification and tagging process in the preceding spring. The thiamine injection boosts egg thiamine concentration. Additionally, because thiamine deficiency decreases a fish’s ability to tolerate stress (Harder et al, 2018; Mantua et al., 2025), it is also possible that thiamine injections prior to the over summer holding period could increase the likelihood that fish return to the FRFH to spawn in the fall. In 2023, however, approximately 66% of both the thiamine-treated and saline-treated fish returned to the FRFH to spawn.

CVSC broodstock identification and tagging were conducted by DWR in 2023. Between May 4 and July 13, 2023, DWR treated a total of 1,969 CVSC broodstock with thiamine HCl injections. An additional 199 CVSC were injected with saline to act as a control group for comparison with the thiamine-injected fish. The saline injections thereby enabled the quantification of thiamine injection impacts and provided baseline egg thiamine concentration levels in the FRFH CVSC broodstock, prior to thiamine treatments.

Eggs from a subset of CVSC broodstock were tested for thiamine concentrations, revealing that eggs from thiamine-treated CVSC (n = 30) had an average thiamine concentration of 22.7 ± 6.4 nmol/g, while eggs from saline-treated CVSC (n = 30) had an average thiamine concentration of 6.0 ± 2.8 nmol/g. Therefore, the mean egg thiamine concentration from thiamine-injected fish fell within the "not likely impacted" category, and the mean egg thiamine concentration of saline-injected fish fell within the "likely impacted" category. Among the saline-injected CVSC, 43.3% were “not likely impacted,” 13.3% were “likely impacted,” 23.3% were “impacted,” and 20.0% were “severely impacted”. In contrast, 100.0% of sampled individuals from thiamine-injected CVSC were classified as “not likely impacted.” To ensure that all CVSC produced at the FRFH would not suffer from TDC during rearing, the CVSC fry produced from saline-injected parents received a thiamine immersion bath immediately before being moved to the outdoor raceways.

While all CVSC juveniles produced at the hatchery received thiamine treatment, whether by thiamine injections of the parents or from a thiamine immersion bath as fry, not all CVSC juveniles produced from naturally spawning CVSC in the river are treated for TDC. Of the 1,969 CVSC adults treated with thiamine injections, 1,072 were recovered at the FRFH, and the other 897 presumably remained in the river where they were able to spawn naturally.

CVFC at the FRFH are treated with thiamine using different methods than those used for CVSC, because adult CVFC are not handled at the hatchery prior to spawning. Therefore, instead of administering thiamine injections to CVFC adults, hatchery staff treat CVFC eggs with thiamine mononitrate at fertilization following established protocols developed by the FHL (Appendix B). To determine baseline egg thiamine concentration levels in CVFC, eggs from a total of 60 untreated CVFC were sampled. The average thiamine concentration in tested eggs was 6.6 ± 3.4 nmol/g. The mean concentration of CVFC sampled eggs fell within the “likely impacted” category. Of the individuals sampled, 30.0% were “not likely impacted,” 13.3% were “likely impacted,” 55.0% were

“impacted,” and 1.7% were “severely impacted”. While CVFC juveniles produced at FRFH were treated for TDC during fertilization at the FRFH, juveniles produced from CVFC spawning naturally in the river did not receive thiamine treatment to help combat TDC.

BY 2024 CVSH were not treated for thiamine deficiency; however, eggs from 45 CVSH were sampled and tested for thiamine concentration levels. The average thiamine concentration of tested eggs was 11.3 ± 3.2 nmol/g. The mean concentration of CVSH sampled eggs fell within the “not likely impacted” category. Of the individuals sampled, 84.4% were "not likely impacted,” 11.1% were “likely impacted,” 2.2% were “impacted,” and 2.2% were “severely impacted.” Juvenile CVSH produced at the hatchery and from naturally spawning adults in the river did not receive any thiamine treatment.

Salmon Carcass Disposal

Chinook Salmon carcasses that were fit for human consumption, typically from culled or spawned fish, were provided to the Enterprise Rancheria of Maidu Indians of California or California Emergency Foodlink, under California Endangered Species Act Memoranda of Understanding with CDFW. California Emergency Foodlink contracted with American Canadian Fisheries, which collected suitable salmon carcasses from the FRFH and processed them for human consumption prior to distribution to local food banks. In 2023, a total of 19,977 Chinook Salmon carcasses were deemed suitable for human consumption. A total of 1,661 carcasses were collected by the Enterprise Rancheria of Maidu Indians of California, and 18,316 carcasses were transferred to American Canadian Fisheries for processing and food bank distribution by California Emergency Foodlink. A total of 1,136 carcasses not suitable for human consumption were disposed of through a contractual agreement with Sacramento Rendering Company.

Aquatic Invasive Species Monitoring

Monitoring for aquatic invasive species was conducted on a quarterly basis throughout the year. Regular sampling was initiated after CDFW received notice from the California State University, Chico Aquatic Bioassessment Laboratory on February 5, 2016, that samples taken from the Feather River adjacent to and downstream of the FRFH on June 2, 2016, tested positive for the presence of New Zealand mud snails. To date, New Zealand mud snails have not been found inside the hatchery or on its surrounding premises.

Public Relations and Outreach

The number of visitors at the FRFH during the 2023-2024 reporting period was estimated using a combination of data collected from vehicle counting sensors located at the visitor parking lots and data collected by DWR personnel on the number of visitors attending their formal tours of the hatchery. For these estimates, each vehicle was counted as 3.2 people. Visitors who arrived at the FRFH by foot or by bus were unable to be captured, and therefore, the estimated number of visitors is likely lower than the actual number. The Salmon Festival is held annually on the fourth Saturday of September to celebrate the return of Chinook Salmon to the Feather River. In 2023, the festival occurred on September 23, 2023, with an estimated attendance of 12,000 people. Over the course of the entire reporting period, it is estimated that there were 281,498 visitors at the FRFH (Table 6).

Table 6: Estimated number of visitors to the FRFH, 7/1/2023 – 6/30/2024.

Month	Estimated Number of Visitors
July 2023	24,131
August 2023	23,923
September 2023	36,860
October 2023	36,481

November 2023	21,762
December 2023	13,642
January 2024	18,018
February 2024	19,797
March 2024	20,104
April 2024	20,817
May 2024	23,331
June 2024	22,631
Total	**281,498**

As a coordinated outreach effort with the CDFW Classroom Aquarium Education Program (CAEP), a total of 5,005 CVFC eggs and 840 CVSH eggs were distributed to 167 public schools across Butte, Colusa, El Dorado, Glenn, Nevada, Placer, Sacramento, San Joaquin, Sutter, Tehama, Yolo and Yuba counties. Through this program, students had the opportunity to monitor the development of salmonid eggs in their classrooms and release the fish once they hatched into the Feather River.

Spring-Run Chinook Salmon Production

2023 Broodstock Identification

Only early arriving Chinook Salmon (i.e., fish that arrive in the spring) are used as broodstock for CVSC production at the FRFH. To identify appropriate CVSC for the spawning that would commence in the fall, the FRFH opens their ladder gate and initiates flow in the ladder in the preceding spring. This allows Chinook Salmon migrating into the Feather River at that time to make their way into the FRFH. DWR staff tag these fish upon their entrance to the FRFH with a visual marker of two identically numbered Hallprint tags. Immediately after tagging, fish are released back into the Feather River. The Chinook Salmon that return to the FRFH in the fall to spawn are then inspected for the presence of Hallprint tags. During CVSC spawning at the FRFH, only fish tagged with Hallprint tags are included in hatchery broodstock. The 2023 CVSC broodstock identification process began during the 2022-2023 annual report period on May 4, 2023, and continued until July 13, 2023. Typically, the broodstock tagging process ends by June 30, but due to a below average number of returning CVSC to the FRFH by the end of June, a drought action was coordinated among the FRHOT to extend the tagging period until July 13, 2023. The intention of this tagging modification was to offset the impacts of multiple years of drought by increasing the number of thiamine-treated CVSC in the Feather River and increasing the potential CVSC broodstock available to the hatchery for spawning in the fall (Harder et al., 2018). Fish tagged prior to June 30 received a green or yellow Hallprint tag, consistent with prior years. Fish tagged after June 30 received a blue Hallprint tag for ease of identification during broodstock collection in the fall. In 2023, DWR tagged a total of 2,168 adult Chinook Salmon as CVSC and returned them to the Feather River. A total of 643 fish returned to the FRFH multiple times during tagging operations (i.e., they were recaptured). Most recaptured fish were only recaptured once (Table 7). Water flow into the FRFH fish ladder was reduced on July 13, 2023, to prevent newly arriving fish from entering the ladder, and the ladder was subsequently closed on July 14, 2023.

Table 7: Number of recaptured CVSC with Hallprint tags in the FRFH during 2023 broodstock tagging, 05/04/2023 – 7/13/2023. Recapture events refers to the number of times an individual fish returned to the FRFH during broodstock tagging operations.

Recapture Events	Number of Recaptured Fish
1	467
2	133
3	34
4	8
5	1

2023 Broodstock Collection and Spawning

Annually, a Spawning and Release Plan for CVSC at the FRFH is developed in coordination with the FRHOT. This plan outlines the goals and approach for egg collections, fish production, and fish release. Important objectives of the egg collection model are to (1) ensure genetic contribution from CVSC throughout their natural spawn timing and (2) reinforce the temporal separation of run times between spring- and fall-run Chinook Salmon produced at the FRFH (Appendix C). BY 2023 CVSC egg collection goals identified in this plan included 3,550,500 freshly fertilized eggs (i.e., green eggs) to develop into a target of 2,987,746 eyed eggs and a target of 2,000,000 (± 10%) smolts for release.

On September 15, 2023, flow to the ladder was initiated allowing adult Chinook Salmon to ascend the ladder for spawning at the FRFH. CVSC broodstock, identified by the presence of green, blue, or yellow Hallprint tags, began entering the hatchery building on September 18, 2023, and were retained for spawning. Spawning of CVSC broodstock began on September 20, 2023, and continued until October 2, 2023. CVSC spawning typically concludes by the end of September; however, in 2023, it was observed that CVSC broodstock females did not reach ripeness until late September. Spawning activities were consequently extended into early October to increase the likelihood that production goals would be met.

In 2023, a total of 471 females (466 marked with adipose fin clips and 5 with adipose fins intact) were spawned (Appendix D), producing 2,353,470 green eggs. This resulted in 66.3% of the predicted green egg collection goal outlined in the 2023 spawning and release plan. On average, each female produced 5,049 green eggs. Of these, 2,054,998 developed into eyed eggs, achieving 68.8% of the predicted target per the 2023 plan. The green-to-eyed egg survival rate was 87.3%, exceeding the anticipated 85% survival rate used in the 2023 spawning and release plan. To estimate fry production, losses during egg picking were accounted for, followed by an 88% survival rate adjustment. Based on this calculation, approximately 1,809,195 CVSC fry were estimated to be ponded into hatchery raceways (Figure 2). The actual survival rate from the eyed egg to fry developmental stages exceeded these estimates, as a total of 1,960,780 individual fry were enumerated during coded wire tag (CWT) operations. As a result, it is estimated that 95.4% of eyed eggs survived to the fry developmental stage.

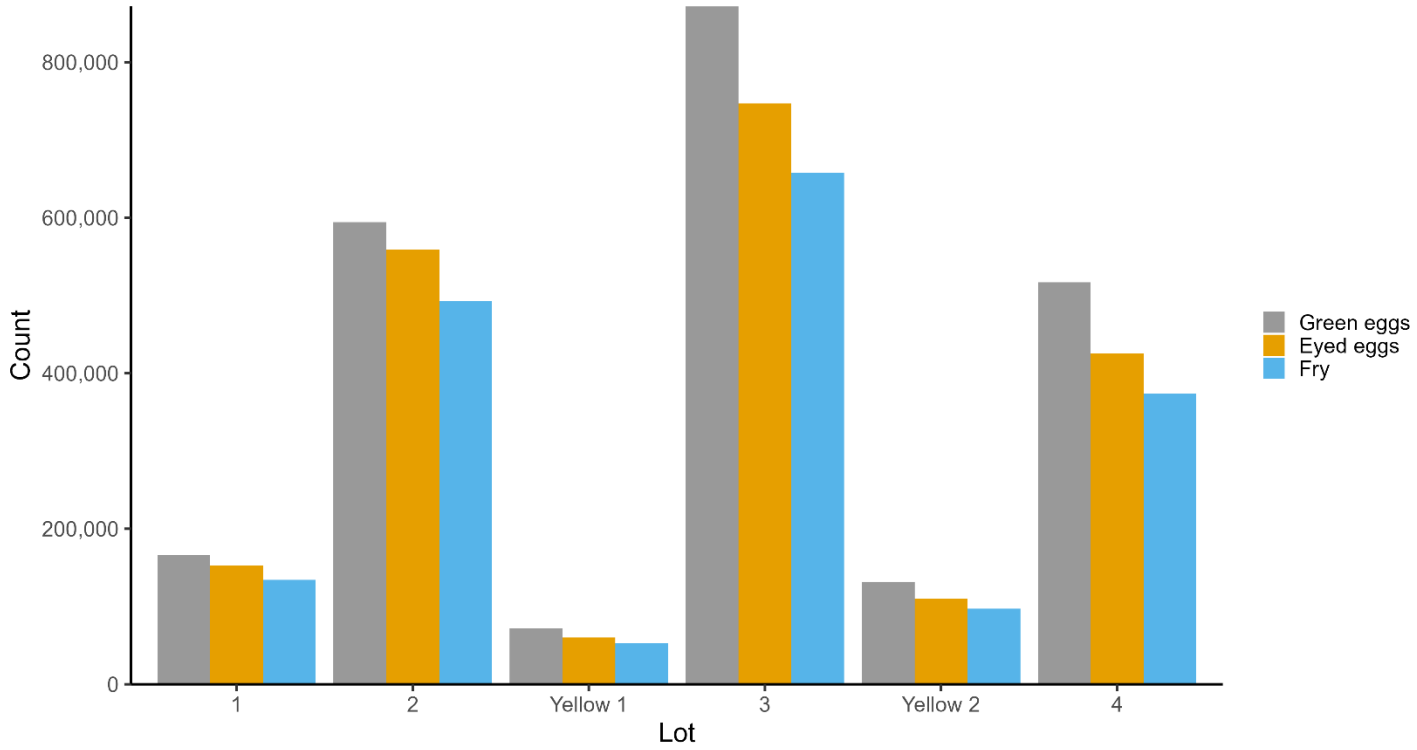

Figure 2: Estimated green eggs collected and estimated eyed eggs and fry produced by lot for BY 2023 CVSC.

CVSC with yellow Hallprint tags were only spawned with other yellow Hallprint-tagged fish, because these fish did not receive thiamine treatments during broodstock tagging in the spring. Instead, the fry produced from these fish were treated with thiamine when ponded. This allowed Dr. Kevin Kwak (FHL) and Dr. Rachel Johnson (NOAA Southwest Fisheries Science Center) to test the thiamine concentrations of eggs from CVSC receiving each type of injection. Analyses revealed that the eggs from thiamine-treated CVSC (n = 30) had an average thiamine concentration of 22.7 ± 6.4 nmol/g, and the eggs from saline-treated CVSC (n = 30) had an average thiamine concentration of 6.0 ± 2.8 nmol/g.

BY 2023 Egg Transfers

Production goals for BY 2023 CVSC included 5,470 eyed eggs that were designated to be transferred from the FRFH to SFB for a quarantine period, then transferred to the Interim Salmon Conservation and Research Facility to be reared to adulthood and used as SJRRP broodstock. In 2023, a total of 5,684 CVSC eyed eggs were transferred to support the SJRRP, accounting for 103.9% of the production goal.

2023 Hatchery Escapement

In 2023, a total of 1,394 Hallprint-tagged CVSC (1,144 fish with green, 133 fish with yellow, and 117 fish with blue Hallprint tags) were sampled at the hatchery during spawning operations from September 19, 2023, through October 25, 2023 (Appendix D). This represented 64.3% of the total number of Chinook Salmon that were tagged with Hallprint tags during the spring of 2023. As part of a drought action that was coordinated with the FRHOT, CVSC that were in excess to those needed to meet production goals were returned live to the Feather River. A total of 327 fish (250 fish with green, 40 fish with yellow, and 37 fish with blue Hallprint tags) were released back into the Feather River to augment in-river spawning. The Hallprint tags on these fish were cut in half before release for ease of identification of fish observed in the Feather River escapement survey or subsequent broodstock collection activities at the FRFH. During spawning operations for the FRFH Inland Chinook Salmon

Program, a total of five male fish with Hallprint tags were recaptured (Appendix D). These fish were subsequently released back into the Feather River. After inland Chinook Salmon spawning operations and during CVFC spawning operations, five males with Hallprint tags were recaptured at the hatchery. Among these, one male was recaptured for a second time. All Hallprint-tagged fish captured at the FRFH after inland Chinook Salmon spawning operations were excised following normal practice.

The FRFH CVSC escapement is estimated using both Hallprint tag recoveries (not including released fish) and CWT information as determined post-spawning. In 2023, 1,072 Hallprint-tagged fish were recovered at the hatchery during spawning; however, subsequent CWT analysis showed that eight of these fish were reared as CVFC at the FRFH and were therefore excluded from the FRFH CVSC escapement. An additional 465 fish that entered the hatchery without a Hallprint tag during FRFH spawning operations were initially classified as CVFC. However, they were later found to contain a CWT indicating they were reared as CVSC at the FRFH and were therefore included in the FRFH CVSC escapement. Altogether, this resulted in a total FRFH CVSC escapement of 1,529 fish for 2023.

Coded Wire Tag Data

Adults

In addition to inspecting fish for Hallprint tags, staff at the FRFH inspected all Chinook Salmon that entered the hatchery during spawning operations for the presence of an adipose fin. When adipose fins are absent (i.e., the fish has an adipose fin clip, also known as an “ad clip”), it indicates that the fish was reared in a hatchery and that the fish contains an implanted CWT. Typically, CVSC from the FRFH are marked with adipose fin clips and tagged with CWTs at a rate of 100% (i.e., 100% of juveniles produced at the FRFH are marked and tagged). During spawning operations at the FRFH, salmon carcass heads are collected for CWT extraction and analysis by staff from the CDFW Central Valley Tissue Archive (CVTA) and CWT Laboratory, as well as staff from DWR and Pacific States Marine Fisheries Commission (PSMFC). CWT analysis allows for the detection of CVFC in the CVSC broodstock so that eggs fertilized through a cross of CVFC and CVSC can be culled. This practice helps maintain the separation between CVSC and CVFC run times.

During the 2023 CVSC broodstock collection and spawning period from September 18, 2023, through October 2, 2023, a total of 1,237 fish confirmed by CWT analysis to be CVSC reared in the FRFH entered the hatchery. Additional fish confirmed by CWT analysis to be FRFH CVSC continued to enter the hatchery until October 20, 2023, with one more fish entering the hatchery on December 13, 2023. In total, 1,459 FRFH CVSC confirmed through CWT analysis (641 adult females, 643 adult males, and 175 grilse) entered the FRFH between September 18, 2023, and December 13, 2023. As determined by CWT analysis, the spawning of BY 2023 CVSC at the FRFH resulted in four spawned pairs of fish that included CVFC. The green eggs produced from those crosses were culled so that only CVSC broodstock confirmed through Hallprint tags and CWTs (if present) were included in the broodstock. A total of 120 FRFH CVFC CWTs were recovered during this period (Figure 3).

CWT analysis was also used to identify Chinook Salmon that originated from other Central Valley hatcheries (Appendix E). During the CVSC broodstock collection and spawning season from September 18, 2023, through October 2, 2023, only CWTs from the FRFH were recovered.

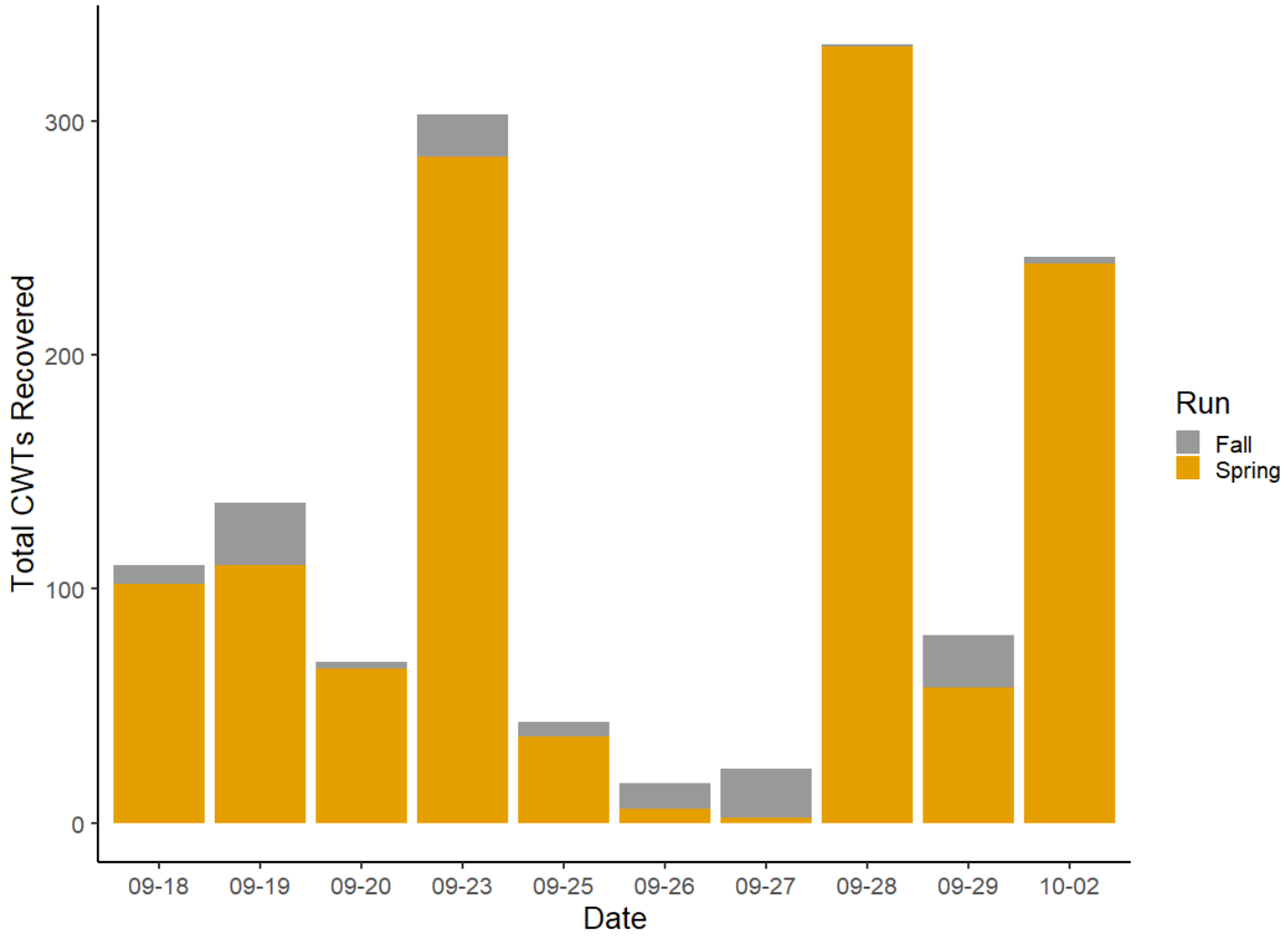

Figure 3: CWT recovery of CVSC and CVFC at the FRFH during CVSC spawning, 9/18/23 – 10/2/23.

The CVTA and CWT Laboratory staff also recorded the fork length, sex, and adipose fin status on every CVSC with a Hallprint tag and/or CWT. The CWT data revealed that two five-year-olds (1 female and 1 male), 47 four-year-olds (28 females and 19 males), 1,235 three-year-olds (612 females and 623 males), and 175 two-year-olds (1 female and 174 males) containing a FRFH CVSC CWT returned to the hatchery in 2023 (Figure 4a). The fork lengths of these fish ranged from 400 mm to 1,053 mm. The average fork length of grilse (i.e., 2-year-olds) was 529 mm, and the average fork length of adults (i.e., 3- to 5-year-olds) was 784 mm (Figure 4b-c). At the FRFH, grilse are identified during spawning operations as any fish with a fork length less than 650 mm. CWT analysis post-spawning revealed that, in 2023, 24 out of 1,459 fish with CWTs were misidentified as grilse based on the fork length criteria. The misidentified fish included one four-year-old female and 23 three-year-olds (11 females and 12 males), which all had a fork length under 650 mm. Notably, no two-year-old fish exceeded a fork length of 650 mm.

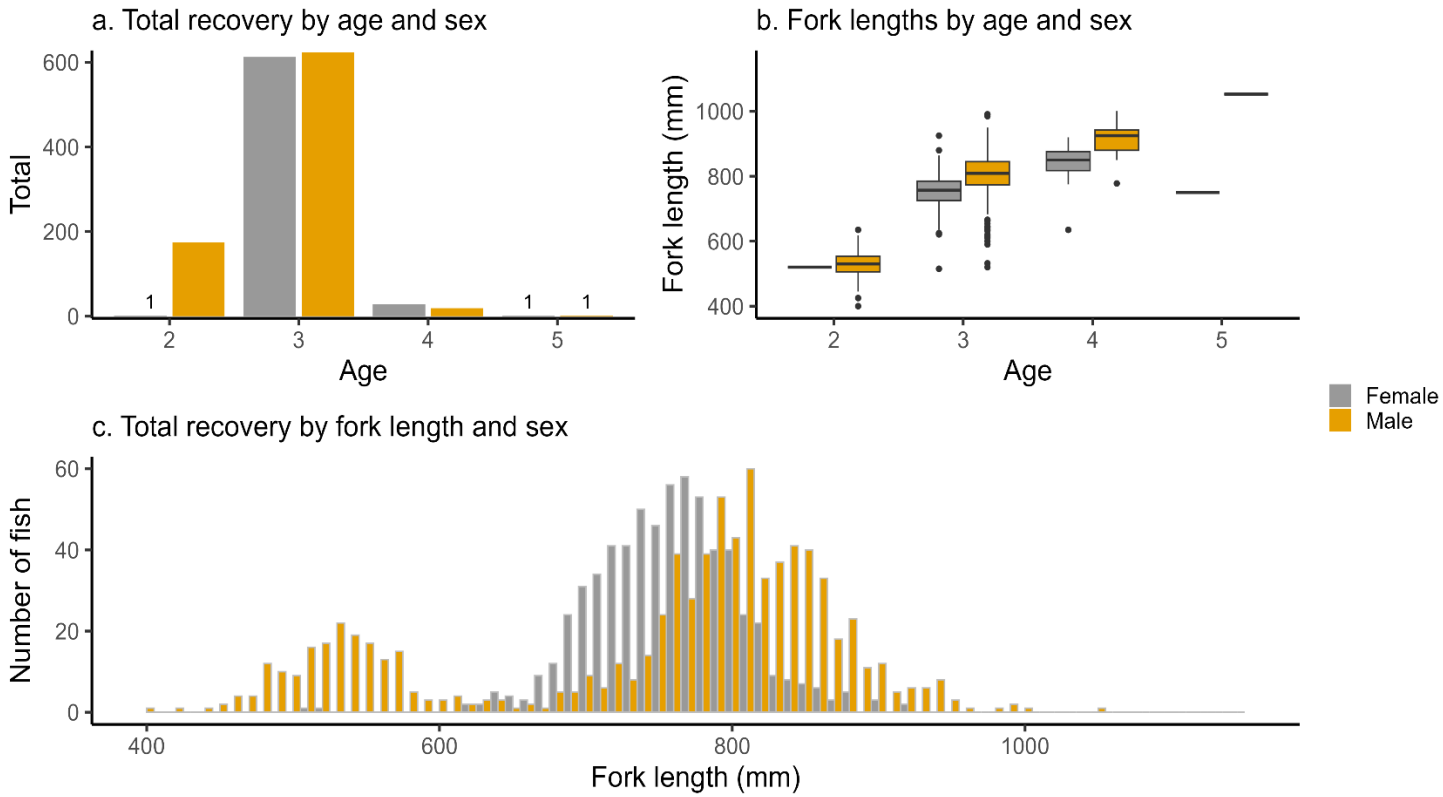

Figure 4: 2023 FRFH CVSC CWT recovery data summarized by age (a), fork length (b), and sex (c), 9/18/2023 – 12/13/2023.

Juveniles

After juvenile CVSC grow to approximately 72 mm in total length, which corresponds to 150 fish per pound, they are implanted with a CWT, and their adipose fin is removed using a Westmark CWT tagging trailer. A total of 1,960,780 BY 2023 juvenile CVSC were divided into eight groups and tagged during the 2023-2024 annual report period. Among these groups, five contained approximately 350,000 juvenile fish each. The remaining three groups consisted of approximately 99,000 fish, 89,000 fish, and 22,000 fish, respectively. Each group was tagged at a rate of 100% with CWTs containing a numeric code unique to the production group and marked at a rate of 100% with adipose fin clips. This work was completed by PSMFC personnel under contract with DWR.

Releases

Historically, releases of CVSC have occurred at locations along the Feather River, including sites such as the Boyd's Pump Boat Launch at river mile (RM) 22.3 and the Gridley Boat Launch at RM 50. Releases of BY 2023 CVSC aligned with the strategy described in the BY 2023 FRFH Spring-Run Chinook Salmon Spawning and Release Plan (Appendix C) for releasing all FRFH CVSC into the lower Feather River using three paired releases during the months of March and April in 2024. A total of 1,960,780 CVSC smolts (98% of the 2,000,000 CVSC smolt production goal) that were 100% tagged with CWTs and marked with adipose fin clips were released into the Feather River (Appendix F). The releases were "paired" such that, on each of the three days when fish releases occurred, half of the fish were released into the Feather River at the Gridley Boat Launch, and the other half of the fish were released into the Feather River at the Boyd's Pump Boat Launch. This led to six distinct groups of fish being released at different locations on different days. Fish in each of these six release groups were implanted with CWTs with unique codes that enable future CWT analyses to assign fish to each of the release groups. Release notifications were distributed via email to interested parties and posted to the Feather River Fish Hatchery page on CalFish at the following website:

https://www.calfish.org/ProgramsData/ConservationandManagement/CentralValleyMonitoring/SacramentoValleyTributaryMonitoring/FeatherRiverFishHatchery.aspx.

The first release of BY 2023 CVSC occurred on March 15, 2024. At this time, fish were sized at approximately 124 to 135 fish per pound. A total of 349,309 fish were released at the Boyd's Pump Boat Launch, and a total of 350,544 fish were released at the Gridley Boat Launch. The second release of BY 2023 CVSC occurred on March 29, 2024, when released fish were sized at approximately 86 to 109 fish per pound. On this day, a total of 350,055 fish were released at the Boyd's Pump Boat Launch, and a total of 350,571 fish were released at the Gridley Boat Launch. The third and final release of BY 2023 CVSC occurred on April 23, 2024. The fish were sized at approximately 61 to 69 fish per pound on this release day. A total of 350,307 fish were released at the Boyd's Pump Boat Launch, and a total of 209,994 fish were released at the Gridley Boat Launch.

2024 Broodstock Identification

During the 2023-2024 annual report period, 2024 CVSC broodstock were identified through the same Hallprint tagging operations described for 2023 CVSC broodstock identification. These tagging efforts were again led by DWR and served to visibly mark Chinook Salmon that entered the FRFH in the spring. This allowed for later identification of appropriate fish to incorporate into the 2024 CVSC broodstock, with corresponding spawning, rearing, and release of fish occurring during the 2024-2025 annual report period.

The 2024 CVSC broodstock identification process began on April 18, 2024, and continued until July 8, 2024 (Table 8). As before, Chinook Salmon that ascended the fish ladder in the spring were trapped, tagged with two identically numbered Hallprint tags, and returned to the Feather River. Thiamine and saline injections were administered during broodstock tagging for the fourth year in a row to evaluate the prevalence and alleviate impacts of TDC. The fish injected with thiamine solution were tagged with green Hallprint tags, and the fish injected with saline solution were tagged with yellow Hallprint tags for ease of identification. The fish injected with the saline solution acted as a control group for this evaluation and will provide baseline egg thiamine level data to compare to the treatment group. The methods followed for thiamine injections were developed by Dr. Kevin Kwak at the FHL (Appendix B). During the 2024 CVSC broodstock tagging operations, 6,753 Chinook Salmon were tagged, with 6,522 marked with green Hallprint tags and 231 marked with yellow Hallprint tags. Additionally, DWR staff tagged 64 CVSC with red Hallprint tags, marking them as potential CVSC broodstock, but these fish are not included in Table 8. Of these, 34 were captured in the Feather River using hook-and-line methods as part of DWR's acoustic telemetry study, while the remaining 30 were tagged at the FRFH as part of DWR's transport study.

Table 8: 2024 CVSC broodstock identification, 4/18/2024 – 7/8/2024. The table records, by date, the total number of fish tagged, including the number of fish injected with thiamine (Green) or saline (Yellow), the numbers of younger grilse and unmarked (no-clip) fish, occurrence of mortalities during tagging, the number of fish tagged with only a single tag, the number and percentage of fish recaptured at the FRFH, and the number and percentage of fish marked with an adipose fin clip.

Date	Fish Tagged	Green/ Thiamine	Yellow/ Control	Grilse	No-clip	Mortalities	Single Tag	Recaps	Recap Percentage	Clipped	Clip Rate
4/18/2024	138	128	10	0	32	0	0	0	0.00%	106	76.81%
4/26/2024	264	244	20	4	41	0	0	11	4.00%	223	84.47%
5/2/2024	112	102	10	4	14	0	0	3	2.61%	98	87.50%
5/13/2024	370	350	20	5	55	0	1	9	2.37%	315	85.14%
5/16/2024	184	164	20	8	36	0	0	2	1.08%	148	80.43%
5/20/2024	691	671	20	28	145	0	13	15	2.12%	546	79.05%
5/21/2024	563	543	20	14	110	0	9	26	4.41%	453	80.46%
5/22/2024	553	533	20	18	113	1	3	53	8.75%	440	79.57%
5/24/2024	437	418	19	13	81	1	5	75	14.65%	356	81.46%
5/28/2024	255	244	11	5	52	0	3	121	32.18%	203	79.61%
5/30/2024	395	385	10	19	81	0	2	190	32.48%	314	79.49%
6/3/2024	481	471	10	24	110	0	7	186	27.89%	371	77.13%
6/5/2024	213	203	10	21	41	0	0	209	49.53%	172	80.75%
6/7/2024	300	300	0	38	66	0	0	178	37.24%	234	78.00%
6/10/2024	157	157	0	20	33	0	0	183	53.82%	124	78.98%
6/12/2024	264	254	10	30	59	0	0	190	41.85%	205	77.65%
6/14/2024	249	249	0	32	41	0	2	160	39.12%	208	83.53%
6/17/2024	280	280	0	42	50	0	4	208	42.62%	230	82.14%
6/19/2024	204	194	10	42	44	0	1	165	44.72%	160	78.43%
6/21/2024	105	105	0	35	18	0	0	94	47.24%	87	82.86%
6/24/2024	27	16	11	7	0	0	0	23	46.00%	27	100.00%
6/26/2024	253	253	0	52	49	0	3	252	49.90%	204	80.63%
6/28/2024	165	165	0	47	31	0	0	72	30.38%	134	81.21%
7/1/2024	91	91	0	21	13	0	2	89	49.44%	78	85.71%
7/8/2024	2	2	0	0	0	0	0	6	75.00%	2	100.00%
Season Total	6753	6522	231	529	1315	3	55	2520	27.17%	5438	80.53%

Inland Chinook Salmon Program

The aim of the Inland Chinook Salmon Program at the FRFH is to produce triploid (i.e., sterile) salmon for release into non-anadromous waters. Such “inland” Chinook Salmon produced at the FRFH are either released into Lake Oroville to support the cold-water fishery or allocated to the CDFW Inland Salmon Program, which stocks fish for cold-water fisheries in several water bodies throughout the state.

2023 Broodstock Collection and Spawning

Annually, a CVFC Spawning and Release Plan for the FRFH, which includes plans for the FRFH Inland Chinook Salmon Program, is developed in coordination with the FRHOT (Appendix G). For BY 2023, the plan for inland Chinook Salmon included egg collection goals to support the cold-water fishery in Lake Oroville, the CDFW Statewide Inland Salmon Program, and the NFFAA conducted by DWR. Typically, only inland Chinook Salmon eggs designated for the Lake Oroville cold-water fishery are incubated and reared at the FRFH, while the remainder of inland Chinook Salmon eggs for the production of the Statewide Inland Salmon Program are reared and incubated at SFB. In 2023, the eggs intended for NFFAA were also transferred to SFB to minimize biosecurity risks for the reintroduction feasibility studies. To compensate for the production of eggs and fry for the NFFAA at SFB, additional eggs were incubated and reared at the FRFH for the Statewide Inland Salmon Program production. The green egg collection goal to remain at the FRFH for incubation and rearing was 500,000, targeting the production of 125,000 fingerlings for Lake Oroville, 100,000 fingerlings for Pine Flat Reservoir, and 25,000 fingerlings for Lake Spaulding. The green egg collection goal to be transferred to SFB was 1,500,000, including 300,000 eggs specifically collected to support the NFFAA target of 125,000 eyed eggs and 25,000 juveniles.

The broodstock that supports the FRFH Inland Chinook Salmon Program is comprised of Chinook Salmon that return to the FRFH during the CVSC spawning period but do not have a Hallprint tag to confirm early run-time necessary for incorporation into the FRFH CVSC broodstock. The use of these fish in inland Chinook Salmon broodstock helps to further genetically separate the CVSC and CVFC produced at the FRFH while also enabling the spawning of non-Hallprint-tagged Chinook Salmon that return to the FRFH during CVSC spawning.

Spawning for the production of BY 2023 inland Chinook Salmon began on October 3, 2023, and ended on October 10, 2023. A total of 483 females (212 marked with an adipose fin clip and 271 with an intact adipose fin) were spawned (Appendix H), producing 2,089,967 green eggs. On average, each spawned female produced 4,327 green eggs. After fertilization, all green eggs were triploided using standard methods, which rendered the fish reproductively sterile. Approximately 1,409,087 green eggs were transferred as triploid green eggs to the SFB on the day of fertilization to support both the Statewide Inland Salmon Program and the NFFAA (93.9% of the green egg goal). In support of the cold-water fishery in Lake Oroville and a portion of the Statewide Inland Salmon Program (Lake Spaulding and Pine Flat Reservoir), approximately 680,880 triploid green eggs (136.2% of the green egg goal) were retained and incubated at the FRFH. Due to an unforeseen loss of the first lot of fertilized eggs, likely caused by excessive agitation during spawning operations, only a total of 220,237 eyed eggs were produced, resulting in a 32.3% green-to-eyed egg survival rate. A total of 203,642 fry were ponded, resulting in 92.5% eyed egg to fry survival rate.

BY 2023 Egg Transfers

Production goals for BY 2023 inland Chinook Salmon included 1,500,000 triploid green eggs to

support the CDFW Statewide Inland Salmon Program and the NFFAA. In 2023, a total of 1,409,087 green triploid eggs were transferred to SFB, resulting in 93.9% of the green egg collection goal.

Coded Wire Tag Data

During the inland Chinook Salmon spawning period from October 3, 2023, through October 10, 2023, a total of 484 CWTs were extracted from the collected salmon carcass heads. The CVTA and CWT Laboratory staff analyzed these CWTs and found that, of the 484 CWT fish that were recovered during the spawning period, 293 were FRFH CVFC (91 females and 27 males) and 190 were FRFH CVSC (118 females and 12 males) (Figure 5).

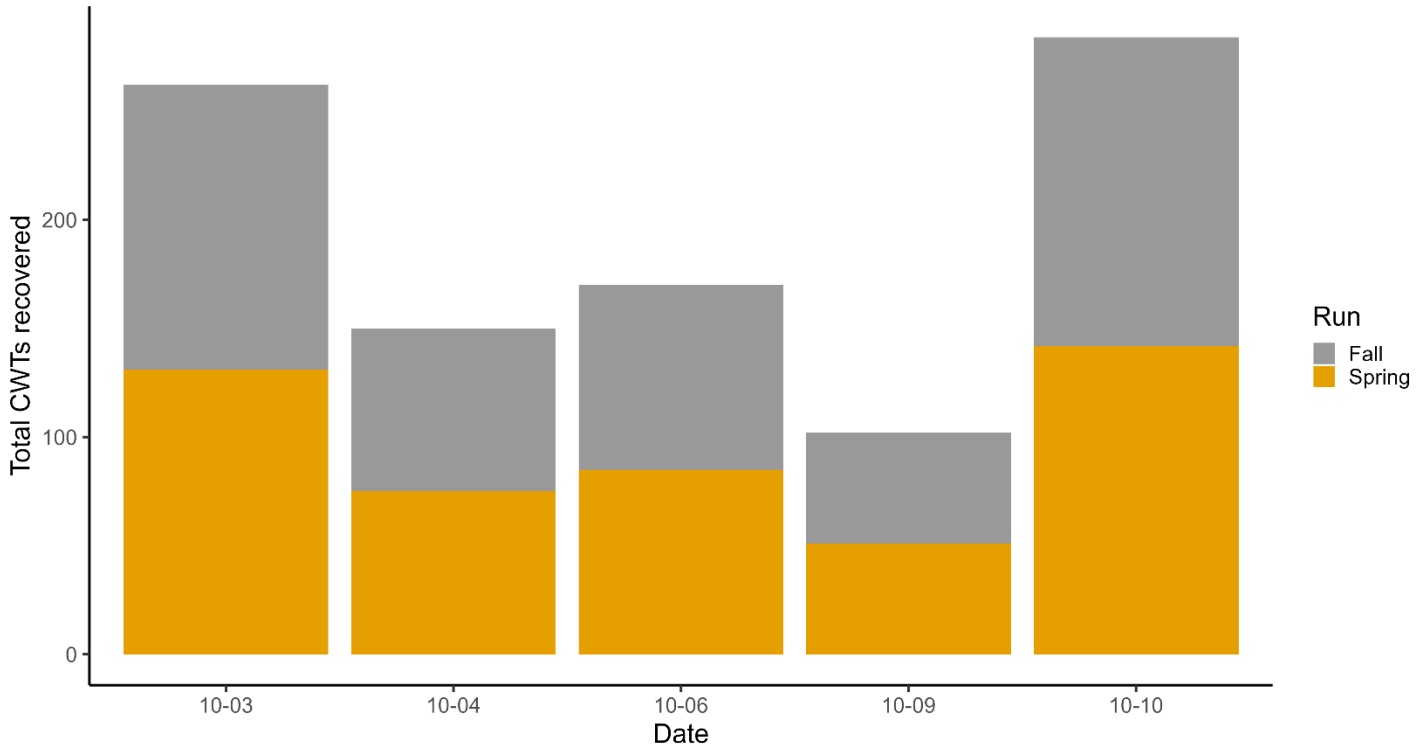

Figure 5: CVFC and CVSC CWT recovery at the FRFH during inland Chinook Salmon spawning, 10/3/2023 – 10/10/2023.

Releases

A total of 138,000 BY 2023 inland Chinook Salmon (110.4% of the production goal) were planted into Lake Oroville on May 6, 2024, at the Loafer Creek Service Ramp. As triploid and inland fish, they were not released with any type of external mark or tag. At the time of release, they were sized at approximately 46 fish per pound. Fish were released at fingerling size as opposed to yearling-sized due to the disinfection system at the hatchery reaching the end of its useful life and not wanting to risk possible disease during the summer period, which could result in not planting. A process is underway to replace the water disinfection system, and once this occurs, the fish will be planted at yearling size. Additionally, approximately 100,000 juveniles reared at the FRFH and allocated to the CDFW Statewide Inland Salmon Program were released into the Pine Flat Reservoir on April 5, 2024, resulting in 100.0% of the production goal. These fish were approximately 85 fish per pound at the time of release. Due to the unexpected loss of eggs in the first lot, the production goals for Lake Spaulding were unable to be met through inland production at FRFH. Instead, the allotment goals for Lake Spaulding were achieved through production at SFB, where 33,800 inland Chinook Salmon were released May 3, 2024.

Notably, the lack of fish tagging operations means that fish are not individually enumerated. Consequently, the release estimates are based on the average weight of each fish and the approximate weight of all truckloads of fish being released.

Fall-Run Chinook Salmon Production

2023 Broodstock Collection and Spawning

Annually, a CVFC Spawning and Release Plan for the FRFH is developed in coordination with the FRHOT. These plans describe the goals and approach for egg collections, fish production, and fish release (Appendix G). The BY 2023 CVFC egg collection goals captured in this plan included 13,798,114 freshly fertilized eggs (i.e., green eggs) for the targeted development of 11,728,397 eyed eggs to produce a combination of 6,000,000 (± 10%) smolts for DWR mitigation objectives, and 2,000,000 (± 10%) smolts and 1,500,000 (± 10%) sub-smolts for drought production. The 1,500,000 pre-smolts for drought production were tagged at a rate of 100% with parentage-based tagging (PBT) in addition to being tagged and marked at a rate of 25% with CWTs and adipose fin clips.

Adult CVFC began arriving at the hatchery concurrently with the CVSC broodstock; however, only adults that entered the hatchery on or after October 11, 2023, were used as CVFC broodstock. Prior to this date, the adult Chinook Salmon that arrived at the FRFH without a Hallprint tag, indicating that they were not appropriate fish to incorporate into the CVSC broodstock, were either retained for use in the FRFH Inland Chinook Salmon Program or culled. Spawning of the 2023 CVFC broodstock began October 12, 2023, and ended on November 16, 2023. CVFC continued to enter the hatchery until December 20, 2023, but any fish not selected for spawning was subsequently culled. A total of 2,720 females (710 marked with adipose fin clips and 2,010 with an intact adipose fin) were spawned (Appendix H), producing approximately 16,832,847 green eggs. This exceeded the green egg collection goal by 21.9%. On average, each female produced 6,181 green eggs.

A total of 21 lots of CVFC green eggs were collected to meet the DWR mitigation and drought production goals, and three lots of CVFC green eggs were collected to meet the drought production goals. However, lot 20, which totaled 524,697, was discarded before reaching the eyed stage due to a positive IHNV detection in two samples of ovarian fluid collected from female parents. After this reduction, there was a total of 16,308,150 green eggs. A total of 12,919,025 eggs developed into the eyed egg stage, thereby exceeding the eyed egg collection goal by 10.2%. The green-to-eyed egg survival rate was consequently 79.2%. An estimated number of fry ponded in the FRFH raceways was calculated by subtracting the number of eggs discarded (i.e., picked) during development, then applying an 88% survival rate adjustment. Based on this calculation, approximately 10,575,837 CVFC fry were ponded (Figure 6). However, actual survival from eyed egg to fry developmental stages exceeded these estimates. A total of 10,738,003 CVFC fry were enumerated during CWT tagging operations, indicating an 83.1% survival rate from eyed egg to fry.

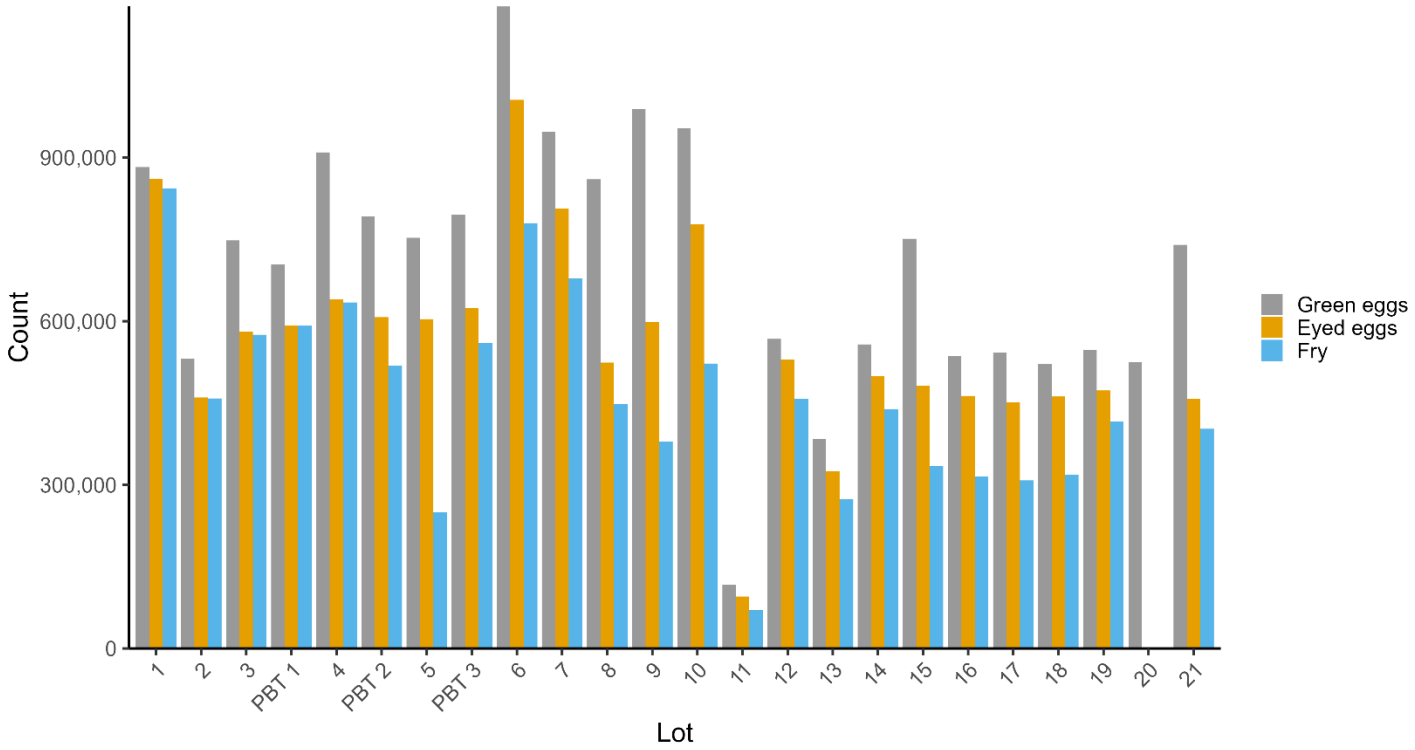

Figure 6: Estimated green eggs collected and estimated eyed eggs and fry produced by lot for BY 2023 CVFC.

2023 Egg Transfers

None of the BY 2023 CVFC eggs were transferred.

2023 Hatchery Escapement

The FRFH CVFC escapement is estimated as the number of Chinook Salmon that return to the FRFH without a Hallprint tag and/or contain a CVFC CWT. In 2023, 18,799 Chinook Salmon (Appendix H) were originally classified as CVFC during spawning operations due to the absence of Hallprint tags. Subsequent CWT analysis revealed that 465 of those fish contained a CVSC CWT. Additionally, there were eight Hallprint-tagged fish that contained a CVFC CWT. This resulted in a final FRFH CVFC escapement value of 18,342 fish for 2023.

Coded Wire Tag Data

Adults

Chinook Salmon trapped at the FRFH throughout the spawning period were examined for the presence of an adipose fin, because adipose fins of juvenile hatchery-origin Chinook Salmon are removed to indicate that the fish have also been implanted with a CWT. Juvenile CVFC from the FRFH are marked with adipose fin clips and tagged with CWTs at a rate of 25% (i.e., 25% of all juvenile CVFC reared at the FRFH are marked and tagged in this way). Between September 18, 2023, and October 10, 2023, prior to the spawning of CVFC, a total of 413 CWT-confirmed CVFC from the FRFH were collected at the hatchery. During the 2023 CVFC broodstock collection and spawning period at the FRFH from October 11, 2023, to November 16, 2023, a total of 3,204 CWT-confirmed CVFC from the FRFH were collected at the hatchery. After that time, CWT-confirmed CVFC from the FRFH continued to enter the hatchery until December 13, 2023, resulting in the collection of an additional 31 CWT-confirmed CVFC from the FRFH. In total, 4,151 CVFC with CWTs

specifically from the FRFH (946 adult females, 2,826 adult males, and 379 grilse) were collected at the hatchery in the fall of 2023 (Figure 7).

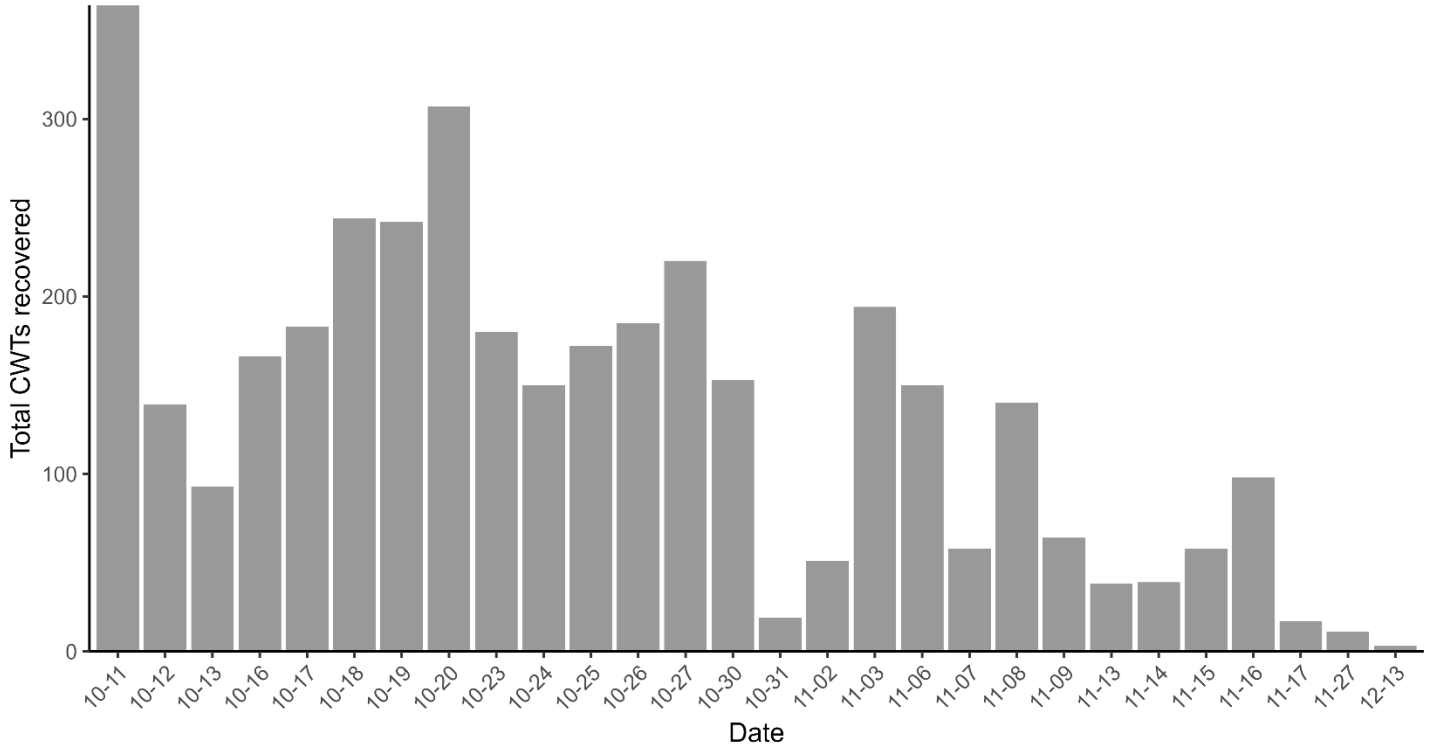

Figure 7: Total CWT recovery of FRFH CVFC during CVFC spawning and post-spawning operations, 10/11/23 – 12/13/23.

For CWT extraction and analysis, the heads of Chinook Salmon carcasses at the FRFH were collected by staff from the CVTA and CWT Laboratory, as well as staff from DWR and PSMFC. The analysis importantly enabled hatchery-origin CVSC to be detected in the FRFH CVFC broodstock, post-spawning. Whenever it was detected that CVSC were spawned with CVFC, the resulting green eggs were culled. This practice was intended to help genetically reinforce the distinct run-timing of CVFC and CVSC. In 2023, there was one CVSC spawned with a CVFC, and their eggs were subsequently culled after receiving the CWT analysis results.

The data that come from CWT analyses are also used to identify Chinook Salmon that entered the FRFH as adults but originated from other Central Valley hatcheries (Appendix I). The green eggs produced from CVFC that originated from other Central Valley hatcheries were not culled; they were allowed to remain incorporated into the BY 2023 CVFC production at the FRFH. In total, from October 11, 2023, to December 20, 2023, a total of 32 FRFH CVSC CWTs were recovered, as well as 152 Mokelumne River Fish Hatchery CVFC CWTs, 22 Coleman National Fish Hatchery CVFC CWTs, 18 Nimbus Fish Hatchery CVFC CWTs, and 2 Merced River Fish Facility CVFC CWTs (Figure 8).

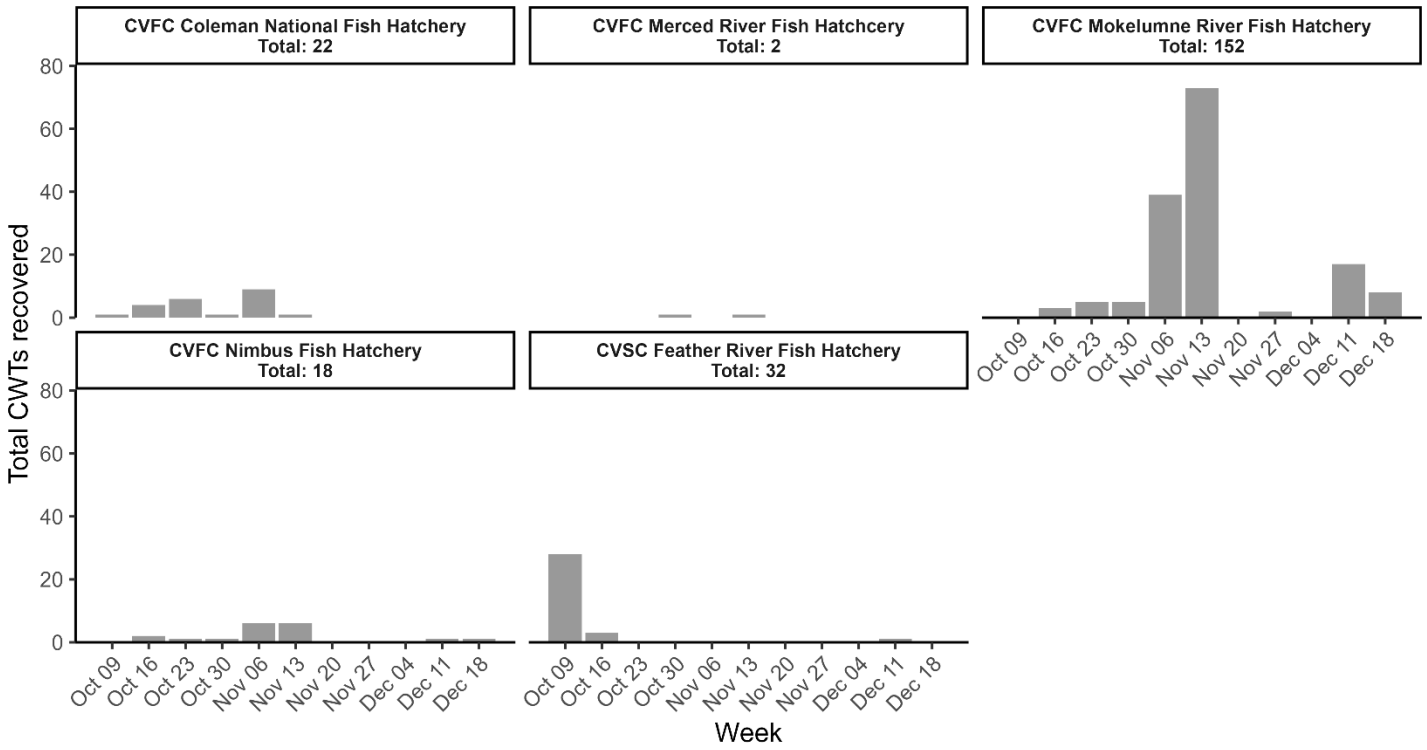

Figure 8: CWT recovery of FRFH CVSC and other hatchery strays at the FRFH, 10/11/2023 – 12/20/2023.

Additional data collected by the CVTA and CWT Laboratory staff included the fork length and sex of all adipose fin-clipped fish. This information is summarized alongside the corresponding CWT analysis in Figure 9. The CWT analysis revealed that 254 four-year-olds (82 females and 172 males), 3,518 three-year-olds (864 females and 2,654 males), and 379 two-year-olds (4 females and 375 males) with CWTs that classified the fish as CVFC from the FRFH returned to the hatchery in the fall of 2023 (Figure 9a). The fork lengths of these FRFH CVFC CWT fish ranged from 458 mm to 1100 mm, with the average grilse fork length being 616 mm, and the average adult fork length being 864 mm (Figure 9b-c). At the FRFH, grilse are classified during spawning operations as any fish with a fork length less than 650 mm. CWT analysis post-spawning revealed that, in 2023, 99 out of 4,151 fish with CWTs were misidentified as either an adult or grilse based on the fork length criteria. Specifically, there were 86 two-year-olds (3 females and 83 males) that measured over 650 mm, and 13 three-year-olds that measured under 650 mm (1 female and 12 males).

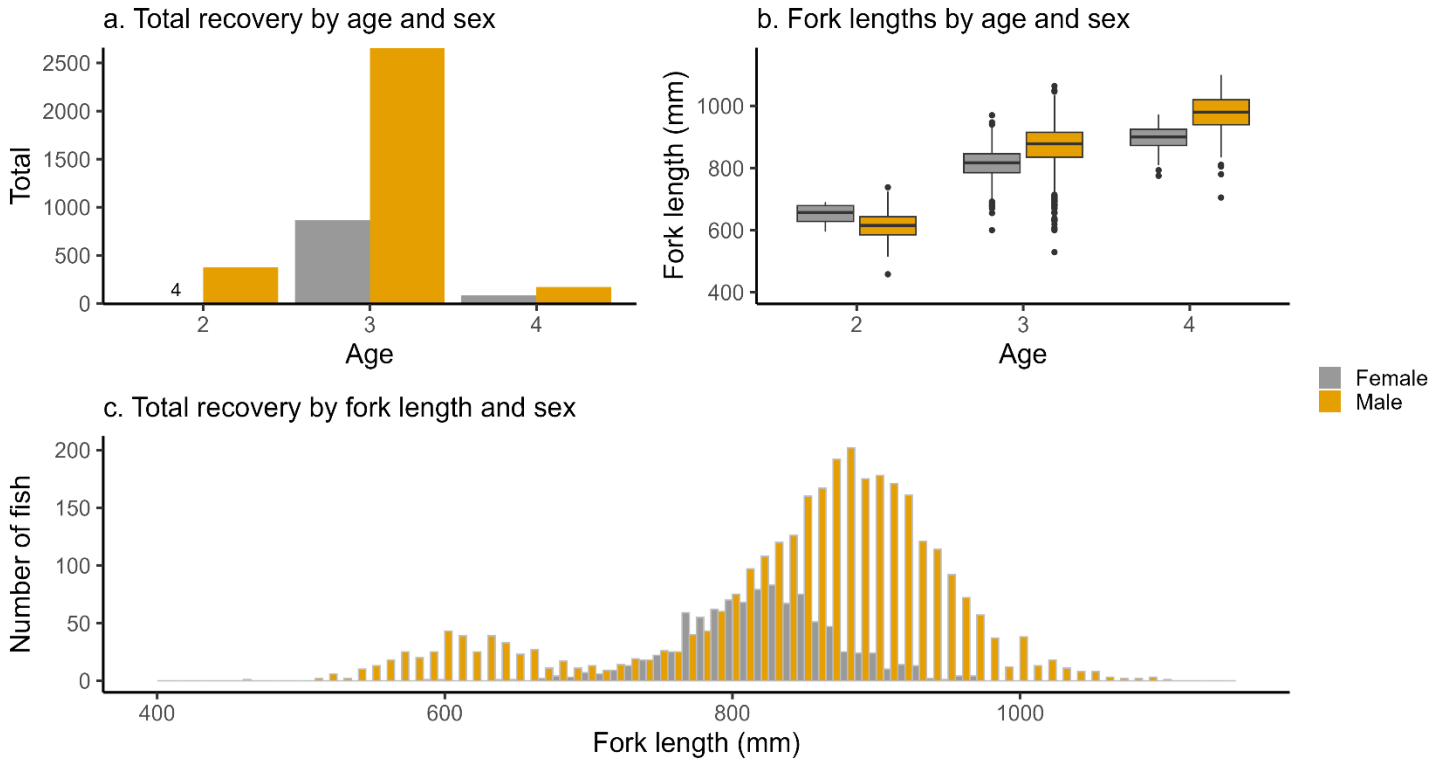

Figure 9: 2023 FRFH CVFC CWT recovery data summarized by age (a), fork length (b), and sex (c), 9/18/2023 – 12/13/2023.

Juveniles

Once juvenile CVFC grow to approximately 72 mm in total length, which corresponds to 150 fish per pound, they can be processed through a Westmark CWT tagging trailer for implantation with a CWT and marking with an adipose fin clip. The BY 2023 juvenile CVFC were split into four groups with approximately 1,000,000 fish each, three groups with approximately 500,000 fish each, twelve groups of approximately 336,000 fish each, and eight groups with fewer than 300,000 fish each. The fish in each of these groups were tagged with CWTs and marked with adipose fin clips at a rate of 25% (i.e., 25% of fish in each of the groups received the tags and marks). While only 25% of fish were tagged and marked, every juvenile CVFC at the FRFH was processed and enumerated by the tagging trailer. This work was performed by PSMFC personnel under contract with DWR. A total of 10,738,003 BY 2023 juvenile CVFC were processed in the tagging trailer, and 2,651,980 of these fish were marked with adipose fin clips and tagged with CWTs.

Releases

Releases of FRFH CVFC typically occur at locations along the Feather River and locations in the San Francisco and San Pablo bays. During the spring of 2024, the releases of CVFC followed the plan that was outlined in the Spawning and Release Plan (Appendix G). The plan specified for 1,000,000 mitigation production smolts and 1,500,000 drought production pre-smolts (±10%) to be released into the Feather River. It additionally specified for the remainder of the mitigation production (5,000,000 smolts ± 10%) and the remainder of the drought production (2,000,000 smolts ± 10%) to be released at locations in the San Francisco and San Pablo bays. Release notifications were distributed via email to interested parties and posted to the Feather River Fish Hatchery page on CalFish at the following website:

https://www.calfish.org/ProgramsData/ConservationandManagement/CentralValleyMonitoring/Sacra

mentoValleyTributaryMonitoring/FeatherRiverFishHatchery.aspx.

A total of 10,651,965 BY 2023 CVFC (112.1% of the production goal) were released from the FRFH in April, May, and June of 2024 into the Feather River and the San Francisco and San Pablo bays (Appendix J). Releases into the Feather River used a daytime direct release strategy at either the Gridley Boat Launch or the Boyd's Pump Boat Launch. The releases into the San Francisco Bay used a direct nighttime release strategy at the Estuary and Ocean Science Center in Tiburon, and the releases into the San Pablo Bay used either a direct nighttime release strategy at Conoco or an acclimatization net pen release strategy at Mare Island.

The BY 2023 CVFC pre-smolts for drought production were released into the Feather River at the Gridley Boat Launch as three distinct release groups. Each group was tagged and marked at a rate of 25% with both CWTs and adipose fin clips. In addition, tissue samples were taken from all spawning pairs that contributed to the pre-smolt production, enabling 100% of the released fish to be genetically identifiable through PBT. The groups, consisting of approximately 556,672, 566,271, and 589,673 fish, were released on April 23, 25, and 29, 2024, respectively. The average size of these fish at the time of release ranged from 90 to 100 fish per pound. The 2,017,428 BY 2023 CVFC smolts for drought production were released into the San Francisco Bay at the Estuary and Ocean Science Center in Tiburon as nighttime direct releases. Approximately 1,011,116 of these were released on May 15, 2024, and 1,006,312 were released on June 17, 2024. These fish were marked and tagged at a rate of 25% with adipose fin clips and CWTs, and at the time of release, the fish were sized at approximately 63 and 71 fish per pound, respectively.

The BY 2023 CVFC smolts produced for DWR mitigation objectives, totaling approximately 6,921,921 fish, were released into the Feather River, the San Francisco Bay at Tiburon, the San Pablo Bay at Mare Island, and the San Pablo Bay at the Cal Maritime Academy. These fish were marked with adipose fin clips and tagged with CWTs at a rate of 25%. A total of 1,010,515 smolts were released into the Feather River at Boyd's Pump on April 24, 2024, when fish were sized at approximately 66 fish per pound. The remainder, totaling approximately 5,911,406 smolts, were released into the San Pablo and San Francisco bays. A total of 1,040,318 CVFC smolts were released into the San Pablo Bay at the Cal Maritime Academy on June 10, 2024, using a nighttime direct release strategy. At the time of release, fish were sized at approximately 71 fish per pound. A total of 897,262 CVFC smolts were released into the San Francisco Bay at Tiburon on June 18, 2024, again using a nighttime direct release strategy. At the time of release, fish were approximately 77 fish per pound. The remainder of the fish, totaling approximately 3,973,826 smolts, were released into the San Pablo Bay at Mare Island using an acclimatization net pen release strategy on May 7-8, May 20-21, June 3-4, and June 7, 2024. The fish in these final release groups were sized at approximately 56 to 61 fish per pound on the day of release.

Central Valley Steelhead Brood Year 2024 Production and Brood Year 2023 Release

Brood Year 2024

2024 Broodstock Collection and Spawning

Annually, a CVSH Spawning and Release Plan for the FRFH is developed in coordination with the FRHOT. This plan describes the goals and approach for egg collections, fish production, and fish release (Appendix K). The BY 2024 CVSH egg collection goals captured in this protocol included 1,500,000 green eggs to produce both 400,000 yearlings in support of DWR mitigation production requirements and 50,000 yearlings in accordance with the 1986 Delta Fish Agreement between DWR

and CDFG.

The 2024 CVSH broodstock collection at the FRFH began on December 13, 2023. Spawning began on December 20, 2023, and ended on February 7, 2024. During this time, 2,216 adult CVSH (1,149 males and 1,067 females) were trapped for broodstock (Table 9). An additional 61 CVSH (42 males and 19 females) measuring less than 16 inches total length (i.e., "half-pounder" CVSH) were trapped and released back into the Feather River in accordance with the protocols described in the 2023 Steelhead Spawning and Release Plan (Appendix K). Half-pounder CVSH are excluded from broodstock to promote anadromy within the hatchery population. CVSH often enter the hatchery during CVSC and CVFC broodstock collection, prior to CVSH broodstock collection and spawning, and are released back to the Feather River at those times. In total, 181 CVSH (87 males and 94 females) were collected and released during CVSC and CVFC spawning and are not included in Table 9.

Table 9: Number of CVSH trapped at the FRFH during the 2024 CVSH spawning season, 12/13/2023 – 02/07/2024. Hatchery-origin fish are designated by "H", and natural-origin fish are designated by "N." Mortalities include both hatchery- and natural-origin fish.

	Spawned				Fish Released (Not Spawned)				Mortalities		
Date	**Male (H)**	**Male (N)**	**Female (H)**	**Female (N)**	**Male (H)**	**Male (N)**	**Female (H)**	**Female (N)**	**Male**	**Female**	**Total**
12/13/2023	0	0	0	0	3	0	1	0	0	0	4
12/20/2023	12	0	12	0	2	0	1	0	0	0	27
1/3/2024	124	2	124	2	0	0	3	0	20	17	292
1/4/2024	120	4	121	3	0	0	0	0	16	12	276
1/10/2024	113	7	118	2	0	0	3	0	16	10	269
1/17/2024	70	2	72	0	9	0	7	0	41	5	206
1/24/2024	117	3	116	4	255	6	245	4	58	17	825
1/31/2024	57	3	58	2	5	0	3	0	0	0	128
2/7/2024	37	1	36	2	39	1	62	1	6	4	189
Total	**650**	**22**	**541**	**131**	**313**	**7**	**325**	**5**	**157**	**65**	**2216**

Beginning in 2018, the FRFH adopted a 2:2 factorial spawning method for CVSH, which has been continued through the 2023 spawning season. Both adipose fin-clipped, and adipose fin-intact adult CVSH were used for broodstock during this spawning season. In total, 672 female CVSH (657 marked with an adipose fin clip and 15 with an adipose fin intact) were spawned, resulting in the collection of 1,958,234 green eggs. This exceeded the green egg collection goal outlined in the CVSH Spawning and Release Plan by 30.5%. On average, each spawned female produced 2,820 green eggs. After being spawned, 1,011 adipose fin-clipped adult male CVSH were released into the Thermalito Afterbay to enhance the recreational fishery.

The CVTA and CWT Laboratory staff collected a tissue sample and recorded the fork length, sex, and adipose fin status on every spawned CVSH at the FRFH. They also collected a scale sample from every fifth fish and/or every adipose fin-intact fish. The fork lengths of the spawned males ranged from 370 mm to 685 mm, with the average fork length being 492 mm. The fork lengths of the spawned females ranged from 385 mm to 680 mm, with the average fork length being 486 mm (Figure 10).

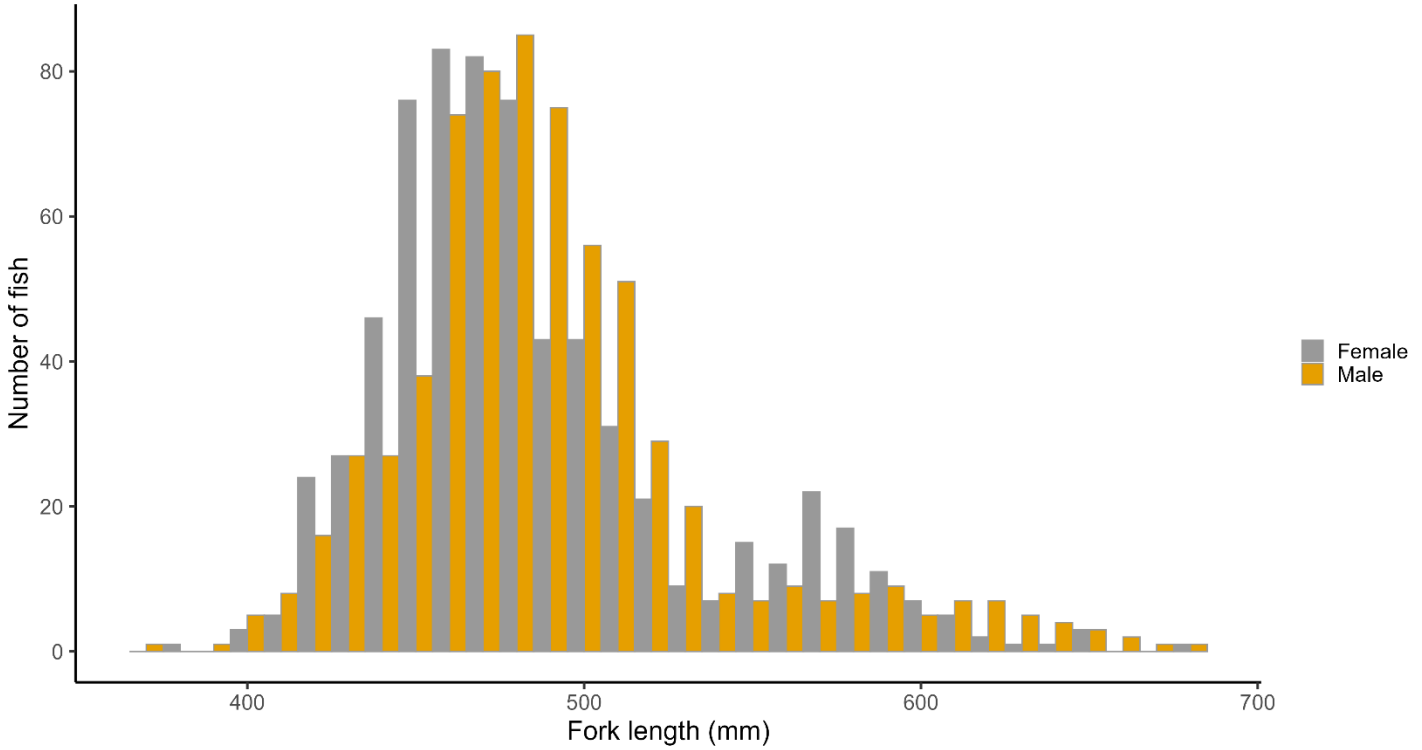

Figure 10: Fork length distribution of spawned CVSH, 12/20/23 – 2/7/24.

The 1,958,234 green eggs developed into approximately 1,488,257 eyed eggs, resulting in a green-to-eyed egg survival rate of 76.0%. A total of 449,218 eyed eggs were culled to meet fish allotment limits, including all of lot 1 which totaled 31,833 eggs. This resulted in a total of 1,039,039 eyed eggs. It is estimated that approximately 1,009,985 CVSH were ponded into the FRFH raceways, resulting in a 97.2% eyed egg to fry survival rate.

Hatchery-Origin Steelhead Recoveries

A total of 2,216 CVSH were trapped during the spawning period of December 20, 2023, to February 7, 2024, and were examined for the presence of adipose fins. In total, 2,165 (97.7%) of the CVSH trapped at the FRFH during spawning operations were adipose fin-clipped, indicating hatchery origin.

Brood Year 2023

Marking of Juvenile Steelhead

The spawning of BY 2023 CVSH occurred during the 2022-2023 annual report period, during which 311 pairs were spawned, yielding a total of 854,344 green eggs. During the 2023-2024 annual report period, BY 2023 CVSH juveniles grew to a sufficient size of approximately 74 mm in total length, which corresponds to 120 fish per pound, which qualified them to be marked with an adipose fin clip through a Westmark CWT tagging trailer. Since 1999, 100% of juvenile CVSH released by the FRFH have been marked with an adipose fin clip. For BY 2023 CVSH, a total of 498,750 juveniles (100%) were marked prior to being released in February 2024. This work was performed by PSMFC personnel under contract with DWR.

Releases

During the 2023-2024 annual report period, the BY 2023 CVSH yearlings were ready for release. In 2024, a total of 445,740 BY 2023 CVSH yearlings (99.1% of the production goal) were released into

the Feather River at the Boyd's Pump Boat Launch starting on February 5, 2024, and ending on February 13, 2024. Approximately 23,200 BY 2023 CVSH yearlings were released into the Thermalito Afterbay at the Wilbur Road Boat Launch on February 12, 2024, to contribute to the local fishery in coordination with DWR. Release notifications were distributed via email to interested parties and posted to the Feather River Fish Hatchery page on CalFish at the following website:

https://www.calfish.org/ProgramsData/ConservationandManagement/CentralValleyMonitoring/SacramentoValleyTributaryMonitoring/FeatherRiverFishHatchery.aspx.

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Appendices

Appendix A: Bio-Oregon and Skretting Manufacturer Recommended Size Guidelines

Bio-Oregon Manufacturer Recommended Size Guidelines

Feed Size	Mash 0.02-0.04	#0 0.03-0.06	#1 0.4-1.0	#2 0.8-1.4	1.2	1.5	2.0	2.5	3.0	4.0	6.0	9.0	12.0
Feed Type	Crumble	Crumble	Crumble	Crumble	Pellet	Pellet	Pellet	Pellet	Pellet	Pellet	Pellet	Pellet	Pellet
Grams	<0.15	0.15-0.8	0.8-1.5	1.5-3.0	3.0-5.0	5.0-8.0	8.0-18	18-40	40-75	75-454	454-908	908-2270	>2270
# of Fish per lb.	>3000	3000-570	570-300	300-150	150-90	90-60	60-25	25-11	11-6	6-1	1-0.5	0.5-0.2	<0.2
Fish Length-inch	hatch	hatch-1.7	1.7-2.1	2.1-2.6	2.6-3.1	3.1-3.5	3.5-4.6	4.6-6.0	6.0-7.4	7.4-12.5	12.5-16	16-22	>22

Skretting Manufacturer Recommended Size Guidelines

	Sinking			Sinking Pellets							Floating Pellets						
Feed Size (mm)	#0	#1	#2	1.0	2.0	3.0	4.0	6.0	8.0	10.0	1.5	2.5	3.5	4.5	5.5	7.5	9.5
Feed Type	Crumble	Crumble	Crumble	Pellet	Pellet	Pellet	Pellet	Pellet	Pellet	Pellet	Pellet	Pellet	Pellet	Pellet	Pellet	Pellet	Pellet
Grams	0.15-0.8	0.8-1.5	1.5-3.0	3-8	8-40	40-80	80-300	300-600	600-2000	>2000	3-8	8-40	40-80	80-300	300-600	600-2000	>2000
# Fish per lb.	3000-570	570-300	300-150	150-60	60-11	11-6	6-1.5	1.5-0.8	0.8-0.2	<0.2	150-60	60-11	11-6	6-1.5	1.5-0.8	0.8-0.2	<0.2
Fish Length-inch	hatch-1.7	1.7-2.1	2.1-2.6	2.6-3.1	3.1-4.6	4.6-7.4	7.4-12.5	12.5-16	16-22	>22	2.6-3.1	3.1-4.6	4.6-7.4	7.4-12.5	12.5-16	16-22	>22

Appendix B: Thiamine Treatment Protocols Developed by CDFW Fish Health Lab (Dr. Kevin Kwak)

Spring-run Chinook Salmon Thiamine HCl injection protocol at Feather River Fish Hatchery Prepared by Kevin Kwak

April 22, 2021

Spring-run Chinook Salmon Thiamine HCl injection protocol at Feather River Fish Hatchery
Prepared by Kevin Kwak

Objective: To determine if intraperitoneal thiamine injections during tagging will prevent thiamine deficiency for Spring-run Chinook Salmon eggs at spawning.

Materials

Items needed to conduct the study

- Tags (Different colors)
- Spring-run Chinook salmon
- CO_2 for sedation
- Thiamine HCl (100ml of 500mg/ml)
- NaCL 0.9% injectable (1L)
- 21g needles 1.5 inches
- Sharps container
- 50 ml Pistol Grip Mega-Shot by Neogen
- Personnel to conduct study
- Recording sheet

Prior to injecting fish, if only one person is tagging/injecting, two repeating syringes should be filled with Thaimine HCl and one repeating syringe filled with saline. A new needle should be used every time the syringe is refilled (unless otherwise indicated). Discarded needles are to be placed into a sharp's container. These syringes will be enough to inject 100 salmon for Thiamine HCl and 50 salmon as control. The number of syringes will likely be adjusted based on the number of expected fish or injection teams operating.

To fill the syringes, always with a new needle with a cap on, attach the needle to the syringe and twist to lock it in place. With the needle attached to the syringe, draw some air (approximately 20 ml) into the syringe before inserting into the bottle. Push the needle into the rubber stop on the top of the thiamine bottle or on the side of the saline bag. While the needle is inserted into the bottle, invert the bottle/syringe and slowly pull back at approximately 10 sec per ml. If the pull is too fast, fluid will likely escape past the plunger and will be wasted. After the syringe is filled by 1/3, air will need to be exchanged for fluid in the bottle. Push the plunger forward and air will be introduced into the bottle. This should relieve some of the vacuum and then continue to draw more thiamine into the syringe. If no air is pushed into the bottle, it may be difficult to draw back.

Once the syringe is filled (it may not be the full 50 ml), replace the needle cap to prevent any accidental pokes or contamination.

Spaghetti tags should be ready to tag fish. These tags will be color coordinated to identify Thiamine vs saline injected fish.

Methods

Tagging/injection: Spring-run Chinook arriving at the hatchery will be sedated, tagged, and injected with 1 ml of either thiamine HCl or 0.9% saline and then release back to the Feather River.

1. Fish will be sedated using CO_2 gas bubbled into the holding tank. Once fish are handleable, the tank will be lifted to where staff can sort fish.
2. Tags to indicated Spring-run and color coded for Thiamine or saline will be inserted in the dorsal fin area.
3. To prepared fish for injection, staff will invert fish so the dorsal fin is towards the ground. Fish will then be injected intraperitoneally (IP) with 1ml of either thiamine HCl or saline. The syringe will be inserted near the pelvic fin region with the needle penetrating approximately 1 inch into the body wall.
4. Fish will then be released back to the Feather River

Spawning: Upon returning, 10gms of eggs will be collected from 30 Spring-run Chinook immediately prior to fertilization from tagged fish injected with Thiamine and saline.

1. Tagged fish will be identified upon returning to the hatchery for spawning.
2. Fish will be sedated using CO_2 gas bubbled into the holding tank. Once fish are handleable, the tank will be lifted to where staff can sort fish.
3. 10gms of eggs (approximately 30) will be placed into a labeled Ziploc bag, spread into a single monolayer and immediately sandwich between two sheets of dry ice. Once frozen, the bag of eggs can be transfer to a storage cooler containing dry ice.
4. Eggs from 30 females injected with Thiamine as well as 30 females injected with saline will be sampled for a total of 60 females.

Thiamine analysis: Egg thiamine levels will be analyzed using reverse phase HPLC

1. Frozen labeled Ziploc bags containing eggs will be ship in a cooler box with dry ice to a lab for reverse phase HPLC.

State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
Fish Health Laboratory
2111 Nimbus Road
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GAVIN NEWSOM, Governor
CHARLTON H. BONHAM, Director

August 19, 2021

Thiamine Mononitrate supplementation during Fertilization for Chinook Salmon at CDFW Anadromous Hatcheries

Prepared by Kevin Kwak

Aim: To increase Thiamine levels in green eggs by supplementing the water used for fertilization during Chinook Salmon spawning.

Materials

- 5-gallon buckets
- Fall-run Chinook salmon
- Spawning water (0.09%-1.3% salt w/w in UV water)
- Thiamine mononitrate powder (TM)
- colander
- Individual spawning tubs

Method

Returning Chinook Salmon from rivers will be used to spawn. Fish will be anesthetized using electric current/Carbon Dioxide, then euthanized with blunt force trauma. For each female, the gills will be cut for exsanguination. A lateral incision starting at the vent and proceeding cranially will be performed to remove eggs. Eggs will be collected into a colander that will drain any excess fluids then place eggs into a spawning tub. It is important to try and avoid any water egg contact.

Spawning water will be made by approximately adding 10 oz of salt to 4.5 gallons.

For TM high dose at 4500ppm, add 76.5 gm of TM to the spawning water bucket and stir until dissolved.

Collect eggs into a colander, drain ovarian fluid off, place eggs into a spawning tub.

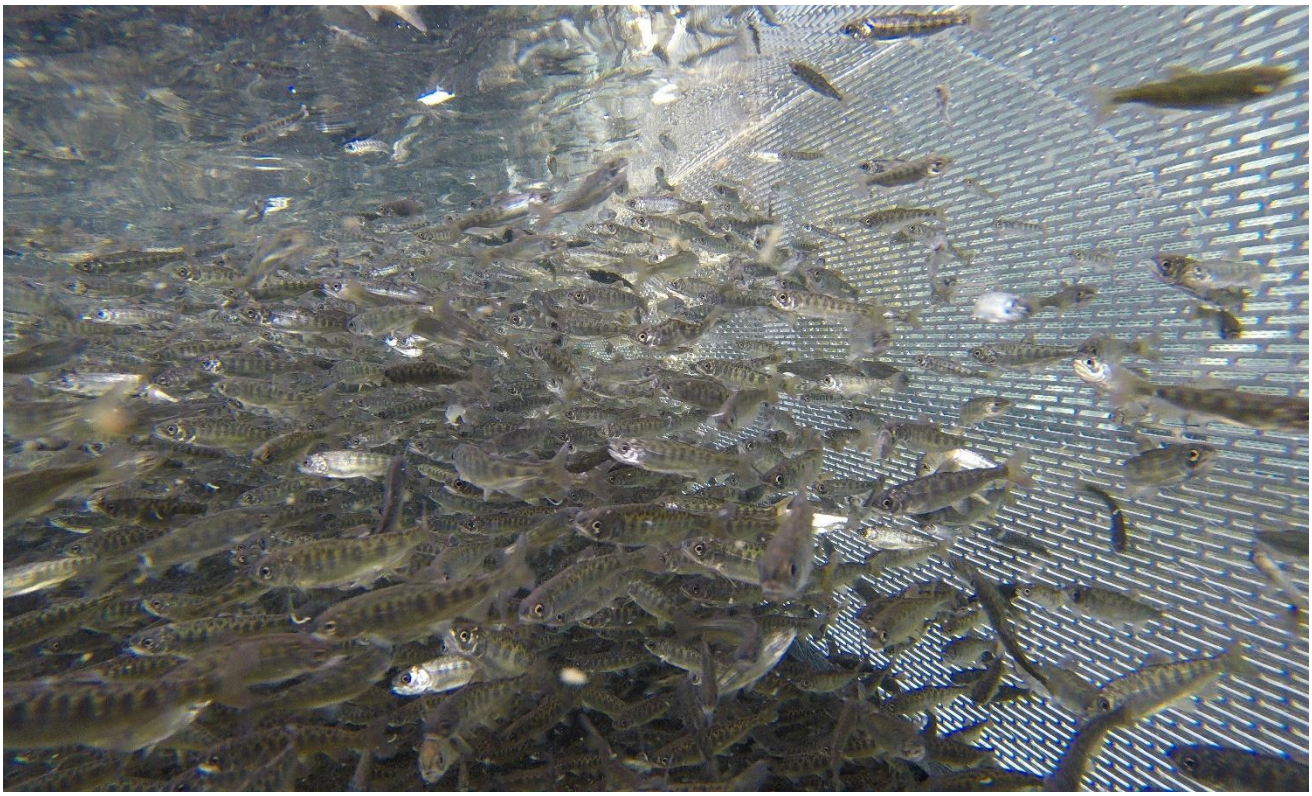
Add milt to the eggs and immediately add the spawning water containing TM. Depending on size of eggs and tub, use enough spawning water with TM to bathe every egg (anywhere from 1-3 cups) and gently mix the eggs, milt, and spawning water by hand (3-5 sec).

Transport the spawning tub to the rinse area, use UV treated water to rinse the eggs (at least 2-3 rinses). This period is about 30-60 sec.

Place fertilized eggs in iodophor (100ppm) for about 20 min. After 20 min., rinse fertilized eggs by either rinsing or moving to Heath stacks for incubation.

Appendix C: 2023 Feather River Hatchery Spring-Run Chinook Salmon Spawning and Release Protocol

2023 Feather River Fish Hatchery Spring-Run Chinook Salmon Spawning and Release Plan



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List of Abbreviations

BKD	Bacterial Kidney Disease
BOH	Back of the house
CA HSRG	California Hatchery Scientific Review Group
CDFW	California Department of Fish and Wildlife
CV	Central Valley
CVFC	Central Valley fall-run Chinook Salmon
CVSC	Central Valley spring-run Chinook Salmon
CVTA	Central Valley Tissue Archive
CWT	Coded-Wire Tag
DCC	Delta Cross Channel
DWR	Department of Water Resources
FOH	Front of the house
FRFH	Feather River Fish Hatchery
FRHOT	Feather River Hatchery Operations Team
HGMP	Hatchery Genetic Management Plan
IHN	Infectious hematopoietic necrosis
NMFS	National Marine Fisheries Service
SJRRP	San Joaquin River Restoration Program
TDC	Thiamine Deficiency Complex
USFWS	United States Fish and Wildlife Service

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Background

The Feather River Fish Hatchery (FRFH) conducts two artificial propagation programs for Central Valley (CV) Chinook Salmon (CV spring-run and CV fall-run) and one artificial propagation program for CV steelhead. CV spring-run Chinook Salmon (CVSC) are listed as threatened under both the California Endangered Species Act and the Federal Endangered Species Act.

The FRFH CVSC is an integrated recovery program with goals including the conservation and promotion of phenotypic spring-run Chinook Salmon in the Feather River. In addition to the recovery and conservation of CVSC, the purpose of the program is to mitigate for the loss of spawning and rearing habitat due to construction of Oroville Dam. Due to the threatened status of CVSC, it is crucial that hatchery operations are conducted in a way that minimizes impacts to natural spawning populations of CV spring-run populations, including those in Mill, Deer, Clear, and Butte Creeks.

Due to past hatchery spawning practices and overlap in spawning habitat in-river, spring- and fall-runs have experienced introgression that blurs the distinctions of CVSC and Central Valley fall-run Chinook Salmon (CVFC) in the Feather River. Since 2012, spawning practices at FRFH have been refined and reviewed annually to further meet California Hatchery Scientific Review Group (CA HSRG 2012) (Appendix A) recommendations and to specifically minimize introgression between runs on the Feather River (California Hatchery Policy Team 2016).

2023 Spring-run Chinook Salmon Production Goals

Mitigation Production

During the 2023-2024 spawning and rearing season, priority will be given to improving temporal separation between CVSC and CVFC. If spring-run production goals cannot be met during the defined spawning period, the spawning days will not be extended to meet the goal.

The 2023-2024 production goal for CVSC at the FRFH is as follows:

- Mitigation production goal of 2,000,000 (± 10%) smolts

Scientific Study Requests totaling: 63,600 juveniles (CVFC will be used if CVSC are not available), and 10 grams of unfertilized eggs per every 30 females spawned and the corresponding head muscle, otoliths, eyes, and scales from the spawned females. Egg collection for special studies will be in excess of egg collection goals for mitigation production.

Egg models and collection goals were developed using survival estimates for specific developmental periods. Estimated survival from green to eyed egg is 85% and estimated survival from eyed egg to fry is 90%. While actual egg survival may be different from these estimates, these estimates allow the hatchery to account for potential mortality in egg trays and culling of trays, if necessary. After addling, eggs above the daily eyed egg goals listed in Table 1 and Figure 1 will be culled. When culling, an equal proportion of eggs will be removed from each tray to maintain groups similar in size and development, which helps feeding, growth, and timing of releases.

Table 10: 2023 Spring-Run Chinook Salmon Egg Collection Model and Survival Projections with a Green Egg to Eyed Egg Survival of A) 80%, B) 85%, C) 90%.

Green Egg to Eyed Egg Survival is 80%								
Date	Lot Number	Predicted Number of Females	Predicted Green Egg Collection (4,500 eggs/female)	Predicted Culling Rate	Predicted Egg Collection After Culling	Green Egg to Eyed Egg Survival (80%)	Eyed Egg to Fry Survival (90%)	Fry to Smolt Survival (90%)
9/18	1	91	409,500	1%	405,405	324,324	291,892	262,702
*	2	150	675,000	1%	668,250	534,600	481,140	433,026
*	3	230	1,035,000	1%	1,024,650	819,720	737,748	663,973
*	4	185	832,500	1%	824,175	659,340	593,406	534,065
9/29	5	133	598,500	1%	592,515	474,012	426,611	383,950
Totals		789	3,550,500		3,514,995	2,811,996	2,530,796	2,277,717

B) Green Egg to Eyed Egg Survival is 85%								
Date	Lot Number	Predicted Number of Females	Predicted Green Egg Collection (4,500 eggs/female)	Predicted Culling Rate	Predicted Egg Collection After Culling	Green Egg to Eyed Egg Survival (85%)	Eyed Egg to Fry Survival (90%)	Fry to Smolt Survival (90%)
9/18	1	91	409,500	1%	405,405	344,594	310,135	279,121
*	2	150	675,000	1%	668,250	568,013	511,211	460,090
*	3	230	1,035,000	1%	1,024,650	870,953	783,857	705,472
*	4	185	832,500	1%	824,175	700,549	630,494	567,444
9/29	5	133	598,500	1%	592,515	503,638	453,274	407,947
Totals		789	3,550,500		3,514,995	2,987,746	2,688,971	2,420,074

C) Green Egg to Eyed Egg Survival is 90%

Date	Lot Number	Predicted Number of Females	Predicted Green Egg Collection (4,500 eggs/female)	Predicted Culling Rate	Predicted Egg Collection After Culling	Green Egg to Eyed Egg Survival (90%)	Eyed Egg to Fry Survival (90%)	Fry to Smolt Survival (90%)
9/18	1	91	409,500	1%	405,405	364,865	328,378	295,540
*	2	150	675,000	1%	668,250	601,425	541,283	487,154
*	3	230	1,035,000	1%	1,024,650	922,185	829,967	746,970
*	4	185	832,500	1%	824,175	741,758	667,582	600,824
9/29	5	133	598,500	1%	592,515	533,264	479,937	431,943
Totals		789	3,550,500		3,514,995	3,163,496	2,847,146	2,562,431

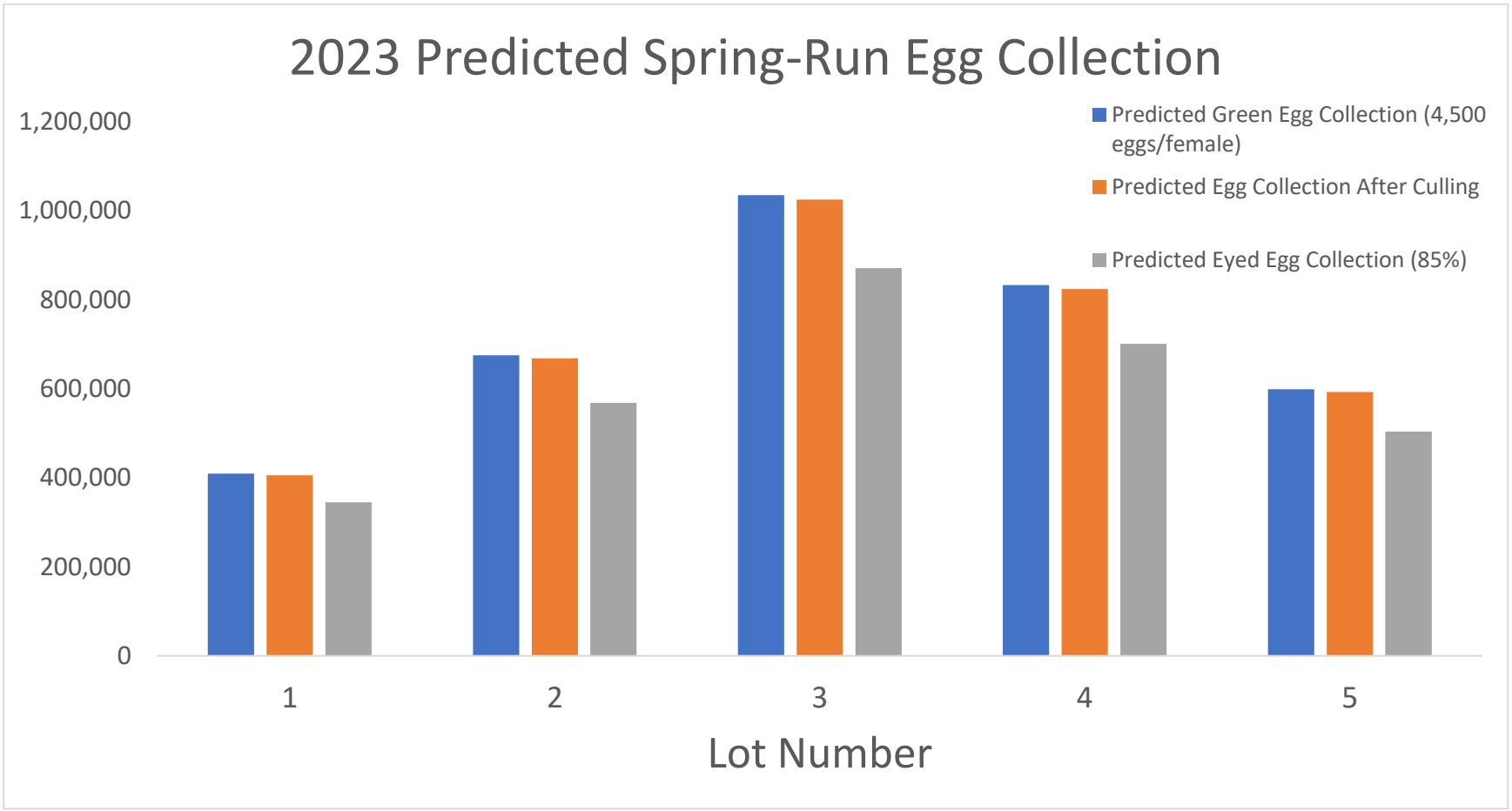

Figure 11: 2023 Spring-Run Chinook Salmon Egg Collection Model using an assumed 85% green egg to eyed egg survival and a 1% culling rate of CVSC x CVFC pairings across all egg lots.

San Joaquin River Restoration Program Egg Collection

Eggs will be collected for transfer to the San Joaquin River Restoration Program (SJRRP) when enough Hallprint tagged CVSC return to the hatchery to meet broodstock collection goals (Appendix C). The goals for the SJRPP program are secondary to collection of CVSC broodstock for the FRFH program. One representative from the SJRRP will collect eggs for that program at FRFH.

To achieve enough genetic variability for the SJRRP, eggs will be collected from the spring run trays ensuring that at least 350 paired crosses are represented for a total take of 5,470 eggs. Data from each pair will be collected for the SJRRP and virology samples will be taken for Infectious hematopoietic necrosis (IHN) or Bacterial Kidney Disease (BKD). This will allow rejection of a significant number of crosses and yet provide substantial genetic variability in the future SJRRP broodstock.

2023 Spring-Run Chinook Salmon Broodstock Identification and Collection

Broodstock Identification

Only early arriving Chinook Salmon are used as broodstock for the spring-run Chinook Salmon hatchery program at FRFH. Fish ascending the fish ladder in the spring are trapped, tagged with two identically numbered Hallprint Dart tags, and recorded as either hatchery- or natural-origin, determined by the absence or presence of an adipose fin, respectively. The 2023 CVSC broodstock identification process began on May 4 and continued until July 13, 2023. Typically, the broodstock tagging process ends by June 30, but due to the low number of returning CVSC to FRFH by the end of June in 2023, a drought action was coordinated with DWR and FRHOT to extend the tagging period until July 13, 2023. This drought action was an effort to offset impacts of multiple years of drought by increasing the number of thiamine treated CVSC and increasing the potential spring-run broodstock available to the hatchery in the fall. Fish tagged prior to June 30 received a green or yellow Hallprint tag. Fish tagged after June 30 received a blue Hallprint tag for easy identification during broodstock collection in the fall.

Water flow into the FRFH fish ladder was reduced on July 13, 2023, to prevent newly arriving fish from entering the ladder, and the ladder was subsequently closed on July 14, 2023. Any mortality observed during the broodstock tagging was documented and heads were removed for coded-wire tag (CWT) extraction from fish with an adipose fin clip.

During spring of 2023, a total of 2,165 adult Chinook Salmon were tagged as spring-run Chinook and returned to the Feather River (Table 2). For comparison to the number of fish tagged in previous years see Table 3.

Table 11: 2023 Spring-Run Broodstock Identification

Date	5/4/2023	5/15/2023	5/22/2023	5/30/2023	6/15/2023	6/20/2023	6/21/2023	6/26/2023	6/30/2023	7/13/2023	Season Total	Percent of Season Total
Fish Tagged	27	357	35	255	342	400	191	107	213	238	2165	100.00%
Green/Thiamine	22	337	30	235	293	352	166	80	213	238	1966	90.81%
Yellow/Control	5	20	5	20	49	48	25	27	0	0	199	9.19%
Grilse	1	27	0	15	20	35	31	24	63	52	268	12.38%
Wild	1	6	0	3	13	37	10	24	35	82	211	9.75%
Mortalities	0	0	0	0	1	1	0	1	1	1	5	0.23%
Single Tag	1	4	0	0	4	10	6	2	0	3	30	1.39%
Recaps	0	2	3	12	65	143	109	98	146	295	873	40.32%

Fish Tagged	27	357	35	255	342	400	191	107	213	238	2165
Wild	1	6	0	3	13	37	10	24	35	82	211
Clipped	26	351	35	252	329	363	181	83	178	156	1954
Clip Rate	96.30%	98.32%	100.00%	98.82%	96.20%	90.75%	94.76%	77.57%	83.57%	65.55%	90.25%

*Blue represents fish that were tagged after June 30, 2023.

Table 12: Total Spring-Run Chinook Salmon Broodstock Tagged 2004-2023

Year	Total Spring-Run Hallprint Tagged
2004	3,650
2005	6,021
2006	17,438
2007	9,755
2008	1,915
2009	1,462
2010	3,502
2011	6,023
2012	7,494
2013	20,057
2014	7,289
2015	5,355
2016	2,917
2017	694
2018	3,176
2019	5,945
2020	2,746
2021	4,797

2022	2,166
2023	2,165
Average	5,728

* 2004 was the first year that juvenile spring-run were coded-wire-tagged at a 100% rate. This likely increased the adipose fin clip rate observed in returning adults for the subsequent four years.

Broodstock Thiamine Treatment

Thiamine Deficiency Complex (TDC) is an ongoing threat to Chinook Salmon within the Central Valley. Juveniles with TDC experience loss of equilibrium, abnormal swimming patterns, lethargy, and early life-stage mortality (Mantua et al. 2021). To help alleviate the impacts from TDC, Thiamine HCl has been administered to the returning CVSC during the broodstock identification process since 2021. CDFW and Department of Water Resources (DWR) mutually agreed to continue the treatment of Thiamine HCl injections on returning adult and grilse CVSC during the broodstock identification process in the spring of 2023. This action is a conservation effort aimed at mitigating the effects of thiamine deficiency in FRFH broodstock but will also benefit treated CVSC that do not return to the hatchery in the fall, and instead spawn in-river.

The treatment methods employed at FRFH result from piloted methods at Livingston Stone National Fish Hatchery during 2020, where adult winter-run Chinook Salmon broodstock were injected with a thiamine solution to help boost egg thiamine concentration. Dr. Kevin Kwak (CDFW Fish Health Lab) developed a Thiamine HCl injection protocol specific to treating the CVSC at FRFH during broodstock identification (Appendix B). At FRFH, a portion of returning adults were injected with a saline solution to act as a control group. Comparison of the control group versus the thiamine treated fish will measure treatment impacts and provide a baseline of egg thiamine levels in FRFH CVSC.

A total of 2,165 returning CVSC were sedated with CO_2, tagged with two identically numbered Hallprint tags, and received a Thiamine HCl or saline injection. A total of 1,728 CVSC were tagged with green Hallprint tags and 238 CVSC were tagged with blue Hallprint tags. These fish were all injected with 1ml of Thiamine HCl. A total of 199 CVSC were tagged with yellow Hallprint tags and were injected with saline. All injections were given near the pelvic fin region with the needle penetrating approximately 1 inch into the body wall (Figure 2). Different color Hallprint tags were used for treatment and control groups for easy identification during spawning. Although the treatment is intended for females only, males and females both received treatment since sexual morphological differences were not identifiable at the time of treatment. Thus far, there have been no adverse effects associated with Thiamine HCl injections.

During the last five seasons (2018-2022) an average of 3,766 CVSC have been Hallprint-tagged per year. During this period, there was a low number of 2,166 fish tagged in 2022, and a high number of 5,945 in 2019. A control group of approximately 200 fish was the target for the saline tagging

program. Typically, upwards of 50% of Hallprint tagged fish return to FRFH. This means that approximately 50 control group females should return to FRFH during the spawning season, more than the minimum of 30 females needed to establish baseline egg thiamine concentrations for the Feather River CVSC population.

Figure 12: Thiamine Injections on Spring-Run Chinook Salmon at Feather River Fish Hatchery

Broodstock Collection

FRFH staff will open the ladder on Friday September 15, 2023, and begin sorting the fish on Monday September 18, 2023. Spawning will commence on Tuesday September 19, 2023, and will continue until Friday, September 29, 2023. Fish entering the hatchery are sorted and Hallprint tagged CVSC broodstock are separated from non-Hallprint tagged Chinook. Additionally, thiamine treated, and saline control groups will be held separately to facilitate spawning operations unique to each group. Spawning will occur whenever enough mature, or ripe, CVSC broodstock of a roughly equal sex ratio have accumulated in the round tanks. Spawning and egg collection will follow the run-timing egg collection model described in Table 1. However, deviations from this model may be necessary if the number of adults available to spawn differ from the model. If any modifications will be made in consultation with the technical team and/or genetic staff.

One round tank will be reserved to hold non-Hallprint-tagged fish that enter the hatchery prior to the start of CVFC spawning and will be used for the Inland Chinook program. All non-Hallprint-tagged Chinook Salmon in excess to those needed for the Inland Program production goals are counted and excised.

2023 Spring-Run Chinook Salmon Broodstock Spawning

Hallprint Tagged Spring-Run Chinook Salmon

During the 2023 CVSC broodstock identification process, CVSC were tagged with either two green, two yellow, or two blue Hallprint tags. Green Hallprint tags indicate CVSC that arrived during the typical broodstock tagging time, May 1 through June 30, and received Thiamine HCl injections. Yellow Hallprint tags indicate CVSC that arrived during the typical broodstock tagging time and received saline injections instead of Thiamine HCl. Blue Hallprint tags indicate CVSC that arrived after June 30 and received Thiamine HCl injections. Thiamine treated and non-treated fish will be separated and will follow spawning operations unique to each group.

The green Hallprint tagged fish, (adipose fin-clipped or non-clipped), will be incorporated into the CVSC following the standard spawning procedure. Green Hallprint tagged fish may be spawned with other green Hallprint tagged fish or blue Hallprint tagged adipose fin-clipped fish, as these have all received Thiamine HCl injections (Table 4). Green Hallprint tagged fish in excess to those needed to meet production goals may be released back into the Feather River following the procedures described below.

The blue Hallprint tagged fish that are adipose fin-clipped will be incorporated into the CVSC following the standard spawning procedures. During the CVSC broodstock tagging, the adipose fin clip rate (65.5%) for the blue Hallprint tagged fish was lower than all other days of broodstock tagging. This indicates a higher proportion of these fish may have been CVFC, and as a result any non-adipose fin clipped fish that returns will not be used in the CVSC broodstock. Instead, these fish will be released back to the river consistent with other thiamine treated Hallprint tagged broodstock. The adipose fin clipped fish with blue Hallprint tags can be used as CVSC broodstock, as these fish will all have CWTs that can be analyzed for run confirmation. The blue Hallprint tagged fish can be spawned with other adipose fin clipped blue Hallprint tagged fish or can be spawned with any green Hallprint tagged CVSC. Blue Hallprint tagged fish (adipose fin clipped and non-adipose fin clipped) in excess to those needed to meet production goals may be released back into the Feather River following the procedures described below.

The yellow Hallprint tagged fish, adipose fin clipped and non-clipped, may be used as CVSC broodstock, however the yellow Hallprint tagged fish need thiamine treatment and can only be spawned with other yellow Hallprint tagged fish. Yellow Hallprint tagged fish in excess to those needed to meet production goals may be released back into the Feather River following the procedures described below.

Table 13: Breakdown of the Spring-Run Chinook Salmon Broodstock Hallprint Colors

Hallprint Tag Color	Adipose Fin Clip	Spawn as CVSC Broodstock	Spawned with other Hallprint Colors	Release into the Feather River
Green	Yes	Yes	Green and Blue	Yes
Green	No	Yes	Green and Blue	Yes
Blue	Yes	Yes	Green and Blue	Yes
Blue	No	NO SPAWNING	NO SPAWNING	Yes
Yellow	Yes	Yes, but needs Thiamine treatment	Yellow	Yes
Yellow	No	Yes, but needs Thiamine treatment	Yellow	Yes

Spawning Procedures

CVSC will be anesthetized using CO_2, lifted into the hatchery, and FRFH staff will sort and check the ripeness of each fish. The fish that are ready to spawn will be excised and sorted on the spawning table by sex. As fish are pulled off the table to spawn, the front of house (FOH) data recorder will record on a data card whether the fish is a grilse or adult based on fork length (650 mm), its adipose fin clip status, and the unique Hallprint tag number for each male and female spawned together. A lateral incision will be made near the female's vent and will extend toward the head. Eggs are carefully removed and placed into a tub that has been cleaned with UV treated water. Milt will be added into the tub of eggs and will be gently mixed by hand.

After the eggs and milt are combined, a 1-ounce sample of eggs will be taken from every egg tub. This sample will be placed into a large measuring cup with all samples from that day. These eggs will be water hardened and counted at end of day to estimate eggs per ounce, and the average eggs per ounce will be applied to the total volume collected each day to estimate the total eggs taken. These eggs will be incubated in a tray together and included in production, assuming there are no CVSC and CVFC crosses. The data card is then attached to the egg tub to track the parentage of the eggs in each tub. Spring-run Chinook are spawned using a true 1 male: 1 female ratio. FRFH staff will limit the reuse of males as much as possible. However, if males are used multiple times, they are treated as new fish each time they are spawned. This is recorded and highlighted on the associated data card for each tub, and the number is recorded for hatchery files. Grilse with a fork length less than or equal to 650 mm are incorporated into FRFH CVSC production at a rate of 2%. If 3- and 4-year-old returns are low, discussion and consensus by the Feather River Hatchery Operations Team (FRHOT) will determine whether adjustment of the grilse incorporation rate for the current broodstock collection season is appropriate.

Each tub of fertilized eggs will have a data card attached and will be brought to the back of house (BOH) data recorder. The fertilized eggs will be drained of ovarian fluid and milt and placed into a measuring cup to measure the ounces of eggs collected from each female. The eggs will then be placed in an incubation tray and disinfected with 4 ounces of iodophor. The BOH data recorder will record on the data cards as well as a datasheet the ounces of eggs that are placed into the incubation tray, as well as the lot, stack, and tray number (Appendix D). When a data card is filled and complete, it will be grouped with the other cards from the day, scanned and distributed to the CDFW Central Valley Tissue Archive (CVTA) for storage. All data sheets will be analyzed for quality assurance and quality control.

Thiamine Treatment of Yellow Hallprint Tagged CVSC

CVSC containing yellow Hallprint tags were injected with a saline solution instead of Thiamine HCl to serve as a control and provide baseline levels of egg thiamine concentrations in the FRFH CVSC population. As such, eggs collected from the yellow Hallprint tagged CVSC could lack sufficient thiamine to offset the effects of TDC and therefore require thiamine treatment for greater progeny success. Untreated eggs are needed to continue studying TDC in Chinook Salmon, therefore these fish will be treated with thiamine HCl as fry when they are ponded.

Data Collection

After spawning, the carcasses will be placed into a designated bin depending on the condition of the fish (e.g., spawned, killed not spawned, or dead in tank). The CVTA and CWT Lab staff will then collect a tissue sample and a scale sample from every CVSC, and if the CVSC is adipose fin clipped, its head will be collected. The heads will be taken to the lab for CWT extraction and analysis. To evaluate origin in each tray/stack, CWT analysis will be used to identify stacks and trays with CVFC contribution and/or strays. Trays that include offspring from CVFC and/or strays from other hatcheries as identified by CWT will be removed from production and culled. The CVTA and CWT Lab staff will also record fish condition, sex, fork length, adipose fin clip status, and Hallprint tag ID on every CVSC. All Hallprint tags will be removed and brought back to the CVTA and CWT Lab for verification. The Hallprint tags removed from adipose fin clipped CVSC will be placed into the bag with the corresponding collected head. The Hallprint tags removed from non-adipose fin clipped fish will be included in the corresponding tissue sample envelope. An example of the data sheets used during CVSC broodstock spawning can be found in Appendix D.

Excess Spring-Run Returned to Feather River

Some adult CVSC that enter FRFH in excess to those needed to meet production goals will be returned live to the Feather River. This is an action coordinated between CDFW and DWR, with guidance from National Marine Fisheries Service (NMFS), to help offset anticipated natural spawning impacts resulting from the multiple years of drought. Once it is projected that egg collection goals will be met and are sufficient to meet CVSC smolt production goals, adult spring-run will be returned to the Feather River under the following conditions:

Adult Hallprint tagged CVSC entering the hatchery will be returned to the river as soon as logistically possible and up to the last scheduled day of spawning for the Inland Salmon Program on October 6, 2023. All Hallprint tagged fish that enter the hatchery after this date will be excised following normal practice.

- Hallprint tagged CVSC that are overripe, spawned out, showing obvious signs of disease including external fungus, or are in otherwise poor physical condition will be excised following normal practice.
- All Hallprint tagged grilse not incorporated into broodstock for the hatchery will not be returned to the river and will be spawned for experimental purposes or excised following normal practice.
- All Hallprint tagged CVSC broodstock released to the river will receive an identifying mark, and the Hallprint tag ID will be recorded for easy identification and counting if observed re-entering the hatchery or during the Feather River carcass survey. Prior to release, the adipose fin status and sex will be recorded and a dorsal fin clip for genetic analyses will be collected from all fish.

CDFW and DWR will coordinate to determine a logistically appropriate schedule for returning qualifying adult CVSC while not interrupting necessary hatchery operations.

2023 Spring-Run Chinook Salmon Feeding Strategy

When 90-100% of the fish in incubation stacks have buttoned-up, they will be transferred to outdoor concrete raceways. Fry will be hand-fed Bio-Oregon Bio- Pro 2 to satiation at each feeding, 4-8 times a day depending on age and size (Table 5). All spring-run will be fed Bio-Pro 2 until release. Medicated and antibiotic feeds will be used, if necessary, as prescribed by CDFW pathologists.

Table 14: Feed Manufacturer Recommended Feeding Scheduled for Chinook Salmon

Fish size (fish/lb.)	Feed Size	Fish Food Type	Fed Times a day
3000 to 570	#0	Bio-Pro2	7-8
570 to 300	#1	Bio-Pro2	7-8
300 to 150	#2	Bio-Pro2	4-6
350 to 150	#2	Bio-Pro2	4-6
150 to 60	#3	Bio-Pro2	4-6
140 to 60	1.2	Bio-Pro2	4-6
140 to 60	1.2	Bio-Pro2	4-6

2023 Spring-Run Ponding, Marking, and Tagging

Chinook salmon will be ponded into two raceways shortly after reaching a button-up fry stage or approximately 1,200 fish/lb. During marking and tagging operations and based on proposed release strategies, fish will be sorted such that each raceway will contain approximately one million fish.

Fish will be marked and tagged (adipose fin-clip and a CWT inserted) at a marking rate of 100% when they reach a minimum of 120 fish/lb. Different tag codes will be used to differentiate between the different release locations and dates.

Brood Year 2023 Spring-Run Chinook Salmon Releases

Release Strategy

Releases in 2024 will replicate the release strategy that began in 2020. The CVSC will be split into 6 groups of 336,000 fish, with each group 100% uniquely tagged with the same CWT number, marked by the removal of the adipose fin, and released into the Feather River, if in-river conditions permit.

The first release of CVSC will be coordinated through the FRHOT and will be timed to coincide with an increase in river flow, ideally generated by a storm event, in early March. The release will occur on the climbing limb of the flow event and will consist of two groups of 336,000 fish each; one group will be released at the Boyd's Pump Boat Launch release location and the other will be released at the Gridley Boat Launch release location (Table 6). The release size will be a minimum of 120 fpp, to enable fish to be processed by the auto fish tagging trailer. However, fish size at the time of release will depend on the timing of a flow event.

The second release will be like the previous release, occurring on the climbing limb of the flow event and consisting of two groups of 336,000 fish each; one group will be released at the Boyd's Pump Boat Launch release location and the other will be released at the Gridley Boat Launch release location. This release will occur during late March or early April. The target release weight is a minimum of 90 fpp.

The third release will be planned for mid- to late April. Like the previous two releases, fish will be released on the climbing limb of the flow event and consist of two groups of 336,000 fish each; one group will be released at the Boyd's Pump Boat Launch release location and the other will be released at the Gridley Boat Launch release location. The target release weight is a minimum of 60 fpp.

Data from the early march releases will be used to evaluate survival of spring-run Chinook Salmon released in-river at a smaller size than past releases and under conditions of high flow and turbidity. Each set of releases will use two in-river release sites (Gridley and Boyd's Pump Boat Launch) to enable evaluation of differences in survival and stray rate by release location.

Sentinel hatchery fish, used as an indicator of exposure to pathogens, will be used during the releases, and water quality samples will be collected to continue monitoring for the prevalence and severity of *Ceratonova shasta* and its effect on Feather River Chinook Salmon.

Table 15: Spring-run Release Strategy for Brood Year 2023

Date	Location	# of Fish	Fish/lb.	With CWT and Mark
Early March	Gridley Boat Launch	336,000	>120	100% Ad Clip
Early March	Boyd's Pump Boat Launch	336,000	>120	100% Ad Clip
Late March	Gridley Boat Launch	336,000	90	100% Ad Clip
Late March	Boyd's Pump Boat Launch	336,000	90	100% Ad Clip
Mid-April	Gridley Boat Launch	336,000	60	100% Ad Clip
Mid-April	Boyd's Pump Boat Launch	336,000	60	100% Ad Clip

Release Criteria and Contingencies

In coordination with 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 2023/2024. These criteria and triggers were developed based on review of water temperature, river flow, and Delta Cross Channel (DCC) Gate operations. Each of the criteria indicated below are intended to be independent of the others, meaning that if any one or more of the criteria are anticipated to be met, then an alternative release location will be coordinated with the FRHOT. If none of the triggers are forecast to be met, then juveniles will be released into Feather River.

Delta Cross-channel Gates operations

- Survival of juvenile salmon are known to be significantly reduced when the DCC gates are open, and increased numbers of fish are diverted into the interior Delta (Perry et al. 2015).

- Cross-channel gates are forecast to be open within 21 days of the date when the hatchery salmon are to be released.

Water Temperature

Prolonged exposure to increased water temperatures above 70°F are thought to result in juvenile salmon survival approaching zero (Nobriga et al. 2021)

- Sustained Daily Average Water temperatures are expected to be greater than 68 F at Verona within 21 days of the date when the hatchery salmon are to be released.
- Sustained Daily Average Water temperatures are expected to be greater than 68 F at Freeport within 21 days of the date when the hatchery salmon are to be released.

Flow

- Flows in the Sacramento River below 12,000 cubic feet per second upstream of the Delta Cross Channel Junctions can lead to significantly reduced survival of juvenile salmon because

of reduced travel times, exposure to increased predation and increased risk of diversion into the interior Delta (Perry et al. 2015, NMFS 2019).

- A Sacramento River flow at Verona of less than 4,000 cfs is forecast* to occur within 21 days of the date when the hatchery salmon are to be released.
- A Sacramento River Flow of less than 12,000 cfs at Freeport is forecast to occur within 21 days of the date when the hatchery salmon are to be released.
- Delta Outflow is forecast* to be less than 3,000 cfs within 21 days of the date when the hatchery salmon are to be released.

Ceratonova shasta

An evaluation of this release contingency criteria has not yet been completed. Data from monitoring prevalence of *C. shasta* within the Feather River would need to be analyzed and discussed before alternate release sites for FRFH CVSC could be considered.

Alternate Release Strategies

If existing/predicted conditions are expected to meet the criteria triggering, an alternate release strategy will be discussed and coordinated with the FRHOT.

- Early release of all CVSC into the Feather River at Boyd's pump.
- Early release of all CVSC into the Feather River during high flow event.
- Releasing CVSC at the Live Oak Boat Launch facility instead of Gridley release location.

Consistent with the Hatchery and Genetic Management Plan (HGMP) for Feather River Fish Hatchery Spring-run Chinook Salmon, portions of the production may be released in or near San Francisco Bay during extreme drought conditions. This is done to increase survival when river conditions are poor due to extreme drought.

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Appendix D: Total Hallprint-Tagged Spring-Run Chinook Salmon Captured at FRFH in 2023

		Spawned				Mortalities Killed Not Spawned and Dead in Tank				Released				Recaptured			
Hallprint Color	Date	Ad-Clipped F	Non-Clipped F	Ad-Clipped M	Non-Clipped M	Ad-Clipped F	Non-Clipped F	Ad-Clipped M	Non-Clipped M	Ad-Clipped F	Non-Clipped F	Ad-Clipped M	Non-Clipped M	Ad-Clipped F	Non-Clipped F	Ad-Clipped M	Non-Clipped M
Green/Blue	19-Sep	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Green/Blue	20-Sep	30	0	29	1	1	0	0	0	0	0	0	0	0	0	0	0
Green/Blue	23-Sep	135	1	135	1	1	0	2	0	0	0	0	0	0	0	0	0
Yellow	25-Sep	13	1	13	1	0	0	0	0	0	0	0	0	0	0	0	0
Green/Blue	28-Sep	166	2	161	7	7	0	4	1	0	0	0	0	0	0	0	0
Green/Blue	29-Sep	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0
Yellow	29-Sep	28	1	28	1	0	0	1	1	13	0	21	0	0	0	0	0
Green/Blue	2-Oct	93	1	90	4	10	0	59	7	62	5	144	14	0	0	0	0
Green/Blue	3-Oct	0	0	0	0	1	0	2	0	3	0	6	1	0	0	0	0
Green/Blue	4-Oct	0	0	0	0	2	0	0	1	15	4	8	4	0	0	0	0
Yellow	4-Oct	0	0	0	0	1	0	0	0	0	0	3	1	0	0	3	0
Green/Blue	6-Oct	0	0	0	0	1	0	0	0	10	0	4	3	0	0	0	0
Yellow	6-Oct	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0
Green/Blue	9-Oct	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0
Yellow	9-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Green/Blue	10-Oct	0	0	0	0	3	0	0	2	0	0	0	0	0	0	0	0
Yellow	10-Oct	0	0	0	0	0	0	2	1	0	0	0	0	0	0	1	0
Green/Blue	11-Oct	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Green/Blue	12-Oct	0	0	0	0	2	0	1	2	0	0	0	0	0	0	1	1
Green/Blue	13-Oct	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
Yellow	13-Oct	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0
Green/Blue	17-Oct	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Green/Blue	19-Oct	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0
Yellow	20-Oct	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Green/Blue	23-Oct	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1

Green/Blue	25-Oct	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	Total	465	6	456	15	30	1	79	20	105	9	187	26	0	0	8	2

Note:
[1]All fish with recorded adipose fin status as “partial” were assumed to be adipose fin-clipped.
[2]All recaptured fish are also counted in the released fish column.
[3]Five of the fish recaptured between the dates of 10/10/2023 and 10/23/2023 are also counted under the mortality column, as these fish returned during CVFC spawning period and were subsequently excised.
[4]Eight of the Hallprint tagged fish had a FRFH CVFC CWT.

Appendix E: Returns of CVSC with FRFH CWTs to the FRFH between July 1, 2023, and June 30, 2024

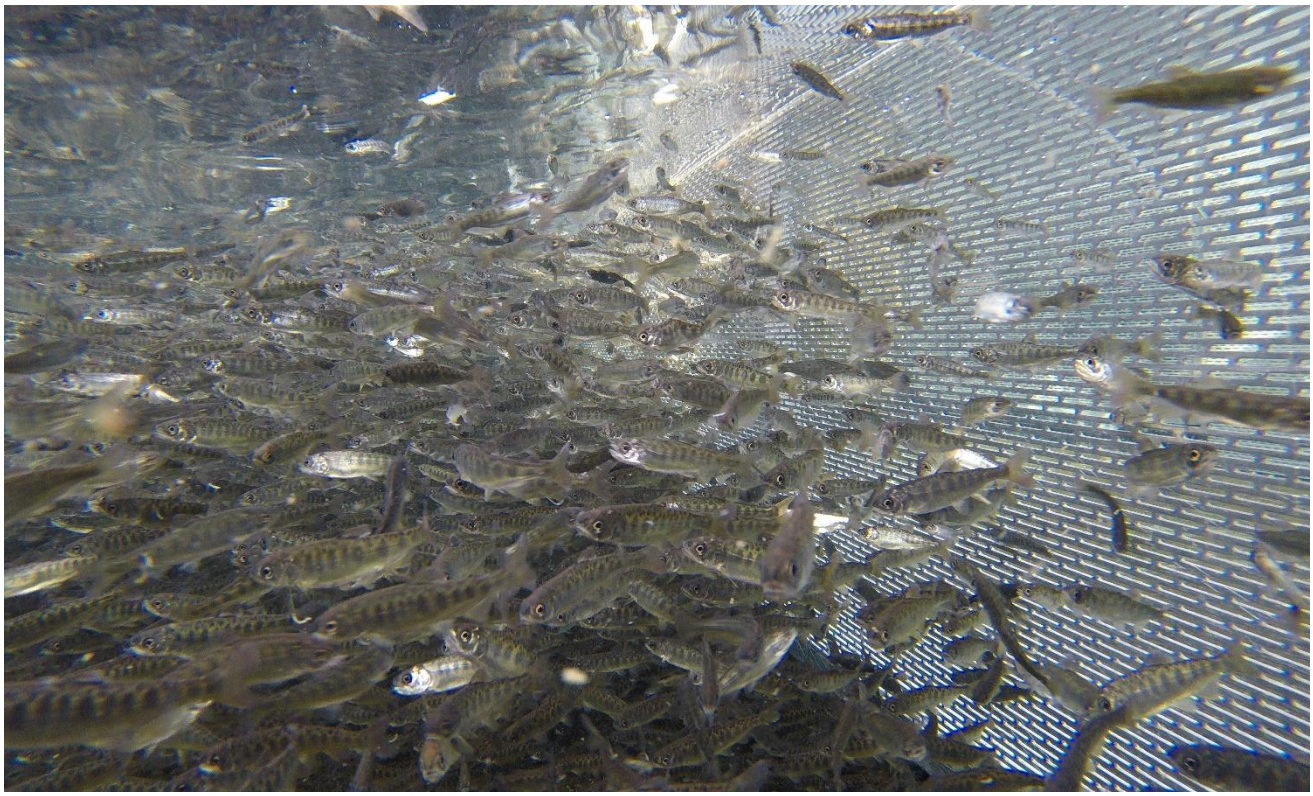
CWT Number	Brood Year	Hatchery of Origin	Release Location	Total Recovered
061607	2018	Feather River Fish Hatchery	Feather River at Gridley	1
061973	2018	Feather River Fish Hatchery	Feather River at Boyd's Pump	1
060502	2019	Feather River Fish Hatchery	Feather River at Gridley	3
060503	2019	Feather River Fish Hatchery	Feather River at Boyd's Pump	11
062043	2019	Feather River Fish Hatchery	Feather River at Boyd's Pump	8
062044	2019	Feather River Fish Hatchery	Feather River at Boyd's Pump	23
062045	2019	Feather River Fish Hatchery	Feather River at Gridley	2
062290	2020	Feather River Fish Hatchery	Feather River at Boyd's Pump	424
062291	2020	Feather River Fish Hatchery	Feather River at Boyd's Pump	428
062292	2020	Feather River Fish Hatchery	Feather River at Boyd's Pump	213
062293	2020	Feather River Fish Hatchery	Feather River at Boyd's Pump	170
062863	2021	Feather River Fish Hatchery	Feather River at Boyd's Pump	7
062864	2021	Feather River Fish Hatchery	Feather River at Gridley	2
062865	2021	Feather River Fish Hatchery	Mare Island Net Pen	78
062866	2021	Feather River Fish Hatchery	Mare Island Net Pen	88

Appendix F: Brood Year 2023 Spring-Run Chinook Salmon Releases

Date	Location	Mark and CWT Code	Fish Size (Fish per Pound)	Total Length (mm)	Released with CWT and Ad-Clip	Total Released
3/15/2024	Feather River, Gridley Boat Launch	Ad-Clip 060080	135	74	350,544	350,544
3/15/2024	Feather River, Boyd's Pump Boat Launch	Ad-Clip 060078	124	75	349,309	349,309
3/29/2024	Feather River, Gridley Boat Launch	Ad-Clip 060079	86	85	350,571	350,571
3/29/2024	Feather River, Boyd's Pump Boat Launch	Ad-Clip 060081	109	79	350,055	350,055
4/23/2024	Feather River, Gridley Boat Launch	Ad-Clip 060679	69	92	98,880	98,880
4/23/2024	Feather River, Gridley Boat Launch	Ad-Clip 063055	69	92	88,788	88,788
4/23/2024	Feather River, Gridley Boat Launch	Ad-Clip 063053	69	92	22,326	22,326
4/23/2024	Feather River, Gridley Boat Launch	Ad-Clip 060082	61	96	350,307	350,307
					Total Released	**1,960,780**

Appendix G: 2023 Feather River Fish Hatchery Fall-Run Chinook Salmon Spawning and Release Protocol

Brood Year 2023 Feather River Fish Hatchery Fall-Run Chinook Salmon Spawning and Release Plan



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List of Abbreviations

BOH	Back of the house
BY	Brood Year
CA HSRG	California Hatchery Scientific Review Group
CDFW	California Department of Fish and Wildlife
CV	Central Valley
CVFC	Central Valley fall-run Chinook Salmon
CVSC	Central Valley spring-run Chinook Salmon
CVSH	Central Valley Steelhead Trout
CVTA	Central Valley Tissue Archive
CWT	Coded-Wire Tag
DCC	Delta Cross Channel
DWR	Department of Water Resources
FOH	Front of the house
FRFH	Feather River Fish Hatchery
FRHOT	Feather River Hatchery Operations Team
HGMP	Hatchery Genetic Management Plan
NFFAA	North Fork Feather Above Almanor Fish Passage Feasibility Study
NMFS	National Marine Fisheries Service
PBT	Parentage-based tagging
SFB	Silverado Fish Plant Base
TDC	Thiamine Deficiency Complex

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Background

The Feather River Fish Hatchery (FRFH) conducts two artificial propagation programs for Central Valley (CV) Chinook Salmon (CV spring-run and CV fall-run) and one artificial propagation program for Central Valley steelhead trout (CVSH). CV fall-run Chinook Salmon (CVFC) are a species of special concern under the federal Endangered Species Act. CVFC originating from the Feather River Hatchery contribute to economically important commercial fisheries as well as popular ocean and inland sport fisheries.

The primary purpose of the FRFH CVFC program is to mitigate the loss of spawning and rearing habitat due to construction of Oroville Dam, with a coequal purpose to support river and ocean fisheries. In addition to the production of CVFC, FRFH produces triploid Chinook Salmon for the California Department of Fish and Wildlife (CDFW) Inland Salmon Program and the Department of Water Resources (DWR) Federal Energy Regulation Commission license requirement to provide a cold-water fishery in Lake Oroville. Triploid Chinook Salmon eggs collected to support the statewide Inland Salmon Program are incubated and reared at the Silverado Fisheries Planting Base (SFB).

Due to past hatchery spawning practices and overlap in spawning habitat in-river, spring- and fall-runs have experienced introgression that blurs the distinctions of Central Valley spring-run Chinook Salmon (CVSC) and CVFC in the Feather River. Since 2012, spawning practices at FRFH have been refined and reviewed annually to meet California Hatchery Scientific Review Group (CA HSRG 2012) (Appendix A) recommendations and to specifically minimize introgression between runs on the Feather River (California Hatchery Policy Team 2016).

Beginning in 2019, juvenile Chinook Salmon produced at FRFH displayed abnormal swimming behavior and suffered higher than normal egg and fry mortality. This increased mortality is attributed to Thiamine Deficiency Complex (TDC) resulting from a dietary shift in adult Chinook Salmon in the Ocean. TDC is an ongoing threat to Chinook Salmon within the Central Valley. Juveniles with TDC experience loss of equilibrium, abnormal swimming patterns, lethargy, and early life-stage mortality (Mantua et al. 2021). To help alleviate the impacts from TDC, thiamine treatments will be given to green eggs at fertilization following a protocol that was developed by Dr. Kevin Kwak (Appendix B). The methods for treating eggs at fertilization were piloted by CDFW Fish Health Lab staff during the fall of 2020 (unpublished). This study demonstrated that sufficient thiamine could be absorbed by the eggs in the moments prior to fertilization to increase egg thiamine levels above the level of concern. These methods will be used at all CDFW anadromous fish hatcheries for eggs collected from all untreated adult Chinook to help prevent the effects of TDC in the hatchery production population.

2023 Inland Salmon Program

Inland Production Goals

In addition to the production goals for the Lake Oroville cold-water fishery and CDFW's Statewide Inland Salmon Program, the FRFH will also collect eggs to support the North Fork Feather Above Almanor Fish Passage Feasibility Study (NFFAA). The 2023-2024 production goals for the Inland Chinook Program are as follows:

- 125,000 triploid fingerlings to support the cold-water fishery in Lake Oroville
- 125,000 triploid fingerlings to support CDFW's Statewide Inland Salmon Program allotments for Spaulding and Pine Flat Reservoir
- 1,500,000 triploid green eggs to support CDFW's Statewide Inland Salmon Program
- A portion of these, up to 300,000 green eggs (incubated and reared at SFB), will be collected to support the NFFAA study with 125,000 eyed eggs and 25,000 juveniles.

After fertilization, all eggs collected for inland production will be triploided following standardized methods with assistance from CDFW's trout hatchery staff. The triploid process of Chinook Salmon at FRFH is still a relatively new process, and therefore egg survival data is limited. The assumed green egg to hatch survival rate has been conservatively set to 50%. The eggs collected for the Inland Chinook Program, along with the fry that hatch, are incubated and reared in a separate building from the CVSC, CVFC, and CVSH raised at FRFH. This dedicated Inland Chinook building has a maximum capacity of 500,000 freshly fertilized, or green eggs. In 2023, the number of green eggs reared in the Inland Chinook building will be maximized to meet the production goals for the cold-water fishery in Lake Oroville and a portion of the Statewide Inland Salmon Program. Typically, all Chinook for the Statewide Inland Salmon Program are raised at SFB. However, due to pathology concerns at FRFH, SFB will incubate and rear eggs and juveniles intended for the NFFAA in addition to those needed to support SFB goals for the inland Chinook program. To help accommodate for the production of eggs and fry for the NFFAA at SFB, a portion of the Statewide Inland Salmon Program Chinook production goal will be raised at FRFH.

Approximately 500,000 green triploid eggs will be incubated in the FRFH Inland Chinook Building to meet the production goal of 125,000 fingerlings for Lake Oroville and 125,000 fingerlings to support the Statewide Inland Salmon Program goals for releases to Spaulding and Pine Flat Reservoirs. The FRFH will also collect 1,500,000 green triploid eggs to support the remaining Statewide Inland Salmon Program production and the NFFAA production goals. These eggs will be transferred to SFB as triploid green eggs on the same day of spawning for incubation, rearing, and release at approved waters throughout the State.

Inland Broodstock Collection and Spawning

All adult Chinook Salmon without a Hallprint tag that enter the hatchery during the Central Valley spring-run Chinook Salmon (CVSC) spawning period, from September 18, 2023, through September

29, 2023, will be held in two of the four round tanks to be used as broodstock for the Inland Salmon Program. Spawning for Lake Oroville's cold-water fishery will occur on October 2, 2023. Eggs collected on this day will be triploided, disinfected, and isolated in the FRFH Inland Chinook building following procedures outlined in FRFH SOP 015 (see Hatchery Manager if more information is requested). Spawning will continue October 3-5 to collect eggs for CDFW's Statewide Inland Salmon Program. Eggs collected on these days will be triploided, disinfected, and a portion of them will be isolated in the FRFH Inland Chinook building, while the remainder will be shipped to SFB on the same day. Spawning for the NFFAA study will occur on October 3, and the eggs collected on this day will be triploided, disinfected, and shipped to SFB on the same day. Losses will be tracked for green eggs shipped to SFB to refine future production targets relative to reservoir allotment goals. Annual data and analyses will be included in annual reports.

All adult Chinook Salmon held as potential broodstock for the Inland Chinook program remaining at the hatchery after October 6, 2023, will be excised before the beginning of CVFC broodstock collection on October 9, 2023.

Spawning Procedures

Inland Salmon Program Spawning Procedures

Adult Chinook Salmon will be anesthetized using CO2, lifted into the hatchery, and FRFH staff will sort and check ripeness of each fish. The fish that are ready to spawn will be excised and sorted on the spawning table by sex, and each fish will be thoroughly dried. The females will be air-spawned by inserting a needle into the female's abdominal cavity and using compressed air to expel the eggs out of the vent. Eggs from each female are collected into a 1-gallon bucket until 60 ounces of eggs is reached. Once eggs have been collected, a lid will be placed on the bucket. And the bucket will be set in a water bath to keep eggs within 5 degrees of the water temperature in which females were collected. Milt from five different males, totaling 30 ml, will be collected into a cup and will be placed in a water bath to keep the milt within 5 degrees of the water temperature in which the males were collected.

A total of 60 ounces of eggs will be mixed with 30 ml of milt and a milt extender to increase mobility of milt. Thiamine mononitrate will also be added to treat for TDC following established protocols developed by the CDFW Fish Health Laboratory (Appendix B). Eggs will then be rinsed and placed into the triploid cylinder. After the triploid process, the eggs will be treated with iodophor and then placed into FRFH incubation trays or prepared for transport to SFB.

North Fork Feather Above Almanor Fish Passage Feasibility Spawning Procedures

Spawning for the NFFAA study will take place on October 3 and will follow the Inland Salmon spawning procedures. However, eggs will need to be separated by family groups to the extent possible through development to facilitate Parentage-based tagging (PBT). Therefore, eggs from

different females will be combined as little as possible. When eggs are combined, they will only be mixed with other eggs assigned to the same experimental variable and the combination will track the IDs for the females and the experimental group. Eggs will then be placed in 60 oz groups, with the goal of keeping family groups together, for the triploid process at Feather River Hatchery. Eggs will be shocked keeping the 60 oz groups created from the triploid process separate. Eggs will then be loaded into shipping containers keeping the release groups separated and labeled. A member of DWR Feather River Program will be present at the hatchery for all activities where eggs are moved or combined to guide and assist in family group tracking.

Data Collection

Inland Salmon Program Data Collection

After spawning fish utilized to meet the cold-water fishery in Lake Oroville, NFFAA, and the Statewide Inland Salmon Program production goals, the carcasses will be placed into a designated bin depending on the condition of the fish (e.g., spawned, killed not spawned, or dead in tank). The CVTA and Coded-Wire Tag (CWT) Lab staff will then collect heads and record fish condition, sex, and fork length from every adipose-fin clipped fish. The heads will be taken back to the lab for CWT extraction and analysis. From every fifth fish (up to 20 fish per day), the CVTA and CWT Lab staff will also record fish condition, sex, fork length, and adipose-fin clip status, and the staff will collect a tissue sample, scale sample, and a fat content measurement. All data sheets used during CVFC broodstock spawning can be found in Appendix C.

North Fork Feather Above Almanor Fish Passage Feasibility Study Data Collection

The post-spawning data collection on the adults used to meet the NFFAA production goals will follow the standard Inland Salmon sampling and data collection process. However, the CVTA lab will also collect a tissue sample from every spawned adult. A fin clip will be collected from a portion of the upper caudal fin that is free from disease and damage for PBT genetic analysis.

Brood Year 2023 Fall-run Chinook Salmon

Fall-run Chinook Salmon Production Goals

During the 2023-2024 spawning and rearing season, priority will be given to improving temporal separation between spring- and fall-runs, and crosses of these two runs will continue to be culled. The production goals for Brood Year (BY) 2023 CVFC at FRFH is as follows:

- Mitigation production goal of 6,000,000 smolts
- Drought enhancement production of 2,000,000 smolts
- Drought enhancement production of 1,500,000 pre-smolts

- Scientific Study Requests totaling: 2,940 juveniles, 6,000 eggs, and 10 grams of unfertilized eggs per every 30 females spawned and the corresponding head muscle, otoliths, eyes, and scales from the spawned females. Egg collection for special studies will be in excess of egg collection goals for the mitigation and drought enhancement productions.

The BY 2023 CVFC total mitigation and drought enhancement production goal at FRFH for 2023-2024 is 9,500,000. The current FRFH mitigation goal for CVFC is 6,000,000 smolts (± 10%) to be released at 60 to 90 fish per pound. In 2023, additional fish will be produced for drought enhancement to help offset the impacts of multiple years of drought on natural production. An additional 2,000,000 smolts (± 10%) to be released at approximately 60 fish per pound and 1,500,000 pre-smolts (± 10%) to be released at approximately 120 fish per pound will be produced. Both the pre-smolts and the smolts produced for the drought enhancement will be marked with adipose fin clips and tagged with coded-wire tags (CWT) at a 25% rate. The pre-smolts will also be paired with PBT and used to evaluate alternative release strategies in the Feather River.

Egg models and collection goals were developed using survival estimates for specific developmental periods. Estimated survival from green to eyed egg is 85% and estimated survival from eyed egg to fry is 90%. While actual egg survival may be significantly different from these estimates, these estimates allow the hatchery to account for potential mortality in egg trays and culling of trays if CWT analysis or virology indicate is necessary. Approximately 13,810,500 green eggs will be collected to meet the production goals this year. This allows for a buffer to meet production targets in case of disease or other loss and culling of trays containing eggs from spring-run parents or that are positive for specific pathogens. After addling, eggs above the daily eyed egg goals listed in Table 1, Table 2, and Figure 1 will be culled. When culling, an equal proportion of eggs will be removed from each tray to maintain groups of similar size and development, which helps feeding, growth, and timing of releases.

Table 1: Proposed female and egg collection for BY 2023 fall-run Chinook Salmon mitigating production by week.

Week	Monday	Tuesday	Wednesday	Thursday	Friday	Total Females	Green Eggs
Oct 9 - 13		**32**	**49**	**71**	**97**	249	1,120,500
Oct 16- 20	**128**	**PBT 1**	**160**	**PBT 2**	**190**	478	2,151,000
Oct 23 - 27	**PBT 3**	**215**	**231**	**237**	**231**	914	4,113,000
Oct 30 - Nov 3	**215**	**190**	**160**	**128**	**97**	790	3,555,000
Nov 6 - 10	**71**	**49**	**32**			152	684,000
						2,583	11,623,500

Table 2: Proposed egg take for BY 2023 fall-run Chinook Salmon

Week	Date	Lot	% of total	Number of Females	Green Egg Collection	Green to Eyed Egg Survival (85%)	Eyed Egg to Fry Survival (90%)	Fry to Smolt Survival (90%)
1	10/10/2023	1	1.24%	32	144000	122400	110160	99144
1	10/11/2023	2	1.90%	49	220500	187425	168683	151814
1	10/12/2023	3	2.75%	71	319500	271575	244418	219976
1	10/13/2023	4	3.76%	97	436500	371025	333923	300530
2	10/16/2023	5	4.96%	128	576000	489600	440640	396576
2	10/17/2023	PBT 1	---	162	729000	619650	557685	501917
2	10/18/2023	6	6.19%	160	720000	612000	550800	495720
2	10/19/2023	PBT 2	---	162	729000	619650	557685	501917
2	10/20/2023	7	7.36%	190	855000	726750	654075	588668
3	10/23/2023	PBT 3	---	162	729000	619650	557685	501917
3	10/24/2023	8	8.32%	215	967500	822375	740138	666124
3	10/25/2023	9	8.94%	231	1039500	883575	795218	715696
3	10/26/2023	10	9.18%	237	1066500	906525	815873	734285
3	10/27/2023	11	8.94%	231	1039500	883575	795218	715696
4	10/30/2023	12	8.32%	215	967500	822375	740138	666124
4	10/31/2023	13	7.36%	190	855000	726750	654075	588668
4	11/1/2023	14	6.19%	160	720000	612000	550800	495720
4	11/2/2023	15	4.96%	128	576000	489600	440640	396576
4	11/3/2023	16	3.76%	97	436500	371025	333923	300530
5	11/6/2023	17	2.75%	71	319500	271575	244418	219976
5	11/7/2023	18	1.90%	49	220500	187425	168683	151814

5	11/8/2023	19	1.24%	32	144000	122400	110160	99144
Mitigation and Drought Totals				2583	11623500	9879975	8891978	8002780
Pre-smolt Totals				486	2187000	1858950	1673055	1505750
TOTAL				3069	13810500	11738925	10565033	9508529

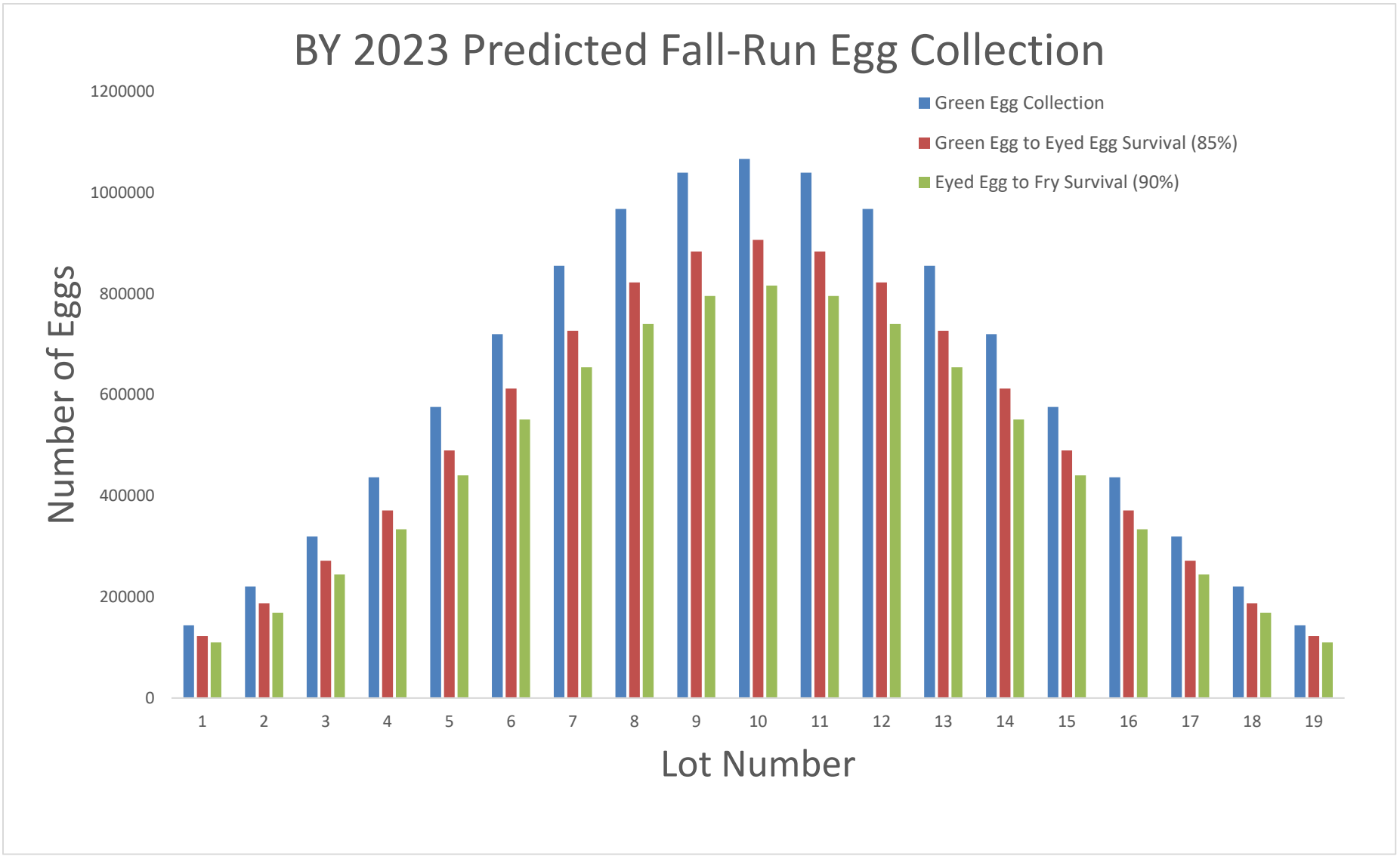

Figure 1: BY 2023 fall-run egg collection (Does not include pre-smolts).

Fall-Run Broodstock Collection and Spawning

CVFC spawning will commence the week of Monday, October 9, 2023. The practice of using Hallprint tags to identify early arriving salmon and real time CWT analysis has confirmed improved separation in the arrival timing of spring- and fall-run adults to the hatchery. All salmon (adipose fin intact and adipose fin clipped) entering the hatchery on or after this date that does not contain a Hallprint tag will be considered a candidate for inclusion in the CVFC broodstock. Broodstock collection and spawning will be conducted in a manner that represents fish arriving throughout the CVFC spawning period. Spawning and egg collection will follow the egg collection model described in Table 1 as closely as logistically possible.

Spawning Procedures

Fall-Run Chinook Mitigation and Drought Enhancement Spawning

CVFC will be anesthetized using CO2, lifted into the hatchery, and FRFH staff will sort and check ripeness of each fish. The fish that are ready to spawn will be excised and sorted on the spawning table by sex. Each adipose fin clipped fish will be marked with a reusable jaw tag (5 ¾ inch safety pin with uniquely numbered tag attached to the lower jaw or operculum). Males will get an odd numbered jaw tag and females will get an even numbered jaw tag. As fish are pulled off the table to spawn, the front of house (FOH) data recorder will record sex, grilse or adult based on fork length (650 mm), adipose fin clip status, and the jaw tag number (if adipose fin clipped) on the data card. A lateral incision will be made near the female's vent and will extend toward the head. Eggs are carefully removed and placed into a tub that has been cleaned with UV treated water. Milt will be added into the tub of eggs and will be gently mixed by hand.

A two-ounce sample of eggs will be taken from every egg tub. This sample will be placed into a large measuring cup with all samples from that day. These eggs will be water hardened and counted at end of day to estimate eggs per ounce, and the average eggs per ounce will be applied to the total volume collected each day to estimate the total eggs taken. After the two-ounce sample of eggs is taken, thiamine mononitrate will be added to the tub to treat for TDC following established protocols developed by the CDFW Fish Health Laboratory (Appendix B). Each tub of fertilized eggs will have a data card attached and will be brought to the back of house (BOH) data recorder. The fertilized eggs will be drained of ovarian fluid and milt and placed into a measuring cup to measure the ounces of eggs collected from each female. The eggs will then be placed in an incubation tray and disinfected with 4 ounces of iodophor. The BOH data recorder will record the ounces of eggs that are placed into the incubation tray, as well as the lot, stack, and tray number on the data cards and the datasheet (Appendix C). When a data card is filled and complete, it will be grouped with the other cards from the day, scanned and distributed to the CDFW Central Valley Tissue Archive (CVTA) for storage. All data sheets will be analyzed for quality assurance and quality control.

CVFC are spawned using a true 1 male: 1 female spawning ratio. FRFH staff will limit the reuse of males as much as possible. However, if males are used multiple times, they are treated as new fish each time they are spawned. This is recorded and highlighted on the associated data card for each tub and the number is recorded for hatchery files. Grilse with a fork length less than or equal to 650 mm are incorporated into FRFH CVFC production at a rate of 2%. If 3- and 4-year-old returns are low, discussion and consensus by the Feather River Hatchery Operations Team (FRHOT), a multi-agency team with representatives from CDFW, DWR, and

NOAA Fisheries, will determine whether adjustment of the grilse incorporation rate for the current broodstock collection season is appropriate.

Pre-Smolt Spawning

Spawning for the pre-smolt releases will occur on three days: October 17, October 19, and October 23, with the goal of collecting 729,000 eggs on each spawning day. To avoid mixing eggs allotted for mitigation purposes with those for PBT, spawning on those days will exclusively be for PBT.

To meet egg collection needs for the production target of 1,500,000, a total of 486 pairs will be spawned at a 1:1 male: female ratio, with 162 pairs spawned on each PBT spawning day. Jacks are incorporated into PBT broodstock at a maximum of 2%; jills are not included in PBT broodstock.

Spawning procedures will be conducted following standard FRFH procedures outlined for the CVFC with minor adjustments to allow for tracking of every pair. Prior to spawning, each fish will be tagged with a reusable jaw tag containing a unique ID, which will be attached to the fish's jaw. Males will be given odd-numbered IDs and females will be given even-numbered IDs. Once spawning occurs, the IDs for the male and female used in the spawning will be recorded; this will allow pairs to be identified during post-spawning data collection. All eggs collected will be treated with thiamine mononitrate at fertilization to treat for TDC following established protocols developed by the CDFW Fish Health Laboratory (Appendix B). Any fish that remain at the end of PBT spawning will be sent to the round tanks and used for smolt production.

Data Collection

Mitigation Production and Drought Enhancement Production Data Collection

After spawning, the carcasses will be placed into a designated bin depending on the condition of the fish (e.g., spawned, killed not spawned, or dead in tank). From every fifth fish, the CVTA and CWT Lab staff will also record fish condition, sex, fork length, adipose fin status, and the staff will collect a tissue sample, scale sample, and (from up to 20 fish per day) fat content measurements. From every adipose fin clipped fish, the fish condition, sex, fork length, adipose fin status, jaw tag ID (if present), and heads will be collected. The heads will be taken back to the lab for CWT extraction and analysis. To evaluate origin in each tray/stack, CWT analysis will be used to identify stacks and trays with CVSC contribution and/or strays. Trays that include offspring from CVSC and/or strays from other hatcheries as identified by CWT, will be removed from production and culled. All data sheets used during CVFC broodstock spawning can be found in Appendix C.

Pre-Smolt Data Collection

The post-spawning data collection on the adults used to meet the experimental pre-smolt production goals will follow the standard CVFC sampling and data collection process. However, the CVTA Lab staff will also collect a tissue sample from every spawned fish, matching individual spawned pairs. A fin clip will be collected from a portion of the upper caudal fin that is free from disease and damage for PBT genetic analysis. These tissue samples will be stored at the CVTA and later processed and analyzed by the CDFW Genetics Research Laboratory.

Chinook Feeding Strategy

When 90-100% of the fish in incubation stacks have buttoned-up, they will be transferred to outdoor concrete raceways. Fry will be hand-fed Bio- Pro 2 to satiation at each feeding, 4-8 times per day depending on age and size. All CVFC will be fed Bio- Pro 2 until release. CVFC being released into the San Pablo or San Francisco Bay will be switched to Bio-Supreme transfer diet at least 6 weeks prior to release. Bio-supreme transfer diet has been formulated to help ease osmoregulatory stress associated with smoltification. Recent studies have shown return rates of Bio-supreme fed fish up to 42% higher than controls in Central Valley Chinook. Medicated and antibiotic feeds will be used, if necessary, as prescribed by CDFW pathologists.

Table 3: Feed manufacturer recommended feeding scheduled for Chinook Salmon

Fish size (fish per pound)	Feed Size	Fish Food Type	Fed Times a day
3000 to 570	#0	Bio-Pro2	7-8
570 to 300	#1	Bio-Pro2	7-8
300 to 150	#2	Bio-Pro2	4-6
350 to 150	#2	Bio-Pro2	4-6
150 to 60	#3	Bio-Pro2	4-6
140 to 60	1.2	Bio-Pro2	4-6
140 to 60	1.2	Bio-Pro2	4-6

Chinook Salmon Ponding, Marking, and Tagging

Chinook salmon will be ponded into six raceways shortly after reaching a button-up fry stage or approximately 1,200 fish per pound. During marking and tagging operations and based on proposed release strategies, fish will be sorted such that each raceway will contain approximately 1,000,000 fish and the rearing channel will contain 4,000,000 fish.

CVFC will be marked and tagged (adipose fin-clip and a CWT inserted) at the standard constant fractional marking rate of 25% when they reach a minimum of 120 fish per pound. Different tag codes will be used to differentiate between the different release locations and dates. Inland Chinook will not be marked with any kind of tag before release.

Brood Year 2023 Chinook Salmon Releases

The release strategy for brood year 2023 will be similar to the strategy used for brood year 2022, consisting of release locations within the Feather River and the San Francisco and San Pablo Bays and release strategies of direct release to water and net pen acclimation (Table 2). Brood Year 2023 will also include three releases of pre-smolts into the Feather River at location to be coordinated with the FRHOT.

Brood Year 2023 Fall-Run Mitigation and Drought Enhancement Production Release

The drought enhancement pre-smolts and mitigation and drought enhancement smolts will be 25% marked with adipose fin clips and CWTs prior to release. Each CWT code will be unique to a release location and date, and all releases will consist of full tag groups. Exceptions to this are logistical constraints that prevent the whole group from being released in one day. If necessary, groups of 1,000,000 like CWT fish may be split and released over two consecutive days from the same location as necessary to meet hatchery logistical constraints.

The release location and strategy of tag groups released into San Francisco or San Pablo Bays will be selected depending on environmental conditions, availability of net pens, and CDFW management review. All releases will be conducted on the outgoing tide and timed such that no more than two days of releases are scheduled in a row from the same location when logistically feasible. Time of plant, temperature of receiving water and transport tank water, and the condition of the fish during release will be recorded on planting receipts and summarized in annual reports. Weight counts will be taken as fish are being loaded into transport trucks and recorded on release receipts following standard hatchery practices. Salt will be added to a level of ten parts per thousand to transport tanks prior to loading fish for transport.

A portion of the mitigation production, 1,000,000 smolts, will be released directly into the Feather River at approximately 90 fish per pound in late-April. This in-river release will be used to assess the behavior, condition, and survival of outmigrating smolts as well as their subsequent adult return and stray rates of in-river in comparison to off-site release. The remainder of the mitigation smolts, 5,000,000 smolts, will be released into the San Francisco and San Pablo Bays using either a net pen acclimation or nighttime direct release strategy during the months of late-April through June when reaching a minimum size of 60 fish per pound.

The 2,000,000-drought enhancement smolts will be released into the San Francisco and San Pablo Bays using a nighttime direct release strategy during the months of late-April through June when reaching a minimum size of 60 fish per pound.

Brood Year 2023 Pre-Smolt Release

Approximately 1,500,000 drought enhancement pre-smolts will be released into the Feather River at approximately 120 fish per pound to help evaluate release strategies of fish in various stages of development and offset impacts of multiple years of drought on natural production. These fish will be released as three separate release groups in April and will be paired with a release of CVSC smolts and/or a release of CVFC smolts.

Table 4: Brood Year 2023 Fall-Run Chinook Salmon Release Strategy

Date	Type of Production	Fish Size	Release Size	Release Location	With CWT and Mark
April	Drought Enhancement	Pre-Smolt 120 fish per	1,5000,000	Feather River	25% with CWT and marked with adipose fin clip and paired with PBT.

		pound			
Late April	Mitigation	Smolt 90 fish per pound	1,000,000	Feather River	25% with CWT and marked with adipose fin clip
Late April-June	Mitigation	Smolt 60 fish per pound	2,000,000	San Franciso and San Pablo Bays	25% with CWT and marked with adipose fin clip
Late April-June	Drought Enhancement	Smolt 60 fish per pound	5,000,000	San Franciso and San Pablo Bays	25% with CWT and marked with adipose fin clip

Brood Year 2023 Inland Chinook Release

Inland Chinook Salmon produced to support the cold-water fishery in Lake Oroville will be released with no tag or mark into Lake Oroville in May 2024. These fish will be approximately 25 to 35 fish per pound and will be released from a boat ramp in Lake Oroville.

Inland Chinook Salmon produced for the Spaulding and Pine Flat Reservoir will be released in March at approximately 100 fish per pound. These releases will be coordinated with and performed by CDFW trout hatchery staff.

Release Criteria and Contingencies

In coordination with 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 2023/2024 for CVFC. These criteria and triggers were developed based on review of water temperature, river flow, and Delta Cross Channel Gate operations. Each of the criteria indicated below are intended to be independent of the others, meaning that if any one or more of the criteria are anticipated to be met then an alternative release location will be coordinated with the Feather River Hatchery Operations Team. If none of the triggers are forecast to be met, then juveniles will be released into Feather River.

Delta Cross-Channel Gate Operations

Survival of juvenile salmon are known to be significantly reduced when Delta Cross Channel Gates are open and increased numbers of fish are diverted into the interior Delta (Perry et al. 2015).

- Cross channel gates are forecast to be open within 21 days of the date when the hatchery salmon are to be released.

Water Temperature

Prolonged exposure to increased water temperatures above 70° F are thought to result in juvenile salmon survival approaching zero. (Nobriga et al. 2021).

- Sustained Daily Average Water temperatures are expected to be greater than 68° F at Verona within 21 days of the date when the hatchery salmon are to be released.
- Sustained Daily Average Water temperatures are expected to be greater than 68° F at Freeport within 21 days of the date when the hatchery salmon are to be released.

Flow

Flows in the Sacramento River below 12,000 cubic feet per second upstream of the Delta Cross Channel junctions can lead to significantly reduced survival of juvenile salmon because of reduced travel times, exposure to increased predation and increased risk of diversion into the interior Delta. (Perry et al. 2015, NMFS 2019).

- A Sacramento River flow at Verona of less than 4,000 cfs is forecast* to occur within 21 days of the date when the hatchery salmon are to be released.
- A Sacramento River Flow of less than 12,000 cfs at Freeport is forecast to occur within 21 days of the date when the hatchery salmon are to be released.
- Delta Outflow is forecast* to be less than 3,000 cfs within 21 days of the date when the hatchery salmon are 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 be release following the release strategies described in this document in the San Francisco or San Pablo Bays.

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Appendix H: Total Fall-Run Chinook Salmon Captured at the FRFH in 2023

		Spawned				Mortalities			
						Killed Not Spawned and Dead in Tank			
Spawning Period	**Date**	**Ad-Clipped F**	**Non-Clipped F**	**Ad-Clipped M**	**Non-Clipped M**	**Ad-Clipped F**	**Non-Clipped F**	**Ad-Clipped M**	**Non-Clipped M**
CVSC	9/18	0	0	0	0	13	3	99	25
CVSC	9/19	0	0	0	0	4	3	135	89
CVSC	9/20	0	0	0	0	0	1	11	10
CVSC	9/23	0	0	0	0	4	1	30	37
CVSC	9/25	0	0	0	0	4	0	14	19
CVSC	9/26	0	0	0	0	1	2	16	24
CVSC	9/27	0	0	0	0	0	7	23	67
CVSC	9/28	0	0	0	0	1	1	1	3
CVSC	9/29	0	0	0	0	1	2	23	41
Inland Chinook	10/3	94	30	10	30	21	25	4	14
Inland Chinook	10/4	31	44	8	17	12	14	23	65
Inland Chinook	10/6	48	77	9	26	10	17	19	39
Inland Chinook	10/9	26	80	12	18	4	15	11	26
Inland Chinook	10/10	13	40	2	13	25	64	102	252
CVFC	10/11	0	0	0	0	88	283	307	889
CVFC	10/12	41	109	35	115	0	18	65	210
CVFC	10/13	20	70	14	76	2	10	61	167
CVFC	10/16	39	81	24	96	0	17	109	447
CVFC	10/17	29	91	31	89	0	12	129	444
CVFC	10/18	30	120	29	121	2	7	170	507
CVFC	10/19	30	90	29	91	3	16	191	549
CVFC	10/20	33	87	29	91	12	67	246	859
CVFC	10/23	30	89	24	96	8	21	119	392
CVFC	10/24	45	135	47	133	7	23	52	211

CVFC	10/25	43	107	39	111	1	18	93	234
CVFC	10/26	33	117	27	123	4	18	122	353
CVFC	10/27	44	106	10	140	5	15	166	405
CVFC	10/30	37	113	23	127	4	0	94	241
CVFC	10/31	6	12	3	15	1	1	10	35
CVFC	11/1	0	0	0	0	1	15	0	18
CVFC	11/2	19	74	24	69	3	0	9	72
CVFC	11/3	21	39	13	47	1	18	170	557
CVFC	11/6	25	65	9	81	0	2	135	335
CVFC	11/7	22	98	28	92	1	2	25	78
CVFC	11/8	21	69	7	83	2	27	124	372
CVFC	11/9	23	67	26	64	3	3	34	79
CVFC	11/13	25	65	23	67	1	4	2	22
CVFC	11/14	24	66	27	63	1	8	3	14
CVFC	11/15	34	56	22	68	1	2	19	39
CVFC	11/16	36	84	27	93	9	28	68	164
No Spawning	11/17	0	0	0	0	12	24	15	55
No Spawning	11/27	0	0	0	0	6	8	8	17
No Spawning	12/13	0	0	0	0	9	16	15	31
No Spawning	12/20	0	0	0	0	2	8	7	9
	Total	922	2281	611	2255	289	846	3079	8516

Note:

[1]All fish with recorded adipose fin status as “partial” were assumed to be adipose fin-clipped.

[2]All fish were presumed to be CVFC due to the absence of a Hallprint tag. Data is not corrected with CWT results.

Appendix I: Total CVFC CWT returns to the FRFH between July 1, 2023, and June 30, 2024.

CWT Number	Brood Year	Hatchery of Origin	Release Location	Total Recovered
062050	2019	Feather River Fish Hatchery	Mare Island Net Pen	51
062049	2019	Feather River Fish Hatchery	Mare Island Net Pen	39
061591	2019	Feather River Fish Hatchery	Mare Island Net Pen	32
061592	2019	Feather River Fish Hatchery	Mare Island Net Pen	28
061593	2019	Feather River Fish Hatchery	Mare Island Net Pen	20
061588	2019	Feather River Fish Hatchery	Mare Island Net Pen	19
061594	2019	Feather River Fish Hatchery	Mare Island Net Pen	18
061589	2019	Feather River Fish Hatchery	Mare Island Net Pen	10
061595	2019	Feather River Fish Hatchery	Mare Island Net Pen	10
061590	2019	Feather River Fish Hatchery	Mare Island Net Pen	9
062048	2019	Feather River Fish Hatchery	Feather River Boyd's Pump	8
061530	2019	Feather River Fish Hatchery	Mare Island Net Pen	6
061596	2019	Feather River Fish Hatchery	Mare Island Net Pen	4
062059	2019	Mokelumne River Hatchery	Fort Baker Minor Pt.	2
056410	2019	Coleman National Fish Hatchery	Coleman National Fish Hatchery	1
061499	2019	Mokelumne River Hatchery	San Joaquin Sherman Island Net Pen	1

061578	2019	Mokelumne River Hatchery	Santa Cruz Harbor	1
062055	2019	Nimbus Fish Hatchery	Mare Island Net Pen	1
062056	2019	Nimbus Fish Hatchery	Mare Island Net Pen	1
062064	2019	Mokelumne River Hatchery	San Joaquin Sherman Island Net Pen	1
062345	2020	Feather River Fish Hatchery	Pt. San Quentin	959
062343	2020	Feather River Fish Hatchery	Fort Baker Minor Pt.	816
062344	2020	Feather River Fish Hatchery	Wickland Oil Terminal	694
062294	2020	Feather River Fish Hatchery	Mare Island Net Pen	167
062342	2020	Feather River Fish Hatchery	Mare Island Net Pen	163
062295	2020	Feather River Fish Hatchery	Mare Island Net Pen	156
062340	2020	Feather River Fish Hatchery	Wickland Oil Terminal	126
062296	2020	Feather River Fish Hatchery	Mare Island Net Pen	92
062341	2020	Feather River Fish Hatchery	Wickland Oil Terminal	87
062376	2020	Feather River Fish Hatchery	Mare Island Net Pen	77
062297	2020	Feather River Fish Hatchery	Mare Island Net Pen	69
062358	2020	Mokelumne River Hatchery	Half Moon Bay Pillar Point Harbor Johnson Pier Net	55
062299	2020	Feather River Fish Hatchery	Mare Island Net Pen	41
062298	2020	Feather River Fish Hatchery	Mare Island Net Pen	40

062371	2020	Feather River Fish Hatchery	Mare Island Net Pen	31
061580	2020	Mokelumne River Hatchery	Monterey Major Port	27
061581	2020	Mokelumne River Hatchery	Santa Cruz Harbor	25
062361	2020	Mokelumne River Hatchery	Fort Baker Minor Pt.	14
056569	2020	Coleman National Fish Hatchery	Pt. San Quentin Net Pens	11
056568	2020	Coleman National Fish Hatchery	Pt. San Quentin Net Pens	9
061536	2020	Nimbus Fish Hatchery	Mare Island Net Pen	5
060461	2020	Nimbus Fish Hatchery	Mare Island Net Pen	4
062354	2020	Mokelumne River Hatchery	San Joaquin Sherman Island Net Pen	3
062360	2020	Mokelumne River Hatchery	Fort Baker Minor Pt.	3
062362	2020	Nimbus Fish Hatchery	Wickland Oil Terminal	3
056572	2020	Coleman National Fish Hatchery	Sacramento River at Butte City	2
062350	2020	Mokelumne River Hatchery	San Joaquin Sherman Island Net Pen	2
062353	2020	Mokelumne River Hatchery	San Joaquin Sherman Island Net Pen	2
061574	2020	Merced River Fish Facility	San Joaquin Sherman Island Net Pen	1
062351	2020	Mokelumne River Hatchery	San Joaquin Sherman Island Net Pen	1
062352	2020	Mokelumne River Hatchery	San Joaquin Sherman Island Net Pen	1

062356	2020	Mokelumne River Hatchery	San Joaquin Sherman Island Net Pen	1
062359	2020	Mokelumne River Hatchery	Fort Baker Minor Pt.	1
062363	2020	Nimbus Fish Hatchery	Pt. San Quentin	1
062364	2020	Nimbus Fish Hatchery	Mare Island Net Pen	1
062374	2020	Nimbus Fish Hatchery	Pt. San Quentin	1
061954	2021	Feather River Fish Hatchery	Pt. San Quentin	186
061958	2021	Feather River Fish Hatchery	Mare Island Net Pen	42
061957	2021	Feather River Fish Hatchery	Wickland Oil Terminal	24
062889	2021	Feather River Fish Hatchery	Fort Baker Minor Pt.	22
062384	2021	Feather River Fish Hatchery	Point Richmond	21
062890	2021	Feather River Fish Hatchery	Pt. San Quentin	19
062887	2021	Feather River Fish Hatchery	Mare Island Net Pen	13
062891	2021	Feather River Fish Hatchery	Fort Baker Minor Pt.	13
062886	2021	Feather River Fish Hatchery	Pt. San Quentin	12
062892	2021	Feather River Fish Hatchery	Fort Baker Minor Pt.	5
062893	2021	Feather River Fish Hatchery	Fort Baker Minor Pt.	5
062896	2021	Feather River Fish Hatchery	Pt. San Quentin	5
060680	2021	Feather River Fish Hatchery	Fort Baker Minor Pt.	3

062888	2021	Feather River Fish Hatchery	Mare Island Net Pen	3
062897	2021	Feather River Fish Hatchery	Pt. San Quentin	3
062949	2021	Mokelumne River Hatchery	Fort Baker Minor Pt.	3
062895	2021	Feather River Fish Hatchery	Wickland Oil Terminal	2
062948	2021	Mokelumne River Hatchery	Fort Baker Minor Pt.	2
061280	2021	Mokelumne River Hatchery	Fort Baker Minor Pt.	1
061533	2021	Mokelumne River Hatchery	Fort Baker Minor Pt.	1
061587	2021	Merced River Fish Facility	San Joaquin Sherman Island Net Pen	1
062894	2021	Feather River Fish Hatchery	Fort Baker Minor Pt.	1
062950	2021	Mokelumne River Hatchery	Fort Baker Minor Pt.	1
062953	2021	Mokelumne River Hatchery	Santa Cruz Harbor	1
062955	2021	Mokelumne River Hatchery	San Joaquin Sherman Island Net Pen	1
062959	2021	Mokelumne River Hatchery	San Joaquin Sherman Island Net Pen	1
062961	2021	Mokelumne River Hatchery	San Joaquin Sherman Island Net Pen	1
062965	2021	Nimbus Fish Hatchery	Mare Island Net Pen	1

Appendix J: Brood Year 2023 Fall-Run Chinook Salmon Releases

Date	Location	Mark and CWT Code	Fish Size (Fish per Pound)	Total Length (mm)	Total Tagged released	Total Released	Production Type
4/23/2024	Feather River, Gridley Boat Launch	Ad-Clip & PBT 06-30-46 06-00-84	94	83	139,066	556,672	Drought Enhancement pre-smolts
4/24/2024	Feather River, Boyd's Pump Boat Launch	Ad-Clip 06-00-99	66	94	252,517	1,010,515	Mitigation smolts
4/25/2024	Feather River, Gridley Boat Launch	Ad-Clip & PBT 06-30-41 06-20-83 06-00-85	100	81	141,514	566,271	Drought Enhancement pre-smolts
4/29/2024	Feather River, Gridley Boat Launch	Ad-Clip & PBT 06-15-66 06-00-86	90	84	147,418	589,673	Drought Enhancement pre-smolts
5/7/2024 & 5/8/2024	San Pablo Bay, Mare Island Net Pen	Ad-Clip 06-01-00	60	96	254,094	1,016,787	Mitigation smolts
5/15/2024	San Francisco Bay, Estuary and Ocean Science Center, Tiburon	Ad-Clip 06-02-00	63	94	252,779	1,011,116	Mitigation smolts

5/20/2024 & 5/21/2024	San Pablo Bay, Mare Island Net Pen	Ad-Clip 06-09-73	56	98	256,538	1,041,151	Mitigation smolts
6/3/2024	San Pablo Bay, Mare Island Net Pen	Ad-Clip 06-00-88 06-00-89	58	98	172,697	691,588	Mitigation smolts
6/4/2024	San Pablo Bay, Mare Island Net Pen	Ad-Clip 06-00-91 06-00-87	60	96	169,158	643,491	Mitigation smolts
6/7/2024	San Pablo Bay, Mare Island Net Pen	Ad-Clip 06-00-90 06-00-92	61	96	166,014	580,809	Mitigation smolts
6/10/2024	San Pablo Bay, Cal Maritime Academy	Ad-Clip 06-28-44 06-00-93 06-00-94 06-00-98	71	91	259,496	1,040,318	Mitigation smolts

6/17/2024	San Francisco Bay, Estuary and Ocean Science Center, Tiburon	Ad-Clip 06-00-97 06-00-96 06-00-95	71	91	251,119	1,006,312	Drought Enhancement smolts
6/18/2024	San Francisco Bay, Estuary and Ocean Science Center, Tiburon	Ad-Clip 06-30-56 06-30-51 06-28-82	77	88	224,212	897,262	Mitigation
					Total Released:	**10,651,965**	

Appendix K: 2024 Feather River Hatchery Steelhead Spawning and Release Protocol

Brood year 2024 Feather River Fish Hatchery Steelhead Spawning and Release Plan

Table of Contents

List of Abbreviations

BY	Brood Year
CDFG	California Department of Fish and Game
CDFW	California Department of Fish and Wildlife
CV	Central Valley
CVSH	Central Valley Steelhead Trout
DWR	Department of Water Resources
FRFH	Feather River Fish Hatchery
HSRG	California Hatchery Scientific Review Group
IHNV	Infectious hematopoietic necrosis virus
NO	Natural origin
TDC	Thiamine Deficiency Complex

List of Tables

Background

The Feather River Fish Hatchery (FRFH) conducts two artificial propagation programs for Central Valley (CV) Chinook Salmon (CV spring-run and CV fall-run) and one artificial propagation program for Central Valley steelhead trout (CVSH). CVSH are listed as threatened under the Federal Endangered Species Act.

The Primary purpose of the FRFH CVSH program is to mitigate the loss of spawning and rearing habitat due to construction of Oroville Dam. This is an integrated production program and provides recreational fishing opportunities. Both hatchery and natural origin CVSH from the Feather River are considered part of the CVSH ESU (NMFS 2006).

In 2012, the California Hatchery Scientific Review Group (HSRG) released the California Hatchery Review Report (CA HSRG 2012) (Appendix A) that establishes specific recommendations for all California hatcheries, including the FRFH. Since 2012, the California Department of Fish and Wildlife (CDFW) continues to incorporate those recommendations when possible (California Hatchery Policy Team, 2016).

Central Valley Steelhead Production Goals

- The **prioritized production goals for this season are as follows:**
- 400,000 yearlings to support mitigation production.
- 50,000 yearlings to support the 1986 Delta Fish Agreement between the Department of Water Resources (DWR) and the California Department of Fish and Game (CDFG).

The brood year (BY) 2024 CVSH total mitigation and 1986 Delta Fish Agreement production goal at FRFH is 450,000 yearlings. The yearling CVSH will be marked with adipose fin clips at a 100% rate and will be released into the Feather River in February of 2025 when they are approximately three fish per pound. In years where excess production occurs (greater than 450,000 smolts), the additional smolts may be released to the Thermalito Afterbay for additional recreational opportunity.

Approximately 1,500,000 green eggs will be collected to meet the production goals this year (Table 1). This provides a buffer against unforeseen losses, including the culling of egg lots positive for specific pathogens (Bacterial Kidney Disease) and disease, to meet production targets. Actual egg collections for each lot may be different from those described in Table 1. The number of eggs collected each week will depend on the number of available females that are ready to spawn.

Table 16: Proposed egg take for BY 2024 CVSH.

Date	Lot Number	Number of green eggs
12/27/2023	1	424,293
1/3/2024	2	292,740
1/10/2024	3	281,424
1/17/2024	4	210,000
1/24/2024	5	160,000
1/31/2024	6	100,000
Total		1,468,457

Egg collection occurs throughout the spawning season to collect eggs from the entire run. If escapement appears to be low, as many eggs as possible will be collected on each spawning day. Otherwise, eggs will be collected on an as-needed basis to represent a run curve with the maximum number of eggs collected within the mean of the run. As eggs develop, culling of eggs from each lot will commence in such a way as to mimic the natural bell-shaped curve of the abundance and timing of escapement as well as to maximize the number of family groups. Data will be collected to allow evaluation of the actual egg collection schedule and its possible effect on shifting migration and spawn timing.

Out-of-sub-basin importation of eggs, juveniles or adults will not occur, unless from Mokelumne River, which historically on several occasions was heavily supplemented with, and thus genetically similar to, Feather River CVSH.

Steelhead Broodstock Collection

The FRFH ladder was opened on September 15, 2023. The ladder will remain open until the end of June 2024. Adult CVSH begin returning to the hatchery starting in late-October and are released to the river until late November, then they are held in round tanks until they are ready to spawn. Spawning of adult CVSH occurs once weekly beginning in the second or third week of December and will continue until late February.

To limit the use of resident (non-anadromous) fish, the current 16- inch (406 mm) minimum length for broodstock will be continued. We acknowledge that resident *Oncorhynchus mykiss* may occasionally exceed 16” in length but this target has been

refined using otolith markers and represents the best balance of broodstock availability and reduction of resident fish. Per HSRG recommendations (CA HSRG 2012), FRFH CVSH program will target at least 10% natural origin broodstock. Historically FRFH incorporation of natural origin (NO) fish is typically between 1-10% because of a lack of availability of NO fish at the hatchery. If the hatchery has more broodstock than are necessary to meet egg take goals, preference will be given to utilizing NO fish.

All natural-origin CVSH are returned to the river (spawned or unspawned), all hatchery-origin females are returned to the river (spawned or eggs removed), and all hatchery-origin males are released back to Feather River at Verona or into the Thermalito Afterbay to supplement the recreational fishery.

Spawning Procedures

HSRG recommendation 3.13 states that a smaller population of less than 250 females should implement factorial spawning by splitting female eggs into two or more lots and each lot be fertilized from a different male. Because of low CVSH broodstock returns, since winter 2016, a partial factorial mating scheme implemented at FRFH for the CVSH spawning program to help improve the effective size and hedge against infertile males and females. To accomplish this, eggs from one female are split in to two equally sized groups. Each group is fertilized with the sperm of one male (Table 2). Additionally, genetic sampling occurs to gather genetic relatedness data on the parents. FRFH Staff will eliminate the reuse of males, as much as possible.

Table 17: BY 2024 CVSH 2x2 factorial mating scheme.

		Males	
		A	B
Females	1	1A	1B
	2	2A	2B

The following mating scheme will be used:

- Spawning **incorporates a 2x2 partial factorial mating scheme:**
- Assuming **two males and two females are available and ripe, the eggs from each female are divided into two separate pans. Each male is used to fertilize a separate pan. Thus, for two females (female 1 and 2) and two males (male A and B), a total of four pans are used, creating four individual families (1A, 2A, 1B, and 2B). The individual mattings are recorded.**

- If there are an unequal number of males and females, FRFH will perform a 2x3 or 3x2 partial factorial mating system.
- Individual **crosses are separated and tracked in egg trays if time and space permit (estimated 30-45 days post-fertilization).**
- FRFH measure to approximate number of juveniles produced per family so that an accurate estimate of effective size can be calculated.
- Limit **male re-use:**
- The **number of times each male fish is spawned is documented and tracked. The re-use of males is limited wherever possible.**

Data Collection

To catalog genetic and age information, all spawned fish will be immediately brought to the sampling station where a tissue and scale sample will be collected by the Central Valley Tissue Archive and Coded-Wire Tag Lab staff. A caudal fin clip (other fin may be used if caudal is covered in fungus or otherwise unusable, fin type will be recorded in comments field on data sheet) will be collected from each spawned fish and given a unique sample ID. A scale sample will be collected from every non-clipped fish and a percentage of the adipose fin clipped fish and given a unique sample ID. The percentage of adipose fin clipped fish sampled is determined at the beginning of the season and is dependent on the number of fish returning to the hatchery for spawning. The goal is to collect scales from 20% of the spawning CVSH in the hatchery or at least 100 individuals. Fish condition, adipose fin status, sex, and fork length will also be recorded on every spawned CVSH.

Steelhead Feeding Strategy

When 90-100% of the fish in incubation stacks have buttoned-up, they will be transferred to four deep tanks and are fed and kept there until they are around 300- 500 fish per pound (approximately 45-54 mm). At that size, they are moved to outdoor concrete raceways. Fry will be hand-fed Bio-Oregon Bio- Pro 2, or Bio- Supreme diet, to satiation at each feeding, 4-8 times a day depending on age and size. All CVSH will be fed Bio-Pro 2 until release. Medicated and antibiotic feeds will be used, if necessary, as prescribed by CDFW pathologists.

Table 18: Feed manufacturer recommended feeding schedule for CVSH.

Fish size (fish/lb.)	Feed Size	Fish Food Type	Fed Times a day
3000 to 570	#0	Bio-Pro2	7 to 8
570 to 300	#1	Bio-Pro2	7 to 8

300 to 150	#2	Bio-Pro2	4 to 6
150 to 90	#3	Bio-Pro2	5 to 6
90 to 60	1.5mm	Bio-Pro2	6 to 6
60 to 11	2.5mm	Bio-Pro2	7 to 6
11 to 4	3.5mm	Bio-Pro2	8 to 6

Pathology Protocols

Thiamine Deficiency Complex (TDC) has been observed in Chinook Salmon populations throughout the CV. To date, CVSH populations have not been fully analyzed for TDC, though there is concern they too are affected by the deficiency. CDFW hatchery managers and Fish Health Lab staff are evaluating the need to treat CVSH for TDC, but there currently is no plan to treat steelhead eggs for TDC.

Green eggs will be disinfected with a 100-ppm solution of iodine for 20 mins while water hardening in incubator trays (vertical stacks). Eggs will then be flushed with water by pushing the trays into the vertical stacks.

Pathologists will take ovarian fluid samples from 60 fish throughout the spawning season to check for infectious hematopoietic necrosis virus (IHNV). If IHNV appears to be present in eggs, pathology lab personnel will plate smears and send samples to a contracted lab for virology testing.

Central Valley Steelhead Releases

Brood Year 2023 Release

Yearling production of FRFH BY 2023 CVSH, spawned December 2022 through February 2023, will all be marked with an adipose fin clip prior to release. At the time this plan was developed, the total number of CVSH rearing at FRFH was approximately 460,028. These fish will be released into the Feather River at Boyd's Pump Boat Launch in February 2024 when they are approximately three fish per pound in size. Any excess fish over the production goal of 450,000 will be released into the Thermalito Afterbay for additional recreational opportunity.

Brood Year 2024 Release

Yearling production of BY 2024 CVSH, spawned December 2023 through February 2024, is targeted at 450,000. Release of BY 2024 CVSH is planned for February 2025. This release will follow release plans from previous years and actual release numbers will be represented in the BY 2025 CVSH Spawning and Release Plan.

References Cited

California Hatchery Policy Team (2016). California Anadromous Hatcheries Strategic Management Implementation 2016 Annual Report. Update on California Hatchery Scientific Review Group Progress and Recommended Actions for the Next 12 Months. California Department of Fish and Wildlife, Fisheries Branch, 1010 Riverside Parkway, West Sacramento, CA. 31 pp. with Appendices.

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