



# California Department of Fish and Game

## Klamath River Project

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

2007



Photo by Brad Klosner

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## ABSTRACT

A total of 17,149 Chinook salmon entered Iron Gate Hatchery (IGH) during the fall 2007 spawning season. Fall-run Chinook salmon (*Oncorhynchus tshawytscha*) began entering IGH on September 25, 2007, and the last was observed on December 10, 2007. Klamath River Project (KRP) staff systematically sampled 1 in every 10 Chinook as well as all adipose-clipped Chinook during recovery efforts. Scale samples and sex and fork length data were collected for all sampled Chinook. Tissue samples and otoliths were collected from every 100<sup>th</sup> Chinook. Analysis of the length-frequency distribution for randomly sampled fall-run Chinook males indicates that the cutoff point between grilse and adults occurred at  $\leq 50$  cm fork length (Figure 3). Randomly sampled male Chinook ranged in size from 40 cm to 95 cm fork length, and randomly sampled female Chinook ranged from 53 cm to 85 cm fork length. During the 2007 spawning season, KRP staff estimated through length frequency analysis that 154 (0.9%) of the run were grilse. Females accounted for 60.9% (10,447) of the run while males accounted for 39.1% (6,702). The 2007 fall Chinook return to IGH represented roughly 13% of the total (Klamath basin) in-river run and 18% of the total spawner escapement (Table 6). Based on coded wire tag expansion, KRP staff estimated that 15,811 (92%) of the Chinook entering IGH during the 2007 season were of hatchery origin.

A total of 779 coho salmon (*Oncorhynchus kisutch*) entered IGH during the 2007-08 spawning season. The recorded dates for the coho salmon run were from October 15, 2007 to December 17, 2007. KRP staff collected biological data (sex, fork length, presence of marks or clips and scale samples) on 100% of the coho salmon returning to IGH. Males ranged in size from 35 to 80 cm. fork length (Figure 6), while female coho salmon ranged in size from 44 to 76 cm. fork length (Figure 7). IGH counts for the 2007-08 coho spawning season included 325 adult females, 300 adult males, and 154 grilse. IGH staff counted 643 with left maxillary clips, 6 with right maxillary clips, 2 with adipose clips, and 1 with both an adipose and left maxillary clip among these 779 coho salmon. A total of 125 unmarked coho salmon were caudal clipped, floy tagged and released from IGH to the Klamath River. Two of the unmarked coho salmon were not floy tagged. Of the floy tagged coho salmon, 7 reentered IGH and were returned to the river, 4 were observed in nearby Bogus Creek, and 5 were recovered from carcasses washed back on the Shasta River weir. 2 floy-tagged, caudal-clipped coho salmon were observed passing the video fish counting station on the Shasta River. No floy tagged coho were reported for the mainstem Klamath River. None of the 7 unmarked coho salmon that returned to IGH after their initial tagging reentered the hatchery on more than one occasion. No coded wire tags were recovered from coho salmon entering Iron Gate Hatchery during the 2007-08 season.

## INTRODUCTION

### Iron Gate Hatchery

The Iron Gate Hatchery (IGH) is located adjacent to the Klamath River (river mile 190), in Siskiyou County, CA, approximately 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 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	May-June	mid September to early
	900,000	November	November
Coho	75,000 yearlings	March	late October to early January
Steelhead	200,000 yearlings	March-May	November to March

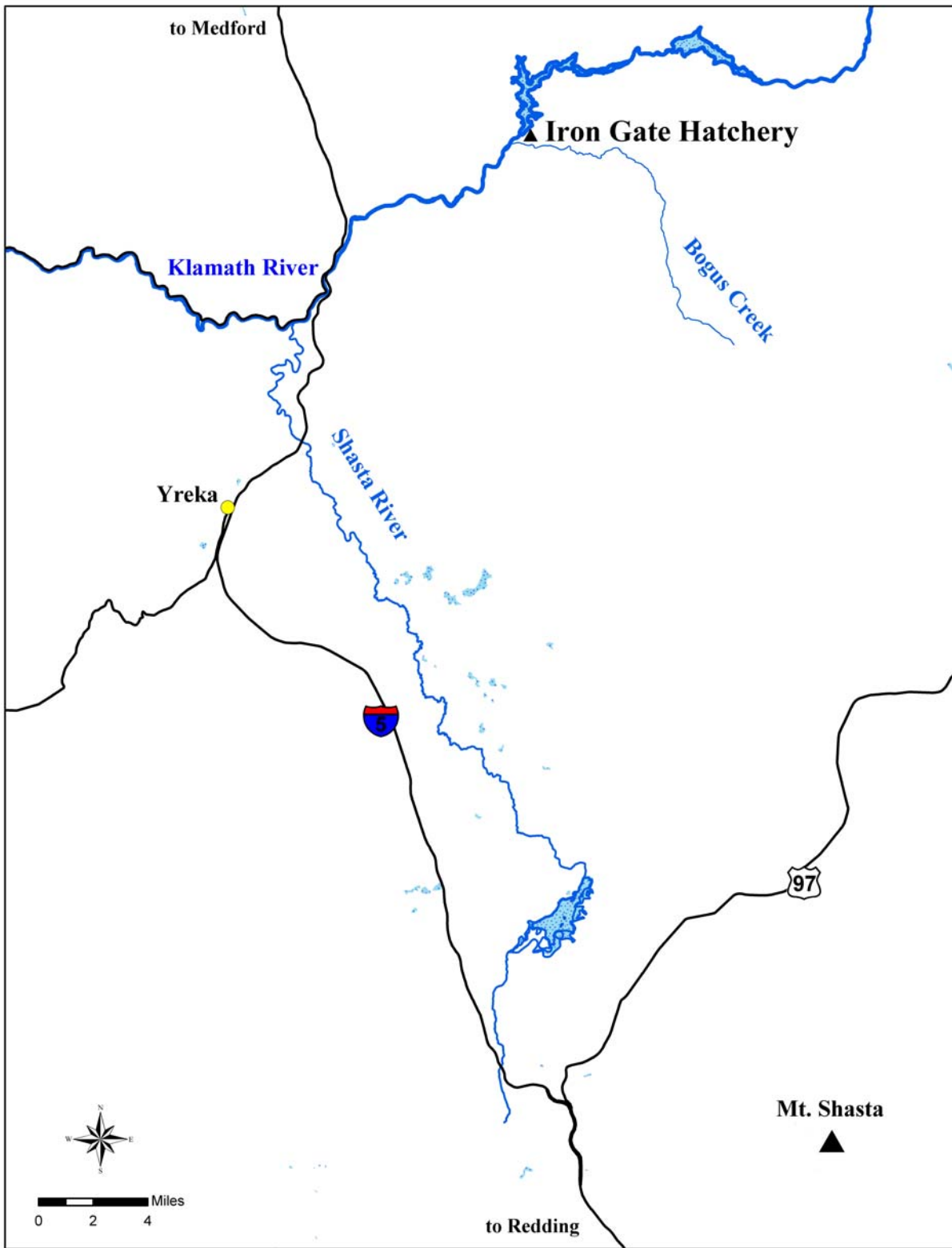


Figure 1. Location of Iron Gate Hatchery (California Department of Fish and Game, Siskiyou County).

## **Klamath River Project**

The California Department of Fish and Game's (CDFG), Klamath River Project (KRP) conducts systematic random sampling of fall-run Chinook salmon (hereafter referred to as Chinook salmon) annually during the Chinook spawning season. The purpose of the sampling is to characterize the adult Chinook salmon entering IGH in terms of age and sex composition, and to recover data from all coded wire tags (CWT) recovered from the heads of adipose fin clipped (ad-clipped) Chinook salmon. All Chinook salmon 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.

## **Coded Wire Tagging**

During April and May of each year, staff of the KRP insert CWT into 300,000 Chinook fingerlings and 100,000 yearling Chinook salmon. These tags contain a code that allows for the identification of six separate release groups of fingerlings, corresponding to different raceways. Yearling groups are also divided among the six raceways, but share a tag code and a November release date. One of the goals of the tagging program is to determine the success of the early release strategy (Hampton 2001). Formerly, smolts were released at IGH from June 1 to June 15 of each year. At the recommendation of the Joint Hatchery Review Committee (2001), CDFG developed an early release strategy, which allows for the release of smolts in four groups, each separated by approximately 1 week, beginning around mid-May. There are several benefits to the early release strategy, including reduced competition with natural salmonids and improved survival of smolts due to lower water temperatures and higher flows.

Release of Chinook smolts are subject to hatchery goals and constraints including size at release (target of 90/lb) and minimum river temperatures. (CDFG, PP&L 1996) If minimum river temperatures exceed 65 degrees F, the smolts may be released at a size smaller than 90/lb.

## **MATERIALS AND METHODS**

### **Chinook Salmon**

In 2007, all Chinook salmon were allowed to enter IGH. Upon entering the hatchery, Chinook salmon were held until they were ready to spawn. Readiness to spawn was determined by hatchery staff and based on timing, firmness of the ovaries, and ease of stripping eggs when handled. KRP staff conducted a systematic random sample of every 10<sup>th</sup> Chinook salmon during each sampling day. A KRP employee was designated each day to identify every 10<sup>th</sup> Chinook salmon on the process line, as well as all ad-clipped Chinook salmon. These random and non-random fish were pulled from the conveyor belt for sampling. After the fish were spawned, KRP staff collected data on fork length, sex, and presence or absence of clips and/or marks. Tissue samples from intact fins were collected from every 100<sup>th</sup> Chinook (every 10<sup>th</sup> Chinook sampled) at the request of NOAA's Salmon Genetic Repository, and otoliths were also

collected from every 100<sup>th</sup> Chinook for a joint study by the Klamath National Forest and the University of California at Davis.

Heads were taken from all ad-clipped Chinook salmon (random and non-random fish) as well as data on fork length and sex, and scale samples.

## Coho Salmon

In 2007, staff of the KRP collected biological data (sex, fork length, presence of marks or clips and scale samples) for all coho salmon which entered IGH. Since 1995, all hatchery-reared coho salmon within the Klamath River basin have been marked with a maxillary clip prior to release. IGH coho salmon receive a left maxillary clip and Trinity River Hatchery (TRH) coho salmon are marked with a right maxillary clip. All ad-clipped coho are checked for the presence of a CWT by passing them through a tag detector.

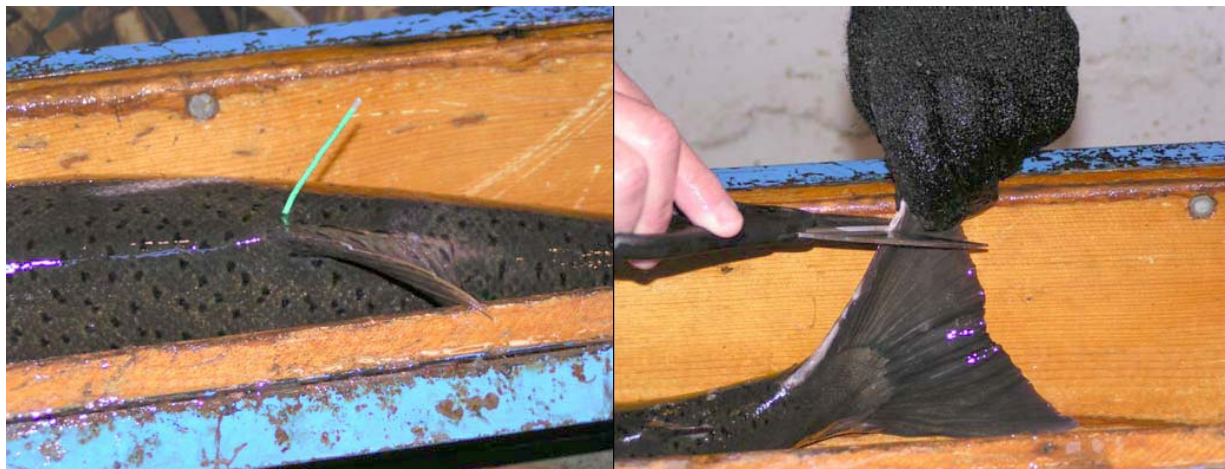
The protocol developed in 2004 by NOAA Fisheries and CDFG to reduce potential take of naturally produced coho salmon was again followed at IGH in 2007. The goals of the protocol are to incorporate unmarked coho salmon into the spawning matrix, to release unmarked coho salmon not spawned, and to monitor unmarked coho salmon releases. The protocol is summarized as follows:

1. Only enough eggs and sperm from unmarked coho will be taken to account for the overall egg take needed to make up 20 to 25% of the total annual release of yearlings at each hatchery. To determine how many coho females will need to be spawned this season at each hatchery to obtain the desired percentage of yearlings released, we assumed 2,600 eggs per female, a 70% survival rate from green eggs to eyed eggs and an 80% survival rate from eyed eggs to yearlings. These figures are based on historical averages seen at both hatcheries over the past 30 years. This will mean that IGH will need to take approximately 10 unmarked coho (5 male and 5 female) to procure 26,000 green eggs. This will produce about 18,200 eyed eggs and 14,560 yearlings (19.4% of 75k). TRH will need to take approximately 70 unmarked coho (35 male and 35 female) to procure 182,000 green eggs. This will produce about 127,400 eyed eggs and 101,920 yearlings (20.4% of 500k). The remainder of the green eggs needed to meet the overall Coho production goals at each hatchery will come only from spawning marked adults of hatchery origin.
2. Spawning protocols will follow a one-to-one mating of males to females. By definition, eggs determined to be of unmarked origin will come from mating one unmarked fish with a marked hatchery origin fish. The Department **will not** pair an unmarked fish with another unmarked fish during spawning activities.
3. By closely following the above spawning protocols, there will be no need to cull any eggs from unmarked origin fish. There is a chance that the final percentage of unmarked origin yearlings released may be slightly higher or lower than 20%

depending on the size of the run and survival rates experienced this season at both hatcheries.

4. All unmarked adults returning to the hatchery will be passed through a tag detector to determine if they contain a coded wire tag indicating they came from Cole Rivers Hatchery in Oregon. All unmarked fish determined to be of Cole Rivers Hatchery origin will not be included in the spawning matrix and will be killed and the cwt will be recovered and decoded to verify the origin of these fish.
5. All unmarked adults not used in the spawning matrix will have their caudal fin clipped, will be floy tagged and then released back into the river at the hatchery site.

Application of a caudal clip and insertion of an individually numbered floy tag to unmarked coho salmon provides an opportunity to monitor the movement of these coho salmon after release (Figure 2). Once released, these coho salmon may return to the hatchery, spawn in the Klamath River downstream of IGH, or enter one of several tributary streams downstream of Iron Gate Dam. Application of the caudal clip serves as a backup mark, in case the floy tag is shed. The caudal clip also provides CDFG with the ability to identify these coho salmon should they pass through one of the video fish counting facilities located on Bogus Creek and the Shasta River. Individually numbered floy tags provide the ability to track individual coho salmon if they return to the hatchery or are recovered in one of the spawning ground surveys.



**Figure 2. Photograph of Floy Tag application (left) and anterior caudal clip (right) applied to unmarked Coho salmon at Iron Gate Hatchery prior to release back to the river during the 2007 spawning season.**

## RESULTS

### Chinook Salmon

Chinook salmon began entering IGH on September 25, 2007. A total of 17,149 Chinook salmon returned to IGH during the fall 2007 spawning season. Of these, KRP staff collected scale samples, determined sex, and measured fork lengths for 2,370 Chinook salmon. Randomly sampled male Chinook ranged in size from 40 cm to 95 cm (Figure 3). Analysis of the length frequency distribution for randomly sampled Chinook males indicated that the cutoff point between grilse and adults occurred at  $\leq 50$  cm in fork length, yielding approximately 0.9% grilse. Therefore, staff estimates that 154 grilse and 16,995 adults entered IGH during the 2007 season. Females accounted for 61% (10,447) of the run and males accounted for 39% (6,702). Randomly sampled female Chinook ranged in size from 53 to 85 cm (Figure 4). The last Chinook to enter IGH for the 2007 spawning season was observed on December 10, 2007.

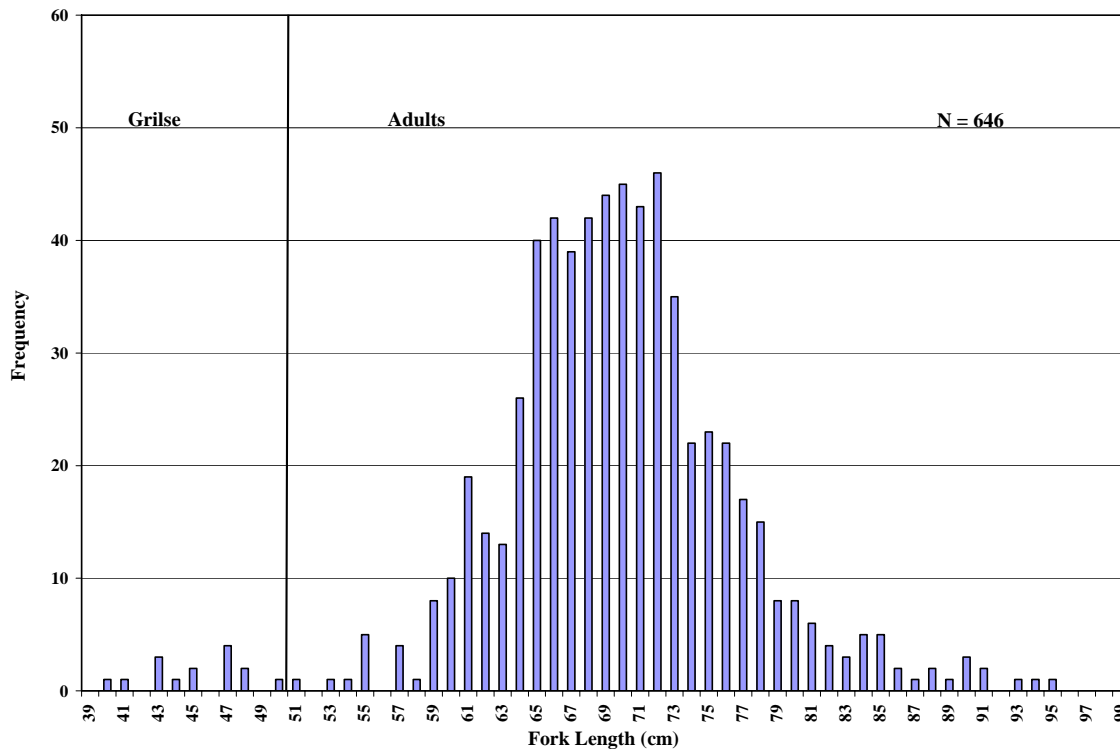


Figure 3. Length frequency distribution for systematic sample of male Chinook salmon recovered at IGH during the 2007 spawning season.

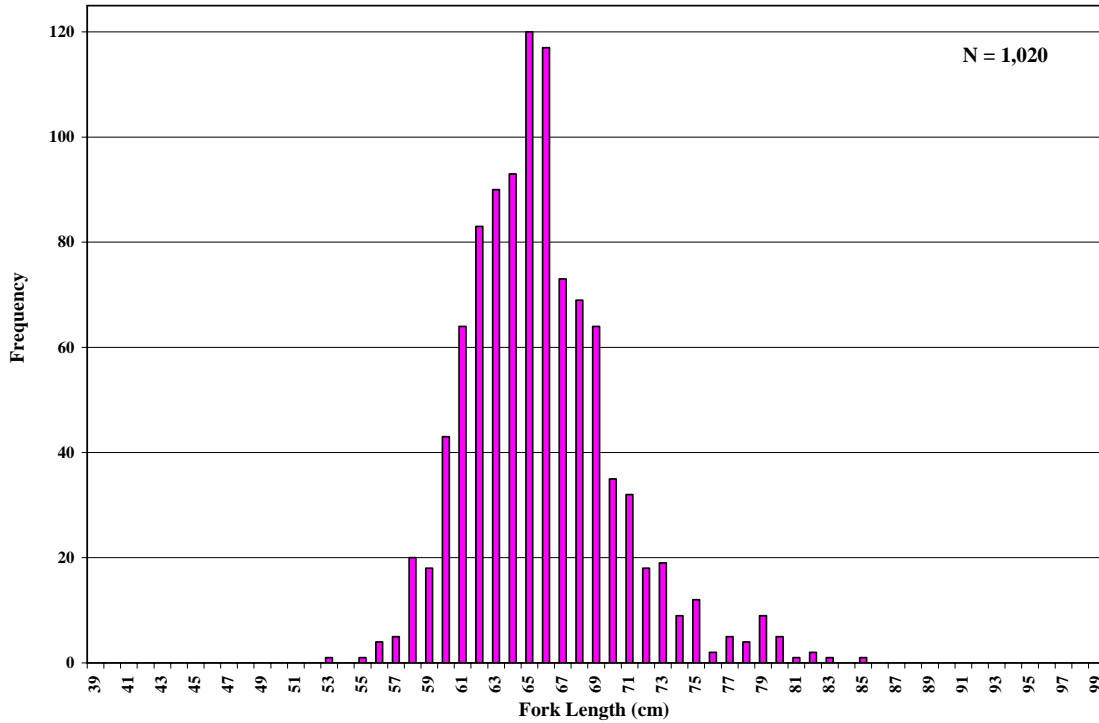


Figure 4. Length frequency distribution for systematic sample of female Chinook salmon recovered at IGH during the 2007 spawning season.

Heads from 779 ad-clipped Chinook salmon (from random and non-random fish) were collected for CWT recovery. Of these, 43 heads contained no tags, 15 CWTs were lost during dissection and 3 CWTs were unreadable. The contribution of lost or unreadable CWTs was estimated by applying the proportions of known CWTs (718) to the 18 lost or unreadable CWT ad-clipped Chinook (Table 2).



**Table 2. Estimated contribution of 18 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 CWT recoveries at IGH during the 2007 season.**

<b>CWT Code</b>	<b>Brood Year</b>	<b># of CWT's Recovered</b>	<b>% of CWT's Recovered</b>	<b>Estimated Number</b>	<b>Production Multiplier</b>	<b>Expanded Estimate</b>
65318	2003	1	0.0014	0.0251	4.01	<b>0</b>
65323	2004	3	0.0042	0.0752	4.06	<b>0</b>
65324	2004	1	0.0014	0.0251	4.05	<b>0</b>
65325	2004	1	0.0014	0.0251	4.14	<b>0</b>
66358	2002	2	0.0028	0.0501	10.52	<b>1</b>
66359	2002	1	0.0014	0.0251	10.00	<b>0</b>
66360	2002	1	0.0014	0.0251	7.99	<b>0</b>
601020407	2002	1	0.0014	0.0251	29.47	<b>1</b>
601020408	2003	5	0.0070	0.1253	19.20	<b>2</b>
601020409	2003	2	0.0028	0.0501	19.28	<b>1</b>
601020500	2003	4	0.0056	0.1003	18.81	<b>2</b>
601020501	2003	1	0.0014	0.0251	20.34	<b>1</b>
601020502	2003	29	0.0404	0.7270	14.11	<b>10</b>
601020503	2003	3	0.0042	0.0752	21.42	<b>2</b>
601020504	2004	117	0.1630	2.9331	17.12	<b>50</b>
601020505	2004	153	0.2131	3.8357	16.61	<b>64</b>
601020506	2004	159	0.2214	3.9861	34.04	<b>136</b>
601020507	2004	89	0.1240	2.2312	37.40	<b>83</b>
601020508	2004	75	0.1045	1.8802	9.09	<b>17</b>
601020509	2004	57	0.0794	1.4290	8.01	<b>11</b>
601020604	2005	3	0.0042	0.0752	37.01	<b>3</b>
601020606	2005	2	0.0028	0.0501	9.25	<b>0</b>
601020607	2005	8	0.0111	0.2006	9.22	<b>2</b>
<b>Totals:</b>		<b>718</b>	<b>1.0</b>	<b>18</b>		<b>387</b>

The estimated contribution of unknown CWT Chinook was then added to the contribution of known CWTs to determine the total contribution of hatchery Chinook entering IGH (Table 3). Ninety-nine percent of CWTs recovered (and successfully read) originated from IGH. Six CWT codes were recovered from fish tagged and released at Trinity River Hatchery (TRH) by the Hoopa Fisheries Program. Of these 6 fish, 5 were from brood year (BY) 2004 and one from BY 2003. Based on the expansion of CWTs, KRP staff estimated that 15,811 (92%) of the Chinook entering IGH during the 2007 season were of hatchery origin (Table 3).

<b>Table 3. 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 2007 spawning season.</b>							
<b>CWT Code</b>	<b>Release Location</b>	<b>Brood Year</b>	<b>Age</b>	<b>Release Type</b>	<b># of CWT's Recovered</b>	<b>Production Multiplier</b>	<b>Expanded Estimate</b>
<b>Estimated contribution of known CWTs:</b>							
65318	TRH	2003	4	Fy	1	4.01	4
65323	TRH	2004	3	Ff	3	4.06	12
65324	TRH	2004	3	Ff	1	4.05	4
65325	TRH	2004	3	Ff	1	4.14	4
66358	IGH	2002	5	Fy	2	10.52	21
66359	IGH	2002	5	Fy	1	10.00	10
66360	IGH	2002	5	Fy	1	7.99	8
601020407	IGH	2002	4	Ff	1	29.47	29
601020408	IGH	2003	4	Ff	5	19.20	96
601020409	IGH	2003	4	Ff	2	19.28	39
601020500	IGH	2003	4	Ff	4	18.81	75
601020501	IGH	2003	4	Ff	1	20.34	20
601020502	IGH	2003	4	Fy	29	14.11	409
601020503	IGH	2003	4	Ff	3	21.42	64
601020504	IGH	2004	3	Ff	117	17.12	2003
601020505	IGH	2004	3	Ff	153	16.61	2541
601020506	IGH	2004	3	Ff	159	34.04	5412
601020507	IGH	2004	3	Ff	89	37.4	3329
601020508	IGH	2004	3	Fy	75	9.095	682
601020509	IGH	2004	3	Fy	57	8.007	456
601020604	IGH	2005	2	Ff	3	37.01	111
601020606	IGH	2005	2	Fy	2	9.24	18
601020607	IGH	2005	2	Fy	8	9.22	74
				<b>Subtotal</b>	<b>718</b>		<b>15424</b>
<b>Estimated contribution of unknown CWT's (Table 4)</b>					<b>18</b>		<b>387</b>
<b>Total Estimated Hatchery Contribution =</b>							<b>15,811</b>
Unknown CWTs: 200000=CWT lost, 400000=CWT unreadable							
Ff = Fall-run Chinook fingerling, Fy = Fall-run Chinook yearling							
The production multiplier value is the inverse of the proportion initially tagged.							

The Klamath River Technical Advisory Team (KRTAT) met in February of 2008 to review the 2007 Chinook salmon run size monitoring efforts and estimate the age composition of the 2007 run (KRTAT 2008). The KRTAT used scale age proportions for developing adult structure and length frequency analysis for the grilse cutoff point for the 2007 IGH fall Chinook salmon returns (Table 4).

**Table 4. Age composition of the 2007 Chinook salmon run that entered Iron Gate Hatchery (IGH), as developed by the Klamath River Technical Advisory Team (KRTAT).**

	Age				Total Adults	Total Run
	2	3	4	5		
Number of Chinook	180	16,528	381	59	16,969	17,149
Percent of Total Run	1.0%	96.4%	2.2%	0.3%		

### Coho Salmon

The first coho salmon returning to IGH was observed on October 15, 2007 and the last coho salmon of the 2007-08 spawning season was observed on December 17, 2007. A total of 779 coho salmon entered IGH during the season. KRP staff collected biological data from 100% of the coho salmon run. . Of the 779, 83% (643) had left maxillary clips, indicating they were of IGH origin. Six coho salmon had right maxillary clips indicating they were of TRH origin. In addition to IGH and TRH returns, two coho salmon with adipose clips and one with a combination adipose and left maxillary clip were recovered, but no CWT were detected with the tag detector. Male coho salmon ranged in size from 35 cm to 80 cm (Figure 6). Female coho salmon ranged in size from 41 cm to 76 cm (Figure 7). Based on the length frequency distribution of 437 male coho salmon, grilse were estimated to be  $\leq 54$  cm fork length (Figure 6). Of the 437 males, 150 (34%) were grilse.

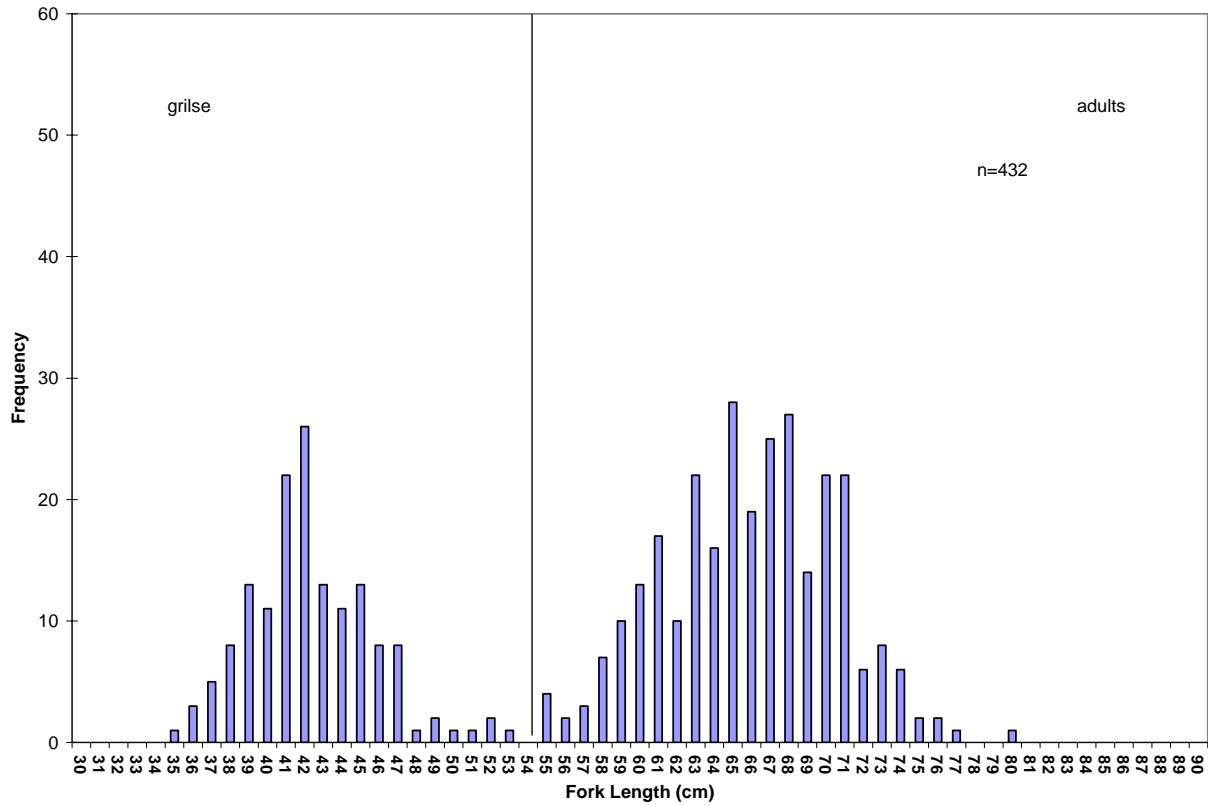


Figure 6. Length frequency distribution for male coho salmon sampled (n = 432) at Iron Gate Hatchery during the 2007-08 spawning season.

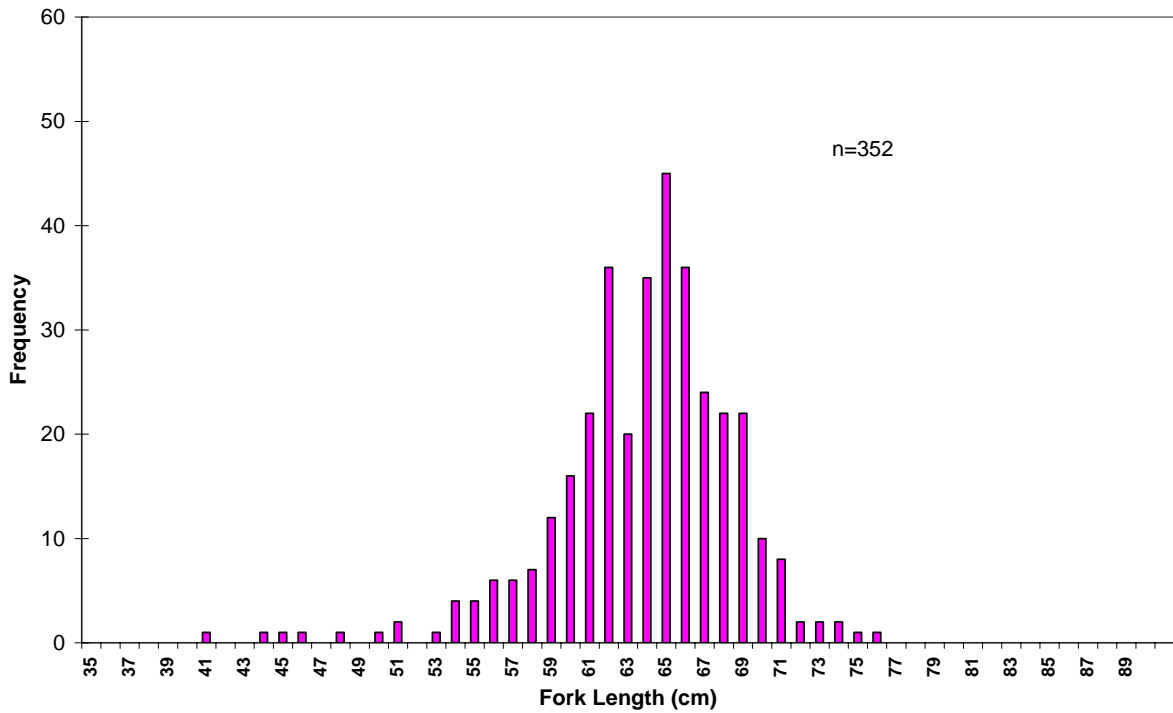


Figure 7. Length frequency distribution for female coho salmon sampled at Iron Gate Hatchery during the 2007-08 spawning season.

A total of 125 unmarked coho salmon were Floy tagged and released from IGH to the Klamath River in 2007. Of these, 7 reentered IGH and were returned to the river, 4 were recovered as carcasses in nearby Bogus Creek, 2 were observed passing through the video flume at the Shasta River Fish Counting Facility, and 5 were recovered from carcasses washed back on the weir at the Shasta River Fish Counting Facility. No Floy tagged coho salmon were reported in the main stem Klamath River. None of the 7 unmarked coho salmon that returned to IGH after their initial tagging reentered the hatchery on more than one occasion.

## DISCUSSION

### Chinook Salmon

The Klamath River Project has been monitoring the escapement of fall-run Chinook salmon in the Klamath River basin, excluding the Trinity River, since 1978. 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 generated from these two efforts is summarized in the CDFG "Mega Table" each year. Chinook salmon run size data provided in the Mega Table is reviewed by the KRTAT during their annual age composition meeting in late January or early February. During the age composition meeting, 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 escapement for 2007 and previous years, coupled with data from CWT recoveries from hatchery stocks, allow for cohort reconstruction of both hatchery and natural components of Klamath River Chinook salmon. The results of cohort reconstruction allow model-based forecasting of next year's abundance in the ocean, ocean fishery contact rates, and percentage of spawners escaping to natural areas (KRTAT 2008). These forecasts are used by the KRTAT as essential inputs to the Klamath Ocean Harvest Model to predict abundance of Chinook salmon at sea. This information is then used to determine fishery allocation levels and determine the potential effects of harvest options upon salmon fisheries along the Pacific Coast. Thus, the run size estimates that are compiled each year provide a critical source of data necessary for the effective management of Klamath River Chinook salmon each year.

The 2007 run (17,149) of Chinook salmon at IGH was 914 fish above the average (16,235) for the period from 1978 to 2007. In 2007 IGH Chinook salmon comprised roughly 12.9% of the total (Klamath basin) in-river run (132,167) and 17.8% of the total spawner escapement (95,998) (Table 5).

During the 2007 spawning season 0.9% (154) of the run was composed of grilse. This is the second lowest grilse percentage observed at IGH in KRP history, the lowest (0.3%) occurred in 2005. The 2007 grilse percentage was well below the 30-year average of 9.4% (1,058). The highest percentage (51.1%) of grilse (3,737) was observed in 1992 (Figure 8). From 1978 to 1990, at least 10% of the run were grilse in 7 out of 13 years.

In contrast, from 1991 to 2007 the proportion of grilse exceeded 10% for only 3 of the 17 years (Table 7). This proportion is similar to what has been observed in nearby Bogus Creek during those same time periods. From 1978 to 1990, at least 10% of the Bogus Creek run were grilse in 10 out of 13 years. In contrast, from 1991 to 2007 the proportion of grilse in Bogus Creek exceeded 10% for only 4 of the 17 years (Table 6). The average percentage of grilse Chinook in Bogus Creek during this 28 year period is 12.4% (667).

The 2006 grilse components of the in-river and IGH runs were a relatively high 30% and 17%, respectively. Since the number of returning grilse provides insight into the survival and abundance of 3-year old fish that are anticipated to be available in the next year, it is not surprising that the 3-year old component of the 2007 run was the dominant age class: 85% of the in-river run and 96% of the IGH run.

Although the low grilse return for Klamath River fall Chinook in 2007 is of concern, in April 2008 the Pacific Fishery Management Council (PFMC) approved a ban on ocean sport and commercial harvest of Chinook for the 2008 season in order to protect Sacramento fall-run Chinook stocks, which experienced a sharp decline in both 2006 and 2007. The federal ban extends from three to 200 miles off the coasts of California and Oregon, and the California Fish and Game Commission voted to prohibit sport and commercial Chinook salmon harvest in the state's ocean waters, which extend three miles offshore. Ocean fisheries impacts on Klamath River fall run Chinook will not take place during the 2008 season. An in-river sport and tribal fishery will take place in the Klamath River during 2008.

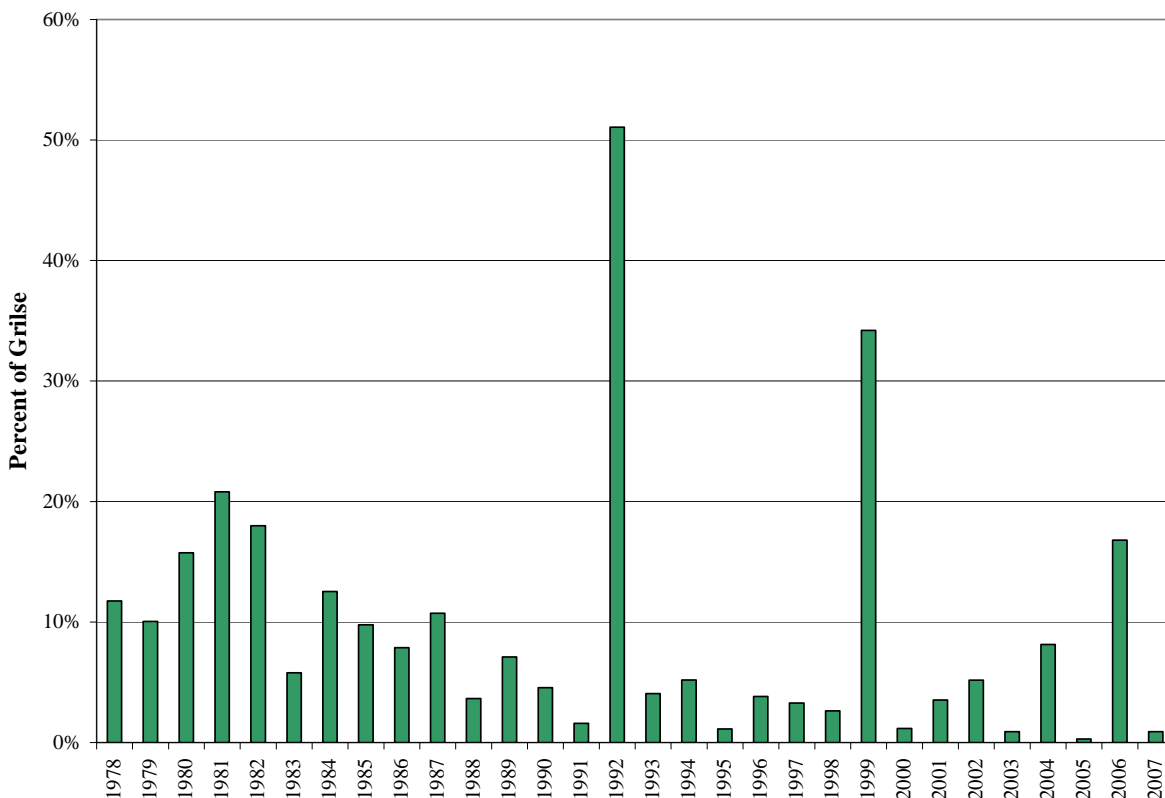


Figure 8. Historical percentages of Chinook grilse observed at Iron Gate Hatchery, Siskiyou County, from 1978 to 2007.

**Table 5. Fall-run Chinook salmon totals (includes adults and grilse) for the Klamath Basin, Iron Gate Hatchery, and Bogus Creek from 1978 to 2007.**

Year	In-River Run (IRR)	Spawner Escapement (SE)		Iron Gate Hatchery			Bogus Creek		
	Totals	Totals	% IRR	Totals	% IRR	% SE	Totals	% IRR	% SE
1978	115,728	90,135	77.9	7,870	6.8	8.7	5,579	4.8	6.2
1979	62,970	42,255	67.1	2,558	4.1	6.1	5,938	9.4	14.1
1980	82,413	57,683	70	2,863	3.5	5	5,070	6.2	8.8
1981	108,422	56,333	52	2,595	2.4	4.6	3,642	3.4	6.5
1982	106,020	67,076	63.3	10,186	9.6	15.2	7,143	6.7	10.6
1983	61,392	47,960	78.1	8,885	14.5	18.5	3,048	5	6.4
1984	55,542	30,375	54.7	6,094	11	20.1	3,504	6.3	11.5
1985	133,827	104,487	78.1	22,110	16.5	21.2	4,647	3.5	4.4
1986	239,559	180,263	75.2	18,557	7.7	10.3	7,308	3.1	4.1
1987	228,182	143,890	63.1	17,014	7.5	11.8	10,956	4.8	7.6
1988	215,696	130,749	60.6	16,715	7.7	12.8	16,440	7.6	12.6
1989	133,440	72,438	54.3	11,690	8.8	16.1	2,662	2	3.7
1990	40,274	25,705	63.8	7,040	17.5	27.4	785	1.9	3.1
1991	34,425	19,121	55.5	4,067	11.8	21.3	1,281	3.7	6.7
1992	40,391	28,479	70.5	7,318	18.1	25.7	1,154	2.9	4.1
1993	64,810	48,945	75.5	21,711	33.5	44.4	3,716	5.7	7.6
1994	78,354	60,850	77.7	14,566	18.6	23.9	8,260	10.5	13.6
1995 <sup>1</sup>	245,542	217,312	88.5	22,940	9.3	10.6	46,432	18.9	21.4
1996	185,305	108,325	58.5	14,165	7.6	13.1	10,797	5.8	10
1997	91,729	70,303	76.6	13,727	15	19.5	10,030	10.9	14.3
1998	95,286	75,157	78.9	15,326	16.1	20.4	6,835	7.2	9.1
1999	70,296	50,088	71.3	14,120	20.1	28.2	6,165	8.8	12.3
2000	228,323	188,642	82.6	72,474	31.7	38.4	35,051	15.4	18.6
2001	198,676	142,324	71.6	38,568	19.4	27.1	12,575	6.3	8.8
2002	170,014	99,016	58.2	24,961	14.7	25.2	17,834	10.5	18
2003	195,791	152,390	77.8	32,260	16.5	21.2	15,610	8	10.2
2004	88,589	53,478	60.4	11,519	13	21.5	3,788	4.3	7.1
2005	67,579	56,188	83.1	13,997	20.7	24.9	54	8	9.6
2006	88,258	70,986	80.4	13,990	15.8	19.7	4,132	4.6	5.8
2007	132,167	95,998	72.6	17,149	12.9	17.8	4,741	3.6	4.9
<b>Average</b>	<b>121,967</b>	<b>86,232</b>	<b>69.9</b>	<b>16,235</b>	<b>14</b>	<b>19</b>	<b>8,839</b>	<b>6.7</b>	<b>9.4</b>
<b>MAX</b>	<b>245,542</b>	<b>217,312</b>	<b>88.5</b>	<b>72,474</b>	<b>33.5</b>	<b>44.4</b>	<b>46,432</b>	<b>18.9</b>	<b>21.4</b>
<b>MIN</b>	<b>34,425</b>	<b>19,121</b>	<b>52</b>	<b>2,558</b>	<b>2.4</b>	<b>4.6</b>	<b>54</b>	<b>1.9</b>	<b>3.1</b>
<b>ST DEV</b>	<b>66,378</b>	<b>50,547</b>	<b>10.0</b>	<b>13,532</b>	<b>7.2</b>	<b>9.1</b>	<b>9,917</b>	<b>3.8</b>	<b>4.6</b>

<sup>1</sup> For the 1995 season the gates at IGH were closed at times, therefore a significant portion of the IGH returns were diverted to Bogus Creek.

**Table 6: Summary of fall Chinook salmon escapement to Iron Gate Hatchery and Bogus Creek from 1978 to 2007.**

Year	Iron Gate Hatchery				Bogus Creek			
	Grilse	Adults	Total	% Grilse	Grilse	Adults	Total	% Grilse
1978	925	6,945	7,870	11.8%	651	4,928	5,579	11.7%
1979	257	2,301	2,558	10.0%	494	5,444	5,938	8.3%
1980	451	2,412	2,863	15.8%	1,749	3,321	5,070	34.5%
1981	540	2,055	2,595	20.8%	912	2,730	3,642	25.0%
1982	1,833	8,353	10,186	18.0%	2,325	4,818	7,143	32.5%
1983	541	8,371	8,912	6.1%	335	2,713	3,048	11.0%
1984	764	5,330	6,094	12.5%	465	3,039	3,504	13.3%
1985	2,159	19,951	22,110	9.8%	1,156	3,491	4,647	24.9%
1986	1,461	17,096	18,557	7.9%	1,184	6,124	7,308	16.2%
1987	1,825	15,189	17,014	10.7%	1,208	9,748	10,956	11.0%
1988	609	16,106	16,715	3.6%	225	16,215	16,440	1.4%
1989	831	10,589	11,690	7.1%	444	2,218	2,662	16.7%
1990	321	6,719	7,040	4.6%	53	732	785	6.8%
1991	65	4,002	4,067	1.6%	20	1,261	1,281	1.6%
1992	3,737	3,581	7,318	51.1%	556	598	1,154	48.2%
1993	883	20,828	21,711	4.1%	431	3,285	3,716	11.6%
1994	758	13,808	14,566	5.2%	443	7,817	8,260	5.4%
1995	259	22,681	22,940	1.1%	1,207	45,225	46,432	2.6%
1996	543	13,622	14,165	3.8%	377	10,420	10,797	3.5%
1997	452	13,275	13,727	3.3%	221	9,809	10,030	2.2%
1998	403	14,923	15,326	2.6%	205	6,630	6,835	3.0%
1999	4,830	9,290	14,120	34.2%	2,628	3,537	6,165	42.6%
2000	839	71,635	72,474	1.2%	373	34,678	35,051	1.1%
2001	1,364	37,204	38,568	3.5%	648	11,927	12,575	5.2%
2002	1,294	23,667	24,961	5.2%	304	17,530	17,834	1.7%
2003	290	31,970	32,260	0.9%	188	15,422	15,610	1.2%
2004	937	10,582	11,519	8.1%	295	3,493	3,788	7.8%
2005	42	13,955	13,997	0.3%	58	5,339	5,397	1.1%
2006	2,386	11,604	13,990	17.1%	764	3,368	4,132	18%
2007	154	16,995	17,145	0.9%	95	4,646	4,741	2%
<b>Average</b>	<b>1,058</b>	<b>15,168</b>	<b>16,235</b>	<b>9.4%</b>	<b>667</b>	<b>8,350</b>	<b>9,017</b>	<b>12.4%</b>

The Chinook salmon releases from IGH include both smolt and yearling releases. The current production goals include releases of 5,100,000 Chinook salmon smolts in May and June and 900,000 yearlings in the following November. For the period of 1991 to 2007, IGH Chinook smolt releases have varied from a low of 3,300,312 in 1993 to a high of 6,171,838 in 2006. For this same period, Chinook yearling releases have varied from 407,177 in 1996 to 1,155,096 in 1993. The average smolt and yearling releases for this period are 5,015,549 and 974,216, respectively. The largest run of Chinook to IGH, from 1962 to 2006, occurred in 2000 (72,474), the lowest in 1965 (678) (Figure 9). The largest in-river Chinook run (1995) observed between 1962 and 2007 occurred two years after the largest yearling release (1993) took place. One of the recommendations of the Joint Hatchery Review Committee is for IGH to produce more yearlings and less



smolts: “DFG should consider the desirability of expanding the Chinook yearling program at IGH and reducing the smolt production. Releasing fewer smolts and more yearlings would relieve some of the hatchery-natural interactions that occur during low-flow and poor water quality conditions present in the Klamath River during June and July. The time of the release from IGH occurs during October 15 – November 15, which coincides with flow release increases from Iron Gate Dam, increased precipitation in the Klamath Basin, and substantially improved water quality conditions in the Klamath River. Interactions between hatchery and natural Chinook would be minimized as a result of improved water quality and because most natural produced Chinook would have already left the Klamath Basin.” (CDFG and NMFS 2001). 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. In 2007, The KRP applied CWT to an additional 100,000 Chinook smolts for a total of 300,000 smolt tags, and 100,000 yearling tags.

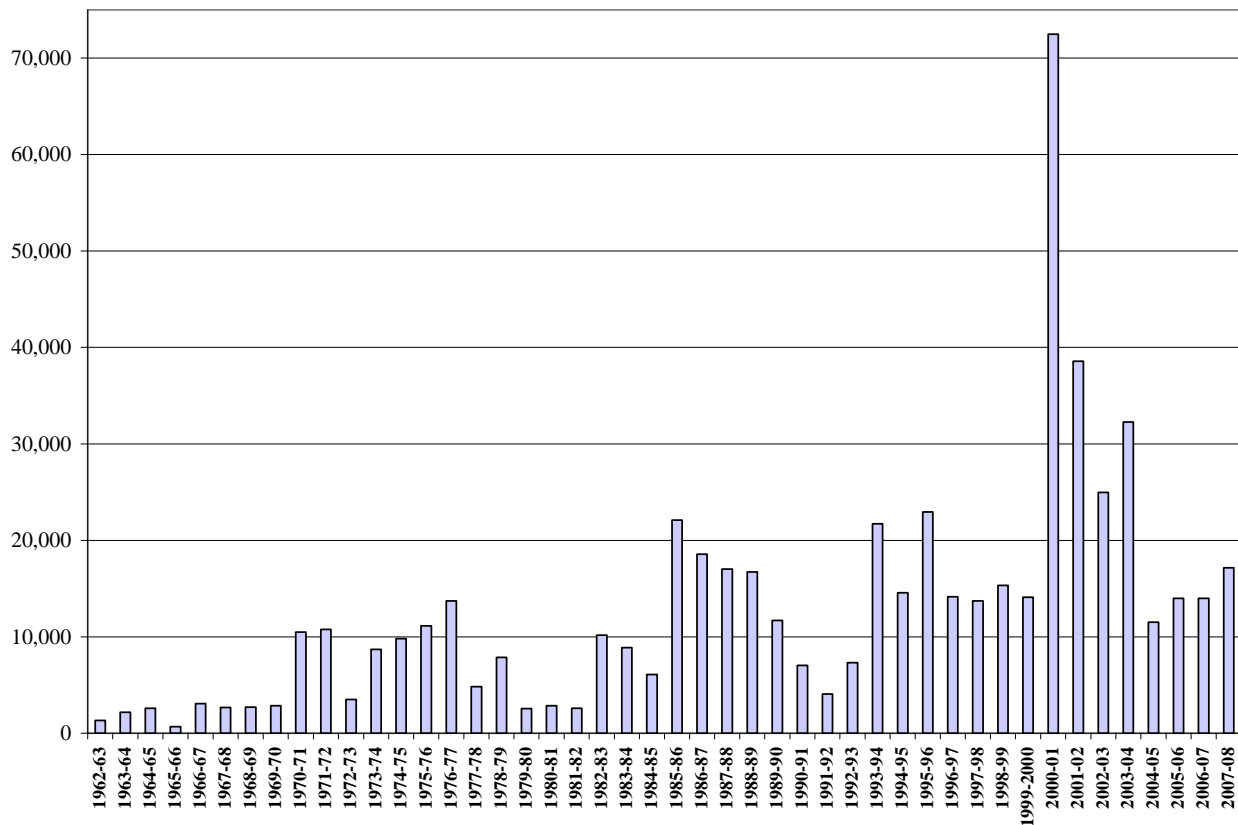


Figure 9. Chinook salmon runs at Iron Gate Hatchery (California Department of Fish and Game), 1962 to 2007.

Analysis of Brood Year (BY) 1979-1984 CWT recovered from Chinook salmon that were released as yearlings from IGH indicates that yearlings outperform fingerlings roughly 4 to 1 in both ocean fisheries and river returns (Baracco 1990). Therefore,

yearling releases provide a combined benefit of lower competition/interaction with natural production and higher percent returns. Analysis of a subset (BY 1990-2000) of fall-run Chinook CWT returns to IGH yields similar results (Table 7). The most striking example of this occurred with BY 1995 where smolts returned at a rate of 0.04% and yearlings at 1.1%. Yearlings were not tagged in 1998 or 1999 (BY 1997 and 1998) due to budget constraints, therefore, contribution rates for these two brood year yearling releases is unknown. Brood Year 1990 through 2002 CWT returns contain the most recent data that includes all potential returns (age-classes: 2, 3, 4, and 5). In view of the fact that yearlings generally return at a substantially higher rates than smolt releases, it would be reasonable to assume BY 1997 and 1998 yearlings would return at a higher rate as well, which should be factored in to the historical estimates of hatchery contributions.

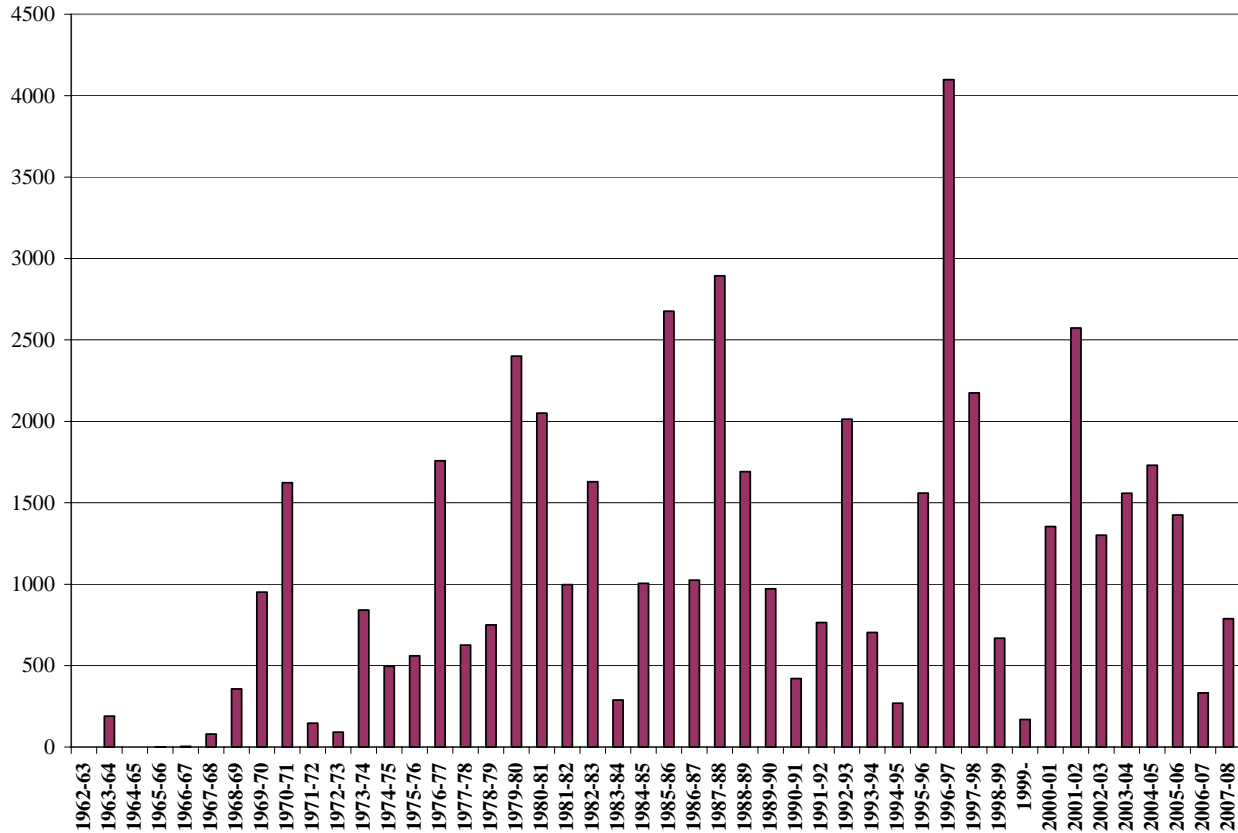
**Table 7. Return rates of IGH smolt and yearling CWT releases for brood years 1990 to 1996 and 1999 and 2000. There were no yearling CWT releases for Brood Years 1997 and 1998 due to budget constraints.**

Brood Year	IGH Smolt Releases			IGH Yearling Releases			Ratio of yearling/smolt return rates
	# CWT's Released	# CWT's Returned	Percent Return	# CWT's Released	# CWT's Returned	Percent Return	
1990	188,595	713	0.3781	95,880	740	0.7718	2.04
1991	191,200	96	0.0502	90,982	167	0.1836	3.66
1992	185,464	1,015	0.5473	74,024	269	0.3634	0.66
1993	188,562	40	0.0212	98,099	196	0.1998	9.42
1994	194,644	94	0.0483	86,564	453	0.5233	10.84
1995	191,799	85	0.0443	90,172	954	1.0580	23.87
1996	196,648	162	0.0824	95,396	581	0.6090	7.39
1999	182,131	686	0.3767	91,220	514	0.5635	1.50
2000	187,417	277	0.1478	100,702	707	0.7021	4.75
2001	198,761	13	0.0065	110,167	756	0.6862	104.92
						<b>Average:</b>	<b>16.90</b>

## Coho Salmon

A total of 779 coho salmon entered IGH during the 2007 spawning season, all of which were sampled by KRP staff. Since 1978 the number of coho salmon entering IGH has ranged from a low of 169 in 1999 to a high of 4,097 in 1996 and has averaged 1,409 (Figure 10), the 2007 coho salmon return was 44% below the historical average.

Starting with the 1994 brood year all hatchery reared coho salmon released within the Klamath Basin have been maxillary clipped. All coho salmon released from TRH receive a right maxillary clip (RM) and all coho salmon released from IGH receive a left maxillary clip (LM). Production goals for coho salmon within the Klamath Basin call for the release of 75,000 yearlings from IGH and 500,000 yearlings from TRH. Cole Rivers Hatchery located at the base of Lost Creek Dam on the Rogue River in Oregon releases about 200,000 coho salmon annually, which include approximately, 150,000 fish with an ad-clip only, 25,000 fish with an ad-clip and CWT, and 25,000 fish that are tagged with a CWT and are not ad-clipped. CWT recovered from both ad-clipped and unmarked coho salmon at IGH have typically found that these fish are progeny from Cole Rivers Hatchery on the Rogue River.



**Figure 10. Coho salmon returns to Iron Gate Hatchery (California Department of Fish and Game), 1962 to 2007.**

The age 3 coho salmon returns in 1997 represent the first adult returns that were marked with a LM clip prior to release from the hatchery. Therefore, survival estimates for coho salmon releases from IGH can be calculated for brood years from 1994 to 2004. Survival of coho salmon progeny released from IGH since the 1994 brood year has ranged from 0.3% to 3.5% and has averaged 1.24% (Table 8).

There is some uncertainty regarding the origin of unmarked coho salmon that return to IGH each year. Both naturally produced coho salmon and those of hatchery origin are potentially present within these returns. Returns of unmarked coho salmon of hatchery origin may be related to clipping error within IGH and TRH, or are unmarked coho salmon that are released from hatcheries located outside the basin.

Table 8. Iron Gate Hatchery (IGH) coho salmon yearling release and adult return summary for BY 1995 through BY 2004.

Brood Year	Yearling Release	Proportion Marked	Marked Release	Unmarked Release	Marked Return	Unmarked Expansion	Expanded Return	Percent Survival	Unmarked returns of IGH origin	Unmarked Returns	Proportion of unmarked returns explained by unmarked IGH releases
1995	81,498	0.990	80,683	815	556	1.0101	562	0.689116	6	251	0.022
1996	79,607	0.985	78,413	1,194	213	1.0152	216	0.271639	3	94	0.035
1997	75,156	0.954	71,699	3,457	515	1.0482	540	0.718282	25	201	0.124
1998	77,147	0.984	75,913	1,234	2621	1.0163	2664	3.452653	43	281	0.152
1999	46,254	0.985	45,560	694	992	1.0152	1007	2.177339	15	245	0.062
2000	67,933	0.970	65,895	2,038	710	1.0309	732	1.077472	22	584	0.038
2001	74,271	0.994	73,825	446	1208	1.0060	1215	1.636294	7	415	0.018
2002	109,374	0.900	98,437	10,937	1467	1.1111	1630	1.490299	163	163	1.000
2003	74,716	0.998	74,567	149	204	1.0020	204	0.273581	0	74	0.006
2004	89,482	0.990	88,587	895	514	1.0101	519	0.580219	5	142	0.037

Quality control estimates for clipping operations have been conducted at IGH since 1996 by IGH staff (1995 BY) and have ranged from a low of 90% effective (2002 BY) to a high of 99.83% effective (2003 BY) and averaged 97.5% effective. With the exception of BY 2002 which was clipped by non-hatchery staff, the effectively clipped proportion of coho salmon releases have been greater than 95.0%. By multiplying the number of marked adults observed by the unmarked expansion, derived by dividing the total released by the effectively marked release, the total number of IGH origin coho salmon that returned to IGH for each brood year can be estimated. Table 9 provides a summary, by brood year, of the number of marked fish observed, the expanded number of IGH produced fish, the percentage of yearlings that survived back to the hatchery, an estimate of the number of unmarked coho salmon that are likely progeny of IGH and the proportion of the total number of unmarked adult returns explained by the unmarked IGH releases. For brood years 1995 to 2004 the number of unmarked coho salmon that were estimated to have originated from progeny of IGH ranged from 0 to 163 fish. In all years excluding BY 2002 the average proportion of unmarked returns explained by the unmarked releases from IGH is 5.5%. Similar results would likely be found for coho salmon progeny released from TRH, however, given the small number of RM clips that are observed at IGH this number would probably be negligible in most, if not all years.

In years prior to 2005, the Department did not scan unmarked coho salmon that entered IGH to determine if any of these fish carried a CWT. During the last three years 100% of the unmarked coho salmon returning to IGH have been passed by a tag detector to determine the presence or absence of a CWT. Of the 139, 67 and 138 unmarked coho salmon that entered IGH during the 2005, 2006, and 2007 seasons respectively not a single one bore a CWT indicating that it was from the unmarked and tagged group of 25,000 fish released from Cole River Hatchery. Therefore, it is possible that an unknown number of unmarked coho salmon that returned to IGH during years prior to 2005 may have been of hatchery origin but their proportion is most likely very low. The number of unmarked coho salmon that stray from hatchery facilities other than IGH and return to IGH in any given year is likely very small and for most years a comparison of the number of IGH (corrected for the unmarked portion) marked versus unmarked coho salmon can be used to estimate the number of naturally produced coho salmon that enter IGH.

**Table 11. Summary of marked and unmarked coho salmon that have entered IGH from 1997 to 2007.**

1997/1998				1998/1999				1999/2000			
FIN CLIPS	ADULTS	GRILSE	Total	FIN CLIPS	ADULTS	GRILSE	Total	FIN CLIPS	ADULTS	GRILSE	Total
Unmarked	121	44	165	Unmarked	207	82	289	Unmarked	12	3	15
LM	1,717	253	1,970	LM	303	75	378	LM	138	15	153
RM	5		5	RM			0	RM			0
AD	24	4	28	AD	1	1	2	AD	1		1
ADLM	5	1	6	ADLM			0	ADLM			0
ADRM			0	ADRM			0	ADRM			0
Total Clipped	1,751	258	2,009	Total Clipped	304	76	380	Total Clipped	139	15	154
Total Returns	1,872	302	2,174	Total Returns	511	158	669	Total Returns	151	18	169
2000/2001				2001/2002				2002/2003			
FIN CLIPS	ADULTS	GRILSE	Total	FIN CLIPS	ADULTS	GRILSE	Total	FIN CLIPS	ADULTS	GRILSE	Total
Unmarked	198	64	262	Unmarked	217	29	246	Unmarked	216	9	225
LM	500	567	1,067	LM	2,054	76	2,130	LM	916	90	1,006
RM	4		4	RM	136	2	138	RM	25	0	25
AD	13		13	AD	51		51	AD	31	7	38
ADLM	8		8	ADLM	7		7	ADLM	5	2	7
ADRM			0	ADRM	1		1	ADRM			0
Total Clipped	525	567	1,092	Total Clipped	2,249	78	2,327	Total Clipped	977	99	1,076
Total Returns	723	631	1,354	Total Returns	2,466	107	2,573	Total Returns	1,193	108	1,301
2003/2004				2004/2005				2005/2006			
FIN CLIPS	ADULTS	GRILSE	Total	FIN CLIPS	ADULTS	GRILSE	Total	FIN CLIPS	ADULTS	GRILSE	Total
Unmarked	575	14	589	Unmarked	399	25	424 <sup>1</sup>	Unmarked	138	2	140
LM	620	218	838	LM	990	213	1,203	LM	1,254	28	1,282
RM	66	3	69	RM	31	1	32	RM	2	0	2
AD	52	6	58	AD	69	0	69	AD	1	0	1
ADLM	2	0	2	ADLM	0	0	0	ADLM	0	0	0
ADRM	2	0	2	ADRM	1	0	1	ADRM	0	0	0
Total Clipped	742	227	969	Total Clipped	1,096	214	1,310	Total Clipped	1,257	28	1,285
Total Returns	1,317	241	1,558	Total Returns	1,495	239	1,734	Total Returns	1,395	30	1,425
2006/2007				2007/2008				Proportion of clipped to unclipped coho			
FIN CLIPS	ADULTS	GRILSE	Total	FIN CLIPS	ADULTS	GRILSE	Total	Season	Clipped	Total	% Clipped
Unmarked	72	8	80	Unmarked	135	2	137	1997/1998	2,009	2,174	92.4%
LM	176	27	203	LM	480	163	643	1998/1999	380	669	56.8%
RM	1	1	2	RM	6	0	6	1999/2000	154	169	91.1%
AD	16	0	16	AD	2	0	2	2000/2001	1,092	1,354	80.6%
ADLM	0	0	0	ADLM	1	0	1	2001/2002	2,327	2,573	90.4%
ADRM	0	0	0	ADRM	0	0	0	2002/2003	1,076	1,301	82.7%
Total Clipped	193	28	221	Total Clipped	489	163	652	2003/2004	969	1,558	62.2%
Total Returns	265	36	301	Total Returns	624	165	789	2004/2005	1,310	1,734	75.5%
								2005/2006	1,285	1,425	90.2%
								2006/2007	221	301	73.4%
								2007/2008	652	789	82.6%
								<b>Average</b>	<b>1,043</b>	<b>1,277</b>	<b>79.8%</b>

LM= Iron Gate Hatchery (left maxillary clip)  
 RM = Trinity River Hatchery (right maxillary clip)  
 AD = Cole M. Rivers Hatchery (adipose clip)  
 \*1 : 7 of these unmarked coho carried a cwt and were actually from Cole Rivers Hatchery

ADLM = Origin unknown, possible ODFW release or injury caused  
 ADRM = Origin unknown, possible ODFW release or injury caused  
 Other = Multiple clips observed, either result of tag error, injury, or unknown origin

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