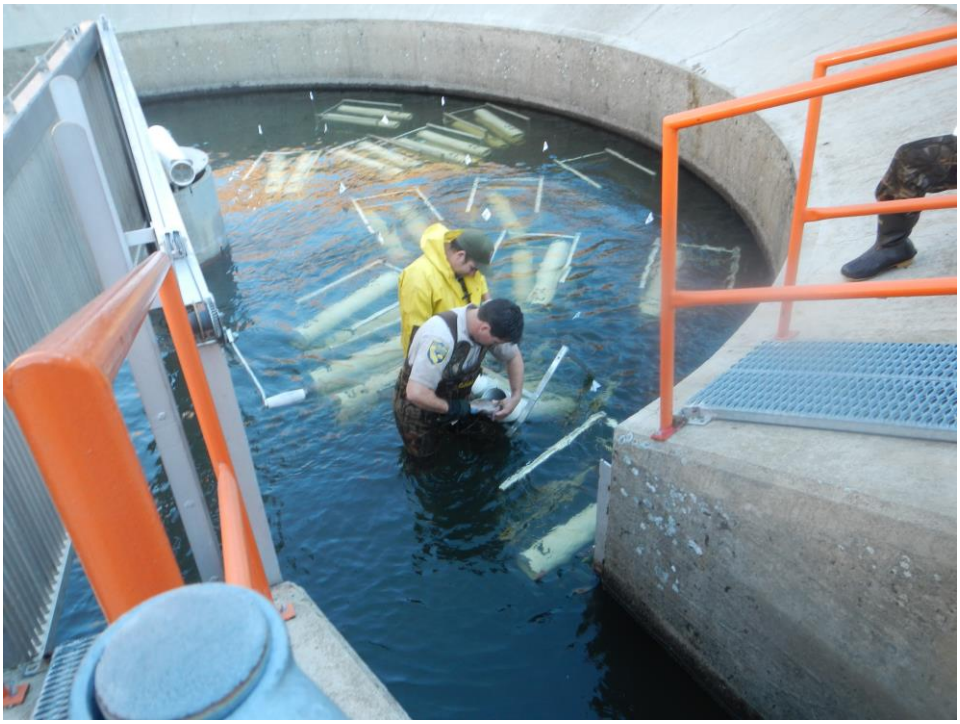
California Department of Fish and Wildlife

Klamath River Project

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

October 8, 2013 to January 21, 2014



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ABSTRACT

A total of 14,754 fall-run Chinook salmon, (Chinook, *Oncorhynchus tshawytscha,* entered Iron Gate Hatchery (IGH) during the fall 2013 spawning season from October 8, 2013 through December 10, 2013. Klamath River Project (KRP) staff systematically sampled 1 in every 10 Chinook, as well as all adipose-clipped (AD) Chinook during recovery efforts, for a sample size of 4,055. Scale samples and sex and fork length 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 ≤ 59 cm. fork length. Systematically sampled male Chinook ranged in size from 41 to 103 cm. fork length (FL), and systematically sampled female Chinook ranged from 53 to 93 cm. FL. Based on scale age analysis, the Klamath River Technical Team (KRTT) estimated that 8.9% (1,323) of the run were grilse. Females accounted for 48.5% (7,153) of the run while males accounted for 51.5% (7,601). The 2013 Chinook return to IGH contributed roughly 8.2% to the total (Klamath basin) in-river run and 16.7% to the total spawner escapement. Based on coded wire tag expansion, KRP staff estimated that 92% of the Chinook entering IGH during the 2013 season were of hatchery origin.

A total of 1,268 coho salmon (coho, *Oncorhynchus kisutch*) entered IGH during the 2013 spawning season. The recorded dates for the coho run were from October 17, 2013 to January 21, 2014. KRP staff collected biological data (sex, fork length, presence of marks or clips, scale samples, and tissue samples) on every coho that entered the hatchery as well as otoliths from coho used for spawning. Males ranged in size from 40 to 81 cm. fork length and represented 48.5% (615) of the run, while females ranged in size from 46 to 80 cm. fork length and represented 51.5% (653) of the run. Based on the length frequency distribution of 615 male coho, grilse were estimated to be ≤ 55 cm. fork length, for an age composition of 5.4% (68) grilse and 94.6% (1,200) adult coho in 2013-14. Five of the coho ≤ 55 cm. fork length were females. The proportion of grilse among males was 10.2%. Of the coho that entered IGH during 2013-2014 91.3%(1,158) had left maxillary clips, 8.3% (105) had no clips, 0.16% (2) had right maxillary clips, 0.16% (2) had both a left and right maxillary clip, and 0.08% (1) had an AD clip but no CWT. The 2013-14 coho spawning season was the fourth in which coho were spawned at IGH using a spawning matrix provided weekly by the National Oceanic and Atmospheric Administration (NOAA). Potential brood stock were held in individual tubes pending genetic analysis. All coho not initially used as brood stock (866) were tagged with a Passive Integrated Transponder (PIT) tag and released back to the Klamath River at IGH, and 40 of these returned and were kept for brood stock after initial release, for a net number of 826 coho released and not used as brood stock. In a pilot study conducted by Yreka Fisheries, a total of 28 female coho were also radio tagged in 2013 and their movements following release were tracked,

INTRODUCTION

Iron Gate Hatchery

The Iron Gate Hatchery (IGH) is located adjacent to the Klamath River at river kilometer 306 in Siskiyou County, CA, 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).

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

Species	Number released	Released	Run 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

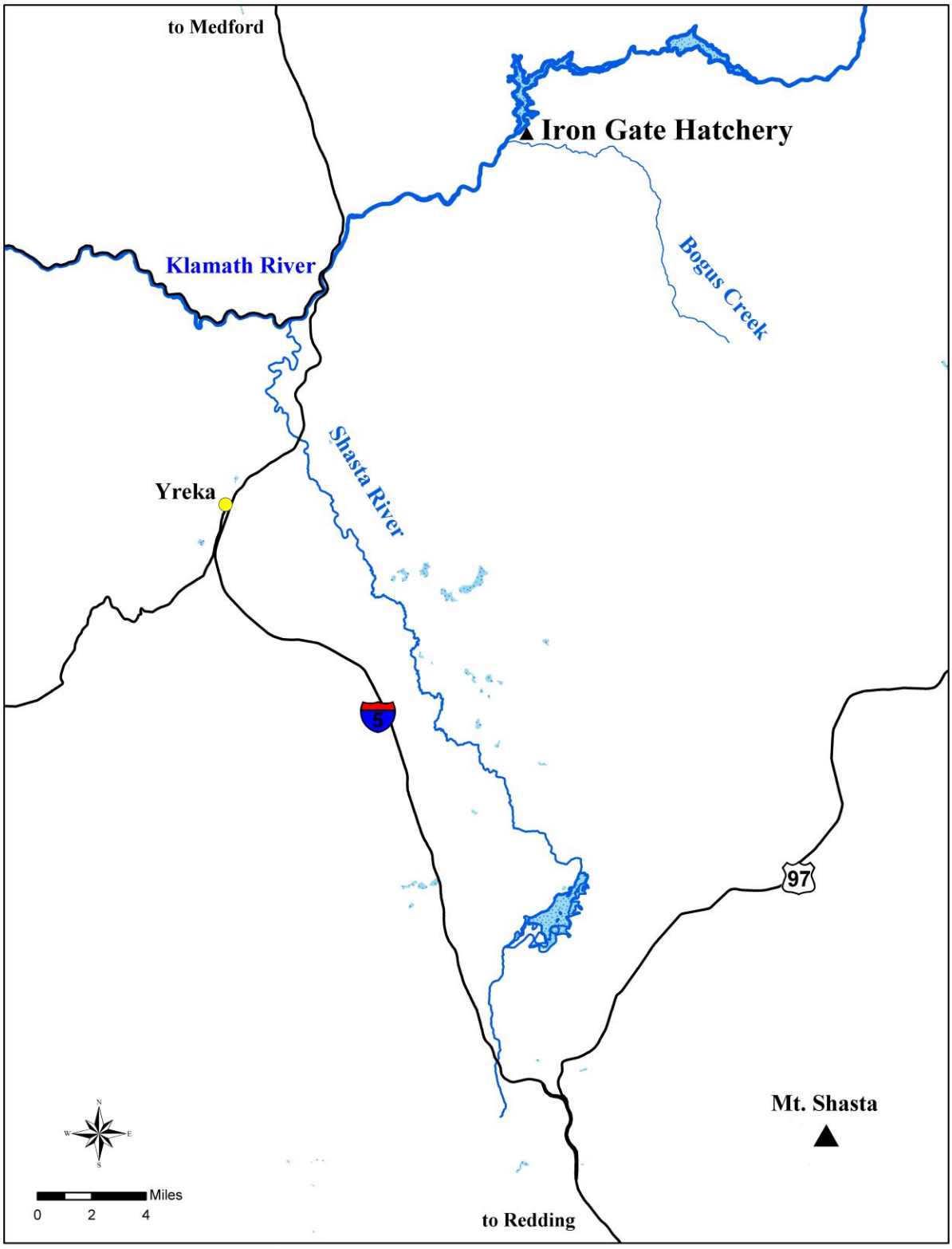

Figure 1. Location of Iron Gate Hatchery, Siskiyou County, California.

Klamath River Project

The California Department of Fish and Wildlife's (CDFW) Klamath River Project (KRP) conducts systematic sampling of fall-run Chinook (Chinook) salmon 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. 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 for Iron Gate Hatchery.

Coded Wire Tagging

In 2013, twenty-five percent of the brood year 2012 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.

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, put on ice, and loaded into trucks by American-Canadian fisheries personnel for on-site processing and later distribution to interested individuals and organizations.

In 2013, 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, 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.

Preliminary grilse and adult cutoff fork lengths were determined using length frequency analysis of systematically sampled male Chinook, and final grilse/adult and age composition determinations were made by the KRTT (2014) using scale age proportions.

Coho Salmon

As coho entered IGH during the 2013-2014 season, hatchery personnel anaesthetized each fish, determined whether it would be retained for potential spawning or released, then sent the fish to a processing tank, where KRP staff collected biological data including tissue samples, fork length, sex and clip/tag information. 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). 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 tagged with a passive integrated transponder (PIT) tag and released into the Klamath River at the spawning building. Tissue samples were sent to NOAA's salmon genetics repository in Santa Cruz, CA. via overnight mail. Scale samples were collected from spawned fish as well as fish that experienced pre-spawn mortality.

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

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 brood stock number of each female coho at the top of a column, and beneath it, brood stock numbers of males in descending order of spawning suitability for that female.

On subsequent spawning days, coho were checked in their tubes for spawning readiness, and were either left in the tubes if not ready to spawn, or brought into the

spawning building from the round tanks, sacrificed and spawned with fish chosen from the spawning matrix. In 2013, coho crosses consisted of two males to one female, with half of the female's eggs being fertilized by each male, and the egg lots kept separate. One lot was culled when it was discovered after spawning that the male was adipose-clipped and therefore from outside the Klamath basin. Its head contained no CWT. IGH and KRP personnel tracked the use of marked vs. unmarked individuals and the use of grilse for spawning. Otoliths were collected from all spawned coho.

After IGH reached its egg-taking goal, all coho not used in spawning were released into the Klamath River at the IGH spawning building. KRP personnel tagged these fish with PIT tags. PIT tag numbers of released coho that re-entered the hatchery were recorded as well. All coho tissue samples were sent at the end of the season to the NOAA Salmonid Genetic Tissue Repository located in Santa Cruz.

In an experimental program designed to evaluate coho movements after release from IGH, CDFW Yreka Fisheries staff fitted 28 female coho with a LOTEK MCFT2-3A microprocessor coded radio transmitter with a unique identifier code set to signal every three seconds (Codes 11 – 35), as well as a PIT tag, and released them into the Klamath River at the spawning building. Their movements were tracked during weekdays between November 1, 2013 and January 1, 2014 (Bean, 2014).

RESULTS

Chinook Salmon

Chinook began entering IGH on October 8, 2013. A total of 14,754 Chinook returned to IGH during the fall 2013 spawning season. Of these, KRP staff collected scale samples (from random fish only), determined sex, and measured fork lengths for 4,055 Chinook, (1,452 randomly sampled and 2,603 non-random AD fish). Systematically sampled male Chinook ranged in size from 41 to 103 cm. fork length (Figure 3), and systematically sampled female Chinook ranged from 53 to 93 cm. fork length (Figure 4). A preliminary grilse cutoff was made using the length frequency distribution from 1,450 systematically sampled Chinook. Two fish were excluded from the fork length histograms due to incomplete data. The preliminary cutoff point of grilse occurred at $\leq$ 59 cm. in fork length, yielding approximately 8.9% grilse (1,323) and 91.1% adults (13,431) for a total run size of 14,754. Females accounted for 48.5% (7,153) of the run and males accounted for 51.5% (7,601). The last Chinook of the season entered IGH on December 10, 2013.

Heads from 2,882 AD Chinook (systematic and non-systematic fish) were collected for CWT recovery, from which positive reads were obtained for 2,798 (Table 2). The remainder were either lost during extraction (37), had shed their tags (45) or the heads were lost prior to extraction (2). The contribution of lost or unreadable CWTs was estimated by applying the proportions of known CWTs (2,798) to the 39 lost or unreadable CWTs (Table 3).

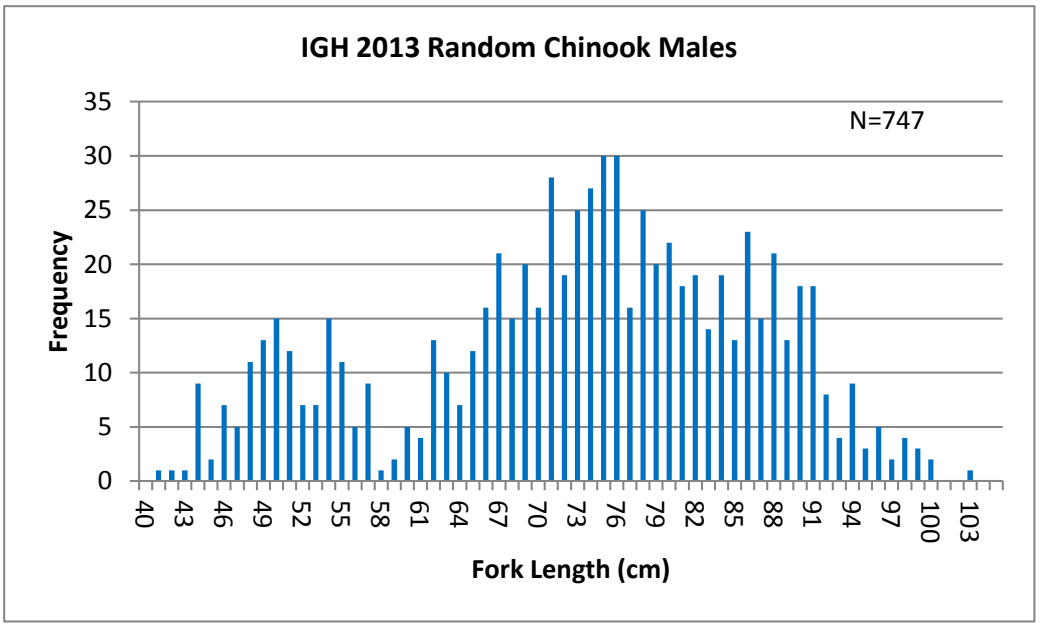

Figure 3. Length frequency distribution for systematic sample of male Chinook salmon recovered at IGH during the 2013 spawning season.

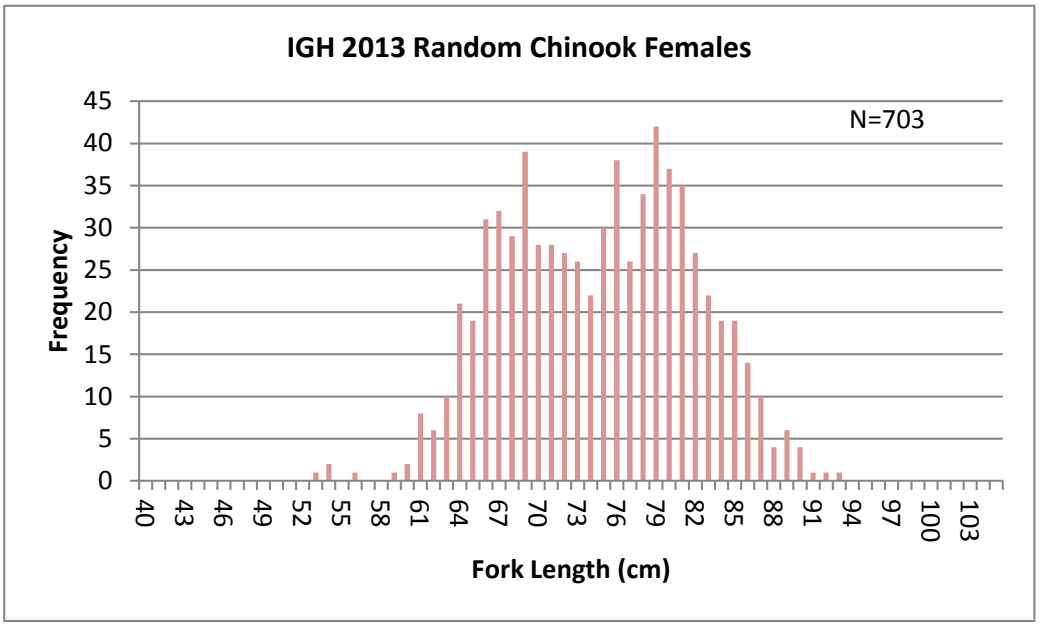

Figure 4. Length frequency distribution for systematic sample of female Chinook salmon recovered at IGH during the 2013 spawning season.

The estimated contribution of unknown CWTs was then added to the contribution of known CWTs to determine the total contribution of hatchery Chinook entering IGH. All but 6 of the 2,798 CWTs recovered (and successfully read) originated from IGH**,** and the remaining 6 originated from Trinity River Hatchery (TRH). Based on the expansion of CWTs, KRP staff estimated that 92% of the Chinook entering IGH during the 2013 season were of hatchery origin. Proportions of hatchery-origin Chinook returning to IGH from 2002-2013 are shown in Figure 5. Of the expanded CWT returns in 2013, 1,737

(13%) were from yearling release groups and 11,650 (87%) were from smolt release groups.

Table 2. Estimated contribution of hatchery origin Chinook salmon returning to Iron Gate Hatchery during the 2013 spawning season.

CWT	Release Location	Brood Year	Age	Release Type	Number Recovered	Production Multiplier	Expanded Estimate
Estimated contribution of known CWTs:							
68710	IGH	2009	**4**	Ff	137	4.02	**551**
68711	IGH	2009	**4**	Ff	227	4.01	**910**
68712	IGH	2009	**4**	Ff	159	4.04	**642**
68713	IGH	2009	**4**	Ff	233	4.17	**972**
68714	IGH	2009	**4**	Ff	261	4.01	**1,047**
68715	IGH	2009	**4**	Ff	185	4.04	**747**
68716	IGH	2009	**4**	Fy	293	4.01	**1,175**
68720	IGH	2009	**4**	Ff	21	4.29	**90**
68826	TRH	2009	**4**	Ff	2	4.11	**8**
68828	TRH	2009	**4**	Ff	2	4.03	**8**
68792	IGH	2010	**3**	Ff	234	4.03	**943**
68793	IGH	2010	**3**	Ff	257	4.17	**1,072**
68794	IGH	2010	**3**	Ff	227	4.02	**913**
68795	IGH	2010	**3**	Ff	247	12.17	**3,006**
68799	IGH	2010	**3**	Fy	55	4.03	**222**
68778	TRH	2010	**3**	Ff	1	4.08	**4**
68781	TRH	2010	**3**	Fy	1	4.08	**4**
60416	IGH	2011	**2**	Ff	36	4.01	**144**
60418	IGH	2011	**2**	Ff	24	4.01	**96**
60419	IGH	2011	**2**	Ff	59	4.01	**237**
60420	IGH	2011	**2**	Ff	28	4.01	**112**
60421	IGH	2011	**2**	Ff	21	4.00	**84**
60422	IGH	2011	**2**	Fy	63	4.00	**252**
60379	IGH	2011	**2**	Fy	21	4.00	**84**
68719	IGH	2011	**2**	Ff	4	4.01	**16**
				Subtotal	**2,798**		**13,339**
Estimated contribution of unknown CWTs							
200000					37		
400000					0		
300000					2		
				Subtotal	**39**		**187**
	Total Estimated Hatchery Contribution =						**13,526**
Unreadable CWTs: 200000=CWT lost, 400000=CWT unreadable, 300000=Head lost							

Table 3. Estimated contribution of 39 Ad-clipped Chinook salmon with unknown coded-wire-tag (CWT) codes (lost or unreadable) that were recovered at IGH based on the proportional distribution of known CWTs recovered at IGH during the 2013 season.

CWT	BY	# CWTs Recovered	Proportion of CWTs recovered	Estimated Number	Production Multiplier	Expanded Estimate
68710	2009	137	0.048963545	2	4.02	**8**
68711	2009	227	0.081129378	3	4.01	**13**
68712	2009	159	0.056826305	2	4.04	**9**
68713	2009	233	0.083273767	3	4.17	**14**
68714	2009	261	0.093280915	4	4.01	**15**
68715	2009	185	0.066118656	3	4.04	**10**
68716	2009	293	0.104717655	4	4.01	**16**
68720	2009	21	0.007505361	0	4.29	**1**
68826	2009	2	0.000714796	0	4.11	**0**
68828	2009	2	0.000714796	0	4.03	**0**
68792	2010	234	0.083631165	3	4.03	**13**
68793	2010	257	0.091851322	4	4.17	**15**
68794	2010	227	0.081129378	3	4.02	**13**
68795	2010	247	0.088277341	3	12.17	**42**
68799	2010	55	0.019656898	1	4.03	**3**
68778	2010	1	0.000357398	0	4.08	**0**
68781	2010	1	0.000357398	0	4.08	**0**
60416	2011	36	0.012866333	1	4.52	**2**
60418	2011	23	0.008220157	0	4.01	**1**
60419	2011	59	0.021086490	1	4.52	**4**
60420	2011	28	0.010007148	0	3.93	**2**
60421	2011	21	0.007505361	0	4.00	**1**
60422	2011	64	0.022873481	1	4.00	**4**
60379	2011	21	0.007505361	0	4.00	**1**
68719	2011	4	0.001429593	0	4.52	**0**
		2,798	**1.0000**	**39**		**187**

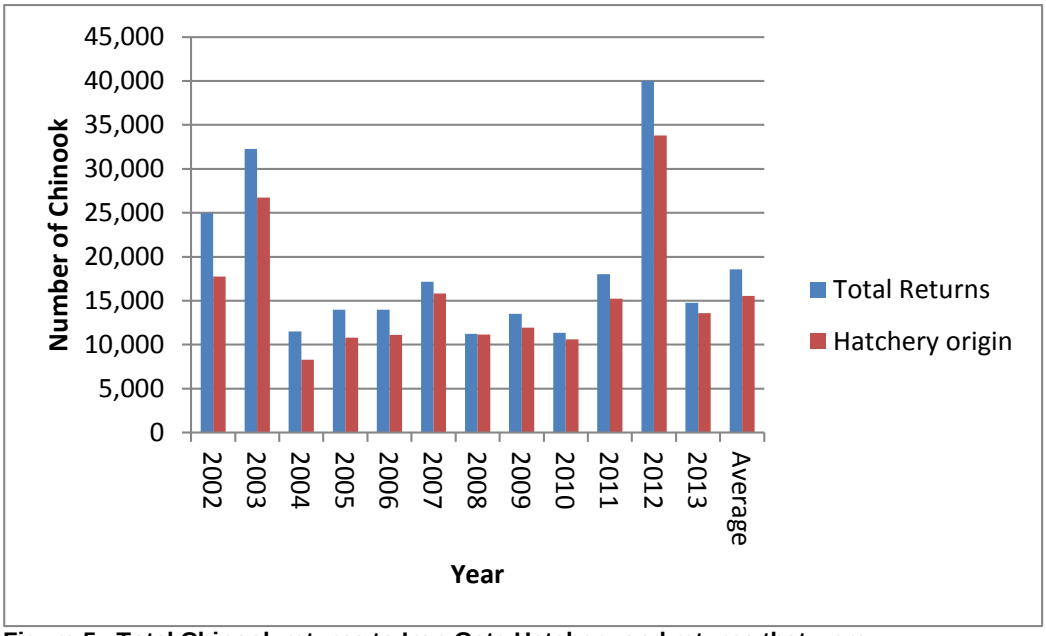

Figure 5. Total Chinook returns to Iron Gate Hatchery and returns that were determined to be of hatchery origin, 2002-2013.

Coded Wire Tagging

2013 was the fifth year of 25 percent constant fractional marking at IGH. Tagging operations were conducted by staff of the Pacific States Marine Fisheries Commission, under contract with PacifiCorps. A total of 1,304,450 juvenile Chinook were AD clipped and coded wire tagged, and 3,894,024 counted but not tagged, for a total of 5,198,474 Chinook processed during the 2013 tagging season. Table 4 shows the proportion of these processed fish that were released as smolts and yearlings.

Table 4. Chinook releases from Iron Gate Hatchery by release type, 2013 (brood year 2012).

Release Type	Tagged	Untagged	Total
Smolts	1,040,836	3,102,744	4,143,580
Yearlings	263,614	791,280	1,054,894
Total Processed	1,304,450	3,894,024	5,198,474

Before correcting for tag retention, the tagging rate was 25.04% for the smolt component and 24.99% for the yearling component. Tag retention rates for the eight tag codes ranged from 99.60 to 100% and averaged 99.78%. (Buttars, 2014). The first smolt release occurred on May 22, 2013 with Klamath River temperature at 60 degrees F and flow of 1,150 cubic feet per second (cfs), the second smolt release occurred on May 24, 2013 with river temperature 60 degrees F and flow 1,160 cfs, the third occurred on May 29, 2013 with river temperature 60 degrees F and flow 1,140 cfs, and the fourth on June 5, 2013 with river temperature 65 degrees F and flow 1,010 cfs. The first and second yearling groups were released on November 13 and 14, 2013, respectively with river temperature 52 degrees F and flow 1,150 cfs, and the third group was released on November 15, 2013, with river temperature 52 degrees F and flow 1,000 cfs.

Coho Salmon

One thousand, two hundred sixty-eight (1,268) coho entered IGH during the 2013-2014 season between October 17, 2013 and January 21, 2014. Male coho ranged in size from 40 to 81 cm. in fork length (Figure 6). Female coho ranged in size from 46 to 80 cm. in fork length (Figure 7). Based on the length frequency distribution of 615 male coho, grilse were estimated to be $\leq$ 55 cm fork length. Analysis of 1,268 coho salmon fork lengths (male and female) determined that 68 (5.4%) were grilse (63 males and 5 confirmed females) and 1,200 were adults. Among males, the grilse component was 10.2%. The coho run to IGH in 2013-14 consisted of 615 (48.5%) males and 653 (51.5%) females.

A total of 866 coho salmon which entered IGH and were in excess of brood stock needs were PIT tagged and released back to the Klamath River between October 17, 2013 and January 21, 2014. Of these, 149 (17.2%) re-entered IGH after their initial release. Forty (40) of these returning fish were retained as potential brood stock. Thirty (30) coho were released without PIT tags after the PIT tag supply was exhausted. These fish were marked with a combination dorsal and operculum punch so they could be identified if they returned to IGH. Eighty (80) female coho and 155 male coho were

used for spawning during the 2013 season, and 137 died prior to spawning for a total of 372 coho retained at IGH.

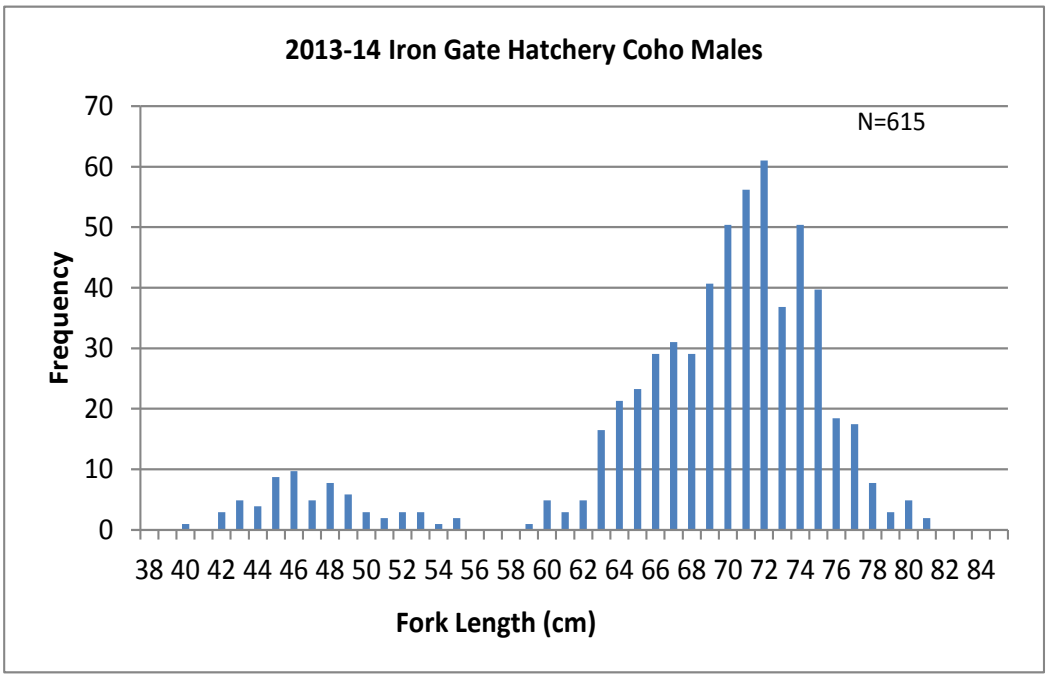

Figure 6. Length frequency distribution for male coho salmon recovered at Iron Gate Hatchery during the 2013 spawning season.

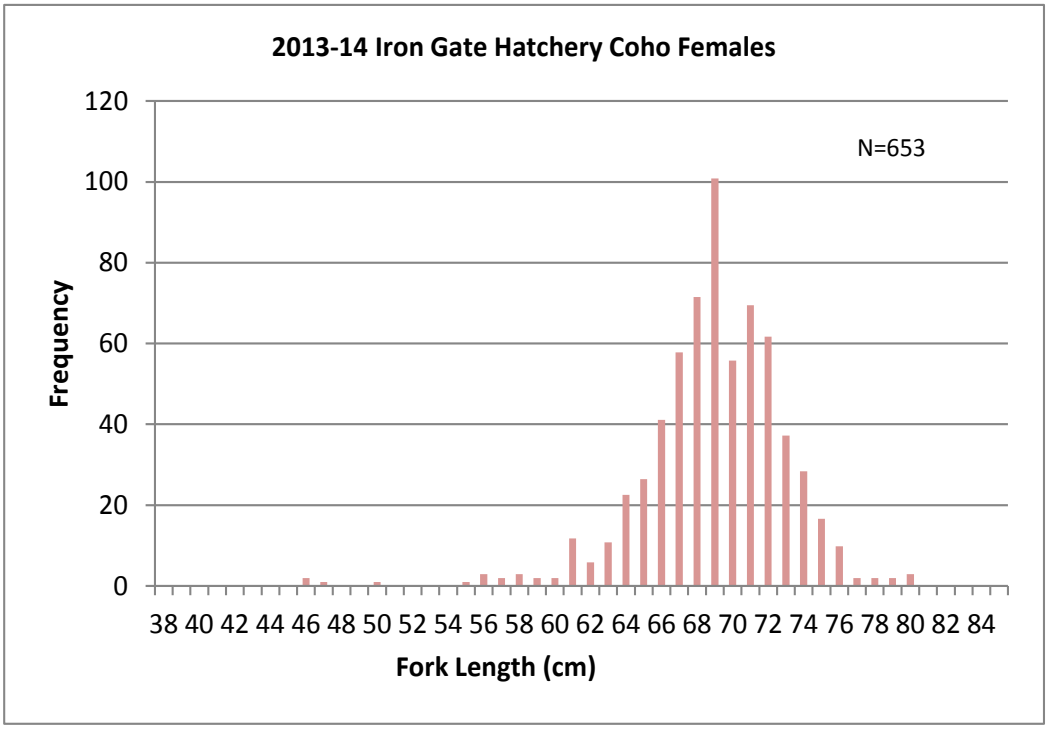

Figure 7. Length frequency distribution for female coho salmon recovered at Iron Gate Hatchery during the 2013 spawning season.

Fifty-six (56) of the IGH-released PIT tagged coho were detected at antenna arrays at the Shasta River Fish Counting Facility (SRFCF), located approximately 24 river kilometers (RKM) downstream of IGH. The number of days elapsed between release from IGH and detection in the Shasta River ranged from 1 to 53 days, with an average of 17 days. Of the 56 coho detected at the SRFCF, 14 were later detected upstream at Shasta RKM 12, and 6 of those were also detected at Shasta RKM 56 (Chris Adams personal communication).

One hundred ninety-three (193) IGH-released PIT tagged coho were detected at antenna arrays at the Bogus Creek Fish Counting Facility (BCFCF), and 9 between the BCFCF and the mouth of Bogus Creek. 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 0 to 48 days. One coho was detected at both locations: in Bogus Creek on November 6, 2013 and at the Shasta River facility six days later (Chris Adams personal communication). Figure 8 shows detections of PIT tagged coho at the Bogus Creek Fish Counting Facility, Shasta River Fish Counting Facility, and Shasta River KM 12 and 56, as well as final radio tag detections of the 28 radio tagged female coho (Bean 2014). Additionally, an antenna was operated at the Scott River Fish Counting Facility, Scott RKM 30, with no detections made.

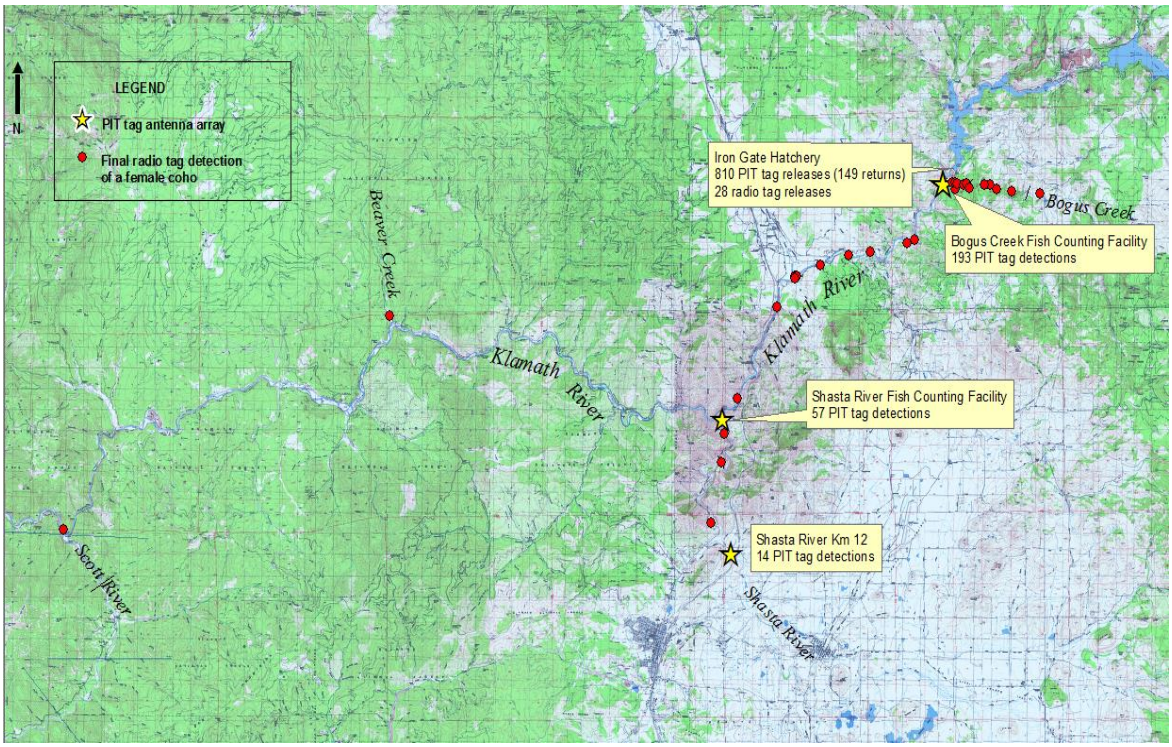

Figure 8. PIT tag and Radio Tag detections of coho salmon released from Iron Gate Hatchery, 2013-14 spawning season.

Arrays at the mouth of Bogus Creek and the Shasta River accounted for a total of 250 of the released coho, 9 were recovered during spawning ground surveys between the

mouth of Bogus Creek and the BCFCF, and 40 returned to IGH and were kept as brood stock. As a result, 567 (65.5%) of the released coho strayed to areas other than IGH, Bogus Creek, Shasta River or the Scott River (above RKM 30). It may be assumed that the final locations of the radio tagged fish represent an approximation of the distribution of the unaccounted for PIT released coho, and could be used as a basis for the expansion of PIT tag antenna arrays to further describe the movements of adult coho releases from IGH.

DISCUSSION

Chinook Salmon

The 2013 run of Chinook to IGH (14,754) was 1,752 fish less than the 36-year average of 16,506 (Figure 9).

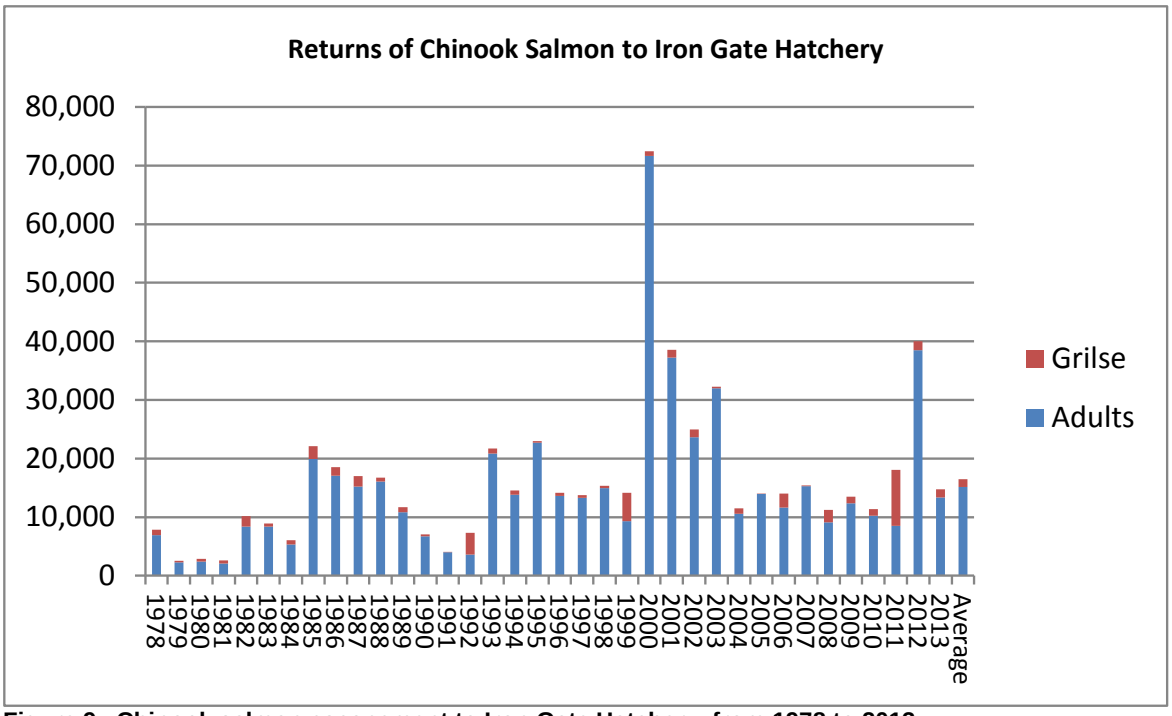

Figure 9. Chinook salmon escapement to Iron Gate Hatchery, from 1978 to 2013.

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 CDFG "Mega Table" each year. Chinook run size data are compiled and reviewed by the KRTT during their annual age composition meeting in late January or early February meeting, 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 2014).

The Klamath Ocean Harvest Model, into which Klamath Basin fall Chinook ocean abundance forecasts are input by the KRTT, models ocean mortality and fishery impacts. The model is used to develop fishery options including ocean (commercial and sport), in-river (tribal and sport) and natural area adult spawner escapement targets. Thus, the run size estimates that are compiled each year provide a critical source of data necessary for the effective management of fall Chinook salmon.

After a record return of grilse to the Klamath Basin in 2011, a large return of three year old Chinook in 2012 was forecasted, and observed, and the strong brood year was again observed as four year olds in 2013 (Table 5). Grilse and adult returns to IGH and Klamath River Basin as a whole from 1978 to 2013 are shown in Table 6.

Table 5. Age composition of Chinook salmon returning to the Klamath Basin, 2011-2013.

2011			2012			2013		
Age	Number	Proportion	Age	Number	Proportion	Age	Number	Proportion
2	85,840	0.45	2	21,473	0.07	2	14,416	0.08
3	59,776	0.32	3	248,532	0.77	3	55,259	0.31
4	41,243	0.22	4	51,352	0.16	4	108,799	0.61
5	1,986	0.01	5	2,225	0.01	5	1,067	0.01
Total	188,845		Total	323,582		Total	179,541	

The Chinook salmon 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.

One of the recommendations of the California Department of Fish and Game, National Marine Fisheries Service Southwest Region Joint Hatchery Review Committee (2001) was for IGH to produce more yearlings and less smolts, to reduce hatchery-origin/natural-origin interactions during the typically low flow and poor water quality months of June and July. Flows during the mid-October to mid-November yearling release period are typically higher, and water quality better, resulting in less competition for food and space during out-migration (CDFG and NMFS 2001). Table 7 shows a comparison of return rates between CWT Chinook released as smolts and as yearlings. At this time there are physical and funding constraints that limit the Department's ability to implement an increased rearing program for yearling Chinook salmon.

Coho Salmon

The 2013 run of Coho to IGH (1,268) was 223 fish more than the 52-year average of 1,045 (Figure 10).

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, moist air incubators and the addition of bird exclusion netting in the outdoor rearing raceways. The draft HGMP also recommends increasing the proportion of natural origin broodstock (pNOB target 20-50%) and the proportion of jacks included in the broodstock (pJacks) (Table 8).

Table 6. Adult and grilse components of Chinook salmon spawner escapement to the Klamath Basin and Iron Gate Hatchery, 1978-2013.

Total Klamath Basin Fall Chinook Escapement					Iron Gate Hatchery Returns				
Year	Grilse	Adults	Total	%Grilse	Year	Grilse	Adults	Total	% Grilse
1978	22,745	92,983	115,728	20%	1978	925	6,945	7,870	12%
1979	11,675	51,295	62,970	19%	1979	257	2,301	2,558	10%
1980	36,773	45,640	82,413	45%	1980	451	2,412	2,863	16%
1981	28,130	80,292	108,422	26%	1981	540	2,055	2,595	21%
1982	39,408	66,612	106,020	37%	1982	1,833	8,353	10,186	18%
1983	3,846	57,546	61,392	6%	1983	514	8,371	8,885	6%
1984	8,281	47,261	55,542	15%	1984	764	5,330	6,094	13%
1985	69,389	64,438	133,827	52%	1985	2,159	19,951	22,110	10%
1986	44,540	195,019	239,559	19%	1986	1,461	17,096	18,557	8%
1987	19,048	209,134	228,182	8%	1987	1,825	15,189	17,014	11%
1988	24,054	191,642	215,696	11%	1988	609	16,106	16,715	4%
1989	9,100	124,340	133,440	7%	1989	831	10,859	11,690	7%
1990	4,392	35,882	40,274	11%	1990	321	6,719	7,040	5%
1991	1,755	32,670	34,425	5%	1991	65	4,002	4,067	2%
1992	13,693	26,698	40,391	34%	1992	3,737	3,581	7,318	51%
1993	7,598	57,212	64,810	12%	1993	883	20,828	21,711	4%
1994	14,371	63,983	78,354	18%	1994	758	13,808	14,566	5%
1995	22,774	222,768	245,542	9%	1995	259	22,681	22,940	1%
1996	9,532	175,773	185,305	5%	1996	543	13,622	14,165	4%
1997	7,993	83,736	91,729	9%	1997	452	13,275	13,727	3%
1998	4,639	90,647	95,286	5%	1998	403	14,923	15,326	3%
1999	19,248	51,048	70,296	27%	1999	4,830	9,290	14,120	34%
2000	10,246	218,077	228,323	4%	2000	839	71,635	72,474	1%
2001	11,343	187,333	198,676	6%	2001	1,364	37,204	38,568	4%
2002	9,226	160,788	170,014	5%	2002	1,296	23,667	24,963	5%
2003	3,845	191,948	195,793	2%	2003	290	31,970	32,260	1%
2004	9,646	78,943	88,589	11%	2004	937	10,582	11,519	8%
2005	2,398	65,125	67,523	4%	2005	42	13,955	13,997	0%
2006	27,073	61,629	88,702	31%	2006	2,386	11,604	13,990	17%
2007	22,745	92,983	115,728	20%	2007	196	15,249	15,445	1%
2008	25,261	70,358	95,619	26%	2008	2,130	9,101	11,231	19%
2009	11,938	100,747	112,685	11%	2009	1,132	12,360	13,492	8%
2010	14,307	55,277	69,584	21%	2010	1,113	10,234	11,347	10%
2011	74,223	70,091	144,314	51%	2011	9,549	8,490	18,039	53%
2012	16,941	173,988	190,929	9%	2012	1,537	38,478	40,015	4%
2013	11,825	76,767	88,592	13%	2013	1,323	13,431	14,754	9%
Average	**18,722**	**101,963**	**120,685**	**16%**	**Average**	**1,349**	**15,157**	**16,506**	**8%**

Table 7. Return rates of IGH smolt and yearling CWT releases for brood years 1990-1996, 1999, 2000 and 2002-2011.

Brood Year	IGH Smolt Releases			IGH Yearling Releases			Ratio of yearling/smolt return rates
	# CWTs Released	# CWTs Returned	% Return	# CWTs Released	# CWTs Returned	% 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	1015	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
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	986,141	269	0.027%	192,339	197	0.102%	3.75
2009*	1,119,054	1223	0.109%	264,253	293	0.111%	1.01
2010*	671,755	1164	0.173%	261,332	63	0.024%	0.14
2011*	1,158,028	172	0.015%	286947	84	0.029%	1.97
AVERAGE			**0.149%**			**0.358%**	**4.64**
* Incomplete returns for BY 2009-2011							

Table 8. Coho male, female and jack returns, number of females spawned, proportion of natural origin broodstock and jacks used in spawning, egg take, fecundity and yearlings released by brood year at IGH from 1993-2013.

Year	Males	Females	Jacks	Females Spawned	Natural Origin Broodstock	pNOB	pJacks	# Eggs	Fecundity	Yearlings released	Date released
1993	361	314	29	219	?	~15	~1	503,326	2,298	79,506	1995
1994	100	72	97	57	?	~15	~1	141,397	2,481	74,250	1996
1995	708	793	29	294	?	~15	~1	782,170	2,660	81,489	1997
1996	1,715	1,831	551	200	?	~15	~1	547,255	2,736	79,607	1998
1997	825	1,047	302	126	16	6.3	~1	304,728	2,418	75,156	1999
1998	243	268	158	122	75	30.7	~1	298,357	2,446	77,147	2000
1999	90	61	18	35	5	7.1	~1	86,519	2,472	46,250	3/29/2001
2000	295	428	631	95	52	27.4	~1	270,151	2,844	67,933	3/27/2002
2001	972	1,494	107	126	22	8.7	~1	404,370	3,209	74,271	3/27/2003
2002	566	627	108	187	68	18.2	~1	609,193	3,258	109,374	3/29/2004
2003	609	708	241	197	172	43.7	~1	502,048	2,548	74,716	4/13/2005
2004	630	865	239	276	10	1.8	~1	799,623	2,897	89,482	4/17/2006
2005	596	799	30	103	10	4.9	~1	295,101	2,865	118,487	4/25/2007
2006	112	151	69	85	10	5.9	~1	236,406	2,781	53,950	4/9/2008
2007	300	325	154	124	10	4.0	~1	316,155	2,550	117,832	4/17/2009
2008	508	770	18	148	9	3.0	~1	455,480	3,078	121,000	4/8/2010
2009	21	25	24	20	6	30.0	30	53,435	2,672	22,236	4/14/2011
2010	193	235	57	91	21	23.1	13.2	259,490	2,852	155,840	3/29/2012
2011	248	204	134	57	26	23.4	11.7	151,241	2,653	39,250	3/18/2013
2012	98	203	343	64	12	10.0	58.3	158,651	2,479	78,000	3/17/2014
2013	552	653	63	80	37	23.1	16.9	224,071	2,801	N/A	N/A
Average	**464**	**565**	**162**	**129**	**33**	**16**	**26**	**352,341**	**2,714**	**81,789**	

Figure 11 shows the relatedness coefficient (Rxy) of pairs of coho salmon spawned (yellow bars) at IGH during the 2013 season with the use of the NOAA spawning matrix (Table 9). This was the fourth season for which the matrix was used. The maroon 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 (Garza et al.,2014). Highly inbred pairings result in Rxy values > 0.10. According to staff of the NOAA genetics lab, no pairings exceeded the Rxy threshold in 2013 and most pairings were well below the threshold. For comparison, 21% of the randomly selected pairs were related at or above rxy=0.125 (Libby Gilbert Horvath, personal communication). In 2013, two egg lots were culled immediately after spawning, when it was discovered that the male used had an adipose fin clip, indicating it was an out of basin fish.

Radio tagging studies conducted during the 2013-2014 season show that coho released alive from the spawning building migrate not only to Bogus Creek and the Shasta River, but also as far away as Beaver Creek (RKM 257) and below the Scott River (RKM 230). PIT tag antenna arrays were located only in the Shasta River and Bogus Creek, so at this time the movements the 567 undetected tagged coho are not known.

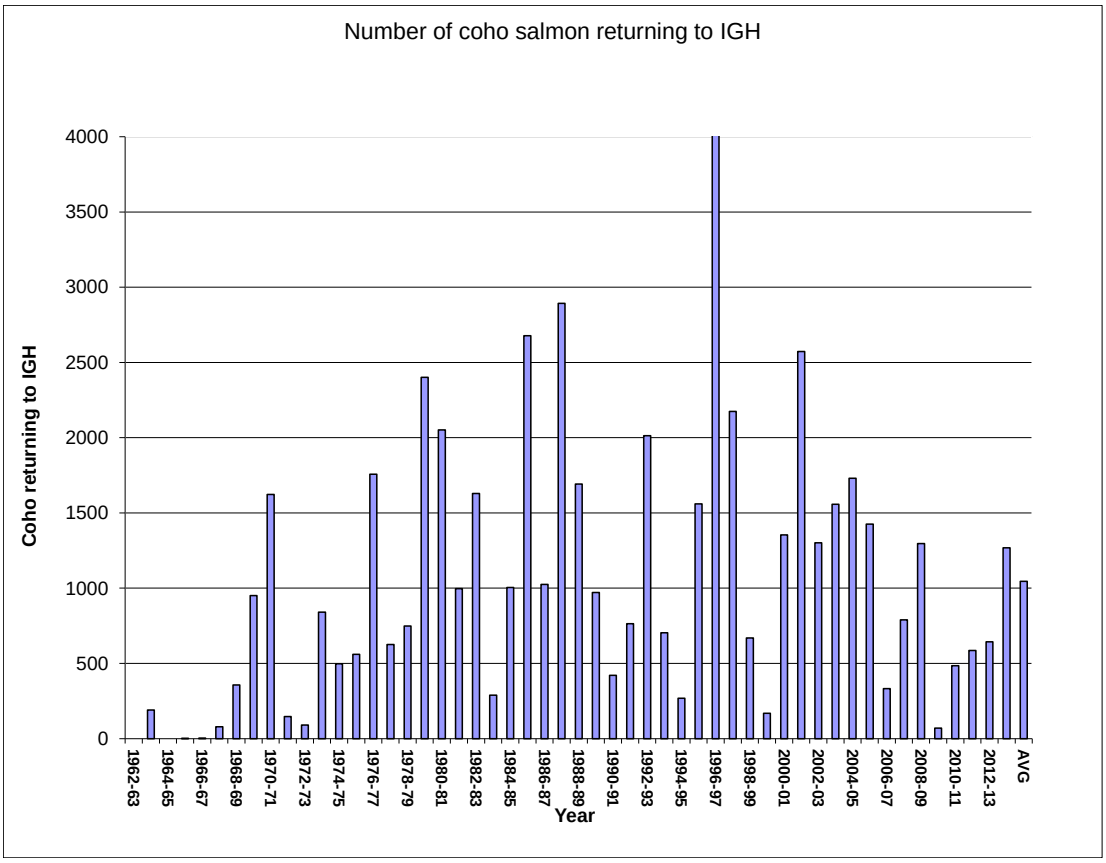

Figure 10. Coho salmon returns at Iron Gate Hatchery from 1962 to 2013.

Future management decisions regarding HOR coho not needed for egg take goals can be further assisted by information on the movements of IGH-released coho. Expansion of PIT tag antenna arrays to the mouths of larger tributaries such as Cottonwood Creek and Beaver Creek may further the knowledge of the movements of coho released from IGH.

Figure 12 shows proportions of marked adult coho, in surplus of brood stock needs, that were released alive into the Klamath River, as well as coho retained at IGH from 1994 (when the SONCC ESU was listed) to the present.

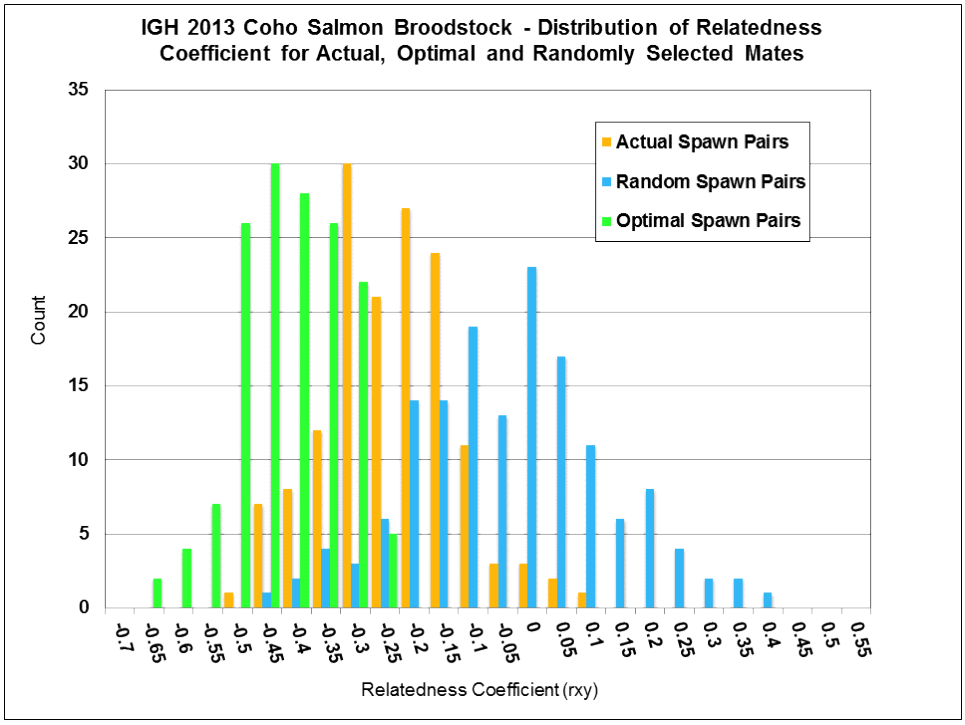

Figure 11. Observed relatedness coefficients of actual spawned pairs, optimally spawned pairs and randomly chosen pairs for IGH coho during the 2013-14 season (Figure provided by NOAA Southwest Fisheries Science Center Salmonid Genetic Laboratory).

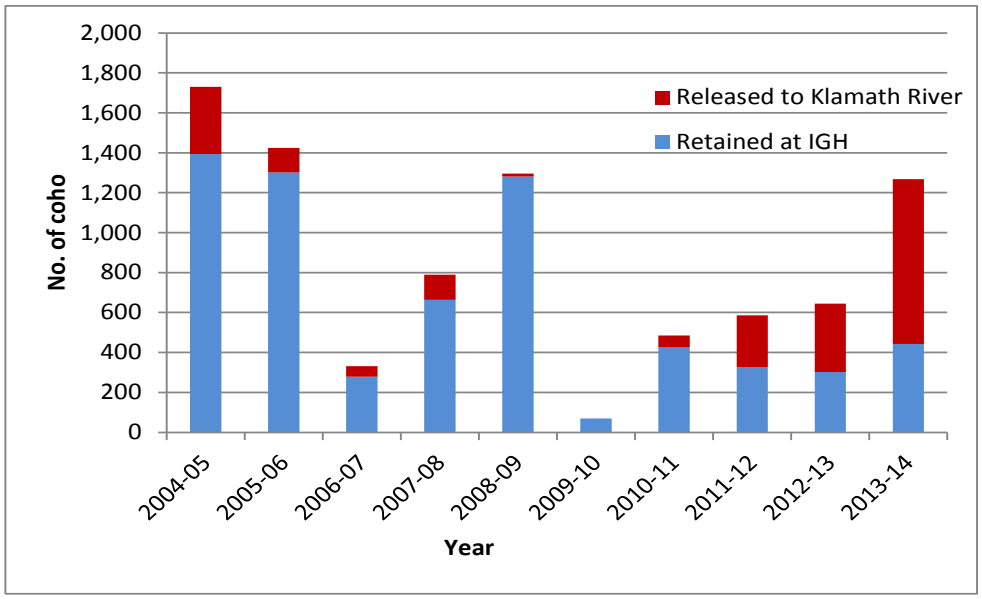

Figure 12. Coho retained at IGH and coho released alive into Klamath River at IGH following listing of SONCC ESU coho salmon in 1994.

Table 9. Spawning matrix created by NOAA Salmon Genetics Repository. The suffix MJ refers to a grilse male, and MN an unmarked male. Males noted in red ink with a double asterisk denotes a male which falls below the suitability threshold and is too closely related to that female to be used for spawning.

F_49F	F_50F	F_51F	F_52F	F_53F
M_55M	M_37M	M_40M	M_47M	M_50MJ
M_63M	M_54M	M_53M	M_39M	M_42MJ
M_47M	M_44MJ	M_56M	M_57MJ	M_57MJ
M_50MJ	M_49MN	M_62M	M_17MJ	M_63M
M_66M	M_20M	M_54M	M_51MJ	M_49MN
M_42MJ	M_35MJ	M_44MJ	M_62M	M_35MJ
M_44MJ	M_41M	M_52MN	M_48MN	M_45MJ
M_35MJ	M_51MJ	M_29M	M_49MN	M_55M
M_40M	M_56M	M_50MJ	M_44MJ	M_26MJ
M_03M	M_59M	M_59M	M_26MJ	M_59M
M_26MJ	M_48MN	M_35MJ	M_56M	M_61M
M_38M	M_38M	M_49MN	M_52MN	M_17MJ
M_46M	M_62M	M_42MJ	M_55M	M_39M
M_61M	M_47M	M_03M	M_03M	M_48MN
M_48MN	M_57MJ	M_39M	M_50MJ	M_41M
M_41M	M_64M	M_55M	M_59M	M_53M
M_20M	M_46M	M_51MJ	M_66M	M_62M
M_17MJ	M_66M	M_20M	M_63M	M_54M
M_29M	M_39M	M_17MJ	M_40M	M_56M
M_52MN	M_45MJ	M_47M	M_29M	M_52MN
M_37M	M_50MJ	M_45MJ	M_41M	M_66M
M_49MN	M_61M	M_26MJ	M_53M	M_03M
M_39M	M_55M	M_66M	M_38M	M_44MJ
M_59M	M_42MJ	M_57MJ	M_64M	M_38M
M_54M	M_17MJ**	M_48MN	M_46M	M_40M
M_57MJ	M_52MN**	M_61M	M_61M	M_64M
M_53M	M_26MJ**	M_63M	M_54M	M_20M
M_51MJ	M_40M**	M_37M	M_42MJ	M_51MJ
M_64M**	M_63M**	M_41M	M_35MJ	M_29M
M_56M**	M_53M**	M_38M**	M_45MJ	M_47M**
M_45MJ**	M_29M**	M_64M**	M_20M**	M_46M**
M_62M**	M_03M**	M_46M**	M_37M**	M_37M**

Table 10. Summary of marked and unmarked coho salmon that entered IGH 1997-2013

Year	# Sampled	LM	RM	AD	OTHER	MARKED	UNMARKED	% MARKED
1997	2,174	1,970	5	28	6	2,009	165	92%
1998	669	378	0	2	0	380	289	57%
1999	169	153	0	1	0	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	0	1,285	140	90%
2006	301	204	2	16	0	222	80	74%
2007	779	643	6	2	1	652	127	84%
2008	1,296	1,268	2	0	1	1,271	25	98%
2009	45	29	7	0	0	36	9	80%
2010	258	222	1	0	0	223	36	86%
2011	586	522	0	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%

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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