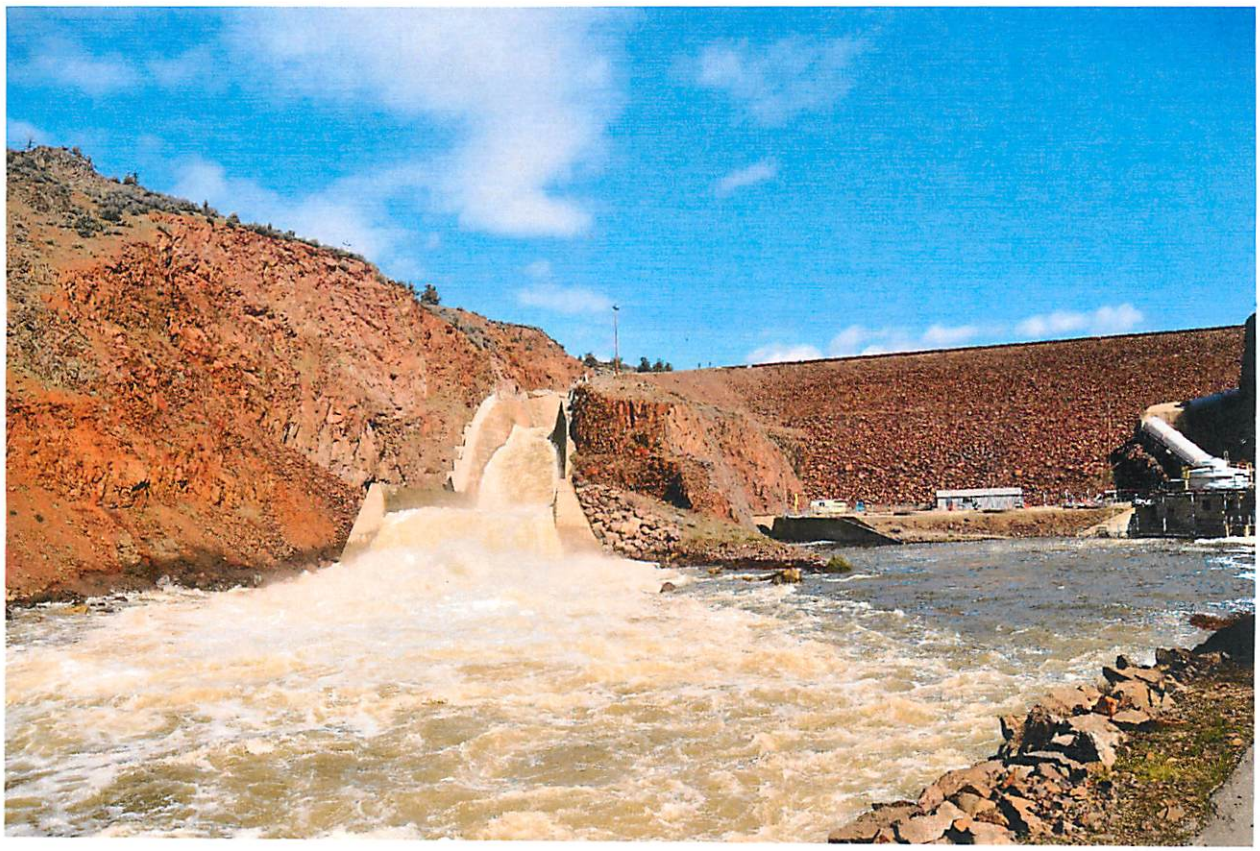
California Department of Fish and Wildlife

Klamath River Project

Recovery of Fall-run Chinook and Coho Salmon at Iron Gate Hatchery

October 8, 2015 to December 3, 2015



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ABSTRACT

A total of 8,176 fall-run Chinook salmon, (Chinook, *Oncorhynchus tshawytscha),* entered Iron Gate Hatchery (IGH) during the fall 2015 spawning season from October 8, 2015, through November 25, 2015. Klamath River Project (KRP) staff systematically sampled 1 in every 10 Chinook, as well as all adipose-clipped Chinook during recovery efforts, for a sample size of 2,343. Scale samples and sex and fork length (FL) data were collected from systematically sampled Chinook. Analysis of the length-frequency distribution for systematically sampled Chinook males indicates that the preliminary cutoff point between grilse and adults occurred at <56 cm FL. Systematically sampled male Chinook ranged in size from 44 to 96 cm FL, and systematically sampled female Chinook ranged from 49 to 89 cm FL. Based on scale age analysis, the Klamath River Technical Team estimated that 2.7% (220) of the run were grilse. Females accounted for 57% (4,643) of the run while males accounted for 43% (3,533). The 2015 Chinook return to IGH contributed roughly 9.8% to the total (Klamath basin) in-river run of 83,846 and 19.0% to the total spawner escapement of 43,125. Based on coded wire tag (CWT) expansion, KRP staff estimated that 82% (6,735) of the Chinook entering IGH during the 2015 season were of hatchery origin.

A total of 72 coho salmon (coho, *Oncorhynchus kisutch*) entered IGH during the 2015 spawning season. The recorded dates for the coho run were from October 23, 2015, to November 23, 2015. KRP staff collected biological data (sex, FL, presence of marks or clips, scale samples, and tissue samples) on every coho that entered the hatchery as well as scales and otoliths from coho used for spawning. Males ranged in size from 37 to 66 cm FL (mean FL 48 cm) and represented 71% (51) of the run, while females ranged in size from 57 to 70 cm FL (mean FL 62 cm) and represented 29% (21) of the run. Based on the length frequency distribution of 51 male coho, grilse were estimated to be <52 cm FL. Using this grilse cutoff, the age composition of the 2015 IGH coho run was 53% (38) grilse and 47% (34) adult coho. The proportion of grilse among males was 74.5%. Of the coho that entered IGH during 2015, 82% (59) had left maxillary clips, 15% (11) had no clips, and 3% (2) had AD clips but no CWT. The 2015 coho spawning season was the sixth in which coho were spawned at IGH using a spawning matrix provided weekly by the National Oceanic and Atmospheric Administration. Potential brood stock were held in individual tubes pending genetic analysis. All coho not initially held as brood stock were tagged with a Passive Integrated Transponder (PIT) tag and released back to the Klamath River at IGH. One of these returned and was used as brood stock after initial release, and three females initially held as brood stock were PIT tagged and released on the final spawning day as no suitable males were available. A net number of 28 coho were PIT tagged and released from IGH in 2015. Of the 28 released coho, 25 had left maxillary clips, one had an AD clip, and two were unmarked.

INTRODUCTION

Iron Gate Hatchery

The Iron Gate Hatchery (IGH) is located adjacent to the Klamath River at river kilometer 306 in Siskiyou County, California, approximately 193 kilometers (120 miles) north of Redding, near the Oregon border (Figure 1). This hatchery was established in 1963 to mitigate for loss of habitat between Iron Gate Dam and Copco Dam. The production goals for the hatchery are listed in Table 1 (CDFG and PP&L IGH Goals and Constraints, 1996).

Klamath River Project

The California Department of Fish and Wildlife's (CDFW) Klamath River Project (KRP) conducts systematic sampling of fall-run Chinook salmon (Chinook) annually during the spawning season at IGH. The purpose of the sampling is to characterize Chinook entering IGH in terms of timing, age and sex composition, and to recover data from all coded wire tags (CWT) recovered from the heads of adipose fin clipped (AD) Chinook. All Chinook tagged at IGH are marked with an adipose fin clip to identify the CWT salmon when they return to the hatchery or other locations during subsequent spawning seasons. Data from CWT fish provide a reference of known-age fish which is used along with scale samples and analysis of length frequency distribution to determine the age composition of the run. The CWT data are also used to evaluate Chinook release strategies, survival rates, ocean distribution, and harvest as well as in-river migration timing, straying and harvest. KRP staff also sample coho salmon (coho) that enter IGH, typically from mid-October through December. All coho entering IGH are sampled, and spawning protocols are employed that are in accordance with the recommendations of the Hatchery and Genetic Management Plan (HGMP) for IGH.

Coded Wire Tagging

In 2015, 25 percent of the brood year 2014 Chinook smolt and yearling groups were adipose-clipped and coded wire tagged prior to release. Tagging operations at IGH were conducted by staff of the Pacific States Marine Fisheries Commission with assistance from the staff of Iron Gate Hatchery (Buttars, 2016).

Table 1. Production goals for anadromous salmonid releases from Iron Gate Hatchery, Klamath River.

Species	Number released	Released	Adult return timing
Chinook Salmon	5,100,000 smolts	May-June	mid-September to early November
	900,000 yearlings	November	
Coho	75,000 yearlings	March	late October to early January
Steelhead	200,000 yearlings	March-May	November to March

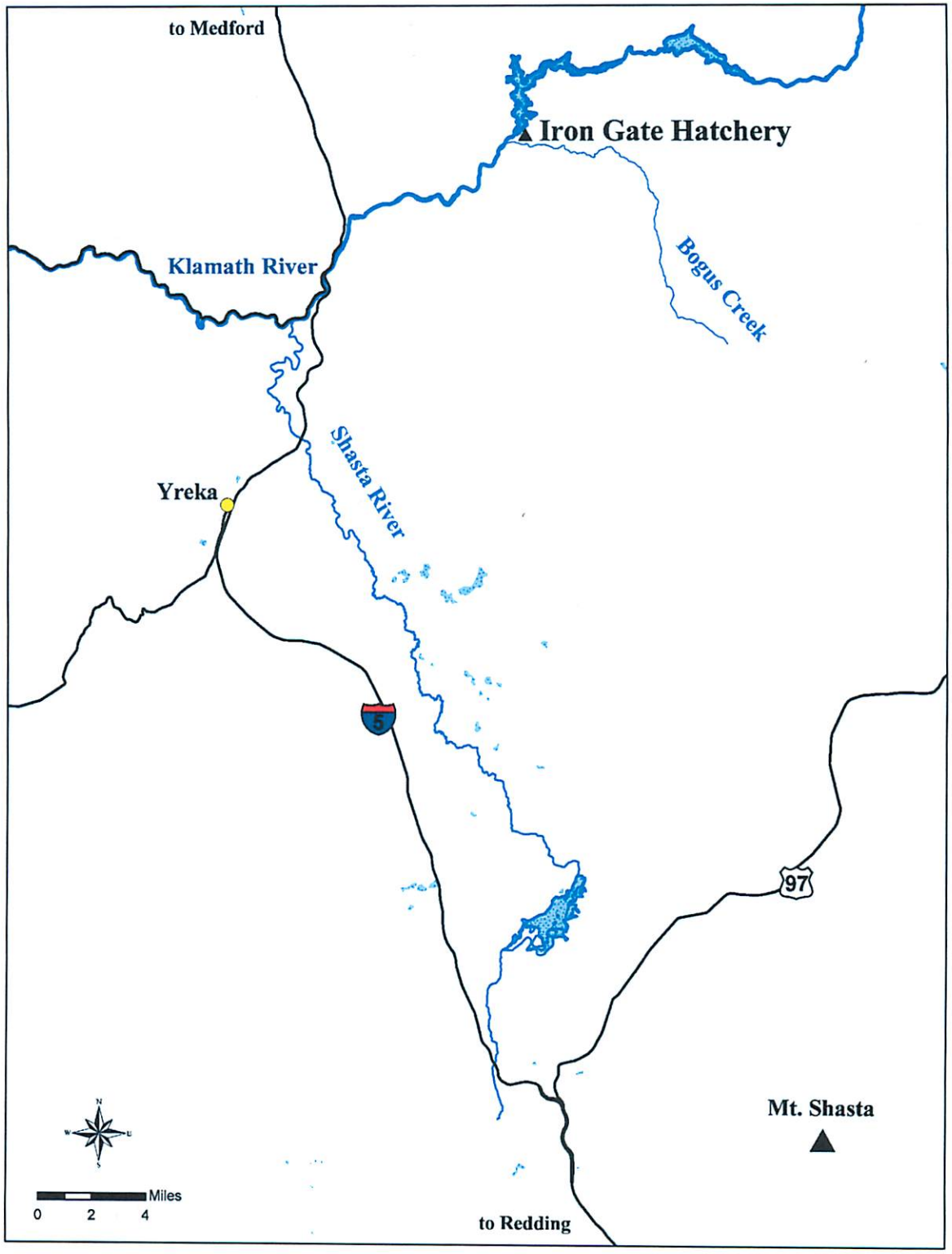

Figure 1. Location of Iron Gate Hatchery, Siskiyou County, California.

MATERIALS AND METHODS

Chinook Salmon

Starting in 1997, all Chinook entering the fish ladders have been allowed to enter IGH. Upon entering the hatchery, Chinook selected by IGH staff as brood stock are spawned or held in round tanks until they are ready to spawn. Readiness to spawn is determined by hatchery staff and based on timing, firmness of the ovaries, and ease of stripping eggs when handled. Once daily or weekly egg goals are met, extra Chinook are sacrificed and collected for off-site processing by American-Canadian fisheries for later distribution to interested individuals and organizations.

In 2015, KRP staff conducted a systematic sample of every 10th Chinook along the process line, as well as all AD Chinook. These systematic and non-systematic fish were set aside for sampling. Sampling included collection of data on fork length (FL), sex, scale samples, presence or absence of clips and/or marks, and spawning disposition. Heads were taken from all AD Chinook (systematic and non-systematic fish). All heads were transported to the KRP's Yreka laboratory for tag extraction and reading.

In 2015, IGH management implemented 1:1 Chinook spawning, a method in which the eggs of one female and milt of one male Chinook were mixed in a pan, and each pair fertilized individually. After fertilization, the eggs were combined in a five gallon bucket with PVP Iodophor solution for disinfection and water hardened prior to transport to the hatchery building. The egg lots were labeled by date, and individual pairings were not tracked when measured into heath stack incubators.

Another change in methodology in 2015 was the air spawning of Chinook and coho to replace the previous technique of evisceration incising along the ventral surface of the female salmon and manually removing the eggs. In air spawning, euthanized female salmon are hung by a hook and a hypodermic needle inserted into the body ½ inch to 1 inch deep, usually in the hollow area under a pelvic fin, and air pressure at 2-3 psi forces the eggs to be expelled.

Preliminary grilse/adult cutoff FLs were determined using length frequency analysis of systematically sampled male Chinook, and final grilse/adult and age composition determinations were made by the Klamath River Technical Team (KRTT) (KRTT, 2016) using scale age proportions.

Systematic sampling for the presence of *Ichtyophthirius multifillis* (Ich) in IGH Chinook salmon was conducted throughout the 2015 spawning season. Twenty (20) adult Chinook were sampled weekly. The first gill arch from the left and right gills of systematically sampled, recently euthanized fish were removed with scissors immediately post-mortem and placed in a sealable plastic bag with a sample number. The samples were cross-referenced with data on sex, FL, left or right gill, clip information, and general appearance of gills. Samples were then placed on ice in insulated containers and were evaluated with a stereo (dissecting) microscope upon return to the Yreka laboratory. In addition to Ich, gills were inspected for columnaris

(*Flavobacter columnare)* and copepods *(Salmincola californensis*) as well as other observed abnormalities.

Coho Salmon

As coho entered IGH during the 2015 season, hatchery personnel netted each fish, determined whether it would be retained for potential spawning or released, then placed the fish in a processing tank, where KRP staff collected biological data including tissue samples, FL, sex and clip/tag information. Fish not retained were tagged with a passive integrated transponder (PIT) tag and released into the Klamath River. Those coho retained as potential brood stock were assigned a unique number, placed in individual PVC tubes, and placed in a round tank (Figure 2) with heads oriented into the flow. These fish were tracked on data sheets and a master board, and as genetic information was received from the National Oceanic and Atmospheric Administration (NOAA), were either used as brood stock or PIT tagged and released into the Klamath River at the spawning building. Tissue samples were sent to NOAA's salmon genetics repository in Santa Cruz, California, via overnight mail. Scale samples were collected from spawned fish as well as fish that experienced pre-spawn mortality, and otoliths were collected from all unmarked spawned coho and also from the first left-maxillary clipped spawned coho on each spawning day.

NOAA laboratory staff developed a spawning matrix designed to minimize the spawning of closely related individuals. The weekly matrix, sent via e-mail to the KRP and IGH, displayed a series of columns with the brood stock ID number of each female coho at the top of a column, and beneath it, brood stock ID numbers of males in descending order of spawning suitability for that female (Table 2).

Figure 2. Coho brood stock held in individually numbered tubes pending spawning readiness and arrival of spawning matrix. (Photo by Rosa Albanese)

On subsequent spawning days, those coho that were included in the spawning matrix were checked in their tubes for spawning readiness, and were either left in the tubes if not ready to spawn (or did not have suitable mates available), or brought into the spawning building from the round tanks, euthanized and spawned with male fish chosen from the matrix. In 2015, coho crosses consisted of two males to one female, when possible, with half of the female's eggs being fertilized by each male, and the egg lots kept separate. IGH and KRP personnel tracked the use of marked vs. unmarked individuals and the use of grilse for spawning. Known out-of-basin coho (those with a healed AD clip) were not included in the spawning matrix but were scanned for CWT, PIT tagged, and released back into the Klamath River.

In 2015, due to a small return of coho, IGH did not meet its egg-taking goal (150,000). Fish that were deemed to be in poor condition or did not have suitable mates on the matrix were PIT tagged and released into the Klamath River at the IGH spawning building. In addition, early coho salmon that entered the hatchery prior to November 9, 2015, during Chinook spawning operations were sampled (tissue samples, FL, sex), checked for clips, PIT tagged, and released. PIT tag numbers of released coho that re-entered the hatchery were recorded as well. All coho tissue samples were sent throughout the season to the NOAA Salmonid Genetic Tissue Repository located in Santa Cruz.

Table 2. **Spawning matrix created by NOAA Salmon Genetics Repository. The suffix M refers to an adult, left maxillary clipped male, MJ a grilse, maxillary clipped male, MN an unmarked male, and MJN an grilse unmarked male. F refers to an adult, left maxillary clipped female, and FN an unmarked female.**

Males noted in red ink with a double asterisk denote a male which falls below the suitability threshold and is too closely related to that female to be used for spawning.

F_24FN	F_32F	F_34F	F_35F	F_38F
M_62MJ	M_68MN	M_68MN	M_71M	M_59MJ
M_59MJ	M_59MJ	M_59MJ	M_62MJ	M_73MN
M_72M	M_57MJ	M_73MN	M_63MJ	M_68MN
M_68MN	M_58MJ	M_57MJ	M_68MN	M_65MN
M_63MJ	M_67MJ	M_60MN	M_72M	M_62MJ
M_57MJ	M_62MJ	M_65MN	M_67MJ	M_72M**
M_58MJ	M_65MN	M_70M	M_73MN	M_60MN**
M_67MJ	M_73MN	M_67MJ	M_57MJ	M_63MJ**
M_65MN**	M_63MJ	M_62MJ	M_60MN	M_70M**
M_71M**	M_60MN	M_58MJ**	M_70M	M_67MJ**
M_73MN**	M_72M**	M_72M**	M_59MJ	M_58MJ**
M_60MN**	M_71M**	M_63MJ**	M_58MJ	M_71M**
M_70M**	M_70M**	M_71M**	M_65MN**	M_57MJ**

RESULTS

Chinook Salmon

Chinook began entering IGH on October 8, 2015. A total of 8,176 Chinook returned to IGH during the fall 2015 spawning season. Of these, KRP staff collected biological data including sex, FL, clip information, spawning disposition, and scales for 794 systematically sampled Chinook, which included AD and non-AD fish, tissue and otolith samples from every 100th Chinook (79), and biological data from 1,549 non-systematically sampled AD fish. The total number of Chinook entering IGH and the systematic 1:10 sample are tracked separately, and the KRP sample does not always represent an exact one tenth of the total Chinook counted by IGH staff. The Systematically sampled male Chinook ranged in size from 44 to 96 cm FL and averaged 70 cm (Figure 3), and systematically sampled female Chinook ranged from 49 to 89 cm FL and averaged 64 cm (Figure 4). A grilse cutoff of less than 56 cm in FL was made using scale age analysis (KRTAT, 2016), yielding approximately 220 grilse (2.7%) and 7,956 adults (97.3%) for a total run size of 8,176. Females accounted for 58% of the systematically sampled fish (463) and males accounted for 42% (331). The last Chinook of the season entered IGH on November 25, 2015.

Heads from 1,709 AD Chinook (systematic and non-systematic fish) were collected for CWT recovery, from which positive reads were obtained for 1,610 (Table 3). The remainder were either lost during extraction (36), had shed their tags (32) or the tags were unreadable (31). The contribution of lost or unreadable CWTs was estimated by applying the proportions of known CWTs (1,610) to the 67 lost or unreadable CWTs (Table 4).

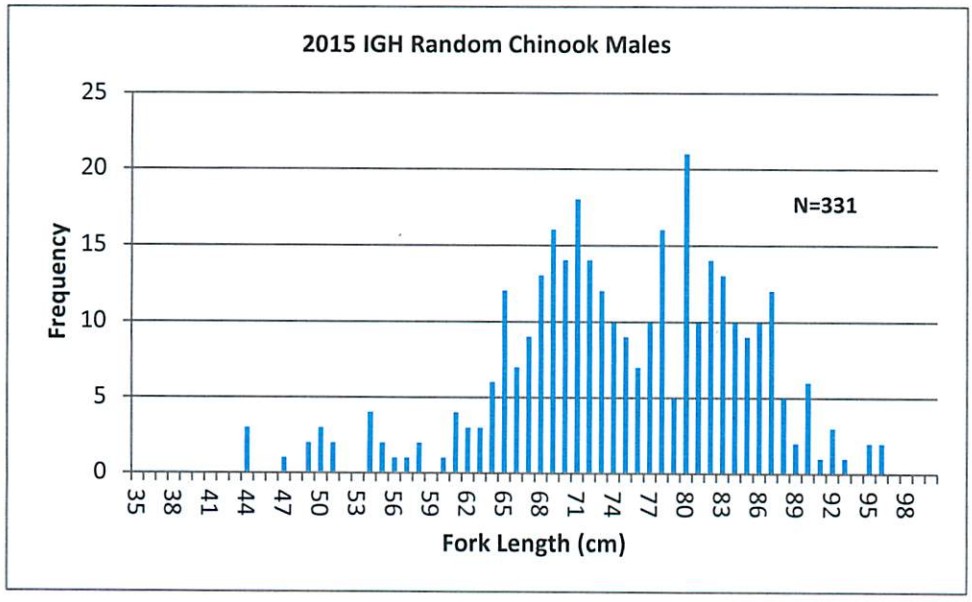

Figure 3. Length frequency distribution for systematic sample of male Chinook salmon recovered at IGH during the 2015 spawning season.

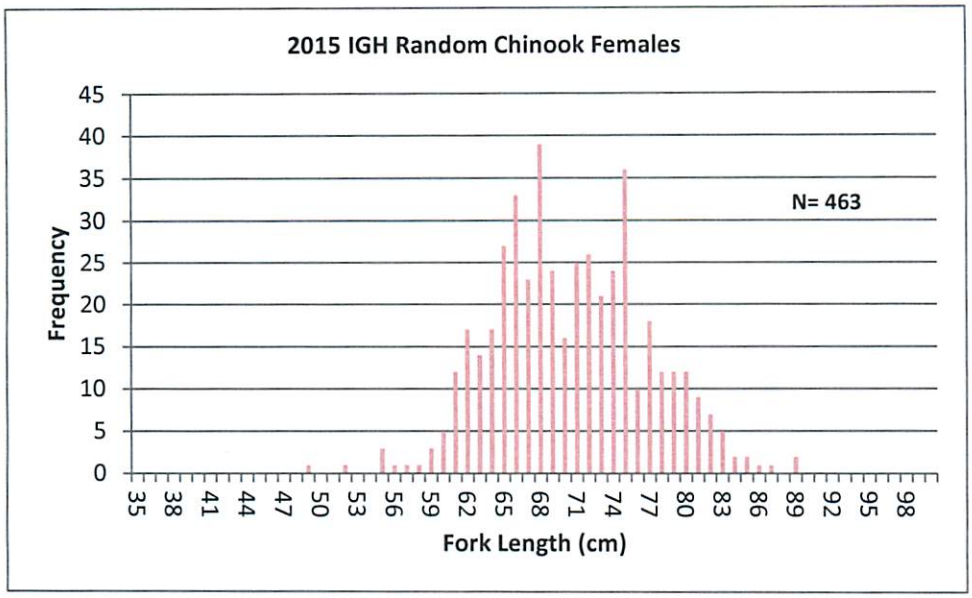

Figure 4. Length frequency distribution for systematic sample of female Chinook salmon recovered at IGH during the 2015 spawning season.

The estimated contribution of unknown CWTs was then added to the contribution of known CWTs to determine the total contribution of hatchery-origin Chinook entering IGH. All of the 1,610 CWTs recovered (and successfully read) originated from IGH. Based on the expansion of CWTs, KRP staff estimated that 82% of the Chinook entering IGH during the 2015 season were of hatchery origin. Proportions of hatchery-origin Chinook returning to IGH from 2002-2015 are shown in Figure 5.
Of the expanded CWT returns in 2015, 390 (24%) were from yearling release groups and 1,220 (76%) were from smolt release groups.

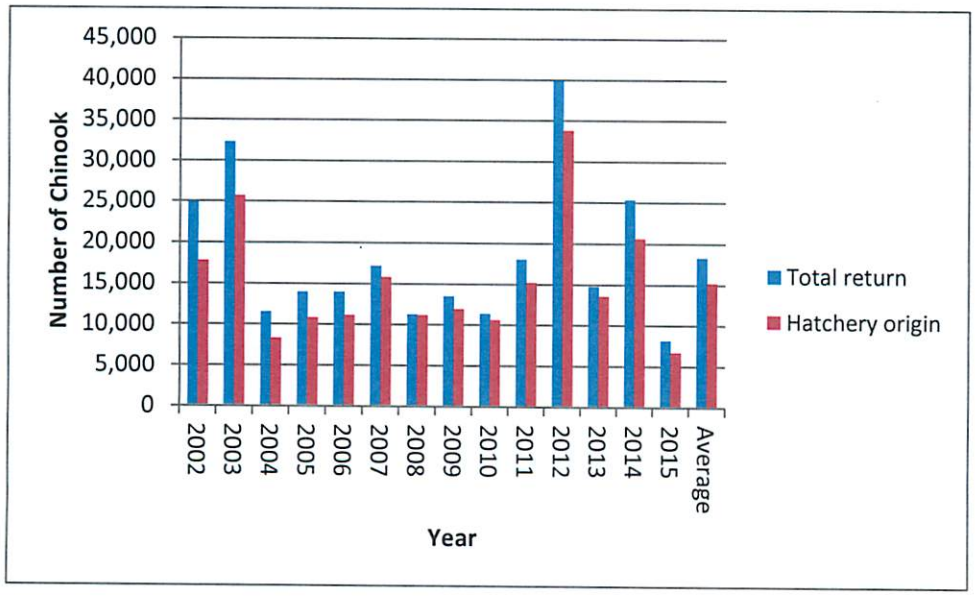

Figure 5. Total Chinook returns to Iron Gate Hatchery and returns that were determined to be of hatchery origin, 2002-2015.

Results of the 2015 season's Ich monitoring effort showed that of 91 Chinook sampled, 7 (7.7%) were found to have Ich trophonts (0 to 2 trophonts each), indicating a very low level of infection. Twenty-two (22) of the 91 Chinook sampled (24%) were infected with columnaris (*Flavobacter columnare),* and 90 of the 91 (99%) showed presence of copepod metacercaria. *(Salmincola californensis*) on their gills; however, none of the fish sampled appeared to be in a diseased state, and overall, the Chinook gills appeared healthy (Hileman and Sullivan, 2016).

Coded Wire Tagging

2015 was the seventh year of 25 percent constant fractional marking at IGH, although Brood Year 2010 was tagged at a rate of 17.2% due to losses from disease and the necessity of releasing surviving smolts before temperature and flow conditions in the Klamath River became detrimental. In 2015, tagging operations were conducted by staff of the Pacific States Marine Fisheries Commission, under contract with PacifiCorp. A total of 1,228,856 juvenile Chinook were AD clipped and coded wire tagged, and 3,689,181 counted but not tagged, for a total of 4,918,037 Chinook processed during the 2015 tagging season (Brood Year 2014). Of the tagged fish 965,584 were released as fingerlings and 263,272 as yearlings (Buttars, 2016).

Coho Salmon

Seventy-two (72) coho entered IGH during the 2015 season, from October 23, 2015, to November 23, 2015. The coho run consisted of 51 males (70.8%) and 21 females (29.2%). Male coho ranged in size from 37 to 66 cm in FL and averaged 48 cm (Figure 6), and female coho ranged in size from 55 to 70 cm in FL and averaged 62 cm (Figure 7). Based on the length frequency distribution of 72 coho, grilse were estimated to be <52 cm FL, yielding a grilse component of 52.8% (38) and an adult component of 47.2% (34).

A total of 28 coho salmon which entered IGH and did not have suitable mates on the matrix, or arrived early during Chinook spawning were PIT tagged and released back to the Klamath River between October 23, 2015 and December 3, 2015. Of these, 3 (10%) re-entered IGH after their initial release, and 1 of the 3 recaptured coho was retained and used as brood stock. Three coho kept as brood stock were released when no suitable mates were found. Thirteen (13) female coho and 19 male coho were used for spawning during the 2015 season, and 13 died prior to spawning.

Six (6) of the 28 IGH-released PIT tagged coho were detected at antenna arrays in the Shasta River, located approximately 24 river kilometers (RKM) downstream of IGH. The number of days elapsed between release from IGH and first detection in the Shasta River ranged from 3 to 22 days, and the furthest upstream detection occurred at the mouth of Parks Creek (Shasta RKM 56). The fish detected at Parks Creek, a 66 cm male, subsequently returned downstream to Shasta RKM 12 and was detected on December 25, 2015, 32 days after its release from IGH.

Four (4) of the 28 IGH-released PIT tagged coho were detected at antenna arrays at the Bogus Creek Fish Counting Facility (BCFCF) in 2015. The confluence of Bogus Creek and the Klamath River is located less than .5 RKM downstream of the IGH release site,

and the BCFCF is located 0.48 RKM upstream of the confluence. The number of days elapsed between release from IGH and detection in Bogus Creek ranged from 2 to 20 days.

Arrays at the mouth of Bogus Creek and in the Shasta River accounted for a total of 10 of the released coho, and one returned to IGH and was kept as brood stock. As a result, 17 (61%) of the released coho ultimately strayed to areas other than IGH, Bogus Creek, or the Shasta River.

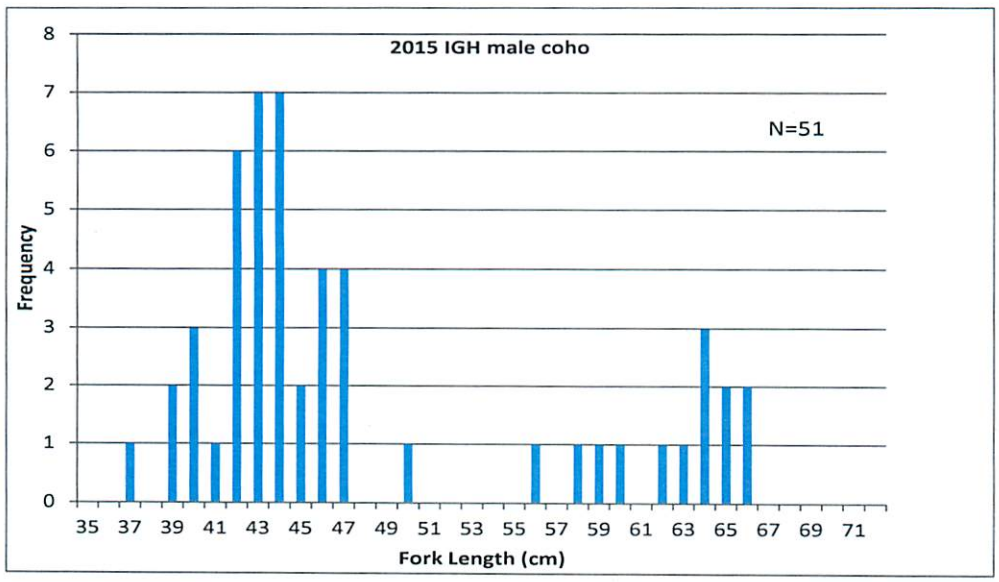

Figure 6. Length frequency distribution for male coho salmon recovered at Iron Gate Hatchery during the 2015 spawning season.

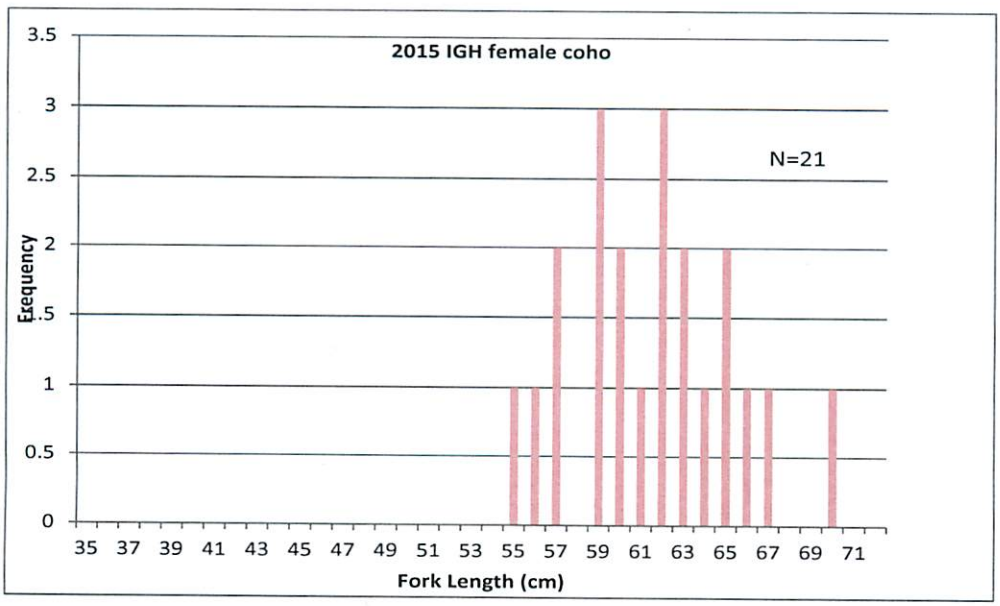

Figure 7. Length frequency distribution for female coho salmon recovered at Iron Gate Hatchery during the 2015 spawning season.

Table 3. Estimated contribution of Chinook from Iron Gate Hatchery (IGH) to total run at IGH, based on coded-wire tags (CWT) recovered from fall-run Chinook salmon at IGH during the 2015 spawning season.

Estimated contribution of Chinook from Iron Gate Hatchery to total run at Iron Gate Hatchery, based on coded-wire tags (CWT) recovered from fall-run Chinook salmon recovered at Iron Gate Hatchery, during the 2015 spawning season.							
CWT	Release Location	Brood Year	Age	Release Type	Number Recovered	Production Multiplier	Expanded Estimate
Estimated contribution of known CWTs:							
68792	IGH	2010	5	F	2	4.03	8
68793	IGH	2010	5	F	5	4.17	21
68794	IGH	2010	5	F	10	4.02	40
68795	IGH	2010	5	F	4	12.17	49
68799	IGH	2010	5	Y	6	4.03	24
68719	IGH	2011	4	F	4	4.01	16
60416	IGH	2011	4	F	94	4.01	377
60418	IGH	2011	4	F	65	4.01	261
60419	IGH	2011	4	F	91	4.01	365
60420	IGH	2011	4	F	102	4.01	409
60421	IGH	2011	4	F	75	4.00	300
60422	IGH	2011	4	Y	257	4.00	1028
60379	IGH	2011	4	Y	108	4.00	432
55660	IGH	2012	3	F	6	1.00	6
68796	IGH	2012	3	F	122	4.00	488
68797	IGH	2012	3	F	172	4.00	688
68798	IGH	2012	3	F	186	4.01	746
60375	IGH	2012	3	F	87	4.02	350
60385	IGH	2012	3	F	7	4.01	28
60501	IGH	2012	3	F	161	4.02	647
60507	IGH	2012	3	Y	15	4.02	60
60597	IGH	2013	2	F	14	4.05	57
60601	IGH	2013	2	F	11	4.04	44
60602	IGH	2013	2	F	2	4.02	8
60604	IGH	2013	2	Y	4	4.01	16
				Subtotal	**1,610**		**6,468**
Estimated contribution of unknown CWTs							
200000					36		
400000					31		
				Subtotal	**67**		**267**
	Total Estimated Hatchery Contribution =						**6,735**
Unreadable CWTs: 200000=CWT lost, 400000=CWT unreadable, 300000=Head lost							

Table 4. Estimated contribution of 67 AD Chinook with unknown CWT codes (lost or unreadable) that were recovered at IGH based on the proportional distribution of known CWTs recovered at IGH during the 2015 season.

CWT	BY	# CWTs Recovered	Proportion of CWTs recovered	Estimated Number	Production Multiplier	Expanded Estimate
68792	2010	2	0.0012422	0	4.03	0.335
68793	2010	5	0.0031056	0	4.17	0.868
68794	2010	10	0.0062112	0	4.02	0.000
68795	2010	4	0.0024845	0	12.17	2.026
68799	2010	6	0.0037267	0	4.03	1.006
68719	2011	4	0.0024845	0	4.01	0.668
60416	2011	94	0.0583851	4	4.01	15.686
60418	2011	65	0.0403727	3	4.01	10.847
60419	2011	91	0.0565217	4	4.01	15.186
60420	2011	102	0.0633540	4	4.01	17.021
60421	2011	75	0.0465839	3	4.00	12.484
60422	2011	257	0.1596273	11	4.00	42.780
60379	2011	107	0.0664596	4	4.00	17.811
55660	2012	6	0.0037267	0	1.00	0.250
68796	2012	122	0.0757764	5	4.00	20.308
68797	2012	172	0.1068323	7	4.00	28.631
68798	2012	186	0.1155280	8	4.01	31.039
60375	2012	88	0.0546584	4	4.02	14.722
60385	2012	7	0.0043478	0	4.01	1.168
60501	2012	161	0.1000000	7	4.02	26.934
60507	2012	15	0.0093168	1	4.02	2.509
60597	IGH	14	0.0086957	1	4.05	2.360
60601	IGH	11	0.0068323	0	4.04	1.849
60602	IGH	2	0.0012422	0	4.01	0.334
60604	IGH	4	0.0024845	0	4.01	0.668
		1610	1	67		**267**

DISCUSSION

Chinook Salmon

The 2015 run of Chinook to IGH (8,176) was 8,388 fish less than, and less than half of, the 38-year average of 16,564 (Figure 8), and the ninth lowest run recorded during that period.

Since 1978, KRP has been monitoring the escapement of fall-run Chinook in the Klamath River basin, excluding the Trinity River. The Trinity River Project (TRP) has been monitoring salmon returns in the Trinity River basin during the same period, and the combined run size information is summarized in the CDFW "Mega Table" each year. Chinook run size data are compiled and reviewed by KRTT during their annual age composition meeting in late January or early February, where results of the scale analysis are integrated into run size data to estimate the age structure for each of the various stocks within the basin. Age-specific estimates of natural and hatchery in-river escapement and harvest, coupled with ocean harvest data allow for cohort reconstruction of Klamath River fall-run Chinook, and are the foundation of model-based forecasting of next year's abundance in the ocean (KRTT 2016).

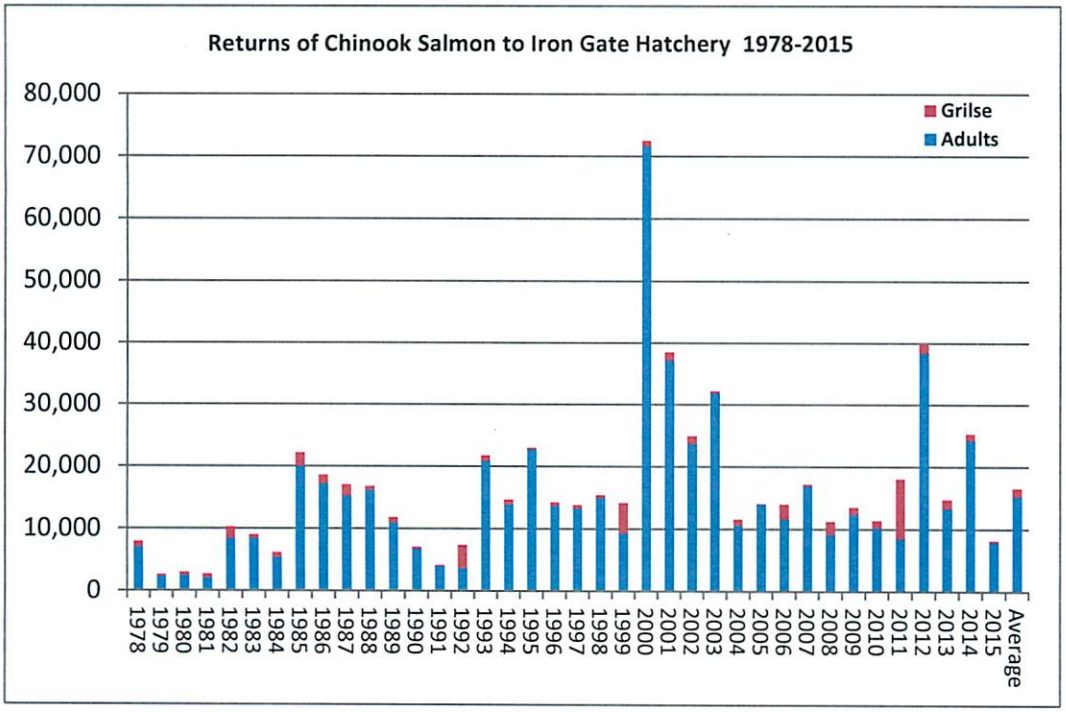

Figure 8. Chinook salmon escapement to Iron Gate Hatchery, from 1978 to 2015.

The KRTT Stock Projection Report describes 2015 ocean abundance forecasts, as well as postseason estimates, for 3-, 4-, and 5-year-old Klamath basin Chinook. In 2015, ocean abundance forecasts were greater than the postseason estimates for 3- and 4-year-olds (1.95 times and 1.08 times, respectively) and the 5-year-old abundance was under estimated (0.79 times its postseason estimate). The 2015 run of adult Chinook

into the Klamath Basin (77,749) was only 65 percent of the projected run of 119,800 (KRTT, 2016).

The Pacific Fishery Management Council (PFMC)'s Salmon Technical Team (STT), in their 2016 Preseason Report 1, notes that the abundance of southern fall Chinook stocks (Sacramento and Klamath), as well as most coho stocks, came in well below preseason forecasts in 2015. Similar over-prediction of stock abundance occurred during the strong El Niño events of 1982-83 and 1997-98. Unusually warm sea surface temperatures in the northeast Pacific are likely to affect the abundance of forage fishes and copepods in the coming months, and result in conditions unfavorable to salmon and other piscivorous fish, birds and marine mammals. The STT is concerned that abundance forecasts presented in their report may prove to be optimistic (PFMC, 2016). Commercial and sport harvest alternatives are currently being considered in the Klamath Management zone, and may include a *de minimis* fishery for the 2016 season.

The Iron Gate Hatchery Coordination Team (HCT) is an inter-agency group comprised of individuals from state and federal agencies, local tribes and PacifiCorp. The IGH HCT has been meeting since 2014 for the purpose of reviewing hatchery practices for Chinook and coho salmon and steelhead, as well as the recommendations of the HSRG. One of the recommendations forwarded to the Statewide Policy Team by the HCT was to implement one-on-one spawning of Chinook in place of the 6:5 spawning ratio previously used. One on one spawning has been shown to increase the overall number of ancestors contributing to a population, and reduces the effects of sperm competition. This procedure was implemented during the 2015 spawning season and was found to work well without disruption to work flow in the spawning building. Due to the small run of Chinook in 2015, it was sometimes necessary to use a male Chinook with more than one female, but no more than one male and one female were spawned per pan.

The air spawning technique employed in 2015 was also found to work well by IGH staff (Keith Pomeroy, pers. comm.). This method has been found to result in cleaner eggs that are less likely to be broken or contaminated by blood, and also results in a cleaner spawning house environment overall. Internal examination of females showed very little residual eggs in spawned Chinook. Another recommendation of the HCT is to exclude AD fish (known hatchery origin fish) from spawning to increase the natural component of the brood stock. This was not implemented in 2015 due to the low return of Chinook, but is likely to be implemented in future seasons.

The Chinook egg take in 2015 was 9,141,898 which was 1,058,102 eggs short of the target of 10,200,000. An additional 118,948 fertilized eggs underwent the triploid process (to render the offspring sterile) and were used for the CDFW's inland Chinook program.

The Chinook releases from IGH include both smolt and yearling releases. The current production goals include releases of 5,100,000 Chinook smolts in May and June and 900,000 yearlings the following November. Table 5 compares return rates of smolt and yearling releases from 1990 to 2013. Between 1990 and 2008, data on 17 brood years show only two years in which fingerlings outperformed yearlings. However, though the

brood year returns are not complete, in four of the last five years (2009 through 2013), fingerlings have outperformed yearlings.

Table 5. Return rates of IGH Chinook smolt and yearling CWT releases for brood years 1990-1996, and 1999-2013.

Return rates of IGH smolt and yearling CWT releases for brood years 1990 to 1996, 1999-2013							
Brood Year	IGH Smolt Releases			IGH Yearling Releases			Ratio of yearling/smolt return rates
	# CWTs Released	# CWTs	% Return	# CWTs Released	# CWTs Returne	% Return	
1990	188,595	713	0.378%	95,880	740	0.772%	2.04
1991	191,200	96	0.050%	90,982	167	0.184%	3.66
1992	185,464	1,015	0.547%	74,024	269	0.363%	0.66
1993	188,562	40	0.021%	98,099	196	0.200%	9.42
1994	194,644	94	0.048%	86,564	453	0.523%	10.84
1995	191,799	85	0.044%	90,172	954	1.058%	23.87
1996	196,648	162	0.082%	95,396	581	0.609%	7.39
1999	182,131	686	0.377%	91,220	514	0.563%	1.50
2000	187,417	277	0.148%	100,702	707	0.702%	4.75
2001\[a]	198,311	11	0.006%	110,167	764	0.693%	125.02
2002	210,114	367	0.175%	109,711	295	0.269%	1.54
2003	261,888	70	0.027%	48,592	60	0.123%	4.62
2004	205,950	691	0.336%	98,752	215	0.218%	0.65
2005	209,754	194	0.092%	103,157	445	0.431%	4.66
2006	309,671	224	0.072%	103,361	230	0.223%	3.08
2007	307,204	340	0.111%	103,876	300	0.289%	2.61
2008\[b]	986,141	269	0.027%	192,339	197	0.102%	3.75
2009	1,119,054	10,224	0.914%	264,253	581	0.220%	0.24
2010\[c]	671,755	2,487	0.370%	261,332	69	0.026%	0.07
2011*	1,158,028	2,691	0.232%	286,947	839	0.292%	1.26
2012*	1,040,836	964	0.093%	263,614	16	0.006%	0.07
2013*	1,117,134	27	0.002%	263,836	4	0.0015%	0.63
AVERAGE			**0.189%**			**0.358%**	**9.65**
* Incomplete returns for BY 2011-2013							
\[a]BY 2001 smolt releases subject to critically dry conditions at release, record low return rates observed							
\[b] BY 2008 was the first to receive 25% constant fractional mark							
\[c] BY 2010 smolt release tagged at 17.16% due to disease and river conditions							

Due to concerns about domestication of yearling-released Chinook, the HCT is - evaluating the HSRG's recommendation that yearling-released IGH Chinook be marked with an external, distinguishing mark and excluded from spawning during years of adequate returns.

Coho Salmon

The 2015 run of coho to IGH (72) was 943 fish less than the 54-year average of 1,015 (Figure 9). The Hatchery Genetic Management Plan (HGMP, v.10, 2013) was developed for IGH as part of the CDFG's application for an ESA Section 10(a) (1)(A) permit for hatchery operation. The HGMP is intended to guide hatchery practices toward the conservation and recovery of listed species, specifically, the upper Klamath River coho population unit. Many recommendations of the draft HGMP (2009) have been implemented at IGH since 2010. These include the use of NOAA's coho spawning matrix, the addition of bird exclusion netting in the outdoor rearing raceways, and the installation of a new water filtration system in the hatchery building. The HGMP also recommends increasing the proportion of natural origin broodstock (pNOB target 20-50%) and the proportion of jacks (pJacks) included in the broodstock (Table 6). Unmarked coho are presumed to be of non-hatchery origin, and are incorporated into spawning as close to the target as possible, if the NOAA matrix shows they are suitable as brood stock. Table 7 shows proportions of marked and unmarked coho that entered IGH from 1997 to 2015.

In past seasons, coho that have entered IGH during the month of October, while IGH and KRP staff were processing Chinook, have been PIT tagged, tissue sampled and returned to the river. In consideration of small runs such as 2015, it may become necessary to hold these early fish for spawning, and to hold coho spawning days prior to the end of Chinook spawning, as soon as a spawning matrix is available. However, infrastructure issues such as limited space in round tanks will need to be addressed before this change can be implemented. Figure 10 shows proportions of coho retained at IGH and released into the Klamath River between 2004 and 2015.

Figure 11 shows the relatedness coefficient (Rxy) of pairs of coho salmon spawned (yellow bars) at IGH during the 2015 season with the use of the NOAA spawning matrix. This was the sixth season for which the matrix was used. The green bars represent the optimal pairings of males and females that could be achieved if the most unrelated male was spawned with its most unrelated female for each mating. In the absence of the spawning matrix and if pairs were selected purely at random the resulting Rxy values are represented by blue bars. Highly inbred pairings result in Rxy values > 0.10. During the 2015 spawning season, all of the actual crosses were below the inbreeding threshold (L. Gilbert Horvath, pers. comm,). Ten (10) inbred crosses were prevented in 2015 with the use of the spawning matrix.

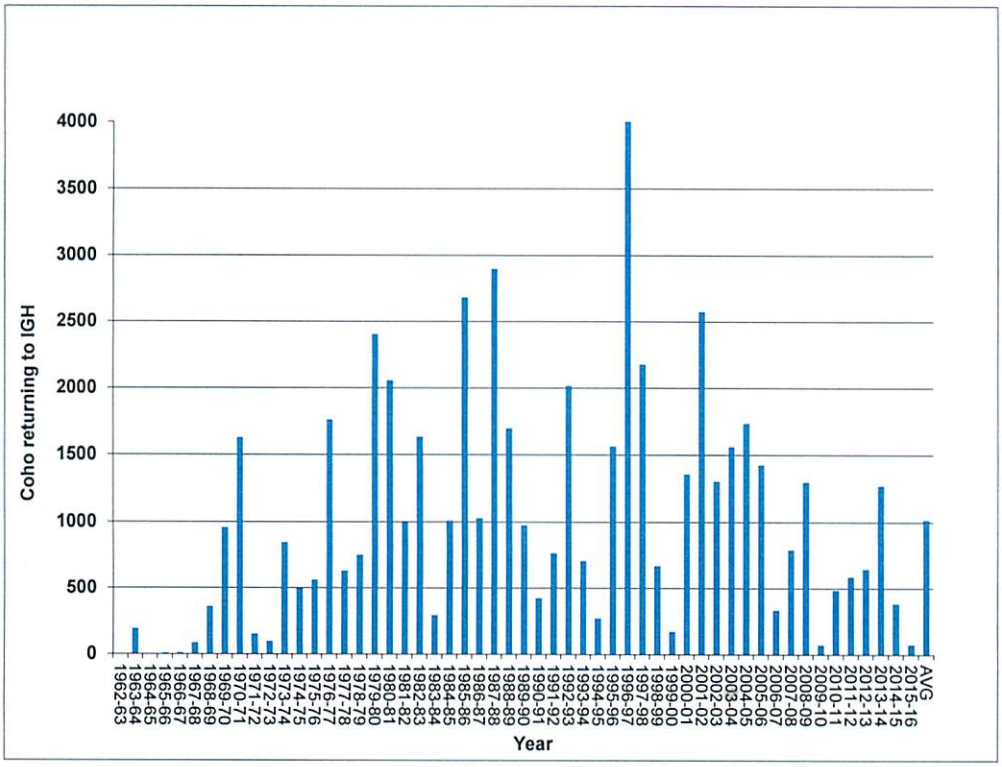

Figure 9. Coho salmon returns at Iron Gate Hatchery from 1962 to 2015.

Table 6. Coho male, female and jack returns, number of females spawned, proportion of natural origin broodstock (pNOB) and jacks (pJacks) used in spawning, egg take, fecundity, and yearlings released by brood year at IGH from 1993-2015.

Year	Males	Females	Jacks	Females Spawned	Natural Origin Broodstock	pNOB	pJacks	# Eggs	Fecundity	Yearlings released	Egg to Smolt Survival	Date released
1993	361	314	29	219	?	~15	~1	503,326	2,298	79,506	16%	1995
1994	100	72	97	57	?	~15	~1	141,397	2,481	74,250	53%	1996
1995	708	793	29	294	?	~15	~1	782,170	2,660	81,489	10%	1997
1996	1,715	1,831	551	200	?	~15	~1	547,255	2,736	79,607	15%	1998
1997	825	1,047	302	126	16	6.3	~1	304,728	2,418	75,156	25%	1999
1998	243	268	158	122	75	30.7	~1	298,357	2,446	77,147	26%	2000
1999	90	61	18	35	5	7.1	~1	86,519	2,472	46,250	53%	3/29/2001
2000	295	428	631	95	52	27.4	~1	270,151	2,844	67,933	25%	3/27/2002
2001	972	1,494	107	126	22	8.7	~1	404,370	3,209	74,271	18%	3/27/2003
2002	566	627	108	187	68	18.2	~1	609,193	3,258	109,374	18%	3/29/2004
2003	609	708	241	197	172	43.7	~1	502,048	2,548	74,716	15%	4/13/2005
2004	630	865	239	276	10	1.8	~1	799,623	2,897	89,482	11%	4/17/2006
2005	596	799	30	103	10	4.9	~1	295,101	2,865	118,487	40%	4/25/2007
2006	112	151	69	85	10	5.9	~1	236,406	2,781	53,950	23%	4/9/2008
2007	300	325	154	124	10	4.0	~1	316,155	2,550	117,832	37%	4/17/2009
2008	508	770	18	148	9	3.0	~1	455,480	3,078	121,000	27%	4/8/2010
2009	21	25	24	20	6	30.0	40	53,435	2,672	22,236	42%	4/14/2011
2010	193	235	57	80	21	26	18	259,490	3,244	155,840	60%	3/29/2012
2011	248	204	134	57	26	23	11	151,241	2,653	39,250	26%	3/18/2013
2012	98	203	343	64	12	9	64	158,651	2,479	78,000	49%	3/17/2014
2013	552	653	63	80	37	23	17	224,071	2,801	89,500	40%	3/17/2015
2014	39	95	250	62	24	31	51	121,421	1,958	27,568	23%	4/5/2016
2015	13	21	38	13	9	52	40	22,240	1,711	N/A	N/A	N/A
Average	**426**	**521**	**160**	**120**	**31**	**16**	**34**	**327,949**	**2,655**	**81,789**	**25%**	

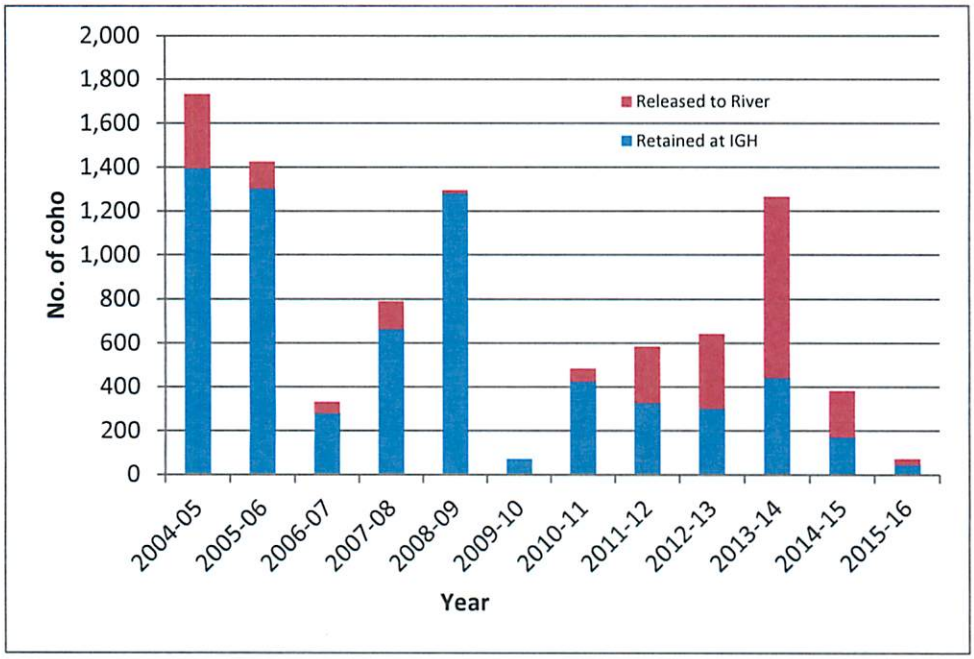

Figure 10. Coho retained at IGH and coho released alive into Klamath River at IGH from 2004 to 2015.

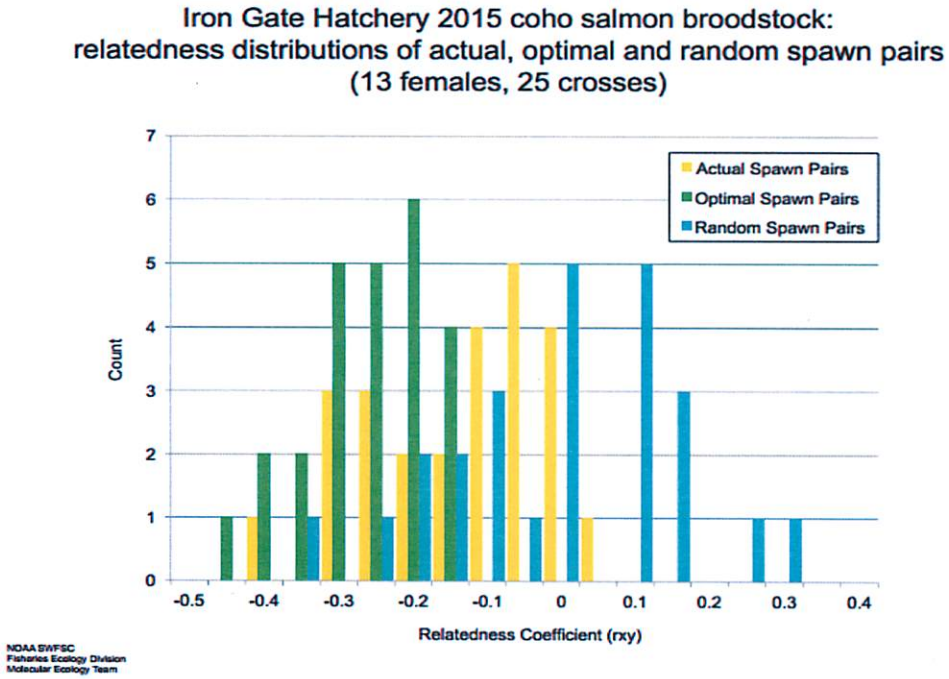

Figure 11. Observed relatedness coefficients of actual spawned pairs, optimally spawned pairs and randomly chosen pairs for IGH coho during the 2015 season. (Figure provided by NOAA Southwest Fisheries Science Center Salmonid Genetic Laboratory).

Table 7. Proportions of marked and unmarked coho that entered IGH from 1997 to 2015

Year	# Sampled	LM	RM	AD	OTHER	MARKED	UNMARKED	% MARKED
1997	2,174	1,970	5	28	6	2,009	165	92%
1998	669	378	-	2	-	380	289	57%
1999	169	153	-	1	-	154	15	91%
2000	1,354	1,067	4	58	4	1,133	262	84%
2001	2,573	2,130	138	51	8	2,327	246	90%
2002	1,301	1,006	25	38	7	1,076	225	83%
2003	1,558	838	69	58	4	969	589	62%
2004	1,734	1,203	32	69	1	1,305	424	75%
2005	1,425	1,282	2	1	-	1,285	140	90%
2006	301	204	2	16	-	222	80	74%
2007	779	643	6	2	1	652	127	84%
2008	1,296	1,268	2	-	1	1,271	25	98%
2009	45	29	7	-	-	36	9	80%
2010	258	222	1	-	-	223	36	86%
2011	586	522	-	2	1	525	63	90%
2012	644	609	4	1	1	615	29	95%
2013	1,268	1,158	2	1	2	1,163	105	92%
2014	384	346	-	5	-	351	33	91%
2015	72	59	-	2	-	61	11	85%

LM = Iron Gate Hatchery (left maxillary clip)
RM = Trinity River Hatchery (right maxillary clip)
AD = (adipose clip) several Oregon projects, may or may not have CWT
Other = unknown origin or result of tag error or injury

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REFERENCES

Buttars, Braden. 2016. Constant Fractional Marking /Tagging Program for Iron Gate Hatchery Fall-run Chinook Salmon, 2015 Marking Season. Pacific States Marine Fisheries Commission. bbuttars@psmfc.org

California Department of Fish and Game, National Marine Fisheries Service Southwest Region Joint Hatchery Review Committee. 2001. Final Report on Anadromous Salmonid Fish Hatcheries in California. Review Draft June 27, 2001. 79pp.

California Department of Fish and Game, Pacific Power and Light Company. 1996. Iron Gate Hatchery Production Goals and Constraints. 3pp.

California Department of Fish and Game, 2013. Hatchery and Genetic Management Plan for Iron Gate Hatchery.Coho Salmon V 10. Prepared for National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

California Hatchery Scientific Review Group, 2012. California Hatchery Review: Statewide Report. 100 pp.

Garza, John Carlos. Molecular Ecology & Genetic Analysis Team 2012. Population Genetic Structure of Coho Salmon in the Klamath River. Southwest Fisheries Science Center

Hileman, J and R. Sullivan, Ich (*Ichtyophthirius multifilii)* Trophont Monitoring of Adult Chinook at Trinity River and Iron Gate Hatcheries, Fall 2015. CDFW Trinity River Project, Weaverville Office.

Horvath, Libby Gilbert. Observed relatedness coefficients of actual spawned pairs, optimally spawned pairs and randomly chosen pairs for IGH coho during the 2015 season. NOAA Southwest Fisheries Science Center Salmonid Genetic Laboratory.

KRTT (Klamath River Technical Team) 2016. Klamath River Fall Chinook Age-Specific Escapement, River Harvest, and Run Size Estimates, 2015 Run.

Pacific Fishery Management Council. 2016. *Preseason Report I: Stock Abundance Analysis and Environmental Assessment Part 1 for 2016 Ocean Salmon Fishery Regulations.* (Document prepared for the Council and its advisory entities.) Pacific Fishery Management Council, 7700 NE Ambassador Place, Suite 101, Portland, Oregon 97220-1384.