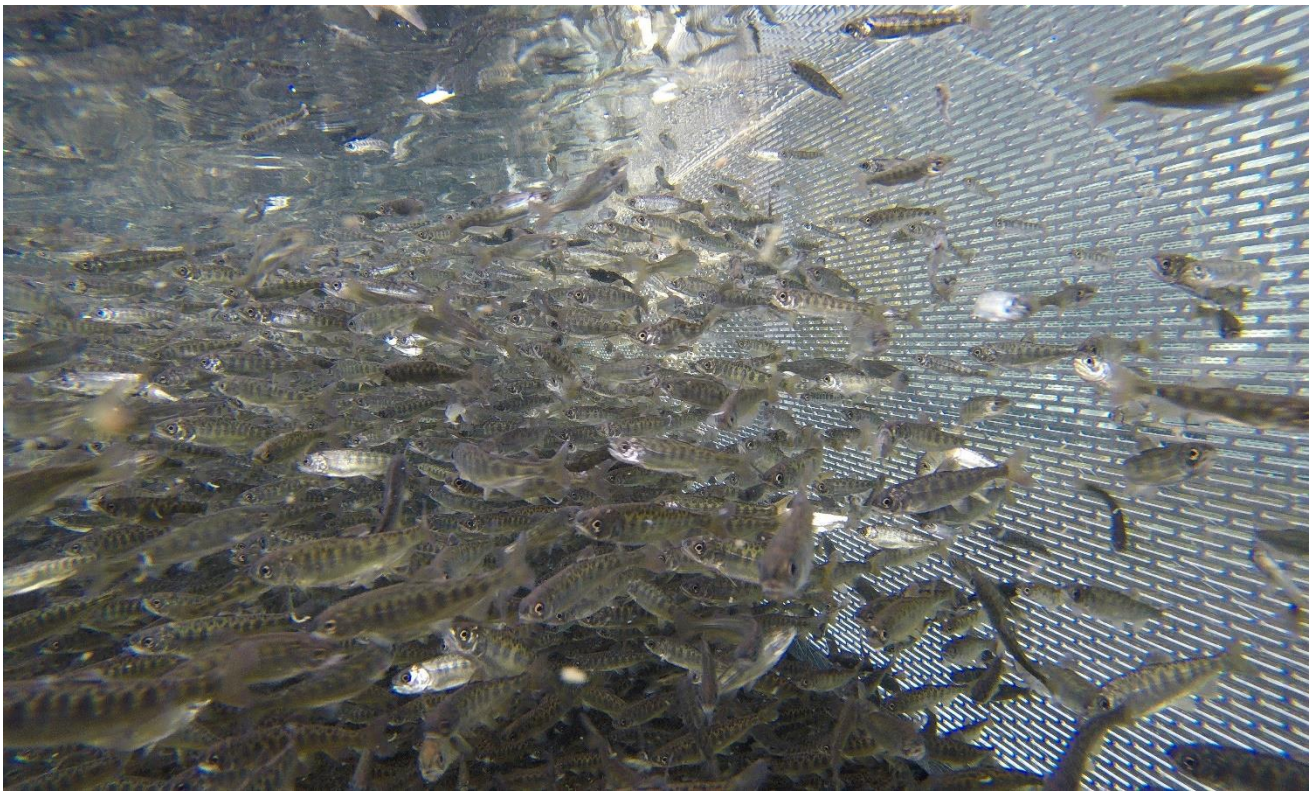
2023 Feather River Fish Hatchery Spring-Run Chinook Salmon Spawning and Release Plan



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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 1: 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%.

A) 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**

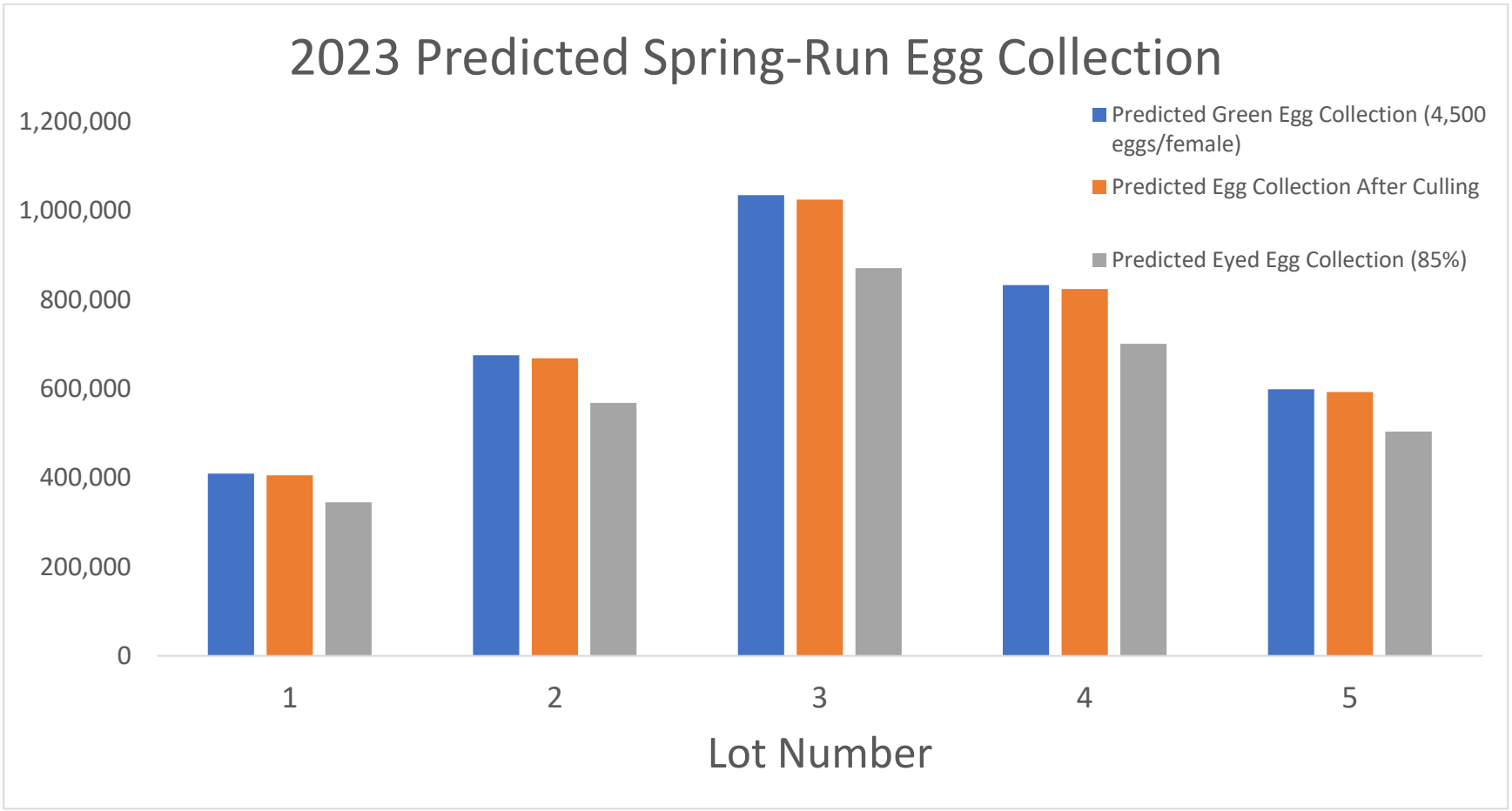

Figure 1: 2023 Spring-Run Chinook Salmon Egg Collection Model using an assumed 85% green egg to eyed egg survival and a 1% culling rate of CVSC x CVFC pairings across all egg lots.

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 2: 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 3: 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 2: 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 4: 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 5: 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 6: 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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Appendices

Appendix A: California Hatchery Review Report, HSRG Recommendations

California Hatchery Scientific Review Group (California HSRG 2012) has established recommendations for the FRFH. For reference some of the recommendations that pertain to production are included:

Recommendations for All Feather River Fish Hatchery Programs

Clear goals should be established for the program. Program production goals should be expressed in terms of the number of age-3 ocean recruits just prior to harvest (Chinook Salmon), and the number of adults returning to freshwater (steelhead).

Transporting and releasing juveniles to areas outside of the Feather River and near or downstream of the confluence of the Yuba River should be discontinued. Juvenile fish should be released at the hatchery, or if not possible, as far upstream in the Feather River from the confluence of the Yuba River as possible to reduce adult straying and increase the number of adult fishes returning to the hatchery. Consider necessary facility modifications or equipment purchases that will facilitate onsite releases. Release locations for steelhead may take into consideration ecological and predation effects on other fish populations but should not compromise homing of adults to the hatchery.

Managers should investigate the feasibility of collecting natural-origin adult fish at alternate locations. The existing trapping location is very limited in its ability to capture fish representing the entire spectrum of life history diversity. Only fish that migrate to the furthest upstream reaches are susceptible to capture.

Adult holding facilities should be upgraded and/or expanded to provide adequate space, water flows and temperature regimes to hold the number of adults required for broodstock at high rates of survival (greater than 90 percent). In addition, because of a lack of adult holding space, fall Chinook are returned to the river to make room for late arriving spring Chinook. Evaluate the prospects of using the Thermalito Annex Facility for the long- term holding of spring Chinook broodstock. While the Annex water temperature is relatively high, a pilot study could be used to determine whether any associated increased holding mortality was sufficiently offset by the Annex's otherwise excellent water quality.

Natural-origin fish should be incorporated into broodstock at a minimum rate of 10 percent to prevent divergence of the hatchery and natural components of the integrated population. This may require auxiliary adult collection facilities or alternative collection methods (e.g., seining or trapping).

A Monitoring and Evaluation Program should be developed and implemented, and a Hatchery Coordination Team formed for the program. Implementation of these processes will inform hatchery decisions and document compliance with best management practices defined in this report.

Performance standards for each phase of the fish culture process should be established and tracked annually. Summaries of data collected with comparisons to established targets must be included in annual hatchery reports.

CDFG should develop and promulgate a formal, written fish health policy for operation of its anadromous hatcheries through the Fish and Game Commission policy review process. Hatchery compliance with this policy should be documented annually as part of a Fish Health Management Plan. The current CDFG fish health policy is inadequate to protect native stocks.

CDFG should develop an updated Hatchery Procedure Manual which includes performance criteria and culture techniques presented in IHOT (1995), Fish Hatchery Management (Wedemeyer 2001) or comparable publications. The fish culture manual (Leitritz and Lewis 1976) is outdated and does not reflect current research and advancements in fish culture.

Feather River Spring Chinook – Major Program Recommendations

The major recommendations of interest to resource managers for the Feather spring Chinook Salmon hatchery program are provided below. Those selected for presentation may represent major changes in operations, changes in approach or outcomes towards achieving harvest or conservation goals or will require substantial investment of resources. The California HSRG's evaluation of program compliance with standards and guidelines and the group's comments about this program are presented in their entirety in Appendix VIII.

Tag analysis should be used to determine the number of fall and spring Chinook spawned during the suspected period of run overlap (e.g., fish spawned in the last two weeks of spring Chinook spawning and the first two weeks of fall Chinook spawning). Tags should be read and egg lots tracked and eliminated from production as appropriate to reduce introgression of the two runs. Incubation techniques should therefore allow for separation of eggs from individual parents/families (no more than two families per tray).

Until all off-site releases of Chinook Salmon are eliminated in the entire Central Valley, coded wire tag analysis should be used to identify stray hatchery-origin fish among those fish selected for broodstock. Strays from other hatchery programs should not be used as broodstock, or if eggs are collected from or fertilized by such fish, they should be culled soon after spawning

Appendix B: 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. HCI

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 CO2 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 CO2 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.

2023 Donor Stock Collection Plan

For the

Reintroduction of Central Valley
Spring-Run Chinook Salmon into the San Joaquin River

January 2023

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Table of Contents

Abbreviations and Acronyms

°C	Degrees Celsius
AGR	Allowable Growth Rate
ATU	Accumulated Thermal Unit
BKD	Bacterial Kidney Disease
BY	Brood Year
CDFW	California Department of Fish and Wildlife
CFSG	Conservation Facility Subgroup
CWT	Coded Wire Tag
DSCP	Donor Stock Collection Plan
DSCWG	Donor Stock Collection Work Group
DWR	California Department of Water Resources
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FMP	Fisheries Management Plan
FMWG	Fishery Management Work Group
FRFH	Feather River Fish Hatchery
GPS	Global Positioning System
HGMP	Hatchery and Genetics Management Plan
IHNV	Infectious Hematopoietic Necrosis Virus
kHz	Kilohertz
NMFS	National Marine Fisheries Service
PIT	Passive Integrated Transponder
Program	San Joaquin River Restoration Program
RMSG	Reintroduction Monitoring Subgroup
RST	Rotary Screw Trap
SCARF	Salmon Conservation and Research Facility
Settlement	Stipulation of Settlement
SJR	San Joaquin River
SJRRA	San Joaquin River Restoration Area
SJRRP	San Joaquin River Restoration Program
Reclamation	United States Bureau of Reclamation
SIG	Small Interdisciplinary Group
US	United States
USFWS	United States Fish and Wildlife Service

Donor Stock Collection Plan

January 2023

1.0 Introduction

The San Joaquin River Restoration Program (SJRRP) is a direct result of a Stipulation of Settlement (Settlement) reached in September 2006 after more than 18 years of litigation. The "Settling Parties" include all plaintiffs, federal defendants, and Friant parties from the stipulation of Settlement Natural Resources Defense Council (NRDC) *et al*. v. Kirk Rodgers *et al*. The SJRRP is responsible for executing the Settlement from the lawsuit, which includes the requirement to reintroduce spring-run Chinook Salmon (*Oncorhynchus tshawytscha*) into the San Joaquin River Restoration Area (SJRRA). The SJRRA extends approximately 150 river miles from Friant Dam to the confluence with the Merced River.

A conservation broodstock program was initiated at the Interim Facility in Friant, California, to help implement Settlement actions. The SJRRP has successfully begun to reintroduce spring-run Chinook Salmon to the SJRRA and will continue its efforts to supplement the population through donor stock selection, broodstock collection and mating, husbandry techniques, release strategies, monitoring and evaluation, and captive breeding activities. Due to the listing status of the Central Valley spring-run Chinook Salmon evolutionarily significant unit (ESU) (spring-run Chinook Salmon) of threatened under the Endangered Species Act (ESA), the SJRRP has developed a process to guide fish collections planned for each year, and to inform the National Marine Fisheries Service (NMFS) of these collections pursuant to the ESA section 10(a)(1)(A) permit number 20571 (FR 2018-28405; herein referred to as section 10(a)(1)(A) permit) and the Hatchery and Genetics Management Plan (HGMP; CDFW 2016). A Donor Stock Collection Plan (DSCP) for the collection of broodstock source fish for the SJRRP is developed annually by a team of technical experts comprising the Donor Stock Collection Work Group (DSCWG).

The DSCWG is a multi-agency collaboration that includes representatives from the Settlement's Implementing Agencies (California Department of Fish and Wildlife [CDFW], California Department of Water Resources [DWR], NMFS, U.S. Bureau of Reclamation [Reclamation], U.S. Fish and Wildlife Service [USFWS]), geneticists from the University of California Davis Genomic Variation Lab and NMFS Southwest Science Center, and fisheries biologists from the SJRRP and donor streams, and other interested parties. Prior to 2018, the DSCWG through technical expert recommendations from members of the Reintroduction Monitoring (RMSG) and Conservation Facility (CFSG) Subgroups developed the DSCP. However, as the SJRRP evolved the technical experts participating in the RMSG overlapped in participation with the CFSG. Therefore, in 2018, the DSCWG decided that the group could operate more efficiently as one large group, eliminating the need for the individual subgroups with overlap in attendance.

The DSCWG is responsible for developing an annual DSCP and providing information to NMFS on the donor stock populations (population status, potential impacts, and collection protocols), collection and reintroduction plans (locations, life stages, timing, and detailed protocols), and collections for the SJRRP's broodstock development at the Conservation Facility. The donor stock collection planning and implementation is driven by interagency collaboration and based on real-time information including: the population status of donor stocks, conservation program status, San Joaquin River (SJR) conditions, the specifics of collection methods, and reintroduction methods. This document describes the SJRRP's recommendation for brood year (BY) 2023 spring-run Chinook Salmon broodstock collections and reintroduction activities. The recommendation includes the number, life stage, timing and methods of collection, genetic and fish health considerations, proposed final disposition of fish, and recent population information for the recommended donor stock population. Protocols covering all recommended activities are provided or can be provided upon request.

A section 10(a)(1)(A) permit is held by the USFWS and authorizes take of: Feather River Fish Hatchery (FRFH) spring-run Chinook Salmon for broodstock collection, Butte Creek spring-run Chinook Salmon for broodstock collection, SJR naturally spawned salmon for broodstock collection, FRFH spring-run Chinook Salmon for direct translocation of tagged juvenile fish into the SJRRA, and the option for opportunistic collections in coordination with NMFS. Fish collections are essential to meeting the needs of the conservation hatchery facility program for broodstock development. Take is authorized for the 5-year term of the permit and coordinated closely with NMFS to ensure that all activities comply with the requirements of the section 10(a)(1)(A) permit. USFWS is in the process of requesting a permit renewal from NMFS that would extend the permit 5-years beyond the current sunset date of December 31, 2023. Therefore, activities covered in this 2023 Donor Stock Collection Plan may transition between permits for the accounting of take.

2.0 Donor Stock Population Status

2.1 Feather River Fish Hatchery

Eggs and/or juveniles will only be collected after the FRFH has collected three million fertilized eggs to meet its production goal of two million spring-run Chinook Salmon smolts, which occurs in most years (Table 1). The number of the fish in excess of those needed to meet the FRFH production target varies from year to year (Table 2). The number of adults that enter the FRFH during the fall spawning period can be estimated based on the number that enter the FRFH ladder in the spring when they are tagged with a Hallprint® tag and then returned to the river until they mature (Anna Kastner, personal communication). Based on tagging data from 2004 to 2022, a mean of 47.45% (range: 17.4% – 91.1%) of the adult spring-run Chinook Salmon tagged at the FRFH in May and June returned to the FRFH in the fall, with 91.1% returning in 2022 (Table 3).

Table 1. Number of FRFH spring-run Chinook Salmon returns and smolt production from BYs 2004 to 2022 (Anna Kastner, personal communication). Numbers reported for BY 2022 are considered draft at the time this document was prepared.

BY	Male	Female	Jack/Jill*	Smolts Released
2004	2,100	1,530	572	3,842,318
2005	927	824	23	1,801,748
2006	1,379	673	9	2,080,210
2007	866	980	2	2,686,808
2008	761	686	7	2,024,012
2009	383	484	122	2,122,131
2010	1,001	654	6	2,337,843
2011	855	976	138	2,244,989
2012	1,591	1,919	228	2,159,091
2013	2,959	1,291	44	2,296,788
2014	1,382	1,217	177	1,764,005
2015	2,443	1,833	150	2,183,890
2016	635	950	34	1,692,754
2017	94	116	212	493,903
2018	904	880	241	1,848,134
2019	724	691	59	1,599,539
2020	794	650	110	2,581,321
2021	1,542	1,083	157	3,387,398
2022	790	965	13	TBD**

*Jack/Jill are fish ≤ 65 millimeter (mm) in fork length.

** The number of smolts released will be available in spring 2023 and not available during the preparation of this plan.

Table 2. Number of adult spring-run Chinook Salmon in excess of those needed to meet the juvenile production target at the FRFH from BYs 2008 to 2022 (Anna Kastner, personal communication). Numbers reported for BY 2022 are considered draft at the time this document was prepared.

BY	Female	Male	Jack/Jill*	Died in Tank
2008	47, unknown sex		No data	240
2009	0	2	34	76
2010	154	23	6	256
2011	255	231	No data	No data
2012	1,591	1,919	228	0
2013	651	2,319	44	0
2014	619	806	0	0
2015	1,429	1,991	100	0
2016	53	393	16	0
2017	0	0	0	No data
2018	309	340	234	7
2019	1,309	258	32	22
2020	252	163	76	29
2021	872	374	139	20
2022	185	344	3	28

*Jack/Jill are fish ≤ 65 mm in fork length.

Table 3. Number of adult spring-run Chinook Salmon tagged at the FRFH during the spring (total tagged) and the number that returned to the FRFH in the fall from BYs 2004 to 2022 (Anna Kastner, personal communication). Numbers reported for BY 2022 are considered draft at the time this document was prepared.

BY	Total Tagged	Spring Hatchery Returns	% Fall Returns
2004	3,650	834	22.8%
2005	5,960	1,835	30.8%
2006	10,179	1,768	17.4%
2007	9,756	1,849	19.0%
2008	1,915	1,058	55.2%
2009	1,462	989	67.6%
2010	3,502	1,661	47.4%
2011	6,023	1,969	32.7%
2012	7,465	3,738	50.1%
2013	20,057	4,294	21.4%
2014	7,289	2,776	38.1%
2015	5,335	3,717	69.7%
2016	2,917	1,635	56.1%
2017	762	442	58.0%
2018	3,516	2,025	57.6%
2019	5,945	2,857	48.1%
2020	2,746	1,663	60.6%
2021	4,797	2,782	57.8%
2022	1,941	1,768	91.1%

2.2 Butte Creek

The SJRRP may collect up to 2,910 juveniles from Butte Creek, including collections for pathology, between approximately December 2023 and March of 2024. The actual number of juveniles collected will depend on the number of adults that were capable of spawning (escapement) in Butte Creek during the fall of 2023. If there are over 250 female spawners, two juveniles may be collected for every female spawned, until there are up to 1,455 spawned females, totaling 2,910 juveniles collected.

Escapement estimates on Butte Creek are determined by a combination of direct adult counts via snorkel surveys at a counting weir during the holding period, and carcass survey estimates during the spawning period (Table 4; Garman 2013, 2014, 2015, 2016a, 2016b, 2018, 2019; Nichols 2020,

2021; Henley 2022). The SJRRP will collect juveniles using a seasonal Rotary Screw Trap (RST) and off-stream diversion fish screen operated by the CDFW at the Parrott-Phelan Diversion Dam (Figure 1), taking advantage of the annual monitoring that is conducted to estimate the number of juvenile out-migrants. The Butte Creek adult escapement estimates by survey type for BYs 2001 to 2022 are reported in Table 5 below. No fish were collected in 2022 from Butte Creek due to extremely warm water temperatures and persistent drought conditions. Butte Creek collection details for 2023 are subject to refinement in coordination with those agencies managing the Butte Creek salmon population and pending further deliberation by the DSCWG. A site visit to view the RST operations occurred in December 2022 and will be followed up with a pre-proposal development to document the details necessary to implement a collection event. More details will emerge from this effort that will ultimately lead to the development of a full proposal for DSCWG consideration.

Figure 1. Photos taken in December 2022 of the rotary screw trap (left) and the off-stream diversion fish screen (right) operated by CDFW at the nearby Parrott-Phelan Diversion Dam. Photo credit: USFWS.

Table 4. Butte Creek adult spring-run Chinook Salmon escapement estimates among surveys for BYs 2001 to 2022 (Grant Henley, 2022).

		Number of Adults	
BY	Snorkel Count	Carcass Estimate	Video Count
2001	9,605	18,312	
2002	8,785	12,897	
2003	4,398	6,063	
2004	7,390	10,221	
2005	10,625	16,998	
2006	4,579	6,303	
2007	4,943	6,214	
2008	3,935	10,082	
2009	2,059	2,561	
2010	1,160	1,979	
2011	2,130	4,859	
2012	8,665	16,140	
2013	11,470	15,886	
2014	3,616	4,851	4,700
2015	1,081	413	1,939
2016	4,450	5,371	4,115
2017	982	515	No data
2018	2,118	2,717	No data
2019	6,253	14,769	5,650
2020	1,559	1,281	2,991
2021	12,252	1,915	7,813*
2022	2,852	TBD**	5,463

*VAKI Riverwatcher passage counts for 2021 were incomplete due to equipment failure. Passage counts are from February to the end of April 2021.

** The number of adult carcass estimates are still being finalized by CDFW and not available at the time this plan was prepared.

Table 5. The total number of juvenile spring-run Chinook Salmon captured by age class at the Parrott-Phelan Diversion Dam using a rotary screw trap and off-stream diversion fish screen from BYs 2012 to 2022 (Grant Henley, 2022).

BY	Juvenile Count (Age-0)*	Juvenile Count (Age-1)*
2012	105,957	39
2013	381,817	32
2014	52,142	152
2015	7,802	3
2016	No data	No data
2017	98,245	0
2018	2,625	0
2019	473,840	3,150
2020	65,549	556
2021	24,330	13
2022**	TBD	TBD

*Only age-0 fish will be collected for SJRRP broodstock. Age-0 fish have a fork length ≤ 90 mm and age-1 > 90 mm fork length.
** BY 2022 numbers will not be available from CDFW until summer 2023 and therefore not available at the time this plan was prepared.

3.0 Broodstock Collection History

Spring-run Chinook Salmon broodstock have been collected annually for the SJRRP from the FRFH since 2012, with the exception of 2017 when there were no collections. The decision to include the Feather River population as a source for donor stock is discussed in the SJRRP's Stock Selection Strategy (SJRRP 2010) and section 10(a)(1)(A) permit. In most years, the FRFH has met its production goal of two million spring-run Chinook Salmon smolts. To reach this target, the hatchery spawns approximately 750 adult pairs to collect approximately three million eggs. Spring-run Chinook Salmon at the FRFH are identified by run timing. Adults that enter the hatchery in the spring (May through June) are marked with two dart tipped Hallprint® tags and returned to the river to hold over summer (Cavallo *et al.* 2012). When adults return to the hatchery in the fall, only fish with Hallprint® tags are categorized as spring-run. The hatchery's fish ladder is open from around September 15 through June to ensure that spring- and fall-run Chinook Salmon and steelhead have an opportunity to enter the hatchery. During the first few days of hatchery spawning, salmon that enter the hatchery are sorted into separate holding tanks based on

the presence or absence of a Hallprint® tags. Spring-run adults are then spawned in the coming days until the egg-take production goal is met. The spring-run Chinook spawn typically lasts from one to three weeks.

In 2017, because of the low spring-run Chinook Salmon escapement numbers in the Central Valley, the SJRRP did not collect a 2017 BY from either Feather River or Butte Creek. The low returns are likely a delayed response to California's previous extended drought period.

The number of eggs previously collected for broodstock from the FRFH for the SJRRP are listed in Table 6. Initially the SJRRP collected 560 eggs for broodstock from the FRFH to meet the fish production goal of spawning 50 to 100 adult pairs each year at the interim salmon hatchery facility (Interim Facility). In 2015, the collection was increased to 1,935 eggs in anticipation of spawning up to 300 females in September 2018. However, delays in the construction schedule for the Salmon Conservation and Research Facility (SCARF) have resulted in the need to reduce the number of fish collected in 2015, and reduce the number of eggs collected in 2016. In 2017, the Conservation Facility Subgroup recommended to collect up to the total permitted number of 2,760-eyed eggs from FRFH, and/or juveniles from Butte Creek but due to low escapement on both systems, no collections occurred due to low adult returns to Feather River. Instead, the SJRRP retained 2,212 from the 2017 BY produced at the Interim Facility to make up for the inability to collect fish at FRFH. The donor stock collection recommendations for spring-run Chinook Salmon 2018 BY was to collect 5,400 eyed eggs from FRFH and up to 2,980 eggs from the SJR. Collections of spring-run juveniles from Butte Creek and the SJR were recommended at 2,980 and 2,910 individuals respectively for broodstock development. No collections of any life stages were collected from Butte Creek or the SJR in 2018 due to population, funding and permitting constraints. The SJRRP has maintained collections from FRFH of collecting up to 5,400 eyed eggs since 2018 with no other donor stock collection outside of the FRFH.

Table 6. Number of eyed eggs collected by from FRFH for broodstock development.

BY	Number of Adult Pairs Mated	Number of Eyed Eggs Collected
2012	90	560
2013	90	560
2014	105	560
2015	360	1,935
2016	350	704
2017	0	0
2018	350	4,963
2019	350	5,265
2020	50	5,464
2021	366	2,196
2022	342	2,394

4.0 Status of the Salmon Conservation and Research Facility

The reintroduction plan for the SJRRP relies on the SCARF to develop a self-sustaining population of spring-run Chinook Salmon for the SJR using genetic management and conservation hatchery techniques (FMWG 2010b). Descriptions of these tools are provided in the Stock Selection Strategy (FMWG 2010a), Hatchery and Genetics Management Plan (CDFW 2016) and Genetic Management Plan (Baerwald *et al*. 2011). Because a facility like the SCARF takes years to design, plan, and construct, CDFW developed an Interim Facility. This way, in the near-term, broodstock could be raised to adulthood, spawned, and their progeny released to the SJR until the full-scale SCARF is constructed. Brood year 2012 spring-run Chinook Salmon broodstock were first transferred to the Interim Facility from FRFH in the spring of 2013 (Mahardja and Adelizi 2014).

The construction of the SCARF is scheduled to be completed in 2023. Until the facility is operational, the SJRRP will continue to use the Interim Facility for fish production. The ability of the SJRRP to rear the full 2023 broodstock collection through adulthood is dependent on completion of the full-scale SCARF and available funding.

5.0 Donor Stock Collection Recommendations for Spring-Run Chinook Salmon

Brood year 2023 spring-run Chinook Salmon are being requested from three sources to further the development of the Conservation Facility's reintroduction broodstock with the additional option to collect opportunistically from other locations in coordination with NMFS. The three donor stock sources and expected contributions to the broodstock include:

1) The FRFH, to develop a multiple year class of spring-run Chinook Salmon;
2) Butte Creek, to develop a multiple stock year class of spring-run Chinook Salmon; and
3) The SJR, to preserve and perpetuate the genetics of individuals who have successfully returned to spawn.

The collection of individuals from Butte Creek and the SJR are conditional upon the number of adults that successfully spawn in Butte Creek and the SJR in 2023 and the ability to receive them at the Interim Facility or SCARF. Table 7 specifies the recommended numbers, purpose, and dispositions, of individuals to be collected from the FRFH, Butte Creek, and the SJR. In 2023, the DSCWG recommends the total collection for broodstock development not exceed 5,470 individuals; therefore, the number of eggs or juveniles collected from the individual donor sources will adjust as necessary to meet this recommendation. These individuals will be reared at the Interim Facility, Conservation Facility, or otherwise approved by the SJRRP and authorized in the section 10(a)(1)(A) permit. However, the DSCWG recommends that the SJRRP release excess broodstock to the SJRRA if the Interim Facility reaches maximum capacity in accordance with the

section 10(a)(1)(A) permit. To accommodate this recommendation, excess broodstock from BYs 2017 through 2022, may be released to the SJRRA as needed at a range of ages, including smolts through age-2^{+} fish. A final decision regarding the number of broodstock collected will be made prior to September 1, 2023.

Table 7. Maximum donor stock collection recommendations for spring-run Chinook Salmon BY 2023.

Source	Collection Timing	Life Stage	Number	Purpose	Disposition
Feather River Fish Hatchery	October 2023	Spring-run eyed eggs	5,400*	Broodstock Development	Interim Facility
		Spring-run eyed eggs	70	Pathology	Sacrificed as juveniles
Butte Creek	December 2023 – March 2024	Spring-run juvenile	2,700*	Broodstock Development	Interim Facility
		Spring-run juvenile	210 (70 per collection up to 3 collections)	Pathology	Sacrificed as juveniles
San Joaquin River	December 2023 – March 2024	Spring-run eggs	1,000*	Broodstock Development	Interim Facility
		Spring-run eggs	70 per collection up to 4 collections	Pathology	Sacrificed as juveniles
		Spring-run juvenile	2,700	Brood Stock Development	Interim Facility
		Spring-run juvenile	70 per collection up to 4 collections	Pathology	Sacrificed as juveniles

*If the SJRRP intends to take fish from Butte Creek, proportionally, fewer fish will be taken from FRFH. Cumulative collection from all possible source stocks will not exceed the maximum number of egg collections authorized in the section 10(a)(1)(A) permit. For instance, the 1,000

eggs collected from the San Joaquin River would be a portion of the 2,700 individuals collected and are not additive to exceed limits identified in the section 10(a)1(A) permit.

5.1 Broodstock Collection Methods

Broodstock collections may occur from multiple lifestages: eggs, juveniles, and adults. The collection and processing methods, including genetic testing, will be subject to an adaptive process. The SJRRP will assess on a case-by-case basis the need for broodstock collection to meet hatchery performance standards. The objective of the SJRRP has been to select and collect broodstock for reintroduction from existing Central Valley spring-run source stock(s) that capture(s) phenotypic and genotypic diversity of the source population(s). The SJRRP will investigate and pursue collections that partner with other existing programs outside the Restoration Area to obtain donor stock in areas where fish handling already occurs, while minimizing effects to the collection species and impact to the source populations. In addition, other discrete collection events may occur that utilize similar methods and equipment to obtain donor stock through salvage and rescue opportunities. Injury and incidental mortality may result from trapping, handling, or transporting salmon; however, in most cases the take should be sublethal and best management practices will be employed at all times by qualified biologists during the collection events to reduce the potential for injury or mortality to occur. Broodstock will not be collected without assurance that sufficient funds will be available for the care and maintenance of the fish collected, at least to an age in which they can be tagged and released with a reasonable expectation of survival.

Throughout this plan, a collection event is being defined as any contiguous effort of collecting broodstock (*i.e.*, eggs or fish) that may consist of one or more collecting actions over a period of time. The resulting broodstock collected will be considered a single lot and the individuals of which will be freely integrated together in transport, quarantine facilities, and fish hatchery. It will be from this lot that required pathology sacrifices will be taken for fish health screening.

5.1.1 Feather River Fish Hatchery

A sufficient number of eggs must be collected to satisfy broodstock needs and to meet other SJRRP objectives, including future yearling and adult releases to the SJR as authorized by the section 10(a)(1)(A) permit. In 2023, it is recommended that up to 5,470 eggs be collected for broodstock, reared to adults, and eventually spawned starting in the fall of 2025 (jacks), with the majority spawned in fall of 2026. Fewer eggs will be collected if it is determined that juveniles will also be collected from Butte Creek and/or the SJR. In all, the cumulative collection from possible source stocks will not exceed 5,470 individuals. The resulting offspring will be released to the SJR in accordance with all permitting requirements.

The broodstock collection will include 70 eggs to account for the 70 juveniles sacrificed for pathology and a sufficient number of males in effort to produce a 2:1 male to female

spawning ratio. SJRRP staff will segregate eggs from approximately 350 paired matings, which will allow rejection of a significant number of crosses and yet provide substantial genetic variability in the future broodstock population. This would apply to when the SJRRP collects eggs at FRFH which typically occurs over three individual spawning dates. Based on the SJRRP criteria (CDFW 2016), preferred crosses will determine the selection of eyed eggs. Parents selected for these crosses will be comprised of 5 percent or less of two-year-old adults. Individual fish data will be tracked for each cross including: Hallprint® tag number, Hallprint® tagging date, adipose fin status, head tag number, coded wire tag (CWT) number, sex, fork length, ovarian fluid pathogen analysis, volume of flaccid eggs per female, daily egg expansion factor, female fecundity, tissue sample number, and corresponding genetic analysis data.

To reduce hatchery-induced selection, crosses may include fish with adipose fins (*i.e.*, supposed wild origin spring-run). During spawning, ovarian fluid samples are collected from each adult female and combined in groups of four or five to screen for viruses and bacteria, including infectious hematopoietic necrosis virus (IHNV) and *Renibacterium salmoninarum*, the causative agent of Bacterial Kidney Disease (BKD) (see Figure 2 below). An individual vertical tray egg incubator disinfected with iodophor and incubated at the FRFH according to the FRFH HGMP (Brown *et al.* 2018) will hold fertilized eggs from two crosses. During incubation, crosses meeting the following selection criteria will be determined from compiled data:

- Disease status - The parental ovarian fluid tests negative for IHNV and BKD.
- Run-timing - Both parents are Hallprint® tagged and CWTs (if present) verify the spring-run phenotype.
- Age of maturity - Two-year-old males and females will comprise 5% or less of the parental crosses unless necessary to meet SJRRP goals.

Figure 2. USFWS staff collecting ovarian fluid samples at the FRFH from each adult female spawned to screen for viruses and bacteria. Photo credit: USFWS.

Once preferred crosses have been identified, eyed eggs will be selected by hand counting near equal number of eggs from each cross until a maximum of 5,470 are obtained from the segregated crosses and transported to the Silverado Fisheries Base (SFB) in Yountville (or to another approved quarantine facility) for quarantine and temporary holding. If disease status testing is not completed by the time eggs are to be transferred to quarantine, eggs from each egg tray will remain segregated by bundling eggs in cheesecloth or similar material until disease status is known (see Figure 3 below for photo of egg tray vertical incubator set up at Feather River Fish Hatchery).

Crosses will not be selected unless the FRFH spring-run egg collection goal has been met and approximately 350 pairs are spawned for potential use. If fish are collected from Butte Creek and/or the SJR, the FRFH collection will be reduced to keep the combined total fish collection below 5,470 individuals. It is the SJRRP's release strategy to recategorize any excess broodstock collections as translocated fish and release them to the SJR, if determined too many fish were collected.

Figure 3. Photo of fertilized eggs being held in egg tray vertical incubators by spawned mating pairs at the FRFH. Photo credit: USFWS.

5.1.2 Butte Creek

The SJRRP currently proposes to collect up to 2,910 juveniles from Butte Creek between December 2023 and March 2024 (2,700 for broodstock, and 210 for pathology). As authorized in the section 10(a)(1)(A) permit, collection will be dependent on annual spawner escapement to Butte Creek, adult over summer survival, and proportion of collections from other donor sources, and may range up to 2,910 individuals. No juveniles will be collected if the number of female spawners is less than 250. The maximum number collected will scale up from 250 on a 2:1 basis; when the number of female spawners exceeds 1,455 up to the maximum of 2,910 juveniles may be collected. Escapement on Butte Creek will be determined by either direct adult counts at a counting weir or by snorkel survey estimates during the holding period. Escapement estimates by carcass surveys will be used for validation and to account for pre-spawn mortality. CDFW regional staff conduct these surveys annually and are consulted in August or September each year to discuss annual escapement and juvenile collection numbers for each BY.

Validation of escapement and confirmation of collection numbers will occur after carcass surveys are complete. Environmental conditions affecting the Butte Creek population (*e.g.*, drought, fire, disease) will also be considered in determining annual collection numbers. The SJRRP will collect juveniles from existing sampling occurring on Butte Creek. Collections will use the RST and side diversion trap at the Parrot-Phelan Diversion Dam near Chico (see Figure 1 above and Figure 4 below), which are used for monitoring spring-run juvenile out-migrants. The site is directly downstream of spring-run spawning habitat and upstream of fall-run Chinook Salmon spawning habitat, although periodically fall-run spawn above the site. Genetic diversity is increased by collecting juveniles after they have mixed with other unrelated individuals within the source stream. At these sites, the proposed maximum broodstock collection numbers will represent just 0.1 to 5.3 percent of captured juveniles, based on trap records from 2012–2015 and 2018–2021 seasons (Garman 2013, 2014, 2015, 2018, 2019; Jessica Nichols, personal communication). Data from the 2022 season is forthcoming and will be available for the 2024 Donor Stock Collection Plan. As typical efficiency rates for RSTs are very low, collections will represent a much smaller proportion of the total number of juveniles in the system (*i.e.*, a fraction of 1%).

The capture of juveniles on Butte Creek will occur up to one to three times per week throughout the outmigration period to maximize the genetic diversity of individuals collected for broodstock, but is limited to three total collection events. Collections will begin in December of each year and will extend through March, which is expected to encompass at least 95 percent of the juvenile outmigration period. Collections may occur anytime during the December to March period, but will likely occur in December and January (Henley personal communications). During fish processing activities at the RSTs, a subsample of randomly selected juveniles of different size groups will be selected for

broodstock collection. Life stages collected (*e.g.*, fry, parr, smolt), fork length ranges for each size group, and numbers collected of each per collection event will vary throughout the collection period to track those seen in the natural population. If, after initial collections, it becomes evident that size selection will be useful to eliminate fall-run Chinook Salmon individuals from the sample, then that may be used. Collected juveniles will be transported (using CDFW protocol SCF-TRN-001-03) to the holding site where they will be held in tanks or cages (which may include cages that are attached to the screw traps; protocol in development) until transferred to the SFB for a minimum 30-day holding and fish health assessment. Thereafter, the individuals will be transferred to the Interim Facility or SCARF for rearing to adulthood. At some point prior to spawning, the broodstock will be analyzed genetically, and any fish identified as fall-run will be removed from the broodstock population. The final disposition of the fall-run will be determined within the Fishery Management Work Group (FMWG) which includes representation from NMFS. Annual collections from Butte Creek will be segregated in up to three groups for quarantine and fish health assessment to reduce the potential for disease transfer between early and late collections of fish.

Figure 4. Photo taken in December 2022 of the rotary screw trap operated by CDFW at the Parrott-Phelan Diversion Dam. Photo credit: USFWS.

5.1.3 San Joaquin River

In the event that adult spring-run Chinook Salmon return to the SJR in the spring of 2023, efforts will be made to collect up to 2,700 (or 2,980 including pathology) offspring for broodstock as either eggs or juveniles. Although authorized in the section 10(a)(1)(A) permit, the SJRRP does not intend to capture adults for collecting eggs this year since this method will likely require the holding of adults, which will not be possible until the SCARF is fully operational.

In salmonid populations, the egg life stage contains the most individuals (SJRRP 2011). Therefore, if collection methods can achieve a high survival rate of collected eggs, then eggs offer the potential for the greatest number of fish obtained with the least effect on the donor stock. However, in order to achieve genetic diversity (and minimize the number of siblings) within the SJR population, a small number of eggs from several redds would need to be collected. Redd extractions can also reduce the risk of disease transfer. Collection of juveniles from donor stocks also offers several advantages such as maximizing genetic diversity while minimizing impacts to donor stocks. Juvenile collections can allow early selection pressure to occur naturally rather than under artificial conditions, but pose an increased risk of disease into the broodstock program (SJRRP 2011).

The SJRRP will explore two basic methods for redd extractions: either redd pumping or redd excavation (SJRRP 2011). Up to 20 eggs per redd may be collected to be incorporated into broodstock to limit the number of siblings in the broodstock. Broodstock collected as eggs will be transferred or held for quarantine and fish health assessment prior to being transported to the SCARF.

Eggs will be collected approximately 20-30 days post-spawning from redds, depending on water temperatures. Eggs are most resistant to disturbance after 200 accumulated thermal units (ATUs in degrees Celsius [°C]). Eggs will be collected prior to 480 ATUs, which is when hatching can begin for Chinook Salmon eggs (Börk *et al.*, 2016). The timing of egg collection will be assessed during the spawning season taking into consideration these (post-spawn timing, ATU calculations, in-river temperature) and others to determine the optimal time to extract the eggs. Depending on the specific on-site conditions, either redd pumping or redd excavation may be used as the preferred extraction method, as described below. On-site decisions will be made by field biologists and based on water clarity, water velocity, water depth, risk to non-target eggs and safety considerations of field staff. With either technique, eggs will be removed from each redd until the desired number reached ($\leq$ 20 viable eggs per redd). This equates to approximately < 0.2 percent of the eggs from an individual female. Therefore, a take of 0.4 percent of the eggs from a female at this life stage should be sustainable (Börk *et al.*, 2016). Egg-to-fry survival rates in the Interim Facility and SCARF is anticipated to exceed 50 percent, with a target of 70 percent or greater. Egg-to-fry survival in naturally spawned Chinook Salmon eggs is extremely variable, and depends on several factors, including temperature, flow, gravel composition,

percolation rate, etc. (Börk *et al.*, 2016). Total eggs collected will depend on redd availability.

Additionally, fry and juvenile life stages may be collected through the SJRRP's emergence trapping and rotary screw trapping efforts in Reaches 1 and 2 as authorized in the section 10(a)(1)(A) permit. During the collection period, broodstock collected as fry or juveniles will be transferred or held for quarantine and fish health assessment prior to being transported to the Interim Facility or SCARF. Genetic testing will be used to confirm spring-run Chinook Salmon origin and manage the genetic diversity in the broodstock and spawning. Each fish will be individually tagged with a Passive Integrated Transponder (PIT) for sorting after genetic testing and for incorporation as broodstock for identification. See Table 7 herein for the maximum donor stock collection recommendation and the methods described in the section 10(a)(1)(A) permit for more detail on broodstock collection.

5.1.3.1 Redd Pumping

If redd pumping is conducted, eggs will be collected from redds using a small portable backpack mounted water pump as described by Murdoch and Hopely (2005). An aluminum probe is inserted into the redd. The probe design allows for air intake, which creates a Venturi effect that combines water and air. The air and water mixture floats the eggs to the surface. On the downstream side, a collection basket covered with wire mesh and a cloth net bag collects the eggs. The basket will be placed over the portion of redd to be sampled. To minimize stress to the redd, hydraulic sampling will begin at the farthest most downstream point of the tail spill and progress systematically upstream as necessary (Börk *et al.*, 2016). This method ensures that disturbance to the redd is confined to the furthest downstream portion of the redd, decreasing the probability of impacts from personnel (*i.e.*, stepping on egg pockets) or the sampling process (*e.g.*, changing the hydraulics of the redd). Each redd will be sampled carefully until the first egg is collected, and the developmental stage verified (*i.e.*, eyed-egg stage). Eyed-eggs will be removed from the collection net by hand or with a small dip net and placed in small buckets. The buckets are placed in coolers on ice for transport to quarantine. Excess eggs will be re-injected into the redd using the hydraulic egg planter (Börk *et al.*, 2016) or carefully returned to the redd by hand. This is a common practice for several programs in the Pacific Northwest that use redd pumping since it is a low impact option for egg extraction (SJRRP 2011). While there doesn't appear to be published studies on the impacts to the eggs left behind in the redds, fisheries managers in the Pacific Northwest agreed that if appropriate techniques were used, the impact would likely be low (SJRRP 2011).

5.1.3.2 Redd Excavations

Redd excavation consists of carefully hand digging into the tailspill of identified spring-run redds to obtain live fertilized eggs. The specific redds from which eggs are to be obtained, will be selected by field biologist from areas of shallower water and gentle velocities to facilitate obtaining eggs without loss. Gravel will be carefully removed from the tailspill of the red, by hand until eggs are reached. The digging process will proceed slowly to create a clear view of the excavated area can be maintained throughout the process. Snorkel gear will be used to get a clear underwater view of the excavated area. A fine mesh dip net will be used to retrieve the eggs. Eggs will be placed into a bucket of river water, maintained at or below the temperature of the river, as they are removed from the gravel. They will be counted as they are placed into the bucket until the desired number of eggs is reached ($\leq$ 20 eggs). Once the eggs are obtained from the redd, gravel will be carefully replaced into the area from which it was removed until the pre-disturbance substrate contour is recreated.

5.1.3.3 Emergence Traps

If fry emergence monitoring is conducted, it will be implemented in conjunction with the redd monitoring and carcass survey using emergence traps (Koski 1966; Hausle and Coble 1976; Beacham and Murray 1985; TID and MID 1991). A stratified random sampling design based on time periods and survey reaches will be used to select redds for emergence monitoring. Water temperature data for each redd will be obtained from the nearest CDEC gauging station to estimate emergence timing via accumulated thermal units prior to installing emergence traps (ATUs; Beacham and Murray 1990). ATUs will be calculated by adding average daily temperatures, 1 ATU = 1 °C for 1 day (Beacham and Murray 1990) and assume that emergence will start at approximately 650 ATUs. Emergence traps will be installed on selected redds no more than two weeks (*i.e.*, 3 to 14 days) prior to the start of expected emergence to minimize the potential for the traps to influence the hydro-geomorphology within monitored redds.

Emergence traps consist of 0.32-cm nylon mesh covering a steel frame and a 30.48-cm canvas skirt made of Dacron sailcloth buried vertically into the gravel to minimize lateral escapement of fish (Figure 5). Emergence traps are tear-shaped and contain a live-box at the narrower cod-end of each trap, which is oriented downstream. Emergence traps measure 2.42-m long and 1.83-m at the widest point and have an area of approximately 2.83 m^2. The live-box is assembled to collect emerging fry using a 3.79-L wide-mouth polyethylene bottle attached at the bottom to a 15-cm diameter funnel. Holes are cut into both sides of the live-box and the 0.32-cm polypropylene mesh is attached with silicone to create a vent, allowing water to escape, and minimizing fish mortality. A sock constructed of Dacron

sailcloth extended from the downstream end of the trap to the live box is attached using a hemmed drawstring around the lip of the funnel.

During installation, each emergence trap is placed on top of the distinct egg pocket. Subsequently, rebar measuring 0.95-cm thick by 76.20-cm long is installed around the emergence trap frame and secured to the frame using washers and hose clamps. The rebar is installed approximately 50-cm into the riverbed using a manual post pounder.

Thereafter, a trench will be excavated around the edges of the trap at a depth of 30.48-cm or until the substrate becomes too armored for digging to continue. Finally, a canvas skirt is buried within the trench, the excavated area is backfilled, and the collection jar is attached to the narrow caudal end of the Emergence traps.

Figure 5. Photo of an emergence trap deployed during fry emergence monitoring in 2020. Photo credit: USFWS.

5.1.3.4 Rotary Screw Traps

Juveniles may be collected by RST on the SJR, which will be checked at least once daily to process fish and remove debris (Figure 6). Under high debris loads, the trap will be checked and cleaned more frequently. If conditions in the live box suggest that in-trap predation is a concern, fish refuge devices will be installed within the live box to dissipate water velocities and reduce predation. If fish refuge devices seem to be causing mortality or injury to listed fish, then these features will be modified or removed to reduce their adverse effects. When monitored at the appropriate time interval relative to the number of fish being collected, RSTs result in low mortality rates. Juvenile spring-run Chinook Salmon outmigration will be monitored annually by RST on the SJR. In some cases, capture locations may allow the capture of both fall- and spring-run Chinook Salmon. If it becomes evident that size selection is more efficient for eliminating fall-run Chinook Salmon individuals from the sample, then that may be used. In these scenarios, larger yearling spring-run Chinook Salmon may be targeted, as they are most readily distinguished from fall-run Chinook Salmon. Collected fish will be genetically tested and PIT tagged to verify spring-run Chinook Salmon origin sometime after they reach a minimum fork length of 65 mm but may not occur until after juveniles are transferred to SCARF or the Interim Facility.

Figure 6. Photo of a rotary screw trap in the fishing position in the SJRRA during a routine trap check. Photo credit: Reclamation.

6.0 Quarantine and Fish Health Testing

Eggs and juveniles will be held in quarantine at either the Interim Facility, SFB, or other approved quarantine facility under the direction of SJRRP staff. Eggs collected at the FRFH or eggs or fish collected from the SJR will be held in quarantine for at least a 30-day period until passing a fish health assessment before being transferred to the Interim Facility or SCARF. Juveniles collected from Butte Creek will be held in up to three individual lots/tanks until pathology testing is complete. Approximately 30 days prior to transport, a maximum of 70 juveniles per lot will be sacrificed for fish health assessment by CDFW's Fish Health Laboratory in Rancho Cordova. In the spring of 2024, the remaining fish will be transferred to the Interim Facility or SCARF. Oxygen levels will be maintained at or above saturation during transport and temperature will be tempered to within 2 °C of the receiving water, pursuant to an accepted fish transfer protocol (Börk *et al.*, 2016, Appendix B). If the SFB nor the Interim Facility is available for holding fish, an alternate quarantine facility will be selected in cooperation with the CDFW Fish Health Laboratory. The SJRRP is investigating the use of the SIRF as a quarantine facility, but requires further evaluation and approvals before it can be used for holding fish. If deemed appropriate to use by the CDFW Fish Health Laboratory and the SJRRP for quarantine and fish health testing purposes, then more information will be provided in the next Donor Stock Collection Plan of its intended use.

Figure 7. Images of spring-run Chinook Salmon eggs being sorted, counted, and incubated in egg trays at the Interim Facility. Photo credit: CDFW.

6.1 Husbandry

At the Interim Facility or SCARF, dissolved oxygen, temperature, mortality, and feed quantity will be measured daily. Fish weights and lengths will be measured every 1-6 months as needed. Fish will be anaesthetized with MS-222 or AQUI-S in accordance with the Fish Sedation and Live Fish Handling and Care protocol SCF-FHP-001-01 prior to being measured. Fish will be fed standard salmon feed and a strict feed regimen will be instituted using the GROW program (Microsoft Excel based) to modulate growth rates. The program calculates the feed ration based on species, water temperature, body weight, feed conversion, and desired Allowable Growth Rate (AGR). Females

will be offered a near full ration (50-160% for Chinook Salmon AGR). Males will be offered a partial ration (*i.e.*, 25-60% of AGR) during September through March of the first two years to limit maturation (Larsen *et al.* 2012).

6.2 Marking and Tagging

Once transferred to the Interim Facility or SCARF, fish will be marked using a CWT and adipose fin clip. After fish reach a fork length of approximately 65 mm, tissue samples will be collected for genotyping and sex identification and marked with a PIT tag. The PIT tag number and corresponding fish data will be stored on a Microsoft Access or Excel database.

6.3 Tissue Sampling

Tissue samples will be taken according to the Interim Facility protocol SCF-GEN-001-04 (Attachment A) after fish have been PIT tagged. All tissue samples will be assigned the corresponding PIT number. Tissues will be transferred to the CDFW Tissue Archive located in Sacramento, California for processing.

6.4 Sex Identification

Sex identification through tissue analysis will be completed on the 2022 BY broodstock by NMFS' Southwest Science Center located in Santa Cruz, California. Results from these analyses will be used to segregate fish according to sex between July and September of 2023 to reduce the precocity rate of males through growth rate modulation. Fish exhibiting precocious maturation will be enumerated by identifying primary or secondary sexual characteristics or through use of ultrasound.

6.5 Final Disposition

6.5.1 Brood Year 2015 to 2021 Broodstock and Resulting Offspring

Mature BY 2015 through 2021 broodstock will be spawned in September/October 2023 using a mating matrix provided by the NMFS Southwest Science Center to maximize genetic diversity in the resulting offspring. The target for the ratio for males and females used in spawning will be 2:1 males to females to increase the effective population size of the offspring and improve the chance that returning adults will be less related. Jacks (mature age-2 males) from the BY 2021 may be spawned with up to 20% of the BY 2015-2020 females although this percentage may be higher if there are not a sufficient number of older males for spawning. Eggs from each female will be split up to four ways and a different male using a factorial mating design will spawn each quarter. Each quarter is incubated separately in a divided egg incubator tray. Survival to the eyed and emergence stage will be enumerated. Family lines will be mixed shortly after emergence. The offspring will be 100% CWT'd and adipose fin clipped in early 2024 prior to release to the

SJR. An estimated 200,000^{+} juveniles will be released to the SJR. Some adults may be released to the river between May and September 2023 (Figure 8).

6.5.2 Brood Year 2022 Broodstock

The BY 2022 FRFH broodstock (up to approximately 2,400) will be CWT'd and reared at the Interim Facility once received from the SFB. Ancillary BY 2022 broodstock may be released to the SJRRA as sub-yearlings in February or March 2023, or as yearlings in November or December 2023, in accordance with the section 10(a)(1)(A) permit.

Figure 8. Photo of CDFW staff holding an adult spring-run Chinook Salmon being released to the SJRRA. Photo credit: CDFW.

6.5.3 Brood Year 2022 Interim Facility Production Juveniles

Juveniles that were spawned at the Interim Facility in the fall of 2022 will be CWT'd in January through March of 2023 and released to the SJR in February - April of 2023. Up to 10,000 fish may be retained for yearling releases in November or December of 2023.

7.0 Timeline for Interim Facility Actions

- January through March 2023
    - Sacrifice 70 of the BY 2022 FRFH juvenile broodstock for fish health assessment at SFB.

- Upon approval from the Fish Health Lab, transfer BY 2022 FRFH juveniles from quarantine to the Interim Facility.
- CWT and adipose fin clip BY 2022 juvenile broodstock.
- CWT and adipose fin clip BY 2022 SCARF production juveniles.
- Release BY 2022 Interim Facility production juveniles to the SJR.
- Practice Butte Creek collections for next year (pending discussion with CDFW).

- April through June 2023
  - Once juveniles exceed 65 mm in fork length, tissue samples will be collected; and BY 2022 broodstock and potentially BY 2022 production fish held for yearlings releases will be PIT tagged at the Interim Facility.
  - Send BY 2022 broodstock tissues to NMFS Southwest Science Center via Tissue Archive for analysis.
  - Ultrasound BY 2015-2021 adults for maturation assessment and potentially release ancillary broodstock to the SJR.

- July 2023
  - Receive sex identification results for BY 2022 broodstock from NMFS Southwest Science Center.
  - Sort BY 2022 juveniles according to sex and begin growth modulation efforts.
  - Monitor incoming water temperatures and utilize water recirculation and chilling equipment if needed.

- August 2023
  - Identify number of mature males and females from BY 2015-2021 using ultrasound and release ancillary mature broodstock (if available) to the river.
  - Provide NMFS Southwest Science Center with list of mature broodstock.
  - Receive mating matrix for BY 2015-2021 adults and jacks from NMFS Southwest Science Center.

- September 2023
  - Begin spawning of adults at Interim Facility or at new SCARF if available.
  - Collect ovarian fluid from spawned BY 2015-2021 females at SCARF for analysis (Coordinate with the CDFW Fish Health Laboratory).
  - Fish ladder opens at FRFH around September 15. Spawn at FRFH and collect ovarian fluid samples for fish health assessment.

- If agreed, ultrasound BY 2015 - 2021 adults and release ancillary broodstock to the SJR.

- October 2023
  - Continue spawning remaining BY 2015 - 2020 adult broodstock and jacks at Interim Facility or at new SCARF if available.
  - Receive pathology data from ovarian fluid at SCARF and discard BKD and IHNV positive eggs.
  - Receive pathology and CWT data for screening BY 2023 broodstock eggs at FRFH. Reject fish of fall-run origin.
  - Transfer up to 5,470 BY 2023 broodstock eggs from FRFH to quarantine, but fewer if Butte Creek (and/or SJR) collection is planned.
  - Collect eggs from SJR return redds for broodstock.

- November through December 2023
  - Incubate eggs and fry in quarantine at Interim Facility or at new SCARF if available.
  - Release up to 10,000 yearling salmon to the SJR.
  - Collect eggs from SJR return redds for broodstock.

- December 2023 through March 2024
  - Begin spring-run juvenile collection on Butte Creek.
  - Transfer of up to three groups of juveniles from Butte Creek to quarantine.
  - Release 2023 BY production juveniles to SJR.

- March through May 2024
  - Transfer of Butte Creek juveniles to Interim Facility or SCARF for tagging (CWT and PIT), tissue sample collection, and rearing.

8.0 Spring-Run Reintroduction Techniques

The objective of the reintroduction of broodstock progeny and ancillary broodstock includes both fisheries research and the potential return of adult salmon to the SJRRA between 2025 and 2027. Some adults may return as age-2 fish in 2025 and age-4 fish in 2027; whereas most adults will be expected to return as age-3 fish in 2026. Releases for broodstock population management may require releases at various life stages from age-0 juveniles to adults, although the majority of

releases are expected to be as age-0 juveniles at either the parr or smolt life stage (see Figure 9 image of adult broodstock in captive rearing at the Interim Facility). Other life stage releases, age-1 to adult, will be conducted to manage facility capacity and for use in studies to inform future decisions and management. Multiple BYs of different life stages may be released during the same calendar year; and a particular BY may be released at various life stages over a multi-year period. All spring-run Chinook Salmon released by the SJRRP will be adipose fin clipped and CWT'd.

Figure 9. Photo of CDFW staff holding an adult broodstock in captive rearing at the Interim Facility. Photo credit: CDFW.

8.1 Juvenile Releases

Most releases from the rearing facilities will be the progeny of the broodstock, but broodstock juveniles could also be released to the river for a variety of other reasons. The number of juveniles produced and released from the Interim Facility or SCARF will increase over time as the facility reaches maximum production. However, actual production will vary year-to-year based on broodstock survival, fecundity, and other factors. In some years, there could be more broodstock than the facility is capable of rearing, or than is needed to meet future production goals. There may be a need to release juveniles to the river based on these unpredictable factors. Additionally, to increase the broodstock effective population size, SJRRP increased collections to double the

number of males. Because of the 50:50 ratio (males to females), and the unknown sex at time of collection, the doubled collection number produced an excess of the same number of females that will need to be released as ancillary juveniles to the river. These excess females may be released entirely as juveniles. To appropriately manage the broodstock population, and in response to river conditions, releases may include up to 5,000 ancillary broodstock.

All released fish will be CWT'd and adipose fin clipped. Release sites and transport times will vary due to migratory barriers, downstream water conditions, research and efficiency studies, or other unforeseen factors. Releases of the BY 2022 production fish will take place between January and April 2023, depending on river conditions and fish size. The BY 2023 production fish will be released at approximately the same time in 2024. Fish will be transported from the Interim Facility, Satellite Incubation and Rearing Facility (SIRF), or SCARF using a transport tank. The tank will be filled with SJR water immediately prior to transport. Water will be tempered closer to the temperature of the receiving water and will not exceed 2 °C of the river location receiving the fish before release. When possible, releases will occur at night to minimize predation. For additional information, see Appendix B of the HGMP for the transportation protocol.

8.1.1 Juvenile Survival with Acoustic Tags

All tagged spring-run Chinook Salmon are released in suitable areas below Sack Dam due to passage limitations upstream unless volitional passage is achievable and fish can be released higher in the SJRRA with reasonable survival. If juvenile survival studies are conducted, a portion of the released fish may be tagged with injectable Juvenile Salmon Acoustic Tracking System (JSATS) tags. In previous years, the University of California at Davis Biotelemetry Laboratory conducted survival studies in the SJRRA to assess within reach survival. Fish releases of acoustically tagged individuals were conducted in conjunction with other fish release events. These fish were reared to a sufficient size for implantation of JSATS transmitters (*e.g.*, ≤5% tag burden). The coordination of these studies with the juvenile releases is valuable to the SJRRP as it will contribute to our knowledge on juvenile salmon survival and migration rates within the SJRRA, lower SJR, and San Francisco Estuary. Multiple studies suggest that survival of juvenile Chinook Salmon emigrating from the Sacramento and San Joaquin rivers through the Delta is generally low (often less than 5%), and that the Central and Southern Delta specifically is associated with high mortality during this life stage (Brandes and Mclain 2001; Buchanan *et al.* 2013; Buchanan *et al.* 2018). Additionally, their survival through the Delta to the fish collection facilities is also a critical question of the SJRRP.

8.2 Yearling and Older Releases

The SCARF provides opportunities to study the yearling and adult life stages as part of planned fish releases. Annual releases of yearlings will increase as the SCARF reaches full capacity. To appropriately manage the broodstock population and in response to river conditions, releases may include up to 5,000 ancillary broodstock annually, primarily as yearlings (age

1+) or at age 2+ or older, as necessary for broodstock population management. The actual percentage of yearling releases may change over time based on information gained on the relative survival of release groups, facility operation needs, or new information regarding the proportion of yearling migrants in wild populations.

Adults may be released to the river as part of restoration and ongoing holding and spawning habitat assessments studying fish behavior as well as habitat availability and suitability of river conditions. The number of yearlings and adults released annually from hatchery production will be based on the recommendations of the FMWG in consultation with the DSCWG.

8.2.1 Criteria for Releasing Yearling and Older Broodstock

8.2.1.1 Facility Carrying Capacity

To account for early rearing stage mortality, each year more broodstock will be collected for the Interim Facility or SCARF than may be held when they reach maturity. In addition, to increase the effective population size of the hatchery population, a ratio of 2:1 (male to female) is used during mating, thus resulting in ancillary females. The carrying capacity of the SCARF allows the spawning of approximately 450 adult females with 900 males annually. Each year up to 5,400 individuals may be collected across all stocks for broodstock development. Estimated rearing mortality accounts for losses of approximately 65 percent. In the spring of their second year, the fish inventory will be evaluated, and fish releases will be made based on the anticipated loss in the coming years and the carrying capacity of the facility.

8.2.1.2 Genetic Relatedness Data

The genotype of the excess fish will be examined, and fish will be selected for release to maximize the effective population size through reducing family size variance in the hatchery broodstock population.

8.2.1.3 Sex Ratio Data

Chinook Salmon are a semelparous species. Early maturing first and second year males are typically not spawned, particularly in a captive rearing program. This disproportionate loss of males' results in a skewed sex ratio. An uneven sex ratio can reduce the effective population size. Therefore, in a typical year, more females will be selected for ancillary release than males due to the anticipated higher precocity rate and loss of first- and second-year males, and the desire to increase the effective population size by using a 2:1 (male to female) spawning ratio.

To minimize hatchery-induced selection, adults from the broodstock population will be released directly into the SJR to allow for natural spawning. Adult

broodstock will be transported from the Interim or SCARF facilities using a transport tank, typically from February through September. Adults will be released in Reach 1 and when possible, adjacent to available holding pool habitat. Transfer from transport tank to the river will be achieved when possible by using methods such as water-to-water transfer or released directly from the tank using a pipe or chute. Direct netting of fish will be minimized to the extent possible to reduce injury and fish stress. Yearling releases will be performed similarly to other juvenile releases and will be conducted with those releases as feasible.

9.0 Spring-Run Monitoring

9.1 Adult Trap and Haul

Adult trap and haul efforts are necessary because volitional upstream passage to the spring-run spawning grounds is not currently possible in all years. Trap and haul operations provides opportunities for the SJRRP to implement population monitoring, and evaluations to implement the restoration requirements for successful long-term establishment of spring-run Chinook Salmon in the SJR. In general, fyke nets or weirs will be deployed in multiple locations in the SJR, connected sloughs, or at fish passage facilities, and dip nets will be used to capture adults that stray into smaller irrigation canals. All fish will be genetically sampled and marked with external tags prior to release into the SJRRA to track spawning adults. Acoustic tags and/or PIT tags may be used for tracking purposes. See the 2023 Adult Spring-run Chinook Salmon Trap and Haul Proposal for more information on the methods associated with its operations.

9.2 Adult Monitoring

9.2.1 Snorkel and Acoustic Surveys

Adults in the holding and spawning reach will be monitored for survival, spatial distribution, and abundance estimated, using a combination of passive and active monitoring methods.

Passive Monitoring

A network of fixed-site acoustic receivers (*i.e.*, VEMCO, VR2W, 69 kilohertz [kHz]) will be used to monitor migration and holding patterns of spring-run Chinook Salmon implanted with 69 kHz coded transmitters. Receivers will be placed throughout Reach 1, between Friant Dam and Skaggs Bridge, focusing around holding areas and spawning riffles. Receivers will be secured to steel cable using pipe clamps and suspended upright between a buoy and weighted block. Receivers will be deployed before adult releases and will remain in the river until spawning surveys are completed, with data offloaded monthly.

Active Monitoring

Surveying crews will locate adult spring-run visually or by use of a portable acoustic receiver (*i.e.*, VEMCO, VR100) while floating the river by drift boat. Monitoring will occur on a weekly basis beginning the first week after fish are released and continuing through the end of the spawning period. Initial surveys may cover extents of the river ranging from Friant Dam to SR-99; however, surveys may be modified to focus on areas where fish are observed, and areas without observations or with inhospitable conditions surveyed less frequently. Data will be collected as fish are observed and will include location, global positioning system (GPS) coordinates, dominant habitat type (*e.g.*, pool, riffle, run, backwater), general fish condition, and water temperature. Monitoring for pre- spawn mortalities will also occur during these drifts, and carcasses observed will be recovered. Tags (*i.e.*, acoustic and PIT) from carcasses will be retrieved, and carcasses will be measured (*i.e.*, fork length to the nearest mm), sexed, females checked for spawning status, and a tissue sample collected.

Snorkel surveys will occur during the holding period to estimate the number of adult spring-run Chinook Salmon that volitionally immigrated into the holding and spawning reach of the SJRRA, supplementing estimates of abundance derived from the redd monitoring and carcass survey. Holding areas will be searched by surveyors, making passes (no more than two passes to minimize harassment of fish) of holding habitat and enumerating salmon while recording location, water temperature, and general condition of observed fish.

9.2.2 Spawning and Egg Survival Surveys

Redd monitoring and escapement surveys will be used to assess reproductive success of returnees. Genetic information may be collected from tissues from fresh carcasses (fish with clear eyes and blood remaining in the gills). Evaluation of adipose fin presence will be used to determine origin (*i.e.*, hatchery versus natural). The head of any fish missing an adipose fin will be collected for CWT extraction and analysis. Escapement may be quantified by marking fresh carcasses using two external tags (*e.g.*, individually numbered aluminum tags attached by hog ring to their maxilla). Escapement is defined as the number of individuals that escaped the recreational and commercial fisheries (*i.e.*, survived) and were capable of producing offspring (Ross 1997). In future years, the use of a segregation weir may also be effective at minimizing effects of introgression and superimposition on the spring-run Chinook Salmon population. Further details are included in the Draft Segregation Protocol for limiting introgression and superimposition of fall-run Chinook Salmon on spring-run Chinook Salmon.

If determined to be implemented, emergence traps will be used to assess egg survival in a subsample of redds as it relates to habitat conditions over time. If egg survival is lower than established habitat targets (*i.e.*, lower than 50 percent), it could limit the SJRRP's success

in reintroducing the population. This information will be used to recommend habitat restoration projects that may be needed to improve the spawning habitat conditions to support optimal egg survival. Emergence Trap protocols were established in the 2018 DSCP and are authorized under the section 10(a)(1)(A) permit. Additionally, the SJRRP may continue an initial study that began in 2020 to determine whether emergence traps have a significant effect on the redd environment in the SJR by measuring the surface and hyporheic water quality parameters. This initial study will be conducted in conjunction with the SJRRP's adult spring-run Chinook Salmon redd emergence trap monitoring, leveraging upon existing field efforts.

9.3 Juvenile Monitoring

Counts of juvenile abundance estimates will be assessed using RSTs along with efficiency releases. Juvenile Chinook Salmon will be sampled in Reaches 1 and 2 of the SJRRA, with RSTs placed in locations during near-term monitoring, as well as downstream locations to evaluate survival through the SJRRA. RSTs will be installed in the following four general areas: 1) near the Highway 99 Bridge; 2) near the Owl Hollow property; 3) near Scout Island; and 4) just downstream of Gravelly Ford. Once established, RST site locations will typically remain fixed each year unless changes in river conditions warrant the need to move them or if new RST sites are considered necessary for long-term study purposes. Juvenile monitoring protocols were established in the 2018 DSCP (DSCP 2018).

10.0 Recommended Research

The DSCWG recommends that the following research be considered for implementation in 2023:

1. Practice egg extractions from redds in the SJR that were constructed from returning adults or hatchery adults released to the river from the Interim Facility/SCARF.
2. Implement plan for possible release of Interim Facility produced adults to the SJR in the spring/summer/fall of 2023.
3. Develop a collection pre-proposal/proposal and translocation plan for broodstock collection from Butte Creek.
4. Investigate conservation hatchery strategies to reduce hatchery induced selection and increase egg and fish survival and fitness.
5. Evaluate survival and migration rates of juvenile production fish within the SJRRA, lower SJR, and San Francisco Estuary with acoustic technology.
6. Monitor the natural returns of spring-run adults to Reach 5 of the SJRRA and trap and haul any successful returns to the spawning habitat in Reach 1.
7. Adults in the holding and spawning reaches will be monitored for survival and habitat use through snorkel surveys and/or acoustic technology.

8. Assess reproduction success of returnees and adult ancillary broodstock releases with redd monitoring and pursue options for assessing egg-to-fry survival of spring-run Chinook Salmon that spawn in the SJRRA.
9. Evaluate survival of juvenile Chinook Salmon in Reaches 1 and 2 of the SJRRA with RSTs.
10. Pursue evaluating areas of low observed survival between RST trap locations in Reaches 1 and 2 of the SJRRA and in Reach 5 during juvenile outmigration.

All monitoring and research projects will be reviewed and recommended by the FMWG or DSCWG and approved by NMFS prior to implementation. Currently, staffing and resources for the SJRRP are provided by the Implementing Agencies. Thus, the commitment to carry out the monitoring activities is contingent on adequate funding to support the recommendation. Decisions regarding the allocation of funding to support the monitoring and reintroduction activities described above are subject to Program Management Team review and revision. Additionally, when possible, the SJRRP will investigate and pursue shared data collection and leverage existing external data collection resources towards monitoring the achievement of spring-run reintroduction.

11.0 Recommended 2022 Donor Stock Collection Plan Modifications

In recent years, scientists from several fish and wildlife agencies launched a rapid research and response effort in California's Central Valley for deficiency of thiamine, or Vitamin B1. This deficiency has been linked to increasing juvenile Chinook Salmon mortality among individuals watershed-wide. The SJRRP coordinated with the NMFS Southwest Science Center to conduct fish collections during trap and haul to undergo thiamine analysis. This involves the collection of eye lens, muscle tissue, eggs, and otoliths from adult Chinook Salmon returns. The tissue samples were used for stable isotopes analysis to reconstruct diets possibly linked to egg thiamine concentrations in a year when other runs of Central Valley Chinook Salmon suffered from thiamine deficiency and reproductive impacts possibly linked to narrowing of their food diets. Similarly, to the fish health samples, the SJRRP will assess annually the need to pursue these collections.

The SJRRP initiated an emergence trap effects study to determine whether emergence traps have a significant effect on the redd environment in the SJR by measuring the surface and hyporheic water quality parameters within trapped and non-trapped artificial redds. This effort started in 2020 and continued for a second year in 2021 in tandem with the regular emergence trap monitoring study and followed the same protocols outlined in section 5.1.3.3 with exception of artificial redd construction. However, this study did not occur in 2022 due to funding limitations and a low number of redds detected in Reach 1 of the SJRRA. Information obtained from the two years this study was conducted will assist in determining if emergence traps are the most suitable method for evaluating egg-to-fry survival estimates. Results of the study have been shared with the FMWG. These estimates are an important indicator of spawning habitat quality, will aid in quantifying the quality of spawning habitat, and identify where spawning habitat restoration actions can be

focused. If there is a future desire to increase the evaluation of this study's scope or degree of confidence in the analysis, the SJRRP may choose to revisit the study for additional survey seasons in later years.

The proposal *Map Study 30 San Joaquin River Spawning Habitat Assessment – Incubation Environment* implementation has been monitoring the physical habitat quality of the incubation environment since spring-run reintroduction efforts started in the SJRRP. Monitoring may include collecting data within the incubation environment of natural redds, simulated redds, and ambient streambed environment. Locations for this study were expanded in 2021 from previous years to inform the emergence trap effects study and flow management decisions within Reach 1. In 2022, this study was not conducted due to a low number of natural redds detected in the Reach 1 spawning grounds. For reference and more details on the study, the full proposal for this effort can be found online at San Joaquin River Spawning Habitat Assessment – Incubation Environment (restoresjr.net).

The 2010 Fisheries Management Plan and 2018 Fisheries Framework both identify disease as a stressor to Chinook Salmon in the SJR watershed. To assess the fish health of salmon found in the SJRRA, the SJRRP has coordinated with the National Wild Fish Health Survey through the USFWS's Fish Health Center to collect fish tissue samples and perform laboratory tests for major fish pathogens. Samples targeting the fish collections of Chinook Salmon and non-natives occurred during the 2020 and 2021 rotary screw trap field season, but did not occur in 2022 due to no rotary screw traps being deployed that field season. Rotary screw traps have been a multi-year study that occurs in the SJRRA to evaluate juvenile salmon migration behavior and survival and to provide an indicator of adult salmon spawning success in the upper reach of the SJRRA. The SJRRP will assess annually the need to pursue fish collections and conduct rotary screw trapping in future years.

Reclamation and CDFW have used rotary screw traps for monitoring juvenile spring-run Chinook Salmon production, survival, and emigration in the SJRRA. During the 2022 spring-run spawning season, only five potential[1] redds were identified in the spawning reach. Data on spring-run Chinook Salmon fecundity, survival, and rotary screw trap efficiency collected by the SJRRP in recent years indicate capture of fish during rotary screw trap monitoring this season would be low, compared to previous monitoring seasons. The low redd development would preclude SJRRP scientists and managers from using key metrics (*i.e.*, egg-to-fry survival, juvenile production, and survival) with confidence since statistical replicates (families contributing to production) were too low to assume calculated metrics would be representative of a true population. Therefore, the objectives of rotary screw trap monitoring could not be achieved, given the low number of redds identified this season. Additionally, inferences, comparisons, and statistical analyses across years

[1] Note: 3 of 22 redds capped with emergence traps in 2018 and 2019 were excluded from analysis due to being test redds or redds of undetermined status.

using data from this season would not stand up to statistical or scientific rigor. Consequently, Reclamation concluded that rotary screw trap monitoring was not scientifically or fiscally appropriate this season. Though low redd development led to canceling monitoring with rotary screw traps this season, unexpended funds from the study were available to provide additional financial support to the SJRRP SCARF hatchery, which is currently experiencing an operating funds shortfall.

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Feather River Fish Hatchery Spawning

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SPRING-RUN Chinook Salmon -BY 2023

Lot # ________________

Spring-Run Chinook Salmon - Gamete Tracking

Date: ___________________ **Data Recorder:** _____________________ **Expansion Factor:** ___________

Comments: ____

Cross #	Total Oz.	Tub #	Tray Location			HallPrint		Comments
			Row	Stack #	Tray #	Female	Male	

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		BROUGHT FORWARD								RECEIVED								SPAWNED							
		MALE		FEMALE		JACK		JILL		MALE		FEMALE		JACK		JILL		MALE		FEMALE		JACK		JILL	
DATE	LOT	NCWT	CWT	NCWT	CWT	NCWT	CWT	NCWT	CWT	NCWT	CWT	NCWT	CWT	NCWT	CWT	NCWT	CWT	NCWT	CWT	NCWT	CWT	NCWT	CWT	NCWT	CWT
		KILLED (NOT SPAWNED)								DIT								NEW BALANCE							
		MALE		FEMALE		JACK		JILL		MALE		FEMALE		JACK		JILL		MALE		FEMALE		JACK		JILL	
DATE	LOT	NCWT	CWT	NCWT	CWT	NCWT	CWT	NCWT	CWT	NCWT	CWT	NCWT	CWT	NCWT	CWT	NCWT	CWT	NCWT	CWT	NCWT	CWT	NCWT	CWT	NCWT	CWT

Spring _____ Fall _____

Date _____

Row _____

Stack _____

LOT _____

TRAY	Female 1	Female 2	Total OZ
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

Spring Fall _____

Date _____

Row _____

Stack LOT _____

_____

TRAY	Female 1	Female 2	Total OZ
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

EGG COUNTS		EGG COUNTS	
DATE_____ LOT_____		DATE_____ LOT_____	
1		1	
2		2	
3		3	
4		4	
5		5	
6		6	
7		7	
8		8	
9		9	
10		10	
11		11	
12		12	
13		13	
14		14	
15		15	
16		16	
17		17	
18		18	
19		19	
20		20	
21		21	
22		22	
23		23	
24		24	

FRH SPRING-RUN GAMETE TRACKING DATA CARD

Date:

Lot # Tub:

☐ DISCARDED

Row A B C D E F

Stack #

Tray #

Sex	Grilse	Ad-Clip	ID Number	Notes
G	J	Y N		
B	J	Y N		

TOTAL OUNCES ____________

FRH SPRING-RUN GAMETE TRACKING DATA CARD

Date:

Lot # Tub:

☐ DISCARDED

Row A B C D E F

Stack #

Tray #

Sex	Grilse	Ad-Clip	ID Number	Notes
G	J	Y N		
B	J	Y N		

TOTAL OUNCES ____________

FRH SPRING-RUN GAMETE TRACKING DATA CARD

Date:

Lot # Tub:

☐ DISCARDED

Row A B C D E F

Stack #

Tray #

Sex	Grilse	Ad-Clip	ID Number	Notes
G	J	Y N		
B	J	Y N		

TOTAL OUNCES ____________

FRH SPRING-RUN GAMETE TRACKING DATA CARD

Date:

Lot # Tub:

☐ DISCARDED

Row A B C D E F

Stack #

Tray #

Sex	Grilse	Ad-Clip	ID Number	Notes
G	J	Y N		
B	J	Y N		

TOTAL OUNCES ____________

FRH SPRING-RUN GAMETE TRACKING DATA CARD

Date:

Lot # Tub:

☐ DISCARDED

Row A B C D E F

Stack #

Tray #

Sex	Grilse	Ad-Clip	ID Number	Notes
G	J	Y N		
B	J	Y N		

TOTAL OUNCES ____________

FRH FALL-RUN GAMETE TRACKING DATA CARD

Date:

Lot # Tub:

☐ DISCARDED

Row A B C D E F

Stack #

Tray #

Sex	Grilse	Ad-Clip	ID Number	Notes
G	J	Y N		
B	J	Y N		

TOTAL OUNCES ____________

Date_____ CSSR_____

Lot_____

	Male		Female		Jack		Jill	
	NCWT	CWT	NCWT	CWT	NCWT	CWT	NCWT	CWT
Brought Forward								
Fish Received								
Fish Spawned								
Fish Killed(not spawned)								
DITs								
Released								
New Balance								
RT 1								
RT 2								
RT 3								
RT 4								

Expansion Factor	
Eggs/Oz.	
Incubated Ounces	
Trashed Ounces	
Daily Total Ounces	
Daily Eggs Incubated	
Daily Eggs Trashed	
Daily Egg Total	
Total Eggs Incubated	
Total Eggs Trashed	

A.M Temp	
DTU:	

Over Ripe Females	
Green Females	

FOH Duties		BOH Duties	
Trap		Put Away	
Sorters		Rinser	
Sorters		Data	
Sorters			
Spawner		Comments:	
Male			
Female			
Data			

Steelhead Released		
Male		
Female		

ADDLE RECORD

DATE_____ TEMP._____

# Eggs Before Bouncing	
Ounces of Bounced Eggs	
#Bounced Eggs Per Ounce	
# of Bounced Eggs	
Egg Loss	
Percent Egg Loss	

Addle Duties	
Addler	
Bouncer	
Picker	
Picker	
Picker	
Measurer	
Egg Packer	

# Bounced Eggs Shipped	
# Of Bounced Eggs Culled	
# Eggs Reduced	
# Eggs This Lot On Hand	
# Oz. Bounced Eggs On Hand	
Total # Of Eggs On Hand	
Current DTU	

Lot Stage	Date	DTU
Date Hatched/DTU		
Date Ponded/DTU		
Number Ponded/DTU		
	Series	Pond
Location Ponded		

Comments:

Sample Date: ____/____/_____
CDFW Samplers: _____

Feather River Hatchery

Daily Totals

Page: _____of _____
Calculated by: _____

Table 1. ALL Fish (**NO Released fish, but includes Recaptured fish**)

	Ad-c	Non-c	Total	Clip Rate
Spring				%
Fall				%

Table 2. Ad-clips ONLY (**NO Released fish, but includes Recaptured fish**)

		Kills		DITs		Spawns		Totals
		M	F	M	F	M	F	
Spring-run	Grilse							
	Adults							
	Sub-Total							
Fall-run	Grilse							
	Adults							
	Sub-Total							
							Ad-clip Total	

Table 3.

Spring-run Released		GREEN Hallprint			BLUE Hallprint		
		M	F	Unk	M	F	Unk
New	Ad-c						
	Non-c						
	Unk-c						
ReCap	Ad-c						
	Non-c						
	Unk-c						

Released Spring-run Total

Table 4. Discarded spawned fish

Circle Run: SPRING / FALL

		Spawns		Totals
		M	F	
Ad-clipped	Grilse			
	Adults			
	Sub-Total			
Non-clipped	Grilse			
	Adults			
	Sub-Total			
			Discarded Total	

* Please note, not all fish in the "Discarded spawned fish" table are accounted for in the following data sheets or in the tables above because we currently do not sample all non-clipped Fall-run spawned fish.

Sample Date: ____/____/_____

Feather River Hatchery

Page: _____of_____

Spring-run ONLY

(Consolidate into Tables 1 & 2)

Daily Totals

Table 5. GREEN Hallprint ONLY (**NO Released, NO Recaptured fish**)

		Kills		DITs		Spawns		Totals
		M	F	M	F	M	F	
Ad-clipped	Grilse							
	Adults							
	Sub-Total							
Non-clipped	Grilse							
	Adults							
	Sub-Total							
							GREEN Spring-run Total	

Table 6. YELLOW Hallprint ONLY (**NO Released, NO Recaptured fish**)

		Kills		DITs		Spawns		Totals
		M	F	M	F	M	F	
Ad-clipped	Grilse							
	Adults							
	Sub-Total							
Non-clipped	Grilse							
	Adults							
	Sub-Total							
							YELLOW Spring-run Total	

Table 7. BLUE Hallprint ONLY (**NO Released, NO Recaptured fish**)

		Kills		DITs		Spawns		Totals
		M	F	M	F	M	F	
Ad-clipped	Grilse							
	Adults							
	Sub-Total							
Non-clipped	Grilse							
	Adults							
	Sub-Total							
							BLUE Spring-run Total	

Table 8. **Recaptured**

		GREEN Hallprint				BLUE Hallprint				Totals
		Kills		DITs		Kills		DITs		
		M	F	M	F	M	F	M	F	
Ad-clipped	Grilse									
	Adults									
	Sub-Total									
Non-clipped	Grilse									
	Adults									
	Sub-Total									
									Recaptured Spring-run Total	

Col. Loc: Feather River Hatchery
Col. Date: ____/____/_____

CA DFW Data Sheet
Spring-run Chinook Salmon

Page _____of _____
Collectors: _____

Tissue ID C23 - FRH		Condition	Ad-Clip	Sex	FL (mm)	Grilse ≤650	Tag # (HP*=SR)	Head Tag	Comment
	1	K D S	Y N	M F		J			
	2	K D S	Y N	M F		J			
	3	K D S	Y N	M F		J			
	4	K D S	Y N	M F		J			
	5	K D S	Y N	M F		J			
	6	K D S	Y N	M F		J			
	7	K D S	Y N	M F		J			
	8	K D S	Y N	M F		J			
	9	K D S	Y N	M F		J			
	10	K D S	Y N	M F		J			
	11	K D S	Y N	M F		J			
	12	K D S	Y N	M F		J			
	13	K D S	Y N	M F		J			
	14	K D S	Y N	M F		J			
	15	K D S	Y N	M F		J			
	16	K D S	Y N	M F		J			
	17	K D S	Y N	M F		J			
	18	K D S	Y N	M F		J			
	19	K D S	Y N	M F		J			
	20	K D S	Y N	M F		J			
	21	K D S	Y N	M F		J			
	22	K D S	Y N	M F		J			
	23	K D S	Y N	M F		J			
	24	K D S	Y N	M F		J			
	25	K D S	Y N	M F		J			
	26	K D S	Y N	M F		J			
	27	K D S	Y N	M F		J			
	28	K D S	Y N	M F		J			
	29	K D S	Y N	M F		J			
	30	K D S	Y N	M F		J			
	31	K D S	Y N	M F		J			
	32	K D S	Y N	M F		J			
	33	K D S	Y N	M F		J			
	34	K D S	Y N	M F		J			
	35	K D S	Y N	M F		J			

Circle HP* Color:

GREEN: Thiamine treated

YELLOW: Control

BLUE: Late return

Tissue Type
Caudal
Tiss. Samp. Rate
100%
Scale Samp. Rate
100%

Page Totals		Kill		DIT		Spawn	
Ad-clip	Grilse	M	F	M	F	M	F
	Adult	M	F	M	F	M	F
Non-clip	Grilse	M	F	M	F	M	F
	Adult	M	F	M	F	M	F

GREEN: Table 5 YELLOW: Table 6 BLUE: Table 7

Col. Date: ____/____/_____

RELEASED Spring-run Chinook Salmon

Collectors: _____

Tissue ID C23 - FRH		Ad-Clip	Sex	ReCap	Tag # (HP*=SR)	ReTag # (Single HP)	Comment
	1	Y N	M F	R			
	2	Y N	M F	R			
	3	Y N	M F	R			
	4	Y N	M F	R			
	5	Y N	M F	R			
	6	Y N	M F	R			
	7	Y N	M F	R			
	8	Y N	M F	R			
	9	Y N	M F	R			
	10	Y N	M F	R			
	11	Y N	M F	R			
	12	Y N	M F	R			
	13	Y N	M F	R			
	14	Y N	M F	R			
	15	Y N	M F	R			
	16	Y N	M F	R			
	17	Y N	M F	R			
	18	Y N	M F	R			
	19	Y N	M F	R			
	20	Y N	M F	R			
	21	Y N	M F	R			
	22	Y N	M F	R			
	23	Y N	M F	R			
	24	Y N	M F	R			
	25	Y N	M F	R			
	26	Y N	M F	R			
	27	Y N	M F	R			
	28	Y N	M F	R			
	29	Y N	M F	R			
	30	Y N	M F	R			
	31	Y N	M F	R			
	32	Y N	M F	R			
	33	Y N	M F	R			
	34	Y N	M F	R			
	35	Y N	M F	R			

Circle HP* Color:

GREEN: Thiamine treated

~~YELLOW: Control~~

RELEASED

Page Totals	New			ReCap		
Ad-clip	M	F	U	M	F	U
Non-clip	M	F	U	M	F	U
Unk-clip	M	F	U	M	F	U

Col. Date: ____/____/_____ **RECAPTURED Spring-run Chinook Salmon** Collectors: _____

Tissue ID C23 - FRH		Condition	Ad-Clip	Sex	FL (mm)	Grilse ≤650	Tag # (HP*=SR)	Head Tag	Comment
	1	K D S	Y N	M F		J			
	2	K D S	Y N	M F		J			
	3	K D S	Y N	M F		J			
	4	K D S	Y N	M F		J			
	5	K D S	Y N	M F		J			
	6	K D S	Y N	M F		J			
	7	K D S	Y N	M F		J			
	8	K D S	Y N	M F		J			
	9	K D S	Y N	M F		J			
	10	K D S	Y N	M F		J			
	11	K D S	Y N	M F		J			
	12	K D S	Y N	M F		J			
	13	K D S	Y N	M F		J			
	14	K D S	Y N	M F		J			
	15	K D S	Y N	M F		J			
	16	K D S	Y N	M F		J			
	17	K D S	Y N	M F		J			
	18	K D S	Y N	M F		J			
	19	K D S	Y N	M F		J			
	20	K D S	Y N	M F		J			
	21	K D S	Y N	M F		J			
	22	K D S	Y N	M F		J			
	23	K D S	Y N	M F		J			
	24	K D S	Y N	M F		J			
	25	K D S	Y N	M F		J			
	26	K D S	Y N	M F		J			
	27	K D S	Y N	M F		J			
	28	K D S	Y N	M F		J			
	29	K D S	Y N	M F		J			
	30	K D S	Y N	M F		J			
	31	K D S	Y N	M F		J			
	32	K D S	Y N	M F		J			
	33	K D S	Y N	M F		J			
	34	K D S	Y N	M F		J			
	35	K D S	Y N	M F		J			

Circle HP* Color:

GREEN: Thiamine treated

~~YELLOW: Control~~

BLUE: Late return

Tissue Type
Caudal
Tiss. Samp. Rate
100%
Scale Samp. Rate
100%

Page Totals		Kill		DIT		Spawn	
Ad-clip	Grilse	M	F	M	F	M	F
	Adult	M	F	M	F	M	F
Non-clip	Grilse	M	F	M	F	M	F
	Adult	M	F	M	F	M	F

(Table 8)