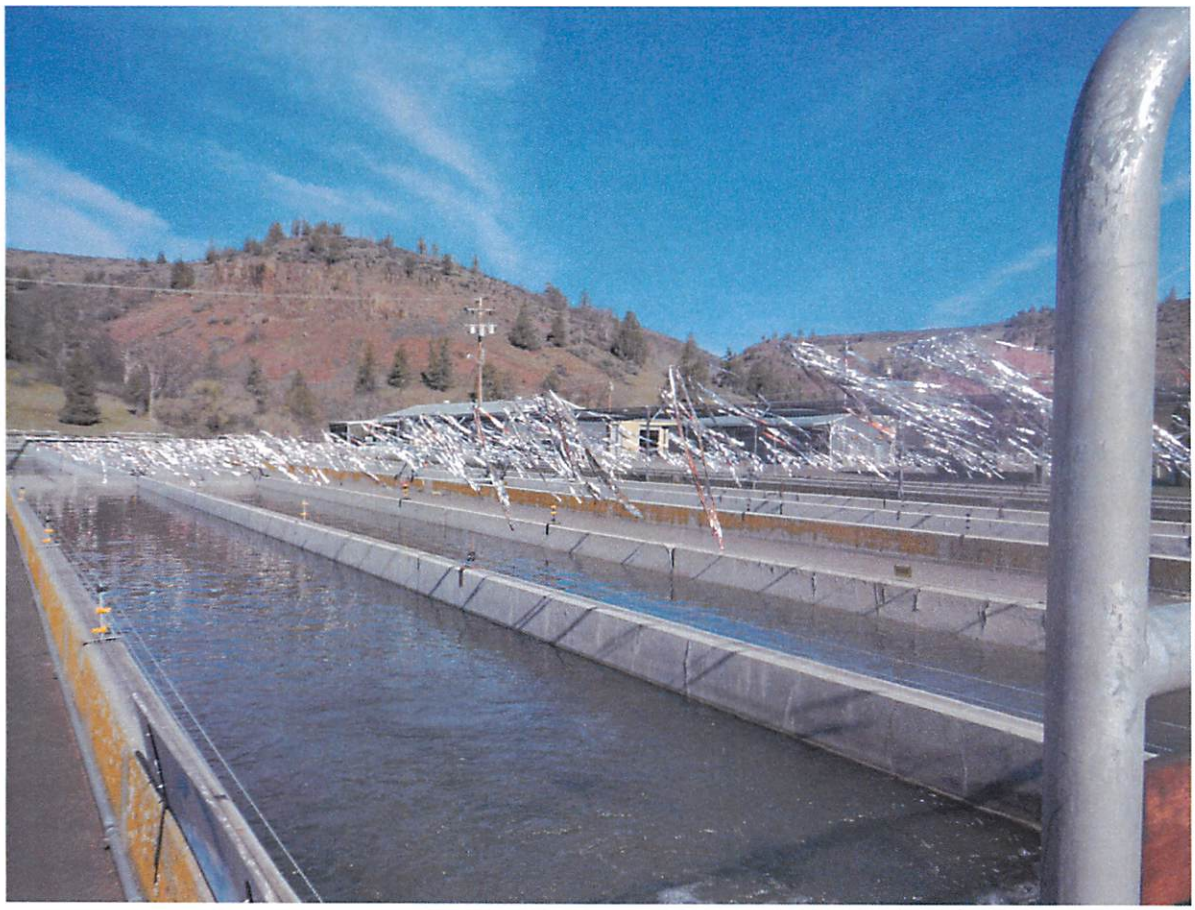
California Department of Fish and Wildlife

Klamath River Project

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

October 7, 2014 to December 19, 2014



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ABSTRACT

A total of 25,339 fall-run Chinook salmon (Chinook, *Oncorhynchus tshawytscha),* entered Iron Gate Hatchery (IGH) during the fall 2014 spawning season from October 7, 2014 through December 19, 2014. Klamath River Project (KRP) staff systematically sampled one in every ten Chinook, as well as all adipose-clipped (AD) Chinook during recovery efforts, for a sample size of 6,491. Scale samples, 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 <60 cm. FL. Systematically sampled male Chinook ranged in size from 48 to 101 cm. FL, and systematically sampled female Chinook ranged from 40 to 91 cm. FL. Based on scale age analysis, the Klamath River Technical Team (KRTT) estimated that 4.1% (1,039) of the run were grilse. Females accounted for 49% (12,416) of the run while males accounted for 51% (12,923). The 2014 Chinook return to IGH contributed roughly 13.8% to the total (Klamath basin) in-river run and 17.4% to the total spawner escapement. Based on coded-wire tag (CWT) expansion, KRP staff estimated that 81% of the Chinook entering IGH during the 2014 season were of hatchery origin.

A total of 384 coho salmon (coho, *Oncorhynchus kisutch*) entered IGH during the 2014 spawning season. The recorded dates for the coho run were from October 20, 2014 to December 16, 2014. 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 otoliths from coho used for spawning. Males ranged in size from 36 to 79 cm. FL and represented 75.3% (289) of the run, while females ranged in size from 42 to 73 cm. FL and represented 24.7% (95) of the run. Based on the length frequency distribution of 289 male coho, grilse were estimated to be <52 cm. FL. Using this grilse cutoff, the age composition of the 2014 IGH coho run was 69.5% (267) grilse and 30.5% (117) adult coho . Seventeen of the coho <52 cm. FL were females. The proportion of grilse among males was 86.5%. Of the coho that entered IGH during 2014, 90.1% (346) had left maxillary clips, 8.6% (33) had no clips, and 1.3% (5) had an AD clip but no CWT. The 2014 coho spawning season was the fifth 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 (236) were tagged with a Passive Integrated Transponder tag and released back to the Klamath River at IGH, and 28 of these returned and were kept for brood stock after initial release, for a net number of 208 coho released and not used as brood stock.

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

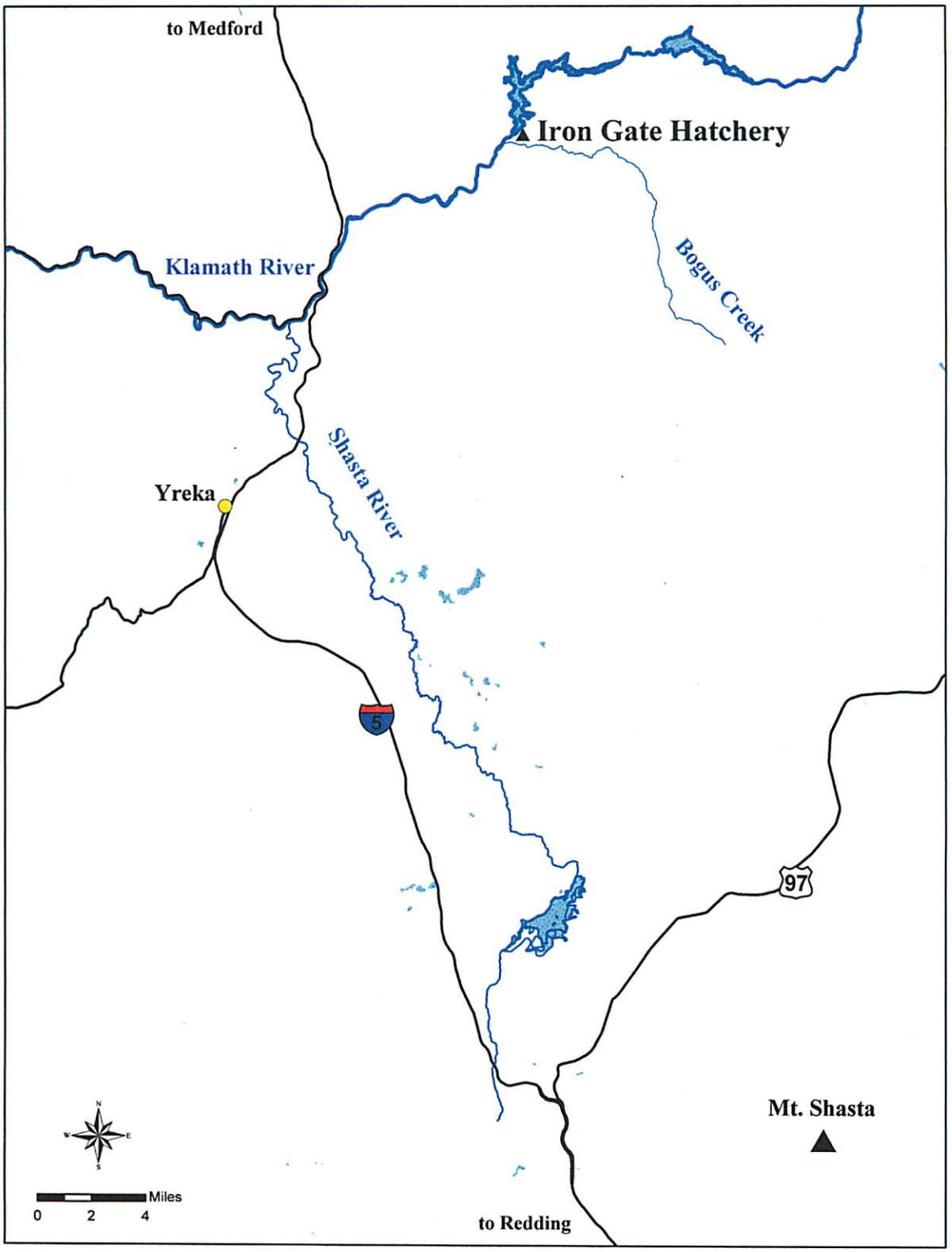

Figure 1. Location of IGH, Siskiyou County, California.

Klamath River Project

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

Coded-Wire Tagging

In 2014, 25% of the brood year 2013 Chinook smolt and yearling groups were adipose-clipped (AD) 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, 2015).

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 off-site processing and later distribution to interested individuals and organizations.

In 2014, KRP staff conducted a systematic sample of every tenth 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.

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 Klamath River Technical Team (KRTT 2015) using scale age proportions.

Coho Salmon

As coho entered IGH during the 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, FL, 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, 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.

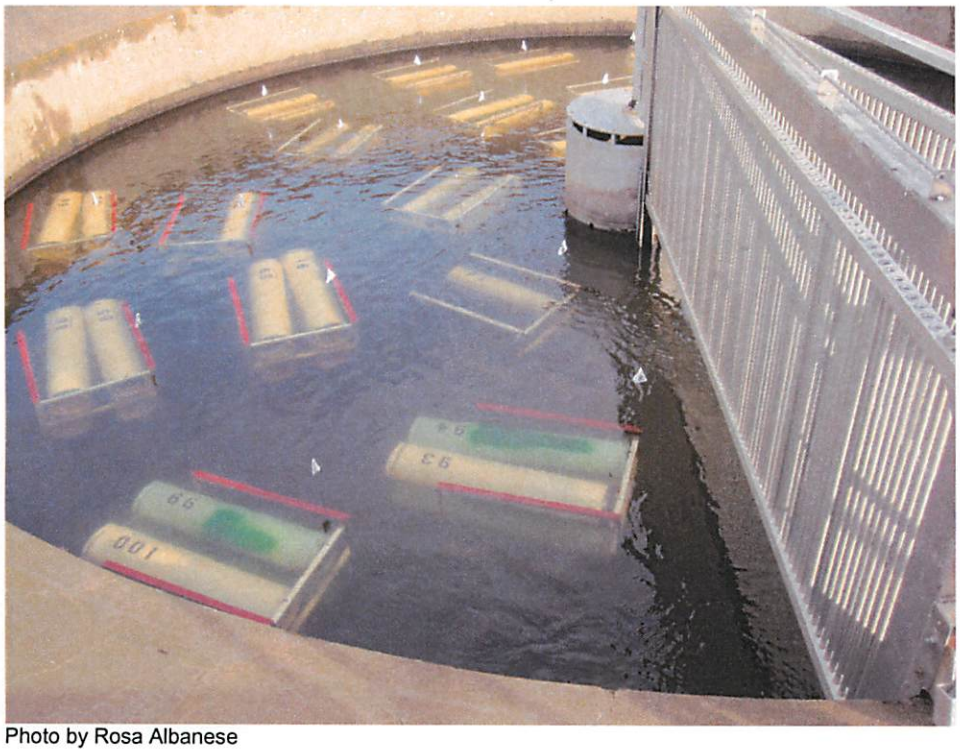

Photo by Rosa Albanese

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 (Table 2).

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

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 on the spawning matrix, or brought into the spawning building from the round tanks, sacrificed and spawned with fish chosen from the matrix. In 2014, 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.

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.

RESULTS

Chinook Salmon

Chinook began entering IGH on October 8, 2014. A total of 25,339 Chinook returned to IGH during the fall 2014 spawning season. Of these, KRP staff collected biological data including sex, FL, clip information, spawning disposition and scales for 2,510

systematically sampled (1 in 10) Chinook, as well as tissue and otolith samples from every 100th Chinook. KRP staff also collected biological data from 3,981 non-random AD fish. Systematically sampled male Chinook ranged in size from 48 to 101 cm. FL and averaged 76 cm. (Figure 3), and systematically sampled female Chinook ranged from 40 to 91 cm. FL and averaged 74 cm. (Figure 4). A grilse cutoff of less than 60 cm. in FL was made using scale age analysis (KRTAT, 2015), yielding approximately 1,039 grilse (4.1%) and 24,300 adults (95.9%) for a total run size of 25,339. Females accounted for 49% (1,239) of the randomly sampled fish and males accounted for 51% (1,269). Two sampled fish were excluded from length frequency histograms due to incomplete data. The last Chinook of the season entered IGH on December 2, 2014.

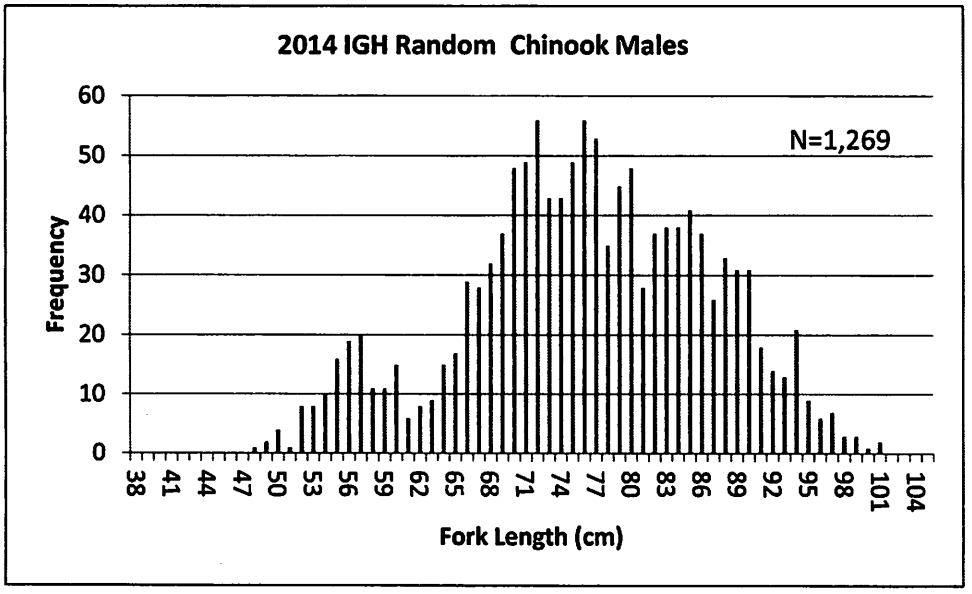

Figure 3. Length frequency distribution for systematic sample of male Chinook salmon recovered at IGH during the 2014 spawning season.

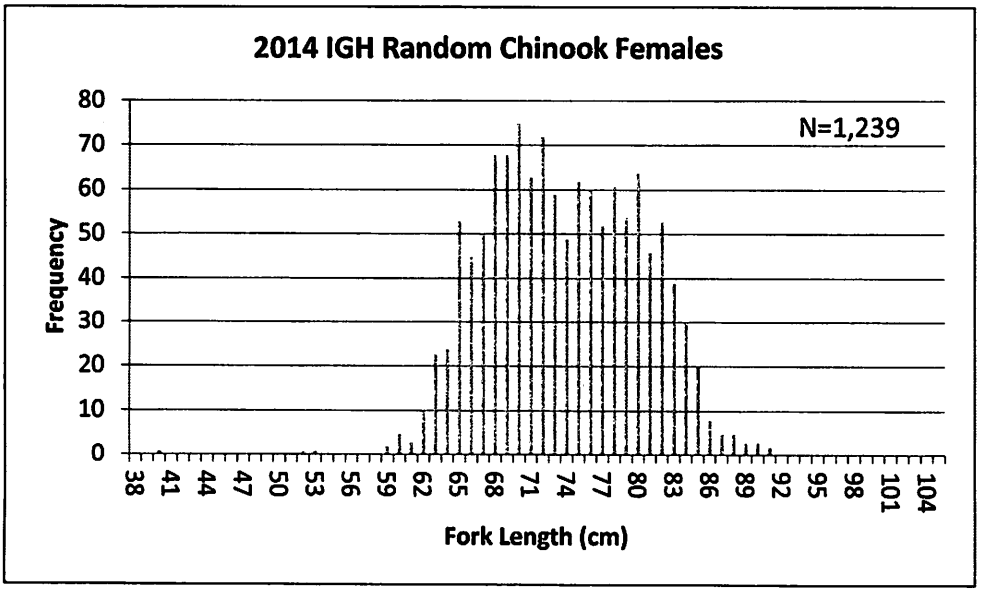

Figure 4. Length frequency distribution for systematic sample of female Chinook

salmon recovered at IGH during the 2014 spawning season.

Heads from 4,398 AD Chinook (systematic and non-systematic fish) were collected for CWT recovery, from which positive reads were obtained for 4,241 (Table 3). The remainder were either lost during extraction (52), had shed their tags (81) or the tags were unreadable (24). The contribution of lost or unreadable CWTs was estimated by applying the proportions of known CWTs (4,241) to the 76 lost or unreadable CWTs (Table 4).

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 but one of the 4,241 CWTs recovered (and successfully read) originated from IGH, and the remaining one originated from Trinity River Hatchery. Based on the expansion of CWTs, KRP staff estimated that 81% of the Chinook entering IGH during the 2014 season were of hatchery origin. Proportions of hatchery-origin Chinook returning to IGH from 2002-2014 are shown in Figure 5. Of the expanded CWT returns in 2014, 2,426 (12%) were from yearling release groups and 17,825 (88%) were from smolt release groups.

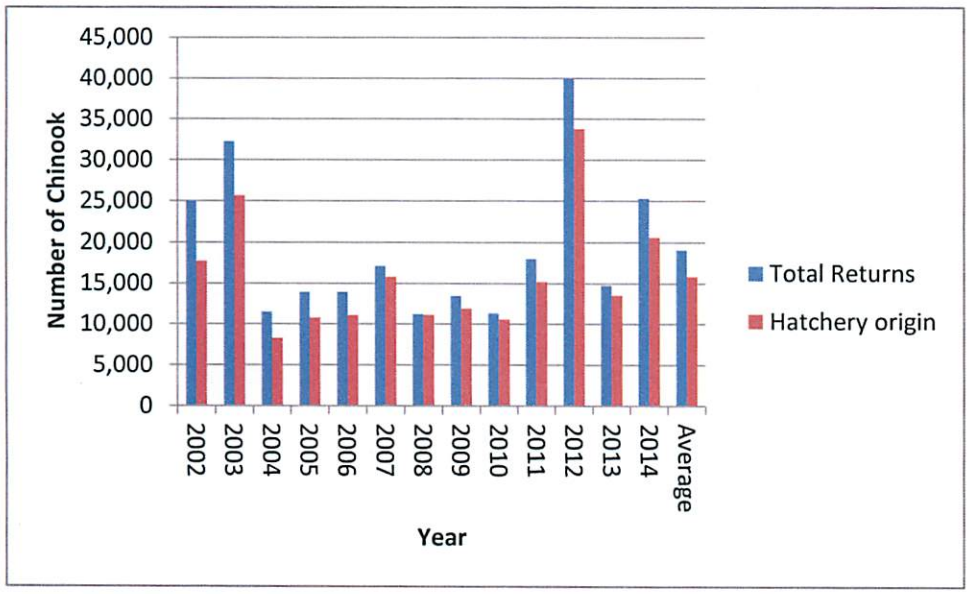

Figure 5. Total Chinook returns to IGH and returns that were determined to be of hatchery origin, 2002-2014.

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 2014 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 2014 spawning season.							
CWT	Release Location	Brood Year	Age	Release Type	Number Recovered	Production Multiplier	Expanded Estimate
Estimated contribution of known CWTs:							
68710	IGH	2009	5	Ff	7	4.02	28
68711	IGH	2009	5	Ff	4	4.01	16
68712	IGH	2009	5	Ff	4	4.04	16
68713	IGH	2009	5	Ff	11	4.17	46
68714	IGH	2009	5	Ff	12	4.01	48
68715	IGH	2009	5	Ff	5	4.04	20
68716	IGH	2009	5	Fy	3	4.01	12
68720	IGH	2010	4	Ff	13	4.29	56
68792	IGH	2010	4	Ff	247	4.03	995
68793	IGH	2010	4	Ff	330	4.17	1,376
68794	IGH	2010	4	Ff	303	4.02	1,218
68795	IGH	2010	4	Ff	389	12.17	4,734
68799	IGH	2010	4	Fy	210	4.03	846
68781	TRH	2010	4	Fy	1	4.08	4
68719	IGH	2011	3	Ff	35	4.01	140
60416	IGH	2011	3	Ff	475	4.01	1,905
60418	IGH	2011	3	Ff	234	4.01	938
60419	IGH	2011	3	Ff	674	4.01	2,703
60420	IGH	2011	3	Ff	368	4.01	1,476
60421	IGH	2011	3	Ff	291	4.00	1,164
60422	IGH	2011	3	Fy	300	4.00	1,200
60379	IGH	2011	3	Fy	90	4.00	360
55551	IGH	2011	3	Ff	11	4.65	51
68796	IGH	2012	2	Ff	52	4.00	208
68797	IGH	2012	2	Ff	41	4.00	164
68798	IGH	2012	2	Ff	53	4.01	213
60375	IGH	2012	2	Ff	23	4.02	92
60385	IGH	2012	2	Ff	3	4.01	12
60501	IGH	2012	2	Ff	51	4.02	205
60507	IGH	2012	2	Fy	1	4.02	4
				Subtotal	**4,241**		**20,251**
Estimated contribution of unknown CWTs							
200000					52		
400000					24		
				Subtotal	**76**		**363**
		Total Estimated Hatchery Contribution =					**20,614**
Unreadable CWTs: 200000=CWT lost, 400000=CWT unreadable, 300000=Head lost							

Table 4. Estimated contribution of 76 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 2014 season.

Estimated contribution of 76 Ad-clipped Chinook salmon with unknown coded wire tag (CWT) codes (lost or unreadable) that were recovered at Iron Gate Hatchery (IGH) based on the proportional distribution of known CWTs recovered at IGH during the 2014 season.						
CWT	BY	# CWTs Recovered	Proportion of CWTs recovered	Estimated Number	Production Multiplier	Expanded Estimate
68710	2009	7	0.0016506	0	4.02	1
68711	2009	4	0.0009432	0	4.01	0
68712	2009	4	0.0009432	0	4.04	0
68713	2009	11	0.0025937	0	4.17	1
68714	2009	12	0.0028295	0	4.01	1
68715	2009	5	0.0011790	0	4.04	0
68716	2009	3	0.0007074	0	4.01	0
68720	2010	13	0.0030653	0	4.29	1
68792	2010	247	0.0582410	4	4.03	18
68793	2010	330	0.0778118	6	4.17	25
68794	2010	303	0.0714454	5	4.02	22
68795	2010	389	0.0917237	7	12.17	85
68799	2010	210	0.0495166	4	4.03	15
68781	2010	1	0.0002358	0	4.08	0
55551	2011	11	0.0025937	0	4.65	1
68719	2011	35	0.0082528	1	4.01	3
60416	2011	475	0.1120019	9	4.01	34
60418	2011	234	0.0551757	4	4.01	17
60419	2011	674	0.1589248	12	4.01	48
60420	2011	368	0.0867720	7	4.01	26
60421	2011	291	0.0686159	5	4.00	21
60422	2011	300	0.0707380	5	4.00	22
60379	2011	90	0.0212214	2	4.00	6
68796	2012	52	0.0122613	1	4.00	4
68797	2012	41	0.0096675	1	4.00	3
68798	2012	53	0.0124971	1	4.01	4
60375	2012	23	0.0054232	0	4.02	2
60385	2012	3	0.0007074	0	4.01	0
60501	2012	51	0.0120255	1	4.02	4
60507	2012	1	0.0002358	0	4.02	0
		4,241	1	76		363

Coded-Wire Tagging

2014 was the sixth year of 25% 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 1,380,970 juvenile Chinook were AD-clipped and coded-wire tagged, and 4,122,669 counted but not tagged, for a total of 5,503,639 Chinook processed during the 2014 tagging season (Brood Year 2013). Table 5 shows the proportion of these processed fish that were released as smolts and yearlings. The remaining 82,643 fish were raceway mortalities.

Table 5. Chinook releases from IGH by release type, 2014 (brood year 2013).

Release Type	Release Date	Number Released
Smolts	5/20/2014	1,000,415
	5/23/2014	873,651
	5/30/2014	877,185
	6/10/2014	875,787
	6/13/2014	800,241
	Total	**4,427,279**
Yearlings	11/12/2014	331,172
	11/13/2014	330,141
	11/14/2014	332,404
	Total	**993,717**

Before correcting for tag retention, the tagging rate was 25.09% for the smolt component and 24.98% for the yearling component. Tag retention rates for the eight tag codes ranged from 98.78 to 100% and averaged 99.53% (Buttars, 2015).

Coho Salmon

Three hundred eighty-four (384) coho entered IGH during the 2014 season, from October 20, 2014 to December 16, 2014. The coho run consisted of 289 males (75.3%) and 95 females (24.7%). Male coho ranged in size from 36 to 79 cm. in FL and averaged 48 cm. (Figure 6). Female coho ranged in size from 42 to 73 cm. in FL and averaged 62 cm.(Figure 7). Based on the length frequency distribution of 384 coho, grilse were estimated to be $\leq$52 cm FL, yielding a grilse component of 69.5% (267) and an adult component of 30.5% (117). Seventeen of the grilse were females.

A total of 238 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 20, 2014 and December 15, 2014. Of these, 86 (35.8%) re-entered IGH after their initial release. Twenty-eight (28) of these returning fish were retained as potential brood stock. Five coho were released with an operculum punch and no PIT tag, after the PIT tag supply was exhausted. Sixty-two (62) female coho and 82 male coho were used for spawning during the 2014 season, and 23 died prior to spawning. One coho kept as brood stock

was released when no suitable mates were found, and one escaped its tube and was not found.

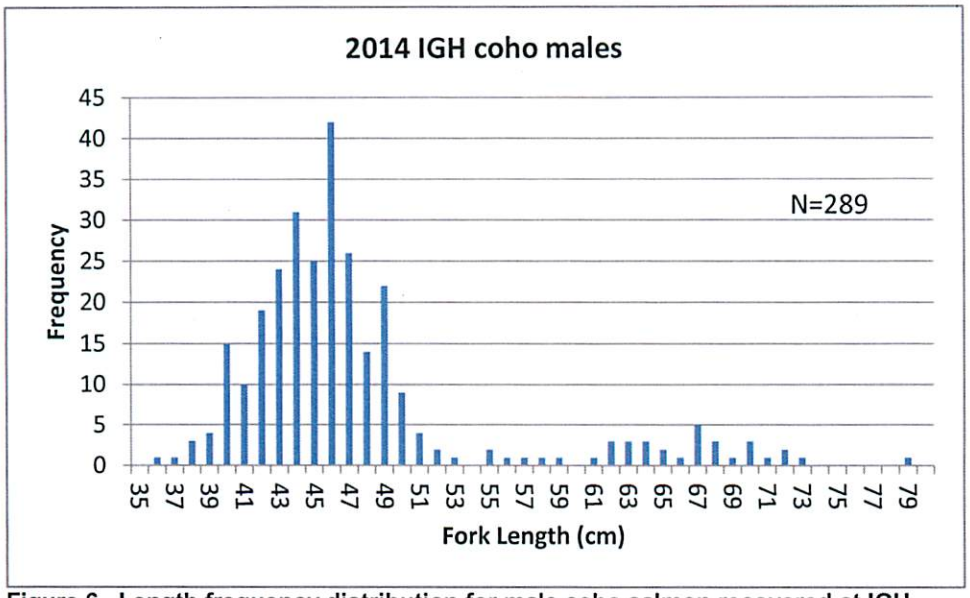

Figure 6. Length frequency distribution for male coho salmon recovered at IGH during the 2014 spawning season.

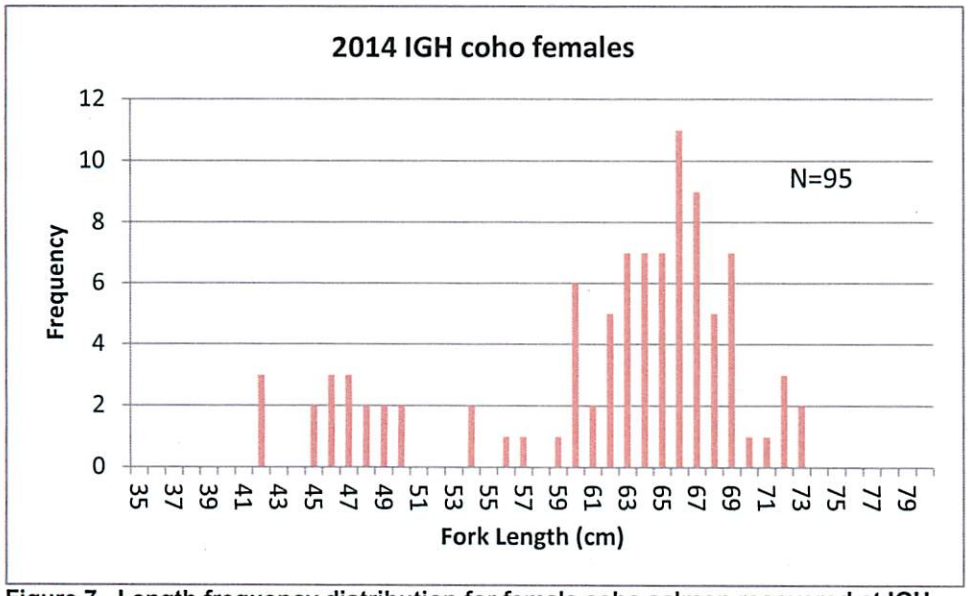

Figure 7. Length frequency distribution for female coho salmon recovered at IGH during the 2014 spawning season.

Thirty-one (31) of the 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 detection in the Shasta River ranged from 4 to 17 days, with an average of nine days. Of the 31 coho detected in the Shasta River, the furthest upstream point of detection was one fish detected in Parks Creek (Shasta RKM 56).

Seventy (70) IGH-released PIT tagged coho were detected at antenna arrays at the Bogus Creek Fish Counting Facility (BCFCF) in 2014. 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 one to 38 days and averaged 13 days. One coho was detected at both locations: in Bogus Creek on November 8, 2014 and at the Shasta River facility six days later (Chris Adams personal communication).

Arrays at the mouth of Bogus Creek and in the Shasta River accounted for a total of 101 of the released coho, and 28 returned to IGH and were kept as brood stock. As a result, 109 (46%) of the released coho ultimately strayed to areas other than IGH, Bogus Creek, or Shasta River.

On the morning of December 8, 2014, a Monday, IGH personnel noticed an unusual odor, described as "hot, burning metal" from the Moist Air Incubator (MAI) housing coho eggs. Upon inspecting the unit, it was found that water temperatures in the sump registered more than 45 degrees C (113 degrees F). Approximately 80,000 coho eggs, effectively all of the eggs on hand, were lost. Causes of the temperature elevation in the MAI are being investigated. Weekend staff had reported power fluctuations that occurred during the weekend, but opening the MAI was not regular weekend protocol. 29,000-30,000 coho eggs were collected on spawning days following the loss, and were placed in gravity-flow stacks.

DISCUSSION

Chinook Salmon

The 2014 run of Chinook to IGH (25,339) was 8,548 fish more than the 37-year average of 16,791 (Figure 8), and the fifth highest 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 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 2015).

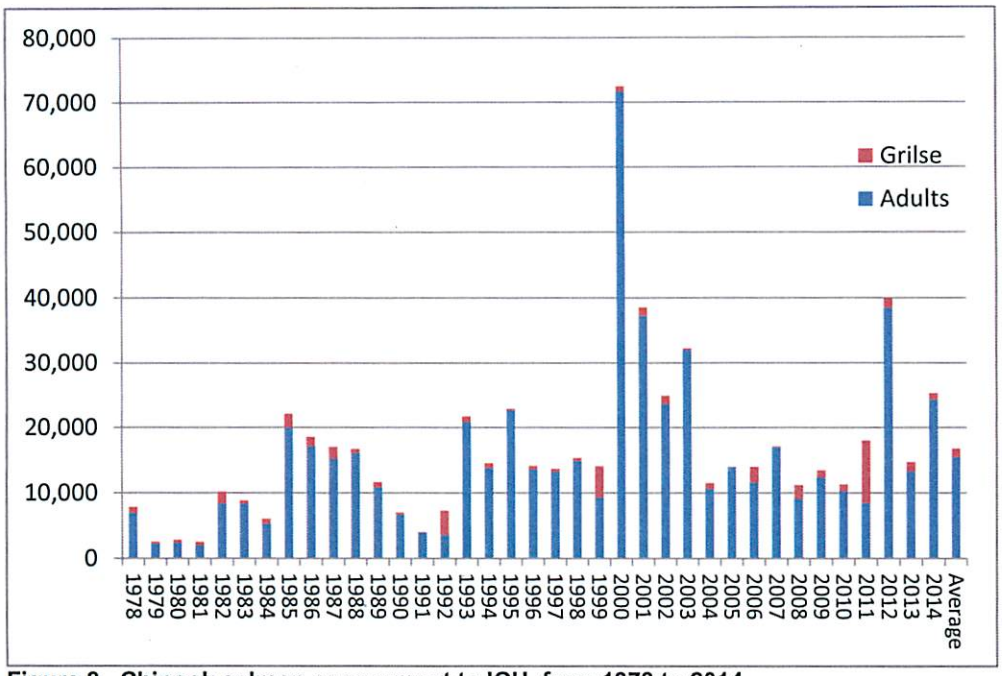

Figure 8. Chinook salmon escapement to IGH, from 1978 to 2014.

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, and an unusually high number of five-year-old fish returning in 2014 (Table 6). Grilse and adult returns to IGH and Klamath River Basin as a whole from 1978 to 2013 are shown in Table 7.

Table 6. Age composition of Chinook salmon returning to the Klamath Basin, 2011-2013.

2011			2012			2013			2014		
Age	Number	Proportion	Age	Number	Proportion	Age	Number	Proportion	Age	Number	Proportion
2	85,840	0.45	2	21,473	0.07	2	14,416	0.08	2	22,348	0.12
3	59,776	0.32	3	248,532	0.77	3	55,259	0.31	3	57,837	0.32
4	41,243	0.22	4	51,352	0.16	4	108,799	0.61	4	98,710	0.54
5	1,986	0.01	5	2,225	0.01	5	1,067	0.01	5	3,897	0.02
Total	188,845		Total	323,582		Total	179,541		Total	182,792	

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.

In 2001, the California Department of Fish and Game, National Marine Fisheries Service Southwest Region Joint Hatchery Review Committee recommended that IGH 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). Conversely, the California Hatchery Scientific Review Group (HSRG, 2012) has recommended excluding Chinook released as yearlings from hatchery brood stock due to concerns about domestication and differential survival rates. Table 7 shows a comparison of return rates between CWT Chinook released as smolts and as yearlings. Exclusion of yearling-released fish from brood stock would require an additional external mark to differentiate those fish when they return to the hatchery. To date, neither recommendation has been implemented and production goals remain unchanged.

Table 7. Return rates of IGH Chinook smolt and yearling CWT releases for brood years 1990-1996, 1999-2012.

Return rates of IGH smolt and yearling CWT releases for brood years 1990 to 1996, 1999-2012							
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	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*	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*	671,755	2,719	0.405%	261,332	274	0.105%	0.26
2011*	1,158,028	2,260	0.195%	286,947	474	0.165%	0.85
2012*	1,040,836	223	0.021%	263,614	1	0.000%	0.02
AVERAGE			0.194%			0.372%	10.07
*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				* Incomplete returns for BY 2010-2012			

The Iron Gate Hatchery Coordination Team (HCT) is an inter-agency group comprised of individuals from state and federal agencies, local tribes and PacifiCorps. The 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 currently in place. 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 in the current 6:5 spawning ratio. This procedure will be implemented during the 2015 spawning season.

Coho Salmon

The 2014 run of Coho to IGH (384) was 649 fish less than the 53-year average of 1,033 (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, moist air incubators (under re-consideration following the 2014 malfunction) and the addition of bird exclusion netting in the outdoor rearing raceways. 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 8). Table 9 shows proportions of marked and unmarked coho that entered IGH from 1997 to 2014. 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.

Figure 10 shows the relatedness coefficient (Rxy) of pairs of coho salmon spawned (yellow bars) at IGH during the 2014 season with the use of the NOAA spawning matrix. This was the fifth 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, two pairings exceeded the Rxy threshold in 2014, one of which was culled before the eggs hatched. The second was not discovered until the eggs had hatched, and can be attributed to spawning house error. The distributions for actual and optimal pairs were very similar, and in many cases the actual mates were also the optimal mates (L. Gilbert Horvath, pers. comm.) Forty-six (46) inbred crosses were prevented in 2014 with the use of the spawning matrix.

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 11 shows proportions of coho retained at IGH and released into the Klamath River from 2004 to 2014.

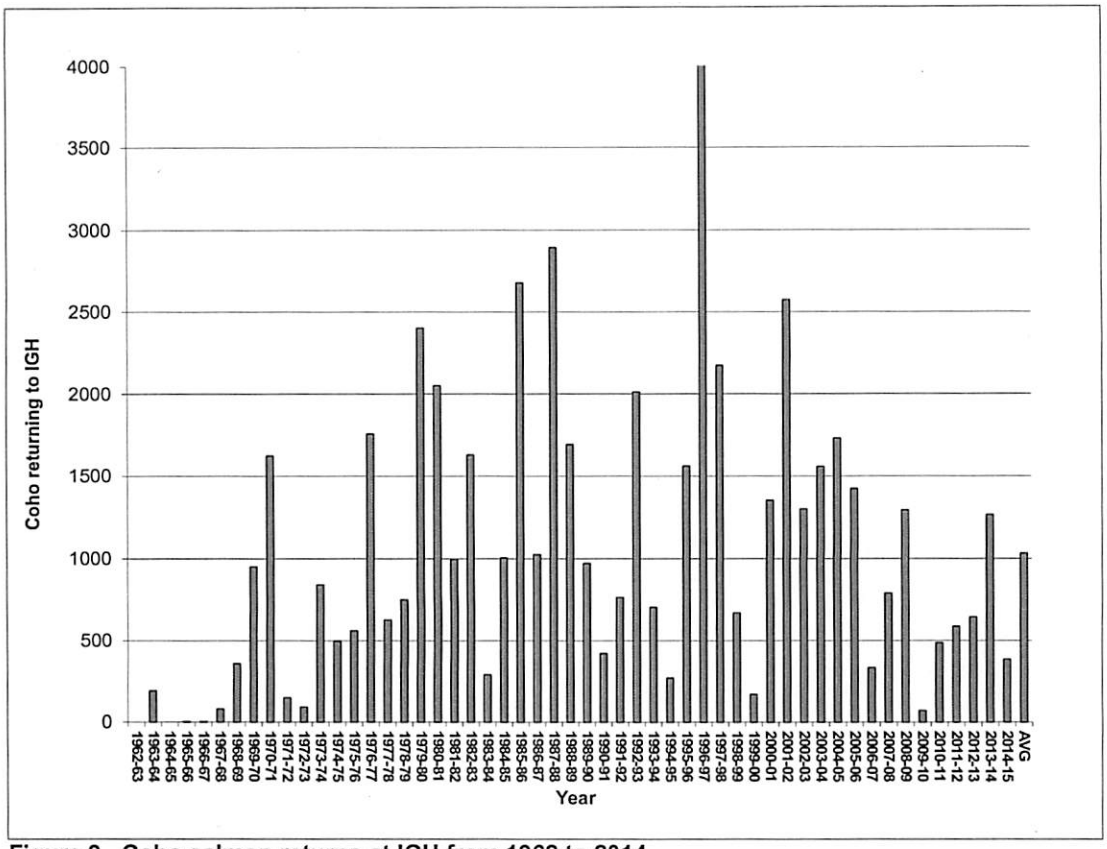

Figure 9. Coho salmon returns at IGH from 1962 to 2014.

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 1993-2014.

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	45.6	11.7	151,241	2,653	39,250	3/18/2013
2012	98	203	343	64	12	18.8	58.3	158,651	2,479	78,000	3/17/2014
2013	552	653	63	80	37	46.3	16.9	224,071	2,801	89,500	3/17/2015
2014	39	95	250	62	24	31.0	51.0	121,421	1,958	N/A	N/A
Average	445	544	166	126	33	17	30	341,845	2,680	81,789	

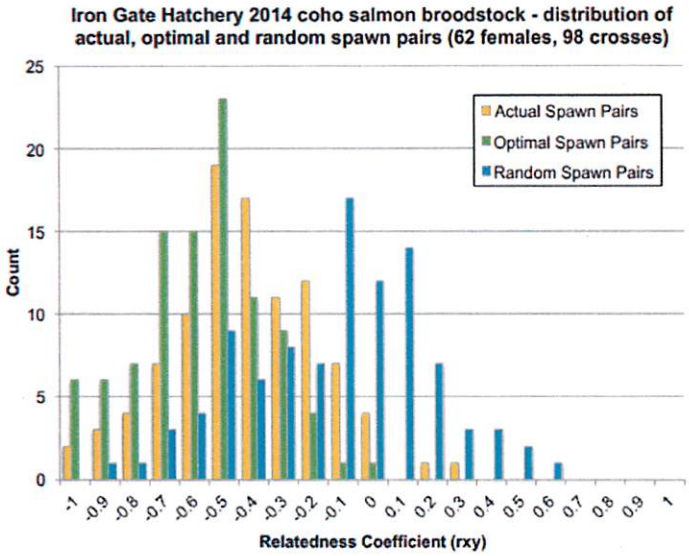

Figure 10. Observed relatedness coefficients of actual spawned pairs, optimally spawned pairs and randomly chosen pairs for IGH coho during the 2014 season (Figure provided by NOAA Southwest Fisheries Science Center Salmonid Genetic Laboratory).

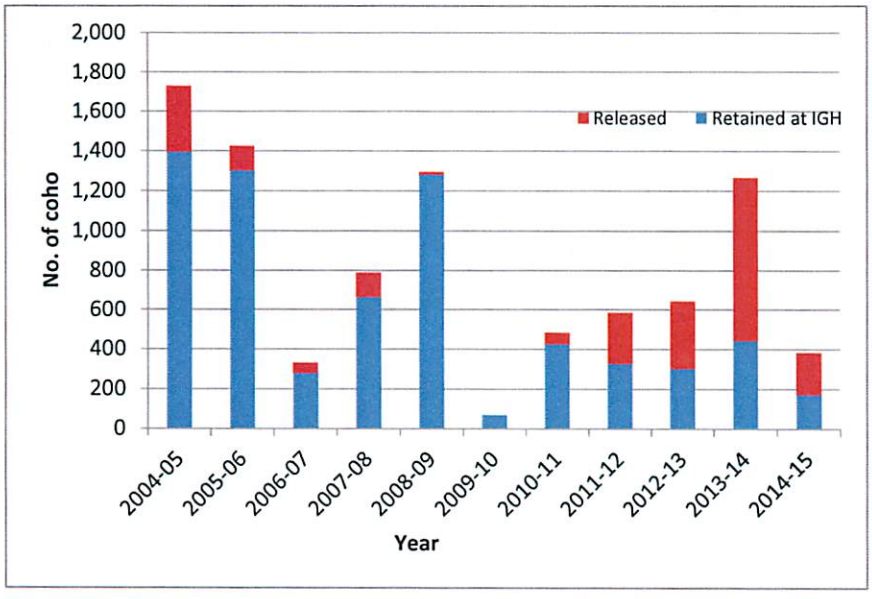

Figure 11. Coho retained at IGH and coho released alive into Klamath River at IGH from 2004 to 2014.

Table 9. Summary of marked and unmarked coho salmon that entered IGH 1997-2014

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%

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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