2015 CHINOOK SALMON TRAPPING, TAGGING AND SPAWNING OPERATIONS AT FEATHER RIVER HATCHERY

Background:

The Feather River Hatchery (FRH) conducts two artificial propagation programs for Central Valley (CV) Chinook salmon: CV spring-run and CV fall-run. CV spring-run Chinook are listed as threatened under both the California Endangered Species Act and the Federal Endangered Species Act. CV fall-run Chinook provide for economically important commercial fisheries as well as popular sport fisheries in the ocean and inland.

The primary purpose of the spring-run program is to conserve and promote remaining phenotypic spring-run Chinook salmon in the Feather River. A secondary purpose of the program is to mitigate for spawning and rearing habitat eliminated due to construction of Oroville Dam. Additionally, due to the threatened status of spring-run it is crucial that hatchery operations are conducted in a way that minimizes impacts to other CV spring-run populations in Mill, Deer, Clear, and Butte Creeks.

Due past hatchery spawning practices and overlap in spawning habitat in-river, spring and fall runs on the Feather River are considered introgressed. Since 2004, spawning practices at FRH have been refined and reviewed annually to minimize introgression between runs. (See Attachment A)

The primary purposes of the fall-run program is to mitigate for spawning and rearing habitat eliminated due to construction of Oroville Dam and secondarily to support river and ocean salmon fisheries. In years when funding and broodstock allow, FRH will produce up to an additional 2 million fall-run Chinook for fishery enhancement. The enhancement program is funded through the Salmon Stamp program. Additionally, fall-run are produced for a small cold-water fishery in Lake Oroville.

1.0 Spring-Run Chinook Broodstock Collection and Spawning Protocol:

1.1 Brood stock Identification

Only early-arriving Chinook salmon ("phenotypic spring-run) will be used as broodstock for the spring-run Chinook program. To this end, fish ascending the fish ladder April through June will be trapped and tagged regardless hatchery or wild of origin. The trapping and tagging process will begin on or about April 1st and continue until June 30th and consist of double tagging fish with two sequentially numbered and color coded Hallprint Dart tags on either side of

the dorsal fin. Number sequences are unique to each fish. The FRH ladder will be closed on July 1st to prevent new fish from entering the ladder.

Any spring-run left in the FRH ladder will have no more than one week to ascend the ladder. The gathering tank will be used to remove any fish in the trap before dewatering the ladder. This process can be less than one week, but after one week period the ladder will be dewatered. Any fish still in the ladder prior to dewatering will be crowded back down the ladder into the river.

1.2 Broodstock collection and spawning

During spring of 2015, approximately, 5,355 fish where tagged following the methods described above (Table 1). See table 2 for comparison to previous years.

Table 1.

2015 FRH Spring-run broodstock tagging

	5/21/2015	5/26/2015	5/28/2015	6/1/2015	6/4/2015	6/8/2015	*6/11/2015	6/15/2015	6/18/2015	6/25/2015	6/29/2015	7/2/2015	Totals	% OF TOTAL
# of Fish Tagged	347	985	249	401	366	828	211	330	33	1070	494	41	5355	
Single tags	10	5	1	3	4	8	1	1	0	6	6	0	45	0.8%
Recaps	0	21	11	18	14	56	16	60	10	235	141	16	598	11.2%
Wild	8	19	3	11	6	25	3	10	1	42	27	4	159	3.0%
Morts	5	2	0	0	1	2	0	0	0	0	0	0	10	0.2%
Acoustic tags	0	0	0	0	1	1	0	1	0	2	0	0	5	0.1%

* Hydraulic system malfunction caused tagging day to be cut short. Tagging was halted at 9:40 am.

Table 2.

Total Spring Run Hallprint Tagged	Year
3650	2004
6021	2005
17438	2006
9755	2007
1915	2008
1462	2009
3502	2010
6023	2011
7494	2012
20057	2013
7289	2014
5355	2015
7691	Average

For spring-run spawning, the FRH ladder will be opened on Monday, September 14th 2015. Fish entering the hatchery will be sorted and all Hallprint tagged spring-run Chinook broodstock will be separated from all other Chinook and placed into round tanks for subsequent spawning. Spawning will occur whenever sufficient numbers of ripe spring-run broodstock (Hallprint Dart tagged fish) have accumulated in the round tanks of roughly equal sex ratio. If it is determined by hatchery staff that spring-run spawning can be conducted, hatchery staff will notify all individuals involved in tissue and scale collection and coded wire tag (CWT) recovery as to when spawning will commence. All other Chinook entering the hatchery during the spring-run spawning period will be excised. No fish will be returned to the river to avoid issues of properly accounting for escapement totals and to reduce hatchery impacts to natural area spawners. The head will be removed from any adipose clipped excised fish for CWT processing. Spring-run broodstock collection and spawning will start September 15th and continue through September 28th 2015.

- Broodstock collection will continue until 1,400 adults of roughly equal sex ratio have been collected or 3 million green eggs have been taken. These collection targets have been shown to allow for meeting production goals and allow for egg lot culling if necessary as well as for assurances against unforeseen mortality/disease issues. Any excess Hallprint Dart tagged broodstock will be excised and not returned to the river. Spring-run spawning operations will be completed by September 28th. If insufficient Hallprint Dart tagged spring-run are collected to meet these targets, then management approvals will be necessary for deviating from protocol.

- Hallprint Dart tagged fish will be spawned using a true 1 male:1 female ratio; the eggs from one female will be placed in a container and then combined with the milt from a single male. Genetic tissues will be collected from all contributing spawners after the fish are spawned. The head will be removed from any adipose clipped (ad-clipped) fish for CWT processing.

- Spring-run spawning will continue until the hatchery reaches its egg take goal of approximately 3 million green eggs or until September 28, 2015.

- If possible, CWT analysis will be used to examine contribution rates of hatchery-origin strays from other CV hatcheries into individual egg lots.

- Eggs will be collected to meet production goals according to the chart provided. (Table 3, Figure 1)

- IHN samples will be collected from the first 60 females.

San Joaquin Collection

A total of 90 pairs will be collected. A single pair is kept in each tray. Data from each pair will be collected for the San Joaquin program and virology samples will be taken for IHN.

There was a request for the 2015/16 spawning season to increase the amount of Brood Stock for the SJRRP egg collection from 90 pairs to 350 pairs. This will required the same data collecting as for the 90 pairs with the exception of incubating 2 pairs in each tray instead of one. This protocol my change depending on the time constraint that may impact the spring-run Chinook program for the Feather River Hatchery (Attachment B).

2.0 Fall-run Chinook Broodstock Collection and Spawning Protocol

2.1 Broodstock collection and spawning

Fall-run spawning will commence on October 7th 2015. Any salmon entering the hatchery on or after this date that does not carry a Hallprint tag will be considered a candidate for inclusion in the fall-run broodstock. Broodstock collection and spawning will be conducted in a manner that represents fish arriving from throughout the fall-run spawning period.

All fish entering the hatchery between the spring and fall-run spawning period (September 29th – October 6th) will be excised with the exception of those fish spawned for the Lake Oroville cold water fishery program. Culling all Chinook salmon entering the hatchery between the spring and fall-run spawning period is intended to help increase the temporal separation between spring and fall runs, decrease the potential for spring-run introgression into fall-run lots, and reduce hatchery impacts to natural area spawners.

During fall-run spawning, broodstock can include all salmon (adipose fin intact and fin clipped) except hallprint dart tagged salmon. Hallprint dart tagged salmon entering the hatchery during the fall-run spawning period will be excised. Preference will be given to spawning adipose fin intact fish if numbers allow or if CWT analysis indicates high proportions of spring-run in fall-run lots. If the numbers of ripe adipose fin intact fall-run entering the hatchery are sufficient to meet egg daily egg collection goals (described below in Table 4) than these fish will be selected for spawning.

Based on CWT analysis of previous years, spring-run contribution rates tends to be elevated in egg lots collected during the first two weeks of fall-run spawning. Targeting adipose fin intact fall-run broodstock, eliminates the potential for incorporating hatchery origin spring-run into fall-run lots but can reduce broodstock available for spawning. If fall-run spawning includes both adipose fin intact and fin clipped fish in the broodstock CWT analysis will be used to identify lots with high spring-run contribution rates (see below for discussion on contribution rates). Fall-run lots containing above a designated proportion of CWT-identified spring-run parents will be culled in a manner that increases the temporal separation between spring and fall runs (i.e. earliest to latest in the fall-run spawning period). The Feather River Hatchery Operations Team will review CWT data on spring-run contribution rates into fall-run lots in near real-time and determine the need for culling.

In previous years, fall-run broodstock included some fish that were collected during the spring-run spawning period and held until fall-run spawning had commenced. By limiting fall-run broodstock collection to the period after October 6th, it allows us to adhere to the conservation goals of increasing temporal separation between spring- and fall runs in the Feather River and limiting introgression.

As in previous years, implementing protocols to improve run separation and reduce gene flow between runs takes precedence over meeting fall-run mitigation goals. Depending upon run size and egg collections, fall-run egg lots may be further culled in a manner that increases the temporal separation between spring and fall runs (i.e. earliest to latest in the fall-run spawning period).

- Fall-run Chinook will be collected and held in round tanks until they are needed for spawning purposes.

- If logistically possible fall-run Chinook will be spawned using a true 1 male:1 female ratio. If this is not logistically possible due to large numbers of fish, fall-run Chinook will be spawned in pairs by combining the eggs from two females with the milt from two males. Genetic tissue samples will be collected from contributing spawners subsequent to spawning. The head will be removed from any adipose clipped fish for CWT processing.

- If needed CWT analysis will be done on broodstock for collected fall-run egg lots to determine spring/fall run contribution rates. Fall-run egg lots with a high (>3%) spring run contribution rate will be culled. The target for the average spring-run parental contribution across all fall-run lots is ≤2% of the total spawners. If broodstock availability allows for culling to a lower average spring-run parental contribution rate then the target will be lowered to the extent possible.

- If possible CWT analysis will be used to examine contribution rates of hatchery-origin strays from other CV hatcheries into individual egg lots.

- In collecting green eggs no more than double the production will be collected. In this case the combined mitigation and enhancement program production goal is 8 million juveniles resulting in a total collection goal of 16 million green eggs from throughout the run. This target will allow for egg lot culling if necessary as well as for assurances against unforeseen mortality or disease issues.

- Eggs will be collected to represent the spectrum of the run to meet production goals according to the chart provided (Figure 2).

Lake Oroville Coldwater Fishery

Adult fall-run Chinook will be used as broodstock for the Lake Oroville cold-water fishery. Lots intended to be used for this program will be isolated immediately after spawning and will be subject to IHN evaluation and prevention measures (see Dr. Cox for IHN protocol for this program). Egg lots to be used for this program will be collected on October 1st and will be collected only from fish having an adipose fin. Using only adipose intact fish is anticipated to eliminate the potential for hatchery produced spring-run being incorporated into fall-run lots. This program is anticipated to require approximately 300,000 green eggs.

Pathology Protocol

During the 2014 FRCS spawn, the Hatchery experienced a large loss of salmon eggs during the hatching phase. Survival to the eyed egg stage was normal. After addling and bouncing the eggs, they were placed in hatching trays. Egg mortality occurred during hatching and was attributed to a fungal growth. Managers and pathologist met to discuss the issue. DFW

pathologist recommended a change for 2015 collection protocols. The regular protocols entail taking fertilized eggs and putting them directly to the spawning tray to water harden with 8 oz. of iodophor used for disinfection. The changes for this year will be to drain ovarian fluid and milt from eggs after fertilization in a colander, briefly rinsing in UV water, and then hardening in incubation trays using 4 oz. iodophor for disinfection. The pathologist felt that this change would improve results in 2015.

If losses continue to occur in 2015, then the hatchery will discuss experimental protocols for 2016.

3.0 Production Goals:

During the 2015/'16 spawning season priority will be given to improving temporal separation between spring and fall runs.
The current production goals for release from FRH are as follows:

Spring-Run Chinook Mitigation:	Up to 2 million smolts
Fall-Run Chinook Mitigation:	Up to 6 million smolts
Fall-Run Chinook Enhancement:	Up to 2 million smolts and post smolts*

*Post smolts range in size between 30-45 fish per pound

For preseason planning purposes, a loss buffer over the production goals will be used for green egg collection to account for potential mortality between green and eyed egg stage and between eyed egg to ponding of fish. For both spring and fall runs, assumed survival from green to eyed egg stage is assumed to be approximately 80 percent between green and eyed egg stage and 90 to 95 percent for eyed egg to ponding of fish. Total green egg take will be over eyed egg stage goals. This egg take buffer over production goals allow for potential mortality in egg lots and culling of lots if necessary due to differential survival between lots. Culling will be done so that the last tally of eyed eggs prior to ponding fish represents no more than 10% over the actual production goals for release and an equal proportion is removed from each lot in order to reach the minimum needed egg take. This will again provide a buffer against any potential mortality while fish are in the raceways.

Table 3.

Feather River Hatchery 2015

Spring-run Eyed Egg Goal 2,000,000

	Date	Status	Lot #	Expected Green Eggs Collection	Actual Green Eggs Collection	Predicted Percent culling rate	Predicted Egg Collection after culling	Actual Percent culling rate	Actual Egg Collection after culling	Assumed 80% Survival to eyed after culling based on Predicted Egg collection	85% Survival to eyed after culling	Assumed 80% Survival to eyed after culling based on actual Egg collection	Assumed 90% Survival from eyed egg to ponded fish based on Predicted Egg collection	Assumed 95% Survival from eyed to ponded fish based on Predicted Egg collection	Actual estimate of ponded fish
1	9/17	Expected	1	300,000		7%	279,000			223,200	237,150	0	200880	212040	
2	*	Expected	2	600,000		7%	558,000			446,400	474,300	0	401760	424080	
3	*	Expected	3	1,000,000		7%	930,000			744,000	790,500	0	669600	706800	
4	*	Expected	4	800,000		7%	744,000			595,200	632,400	0	535680	565440	
5	9/28	Expected	5	600,000		7%	558,000			446,400	474,300	0	401760	424080	
		Totals		3,300,000			3,069,000		0	2,455,200	2,608,650	0	2,209,680	2,332,440	

* **Specific spawning dates and lot sizes are variable and depend on availability of ripe fish.**

Figure 1.

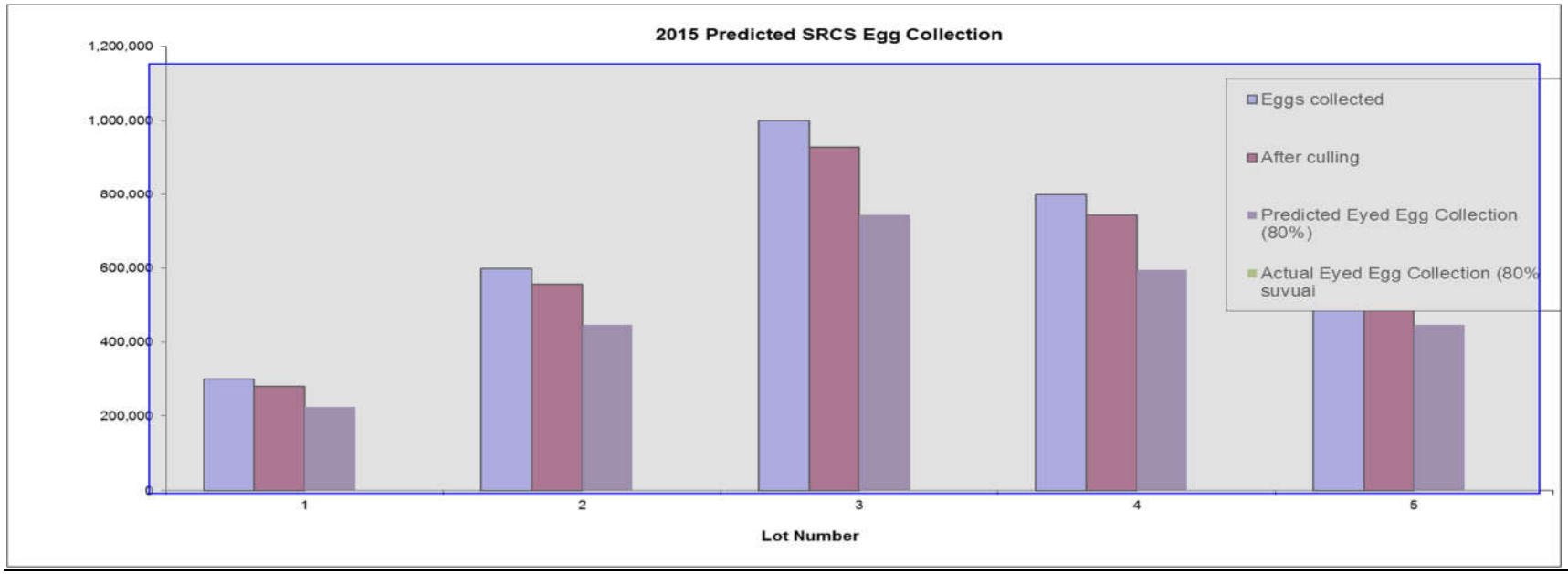


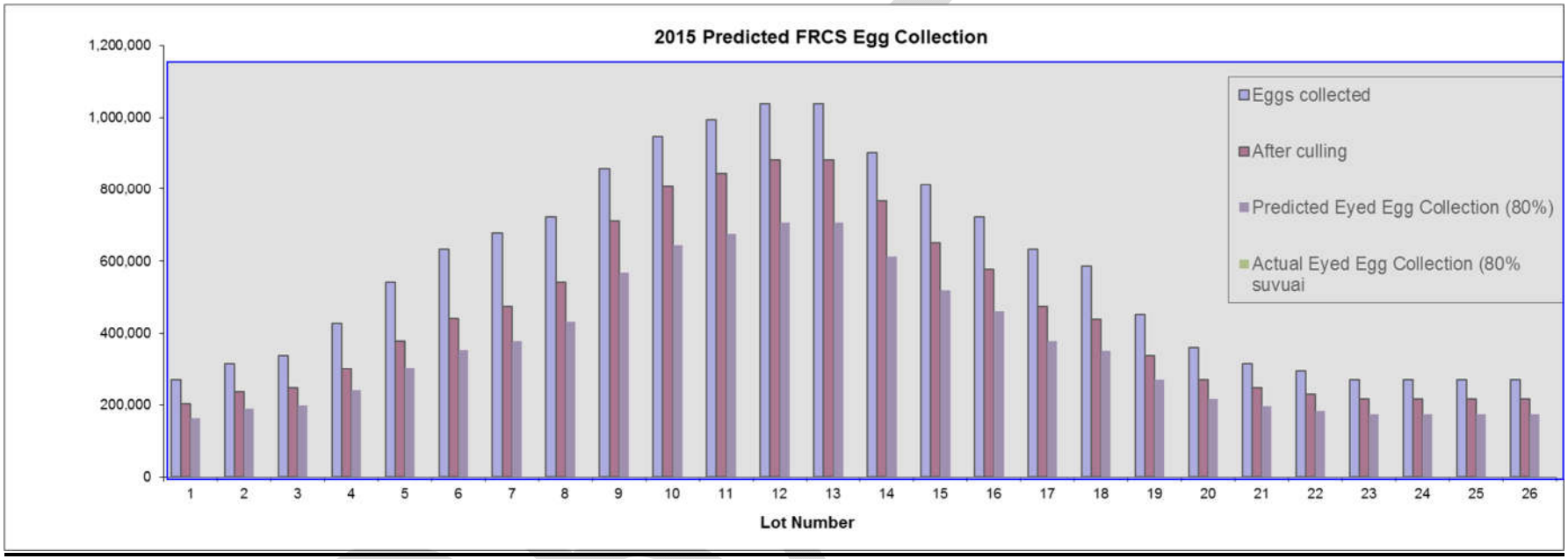
Table 4.

Feather River Hatchery 2015

Fall-run Eyed Egg Goal 8,000,000 (6,000,000 mitigation & 2,000,000 enhancement)

	Date	Status	Lot #	Expected Green Eggs Collection	Combined lots for minimum lot size logistical needs	Actual Green Eggs Collection	Predicted Percent culling rate	Predicted Egg Collection after culling	Actual Percent culling rate	Actual Egg Collection after culling	Assumed 80% Survival to eyed after culling based on Predicted Egg collection	85% Survival to eyed after culling	Assumed 80% Survival to eyed after culling based on actual Egg collection	Assumed 90% Survival from eyed egg to ponded fish based on Predicted Egg collection	Assumed 95% Survival from eyed to ponded fish based on Predicted Egg collection	Actual estimate of ponded fish
1	10/7	Expected	1	270,750			25%	203,063			162,450	172,603	0	146,205	154,328	
2	10/8	Expected	2	315,875			25%	236,906			189,525	201,370	0	170,573	180,049	
3	10/9	Expected	3	338,438			27%	247,059			197,648	210,000	0	177,883	187,765	
4	10/12	Expected	4	428,688			30%	300,081			240,065	255,069	0	216,059	228,062	
5	10/13	Expected	5	541,500			30%	379,050			303,240	322,193	0	272,916	288,078	
6	10/14	Expected	6	631,750			30%	442,225			353,780	375,891	0	318,402	336,091	
7	10/15	Expected	7	676,875			30%	473,813			379,050	402,741	0	341,145	360,098	
8	10/16	Expected	8	722,000			25%	541,500			433,200	460,275	0	389,880	411,540	
9	10/19	Expected	9	857,375			17%	711,621			569,297	604,878	0	512,367	540,832	
10	10/21	Expected	10	947,625			15%	805,481			644,385	684,659	0	579,947	612,166	
11	10/22	Expected	11	992,750			15%	843,838			675,070	717,262	0	607,563	641,317	
12	10/23	Expected	12	1,037,875			15%	882,194			705,755	749,865	0	635,180	670,467	
13	10/26	Expected	13	1,037,875			15%	882,194			705,755	749,865	0	635,180	670,467	
14	10/27	Expected	14	902,500			15%	767,125			613,700	652,056	0	552,330	583,015	
15	10/28	Expected	15	812,250			20%	649,800			519,840	552,330	0	467,856	493,848	
16	10/29	Expected	16	722,000			20%	577,600			462,080	490,960	0	415,872	438,976	
17	10/30	Expected	17	631,750			25%	473,813			379,050	402,741	0	341,145	360,098	
18	11/2	Expected	18	586,625			25%	439,969			351,975	373,973	0	316,778	334,376	
19	11/3	Expected	19	451,250			25%	338,438			270,750	287,672	0	243,675	257,213	
20	11/4	Expected	20	361,000			25%	270,750			216,600	230,138	0	194,940	205,770	
21	11/5	Expected	21	315,875			22%	246,383			197,106	209,425	0	177,395	187,251	
22	11/6	Expected	22	293,313			22%	228,784			183,027	194,466	0	164,724	173,876	
23	11/9	Expected	23	270,750	541,500		20%	216,600			173,280	184,110	0	155,952	164,616	
24	11/10	Expected	24	270,750			20%	216,600			173,280	184,110	0	155,952	164,616	
25	11/11	Expected	25	270,750	541,500		20%	216,600			173,280	184,110	0	155,952	164,616	
26	11/12	Expected	26	270,750			20%	216,600			173,280	184,110	0	155,952	164,616	
		Totals		14,958,938				11,808,084		0	9,446,468	10,036,872	0	8,501,821	8,974,144	

Figure 2.


2015 Predicted FRCS Egg Collection
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
Lot Number
Eggs collected
After culling
Predicted Eyed Egg Collection (80%)
Actual Eyed Egg Collection (80% suvuai

4.0 Release Strategy

Release strategies differ for spring and fall-run Chinook salmon produced at Feather River Hatchery. As release strategies have implications on juvenile survival and adult stray rates, the Feather River Hatchery Operations Team will meet following the end of fall-run spawning (early December, 2015) to discuss specific release strategies for each run, including release locations, timing, and coded wire tagging needs.

Attachment A:

- HSRG recommendations -

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

- The program should limit the number of eggs taken to the number necessary to meet production goals (which would include a reasonable overage to account for egg loss and culling of spring x fall crosses). On average, the program takes about 20 million eggs to produce 6 million juveniles.

- Tag analysis should be used to determine the fall and spring hatchery‐origin 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). Only unmarked fish should be spawned in the fall brood (FRH spring Chinook are 100 percent adipose fin‐clipped, FRH fall Chinook are 25 percent adipose fin‐clipped) to reduce the need for culling. Any spring x fall Chinook crosses of hatchery‐origin fish (e.g., due to marking or mark detection errors) should be identified by coded wire‐tag analysis and eggs should be culled soon after spawning.

- 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.

Attachment B:

EGG COLLECTION METHOD FOR SAN JOAQUIN SPRING RUN EGGS

Draft Conservation Facility Subgroup 2015 Donor Stock Recommendation Protocol

1.1. Egg Collection Method

A sufficient number of eggs must be collected to satisfy both broodstock needs and to meet other Program objectives such as eggs for fish that may be directly released to the San Joaquin River from FRFH (i.e. translocation fish) as allowed by 10(a)1(A) Permit 17781. Up to 2,760 eggs would be collected for broodstock and eventually spawned starting in the fall of 2018. Their resulting offspring would be released to the San Joaquin River in accordance to NMFS Permit 17781. This includes 60 eggs to account for the 60 juveniles that are to be sacrificed for pathology. In order to meet this objective, throughout the 2015 spring-run Chinook spawning period at FRFH, Program staff would segregate crosses from a minimum of 105 paired matings. This would allow the rejection of up to 55 crosses according to the criteria listed below and still provide a minimum of 50 crosses to promote sufficient genetic diversity. Individual fish data would 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 and kidney tissue sample number, volume of flaccid eggs per female, daily egg expansion factor, female fecundity, tissue sample number and corresponding genetic analysis data. The data would then be used to select eyed eggs from preferred crosses based on Program criteria.

On the first three spawning dates of the season at FRFH, at minimum, the first 35 crosses of the day would be separated and used for the Program. Parents selected for these crosses would be comprised of 5 percent or less of two-year-old adults in accordance to NMFS Permit #14868. Fish with adipose fins (i.e. supposed wild origin spring-run) may be used in crosses in effort to reduce hatchery induced selection. In the event that there are insufficient numbers to conduct 35 crosses per day, then proportionally more crosses would be separated on subsequent spawning days until a total of 105 crosses, or more, have been collected.

During spawning, ovarian fluid would be collected from each female and screened for viruses, including infectious hematopoietic necrosis virus (IHNV). Kidney tissue from each female would be screened for *Renibacterium salmoninarum*, the causative agent of Bacterial Kidney Disease (BKD). Fertilized eggs from each cross would be placed into an individual vertical tray egg incubator, disinfected with iodophore and cared for at FRFH according to the FRFH HGMP (Cavallo et al. 2012). If more than 105 crosses are used, eggs from more than one female may be placed in a tray as long as each cross can be accurately assigned to a tray. During the incubation period, data would be compiled to determine which crosses meet the following selection criteria:

- FRFH production goal - The FRFH spring-run egg collection goal has been met
- Genetic variability – Offspring are derived from no fewer than 50 crosses
- Disease status - The parental ovarian fluid and kidney tissue test negative for IHNV and BKD
- Run-timing
    - Both parents possess a Hallprint tagged
    - Coded wire tags (if present) identify the spring-run phenotype
- Age of maturity – Two-year-old males and females would comprise 5% or less of the parental crosses unless necessary to meet Program goals

Once preferred crosses have been identified, eyed eggs would be selected by hand counting near equal number of eggs from each cross until a maximum of 2,760 are obtained from the segregated crosses and transported to the Silverado Fisheries Base (SFB) in Yountville for quarantine and temporary holding.