

California Department of Fish and Game

Klamath River Project

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

October 6, 2003 to December 31, 2003

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ABSTRACT

The California Department of Fish and Game's (CDFG), Klamath River Project (KRP) conducts random sampling of fall-run Chinook salmon (*Oncorhynchus tshawytscha*) annually, during the Chinook spawning season. The purpose of the sampling is to determine the abundance of adult fall-run Chinook salmon entering Iron Gate Hatchery (IGH), to characterize the run in terms of age and sex composition, and to recover all coded wire tags (from random and non-random fish) from adipose fin clipped (ad-clipped) Chinook. Fall-run Chinook salmon began entering IGH on September 15, 2003. A total of 32,260 Chinook salmon returned to IGH during the fall 2003 spawning season. Of these, KRP staff collected scale samples, determined sex, and measured fork lengths for 4,483 Chinook salmon (approximately twice the previous year's effort: 2,419 samples) and recovered heads from 1,532 ad-clipped salmon. Analysis of the length-frequency distribution for randomly sampled fall-run Chinook males indicates that the cutoff point between grilse and adults occurred at 55 cm (Fig. 2). During the 2003 spawning season 0.9% (290) of the run were grilse (according to scale analysis; length-frequency analysis yielded approximately 1.1% grilse), compared to 2001 and 2002 where 3.5% and 5.2% of the run were grilse, respectively. Females accounted for 51.3% (16,563 fish) of the run while males accounted for 48.7% (15,697 fish). The last Chinook of the 2003 spawning season was observed on December 3, 2003. The 2003 run (32,260) of fall-run Chinook salmon recovered at IGH was the third largest run recorded at IGH in the last 26 years (Fig. 5), since the beginning of the Klamath River Project, surpassed only by 2000 (72,474) and 2001 (38,568). Although 2003 ranked 3rd highest for total IGH run numbers, percent contributions to total (Klamath basin) in-river run and total spawner escapement were only 9th highest and 11th highest, respectively (Table 4). Due to budget constraints, biological data for coho salmon (sex, fork length, presence of marks or clips and scale samples) were not collected by staff of the KRP during the 2003-04 season. Prior to budget cuts, staff of the KRP collected biological data for a large portion of the coho which entered IGH. Results from the 2002-03 coho spawning season sampling are detailed in the 2002-03 KRP Iron Gate Recovery Report. Results from the Iron Gate Hatchery counts for the 2003-04 coho spawning season are included. The recorded dates for the coho run were from October 17 to December 31, 2003.

INTRODUCTION

Iron Gate Hatchery

The Iron Gate Hatchery is located adjacent to the Klamath River (river mile 190), in Siskiyou County, CA, approximately 120 miles north of Redding, near the Oregon border (Fig. 1). This hatchery was established in 1963 in order to mitigate for the effects of Iron Gate Dam on anadromous species. The production goals (CDFG and PP&L 1996) for the hatchery are listed in Table 1 (the Steelhead Research and Monitoring Program collects data on the steelhead run).

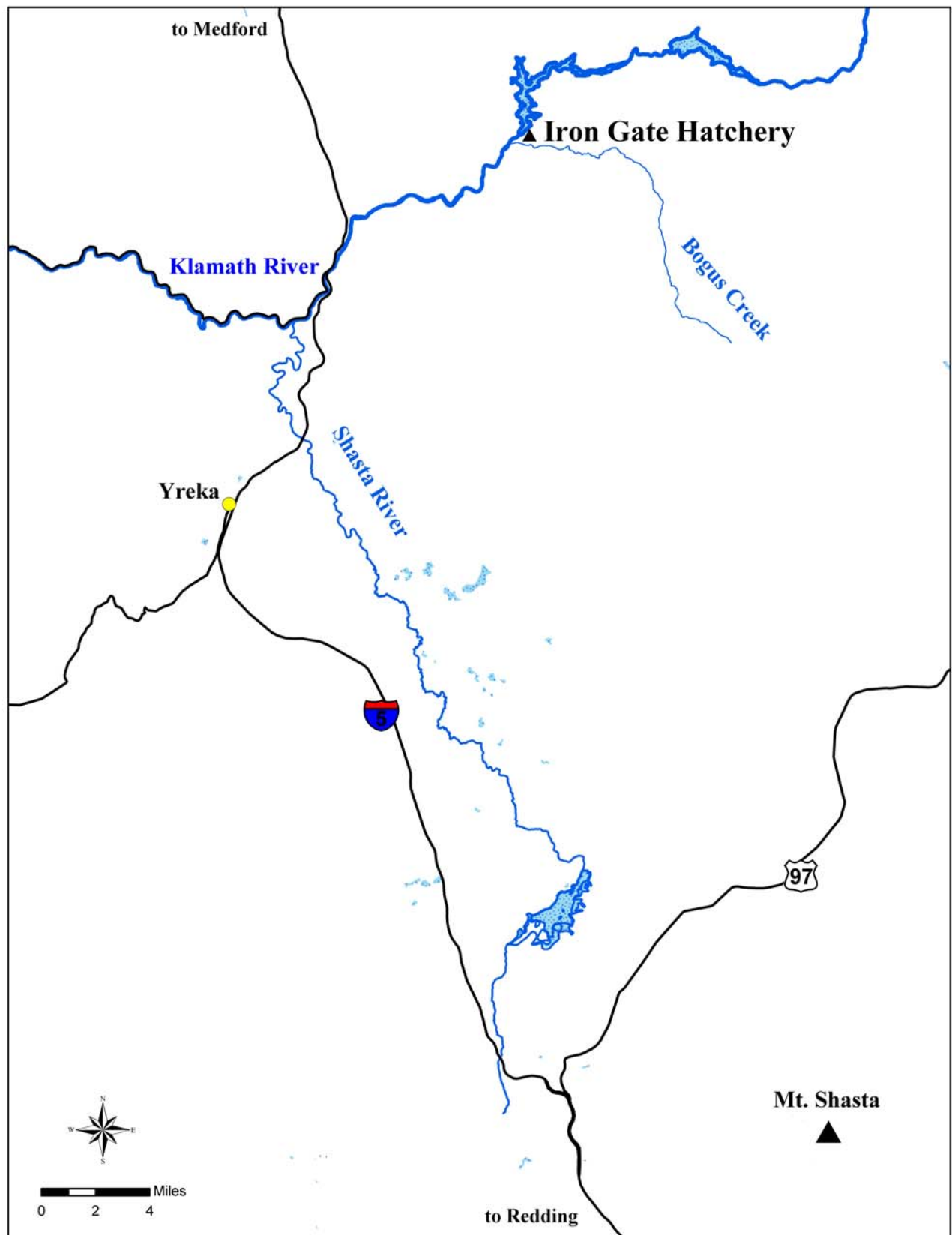


Figure 1. Location of Iron Gate Hatchery (California Department of Fish and Game, Siskiyou County).

Table 1. Production goals for Iron Gate Hatchery (California Department of Fish and Game, Siskiyou County).

Species	Number released	Released	Run timing
Chinook Salmon	4,920,000 smolts	May-June	mid September to early November
	1,080,000 yearlings	November	November
Coho	75,000 yearlings	March	late October to early January
Steelhead	200,000 yearlings	March-May	November to March

Klamath River Project

All tagged Chinook are marked with an adipose fin clip, which allows for identification and recovery of the coded wire tags (CWTs) when the Chinook return to the hatchery during subsequent spawning seasons. The goals of the recovery project are to collect biological data on a random sample of Chinook and coho salmon (when funding is available to recover coho) entering IGH and to recover all coded wire tags identified. These tagged fish provide a reference of known-age fish which is used, along with scale samples and analysis of length frequency distribution, for the determination of age composition.

MATERIALS AND METHODS

Coded Wire Tagging

During April and May of each year (since 1979), staff of the KRP insert CWTs into 200,000 Chinook smolt (90 fish/lb) and 120,000 yearling Chinook salmon. Smolts (fingerlings) receive a half length tag; yearlings receive a full length tag. These tags contain a code that allows for the identification of four separate groups of fingerlings and three groups of yearlings (which correspond to different raceways). 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. At the recommendation of the Joint Hatchery Review Committee (2001), CDFG developed this 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). One of these yearling groups are raised at Fall Creek Hatchery, which is adjacent to Fall Creek (a tributary to Iron Gate Reservoir), an excellent source of high quality water. 2002 was the first year that Fall Creek yearlings were tagged with a unique CWT code. This unique CWT code will help to determine if Fall Creek yearlings have a higher survival rate than IGH yearlings.

Random Sampling and Coded Wire Tag Recovery

All Chinook are allowed to enter IGH. Upon entering IGH in the fall of 2003, Chinook salmon were held until they were 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 the fish are spawned, they are counted, sexed and examined for clips and/or marks, by staff of the KRP. During each sampling day, a random sample (every 10th Chinook,) was processed. Fork length and sex were determined and a scale sample was collected for each of these random fish. Heads containing CWTs and scale samples, as well as fork length measurements and sex determinations, were collected from all

ad-clipped Chinook (random and non-random fish). Excess fish are killed and added to the post-spawned fish. All fish are processed and donated to local food banks, churches, and the public.

Coho

Due to budget constraints, KRP staff did not collect biological data for coho during the 2003-04 coho spawning season. Prior to budget cuts, data collected included sex, fork length, presence of marks or clips and scale samples, for a large percentage of the coho that entered IGH. Each coho was inspected for the presence of marks and clips (adipose and right or left maxillary). Since 1995, all hatchery reared coho salmon within the Klamath River basin have been marked with a maxillary clip prior to release. IGH coho receive a left maxillary clip; Trinity River Hatchery (TRH) coho are marked with a right maxillary clip.

RESULTS

Chinook

Chinook began entering IGH on September 15, 2003. A total of 32,260 Chinook salmon returned to IGH during the fall 2003 spawning season. Of these, KRP staff collected scale samples, determined sex, and measured fork lengths for 4,483 Chinook salmon (approximately twice the previous year's effort: 2,419 samples). Randomly sampled male Chinook ranged in size from 39 cm to 106 cm (Fig. 2). Analysis of the length frequency distribution for randomly sampled fall-run Chinook males indicated that the cutoff point between grilse and adults occurred at 55 cm in fork length. Length-frequency analysis yielded approximately 1.1% grilse as opposed to scale analysis which yielded 0.9% grilse. Final grilse proportions were derived from scale analysis due to the low numbers of grilse. Therefore, 290 grilse and 31,970 adults entered IGH, according to scale analysis. Females accounted for 51.3% (16,563 fish) of the run and males accounted for 48.7% (15,697 fish). Randomly sampled female Chinook ranged in size from 52 to 93 cm (Fig. 3). The last Chinook to enter IGH for the 2003 spawning season was observed on December 3, 2003.

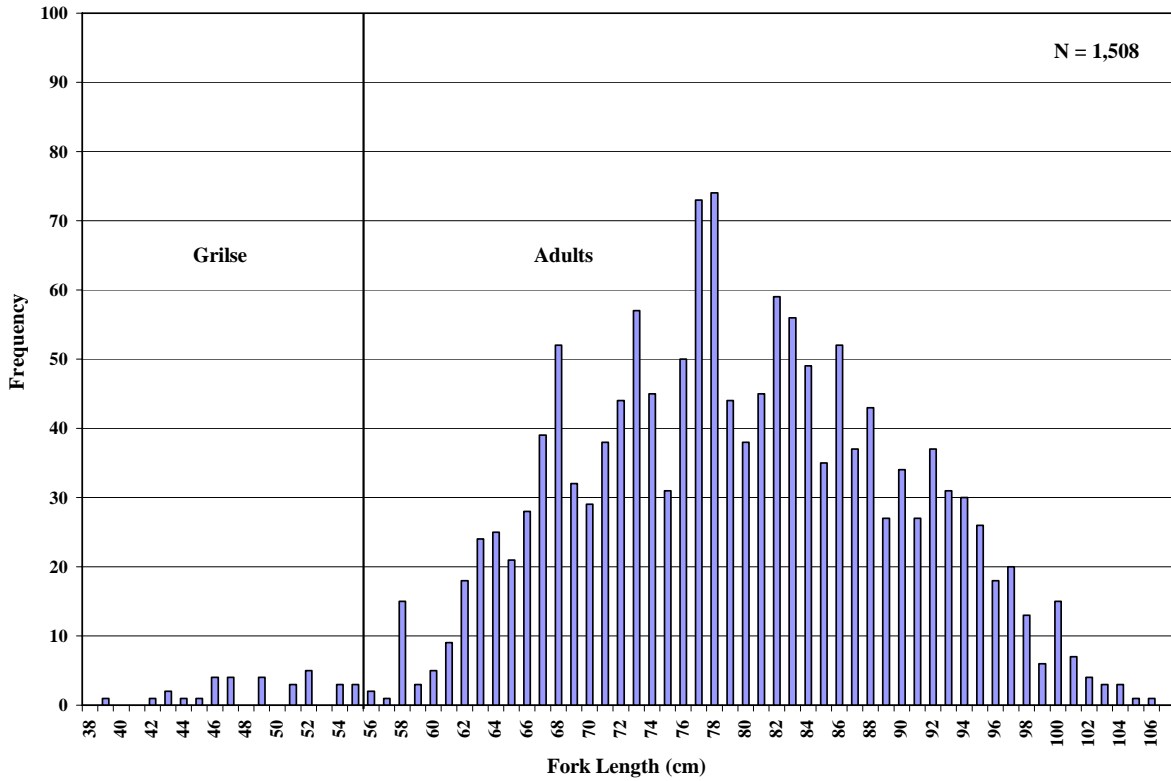


Figure 2. Length frequency distribution for random male Chinook salmon recovered at IGH during the 2003 spawning season.

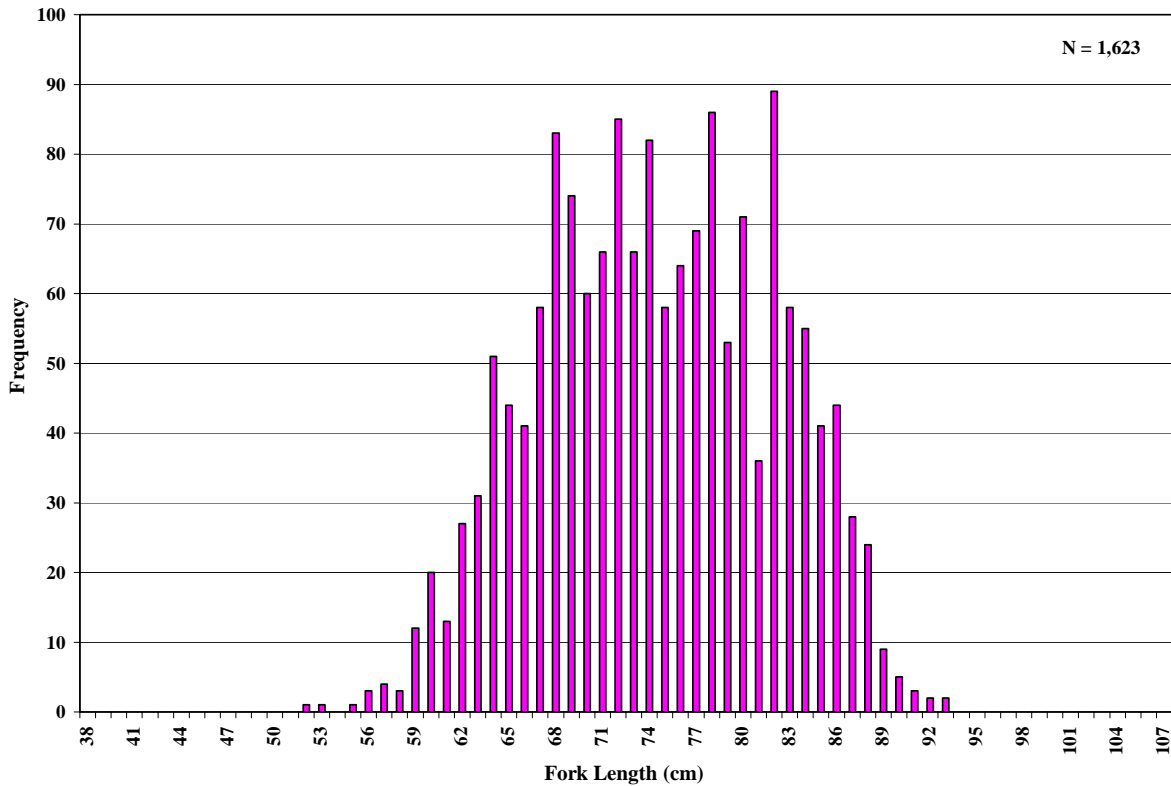


Figure 3. Length frequency distribution for random female Chinook salmon recovered at IGH, during the 2003 spawning season.

In addition to the random sampling, heads from 1,532 ad-clipped Chinook salmon (from random and non-random fish) were collected for CWT recovery (Table 2), which is over twice the number collected in 2002 (707 heads). The contribution of lost and unreadable CWTs recovered from ad-clipped Chinook was estimated by applying the proportions of known CWTs to the 80 lost or unreadable CWT ad-clipped Chinook (Table 3). This estimated contribution was then added to the contribution of known CWTs to yield the total contribution of hatchery Chinook entering IGH (Table 2). All Chinook CWTs recovered (and successfully read) originated from IGH except for one Chinook from Trinity River Hatchery. Based on the expansion of these CWTs, the KRP estimated that 25,663 (79%) of the Chinook entering IGH during the 2003 season were of hatchery origin (Table 2), versus 2002 where 71% of Chinook entering IGH were of hatchery origin. Yearlings were not tagged in 1998 or 1999 (Brood Year 1997 and 1998) due to budget constraints (Appendix A). Therefore, all contribution estimates from 1999-2004 would be underestimated due to the unknown contribution of yearlings from Brood Year (BY) 1997 and 1998 for each spawning run. In 2002 the additional contribution to IGH from BY 1997 and 1998 yearlings would be limited to 5 year-old and 4 year-old Chinook (the expanded estimate for 5 and 4 year-olds was 0.1% and 27.2%, respectively). The unaccounted contribution to 2003 would be smaller, as the returns would be limited to 5 year-olds from BY 1998 (the expanded estimate for 5 year-olds for 2003 was 0.4% of the run). In view of the fact that yearlings returned at a significantly higher rate than fingerlings for BY 1995 and 1996 (1.1% vs. 0.05% and 0.61% vs. 0.08%, respectively) it would be reasonable to assume BY 1997 and 1998 yearlings would return at a higher rate as well, which should also be factored in to the estimate of hatchery contributions (Appendix A).

Table 2. Estimated contribution of Chinook from Iron Gate Hatchery to total run at Iron Gate Hatchery, based on coded wire tags (CWTs) recovered from fall-run Chinook salmon that entered Iron Gate Hatchery, during the 2003 spawning season.

CWT	Release Location	Brood Year	Age	Release Type	Number Recovered	Production Multiplier	Expanded Estimate
601020401	IGH	2001	2	Ff	1	17.97	18
601020403	IGH	2001	2	Ff	1	30.66	31
66355	IGH	2001	2	Fy	9	9.32	84
66356	IGH	2001	2	Fy	4	10.55	42
66353	IGH	2000	3	Fy	133	9.64	1,283
66354	IGH	2000	3	Fy	224	8.51	1,906
601020305	IGH	2000	3	Ff	67	17.69	1,185
601020306	IGH	2000	3	Ff	44	17.76	781
601020307	IGH	2000	3	Ff	54	39.30	2,122
601020308	IGH	2000	3	Ff	61	32.44	1,979
601020309	IGH	1999	4	Ff	69	27.49	1,897
601020310	IGH	1999	4	Ff	83	27.49	2,282
601020311	IGH	1999	4	Ff	131	27.49	3,602
601020312	IGH	1999	4	Ff	65	27.49	1,787
65254	TRH	1999	4	Ff	1	10.83	11
66351	IGH	1999	4	Fy	187	11.46	2,143
66352	IGH	1999	4	Fy	233	11.46	2,670
601020301	IGH	1998	5	Ff	1	26.38	26
601020303	IGH	1998	5	Ff	2	26.38	53
601020304	IGH	1998	5	Ff	1	26.38	26
				Sub Total =	1,371		
Estimated contribution of lost, unreadable, or no CWTs					80		1,736
Total Estimated Hatchery Contribution =							25,663
Unreadable CWTs: 200000=CWT lost, 300000=head lost (or not collected), 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.							

Table 3. Estimated contribution of 80 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 2003 season.

CWT	BY	Number of actual CWTs recovered	Proportion of actual CWTs recovered	Assumed Number	Production Multiplier	Estimate
65254	1999	187	0.068223276	5.457862094	10.83	59
66351	1999	233	0.085005472	6.800437796	11.45912951	78
66352	1999	1	0.00036483	0.029186428	11.45921734	0
66353	2000	224	0.081721999	6.537759942	9.643396424	63
66354	2000	67	0.024443634	1.955490697	8.509614839	17
66355	2001	4	0.001459321	0.116745713	9.324617876	1
66356	2001	133	0.048522437	3.881794965	10.55047319	41
601020301	1998	2	0.000729661	0.058372857	26.3808408	2
601020303	1998	1	0.00036483	0.029186428	26.38111981	1
601020304	1998	1371	0.500182415	40.01459321	26.38093052	1056
601020305	2000	44	0.016052536	1.284202846	17.68625094	23
601020306	2000	54	0.019700839	1.576067129	17.75677166	28
601020307	2000	61	0.022254652	1.780372127	39.29886071	70
601020308	2000	69	0.025173294	2.013863553	32.43528734	65
601020309	1999	83	0.030280919	2.42247355	27.49330958	67
601020310	1999	131	0.047792776	3.823422109	27.49346726	105
601020311	1999	65	0.023713973	1.89711784	27.49384433	52
601020312	1999	1	0.00036483	0.029186428	27.49373021	1
601020401	2001	1	0.00036483	0.029186428	17.97416803	1
601020403	2001	9	0.003283473	0.262677855	30.66311208	8
Totals		2,741	1	80		1,736
80 ad-clipped Chinook had either lost or unreadable CWTs						

Coho

Due to budget constraints, biological data for coho salmon (sex, fork length, presence of marks or clips and scale samples) were not collected by staff of the KRP during the 2003-04 season. Prior to budget cuts, staff of the KRP collected biological data for a large portion of the coho which entered IGH. Results from the 2002-03 coho spawning season sampling are detailed in the 2002-03 KRP Iron Gate Recovery Report. Results from the Iron Gate Hatchery counts for the 2003-04 coho spawning season are included.

The first coho to enter IGH was observed on October 17, 2003 and the last coho of the 2003-04 spawning season was observed on December 31, 2003. A total of 1,558 coho salmon entered IGH during this period. 969 marked coho were recovered at IGH (Fig 4). Of these, 86.5% (838) were progeny of IGH (marked with a left maxillary clip), 7.1% (69) were from Trinity River Hatchery (TRH, right maxillary clipped) and 6% (58) were from Cole M. Rivers Hatchery (Appendix C). During the 2002-03 coho spawning season 1,076 marked coho entered IGH, which included 93.5% (1,006) IGH returns, 2.3% (25) originating from TRH and 3.5% (38) from Cole M. Rivers Hatchery (Appendix C).

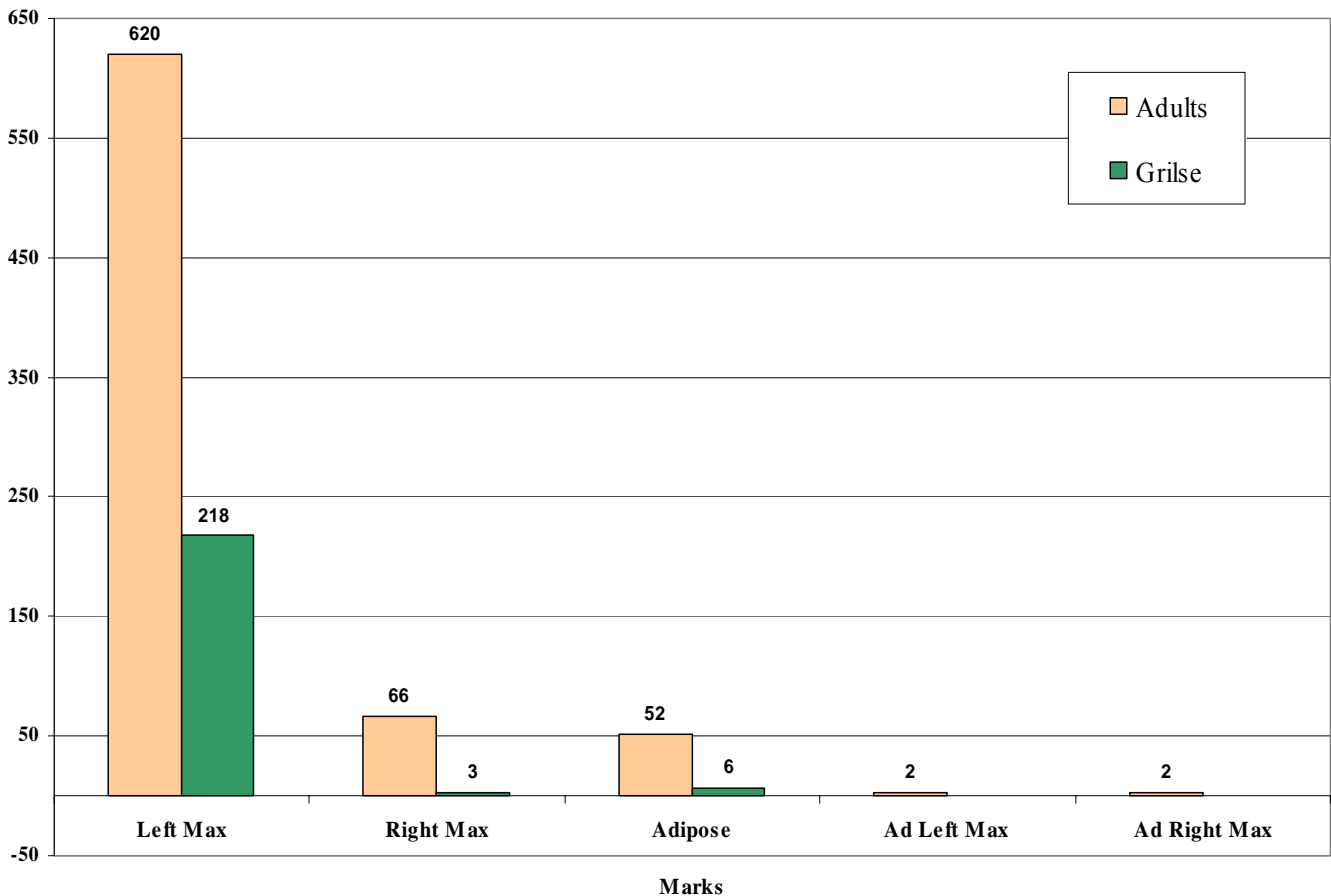


Figure 4. Marked (maxillary and adipose clips) coho salmon recovered at Iron Gate Hatchery during the 2003-04 spawning season.

DISCUSSION

Historic Chinook Runs

The 2003 run (32,260) of fall-run Chinook salmon recovered at IGH was the third largest run recorded at IGH in the last 26 years (Fig. 5), since the beginning of the Klamath River Project, surpassed only by 2000 (72,474) and 2001 (38,568). Although 2003 ranked 3rd highest for IGH total run numbers, percent contributions to total (Klamath basin) in-river run and total spawner escapement were only 9th highest and 11th highest, respectively (Table 4). During the 1995 Chinook salmon spawning season, the gates at IGH were closed at times; therefore a significant portion of the IGH Chinook returns were diverted to nearby Bogus Creek (Fig. 1). The largest in-river run of Chinook also occurred in 1995 (245,542), which was nearly double the average run (126,248) for the same period (Table 4 and Fig. 6). As expected, total Chinook spawner escapement for this period also peaked in 1995 at 217,312 (Table 4). The percent contribution of Bogus Creek escapement to total in-river run and spawner escapement also peaked in 1995, at 19% and 21%, respectively (Fig. 7). In comparison, the peak contribution of IGH to total in-river run and spawner escapement (34% and 44%, respectively) occurred in 1993 (Fig. 8). However, if all of the Chinook returning to IGH in 1995 had entered IGH, then the contribution rates for IGH would have been much higher in 1995.

Table 4. Historic fall-run Chinook salmon totals (includes adults and grilse) for the Klamath Basin, Iron Gate Hatchery, and Bogus Creek.

Year*	In-River Run (IRR)	Spawner Escapement (SE)		Iron Gate Hatchery (IGH)			Bogus Creek		
Low flow years	Totals	Totals	% of IRR	Totals	% of IRR	% of SE	Totals	% of IRR	% of 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	70.0	2,863	3.5	5.0	5,070	6.2	8.8
1981	108,422	56,333	52.0	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	5.0	6.4
1984	55,542	30,375	54.7	6,094	11.0	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	2.0	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	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	10.0
1997	91,729	70,303	76.6	13,727	15.0	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	198,675	142,323	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	17,835	10.5	18.0
2003	195,822	152,545	77.9	32,260	16.5	21.1	15,610	8.0	10.2
Average	126,248	88,864	69.3	16,553	13.5	19.1	9,710	6.9	9.8
MAX	245,542	217,312	88.5	72,474	33.5	44.4	46,432	18.9	21.4
MIN	34,425	19,121	52.0	2,558	2.4	4.6	785	1.9	3.1
STDEV	69,855	54,474	10.0	14,525	7.6	9.7	10,375	4.0	4.8

Note: As of Feb 2004, all In-River Run and Spawner Escapement values changed due to a retroactive change in the angling and net mortality rates.

*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.

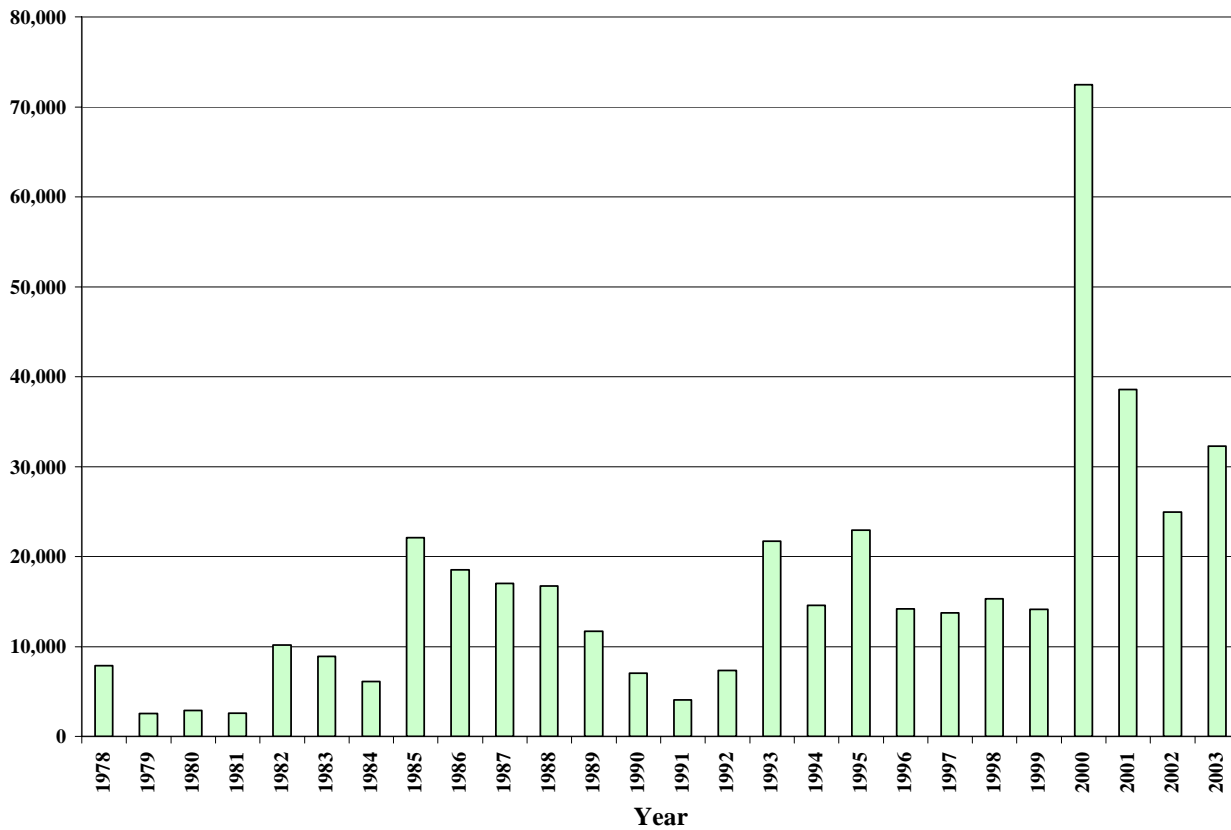


Figure 5. Total Chinook salmon escapement to Iron Gate Hatchery, 1978 to 2003.

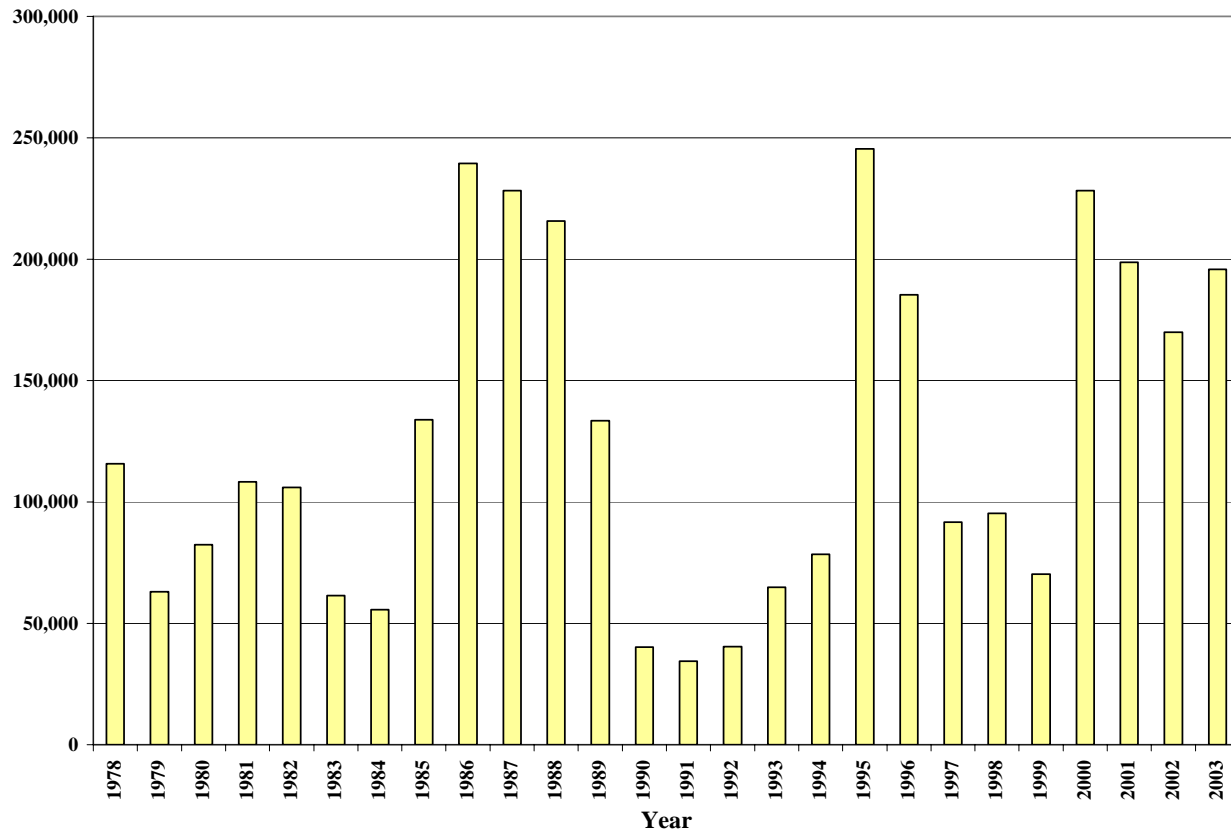


Figure 6. Total in-river run of Chinook salmon in the Klamath River, 1978 to 2003.

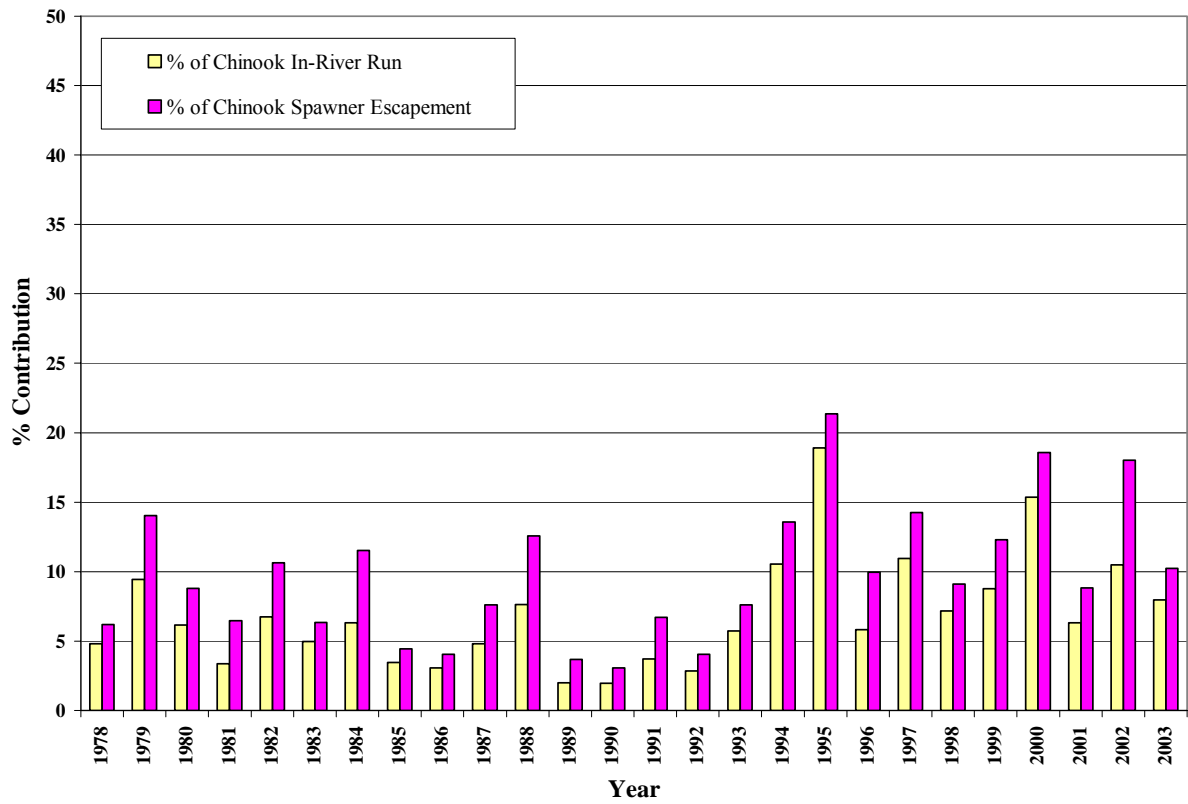


Figure 7. Percent contribution of Bogus Creek Chinook salmon to total Chinook spawner escapement and total Chinook in-river run (Klamath basin) 1978 to 2003.

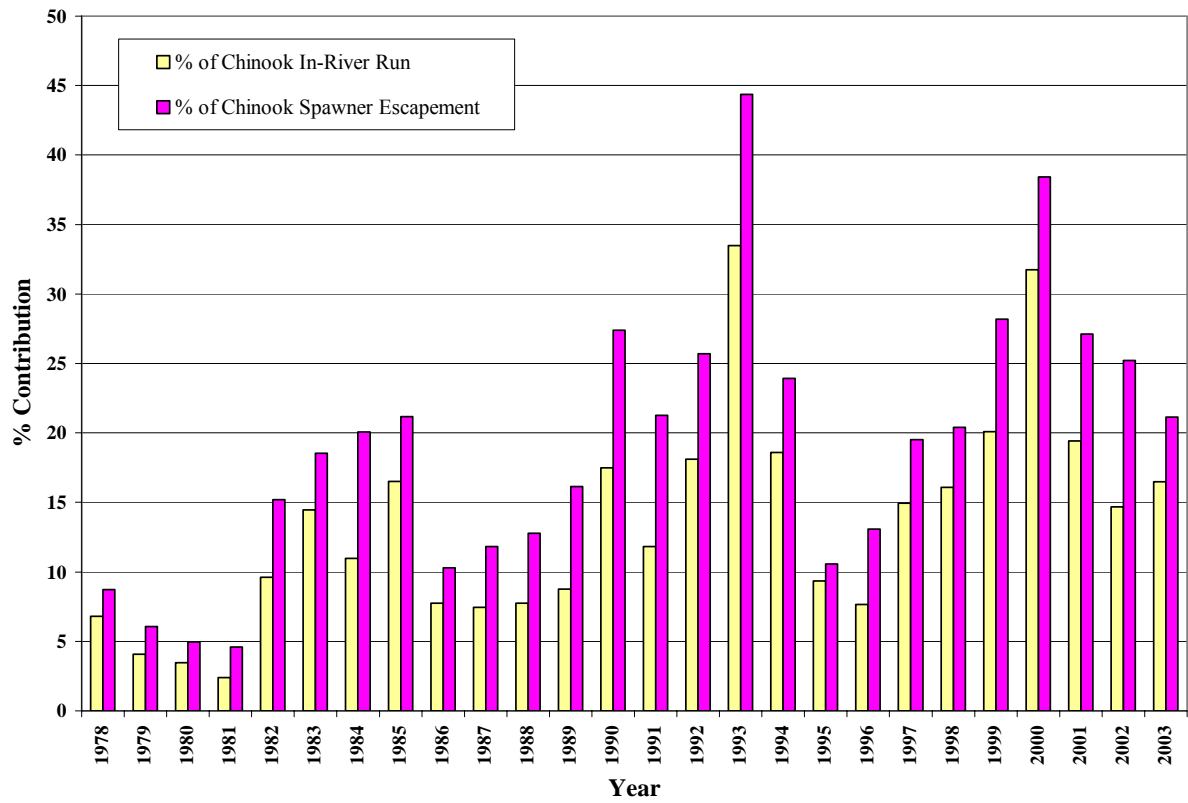


Figure 8. Percent contribution of Iron Gate Hatchery Chinook salmon to total Chinook spawner escapement and total Chinook in-river run (Klamath basin) 1978 to 2003.

Historic Coho and Chinook Releases and Returns

For the period of 1991 to 2003, IGH Chinook smolt releases have varied from a low of 3,300,312 in 1993 to a high of 5,626,408 in 1996 (Fig. 9). 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 4,872,313 and 1,013,353, respectively. The largest run of Chinook to IGH, from 1962 to 2003, occurred in 2000 (72,474), the lowest in 1965 (678) (Fig. 10). The largest in-river Chinook run (1995) occurred two years after the largest yearling release (1993). 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 the 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 Chinook would have already left the Klamath Basin.” (CDFG and NMFS 2001).

Analysis of Brood Year (BY) 1979-1984 CWTs 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 1995-98) of fall-run Chinook CWT returns to IGH yields similar results (Appendix A). For BY 1995, smolts returned at a rate of 0.05%, yearlings at 1.1%. BY 1996 results were similar with smolt returns at 0.08% and yearling returns at 0.61%. Yearlings were not tagged in 1998 or 1999 (BY 1997 and 1998) due to budget constraints. Therefore BY 1995 and 1996 contain the most recent CWT data that includes all potential returns (all age-classes). It is more common to observe a Trinity River Hatchery (TRH) Chinook straying to IGH than vice versa.

IGH coho yearling releases, for the period from 1991 to 2003, ranged from 46,254 in 2001 to 144,998 in 1993, averaging 84,048 (Fig. 9). IGH coho runs, for the same period, peaked in 1996 (4,097) and were lowest in 1999 (169) (Fig. 11). The average number of coho entering IGH from 1978 to 2003 was 1,462, while the Chinook average was 16,553 (Fig 10). For coho release years 1969 to 2002, the highest percent return of coho (assuming 3-year-old females) was the release year 1973 (BY 1972), when 5.26% of the coho females returned to IGH (Fig. 12 and Appendix B). The lowest percent return was release year 1971, when 0.01% of the coho females returned. The average return rate for coho females during this period was 1.5%. No coho were released from IGH in 1976. These percentages should be adjusted since they are based on the assumption that all coho entering the hatchery are hatchery returns. Since 1995 all IGH coho have been marked with a left-maxillary clip. The average return rate of marked (clipped) coho to IGH from 1997 to 2003 is 79.5% (Appendix C). Therefore, up to 20% of the coho entering IGH could be naturally produced.

TRH coho receive a right maxillary clip (Fig. 4). The adipose left maxillary and adipose right maxillary clipped coho are either Cole M. Rivers Hatchery fish without maxillaries due to injury, IGH coho that birds may have dropped into the steelhead ponds prior to steelhead clipping (steelhead are marked with an adipose left maxillary or right maxillary clip, depending on the year), or improperly marked coho. Cole M. Rivers Hatchery is located on the Rogue River, at the base of Lost Creek Dam, 153 river miles from the ocean. Cole M. Rivers Hatchery is the largest hatchery on the west coast. Their annual releases include 320,000 coho smolts and 2,212,000 spring-run and fall-run Chinook smolts, compared to the 75,000 coho yearlings and 4,920,000 fall-run Chinook smolts and 1,080,000 Chinook yearlings released at IGH.

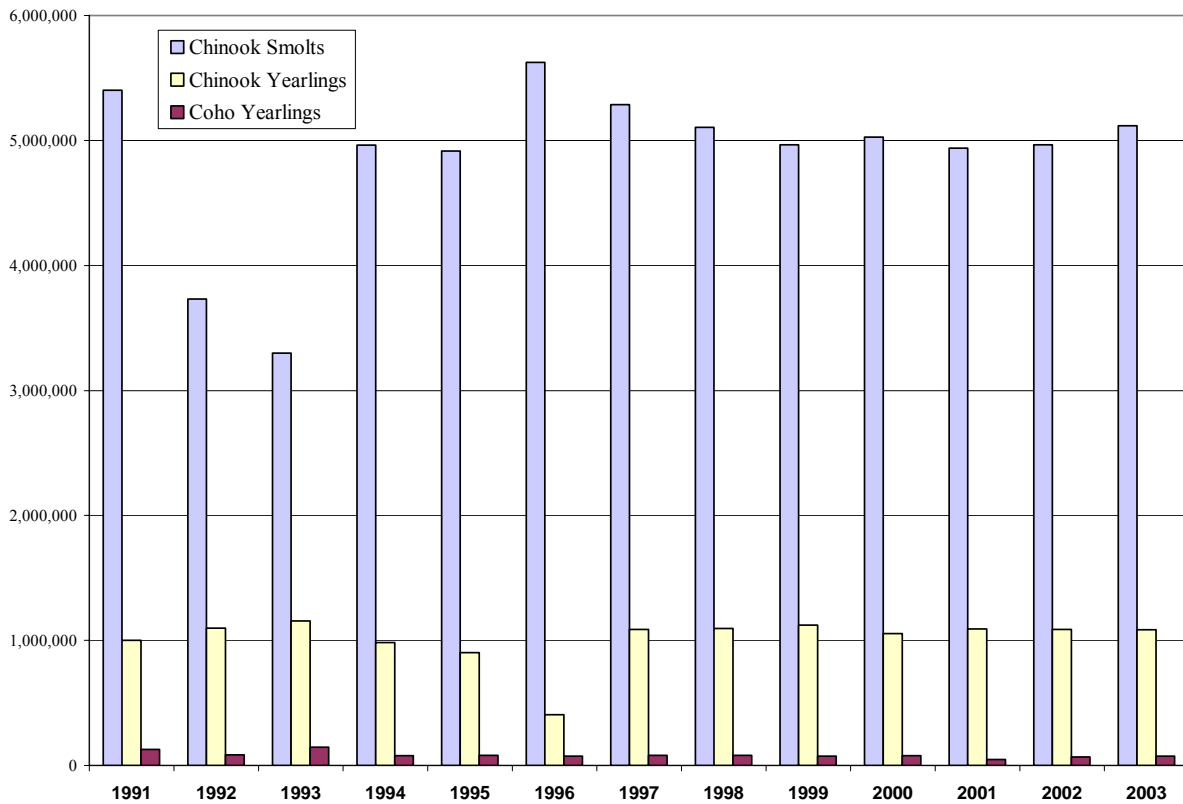


Figure 9. Iron Gate Hatchery (California Department of Fish and Game) Chinook and coho salmon releases, 1991 to 2003.

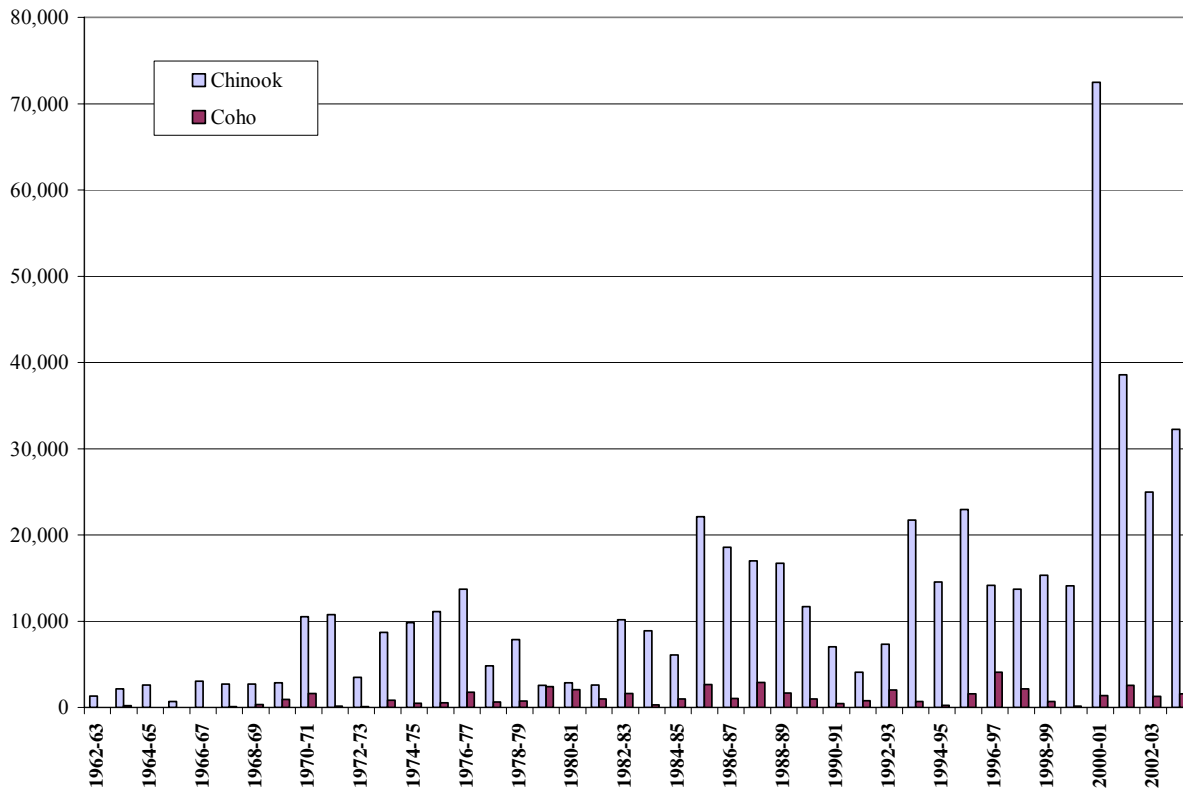


Figure 10. Chinook and coho salmon runs at Iron Gate Hatchery (California Department of Fish and Game), 1962 to 2003.

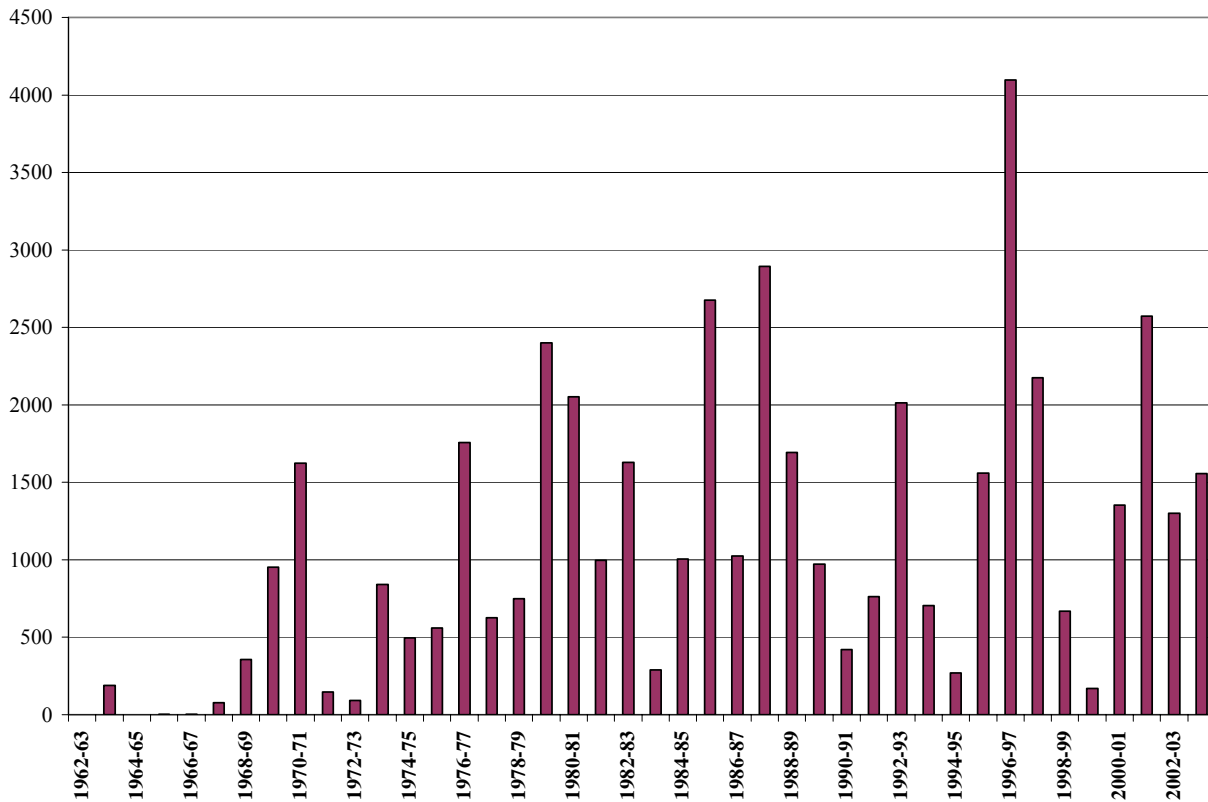


Figure 11. Coho salmon runs at Iron Gate Hatchery (California Department of Fish and Game), 1962 to 2004.

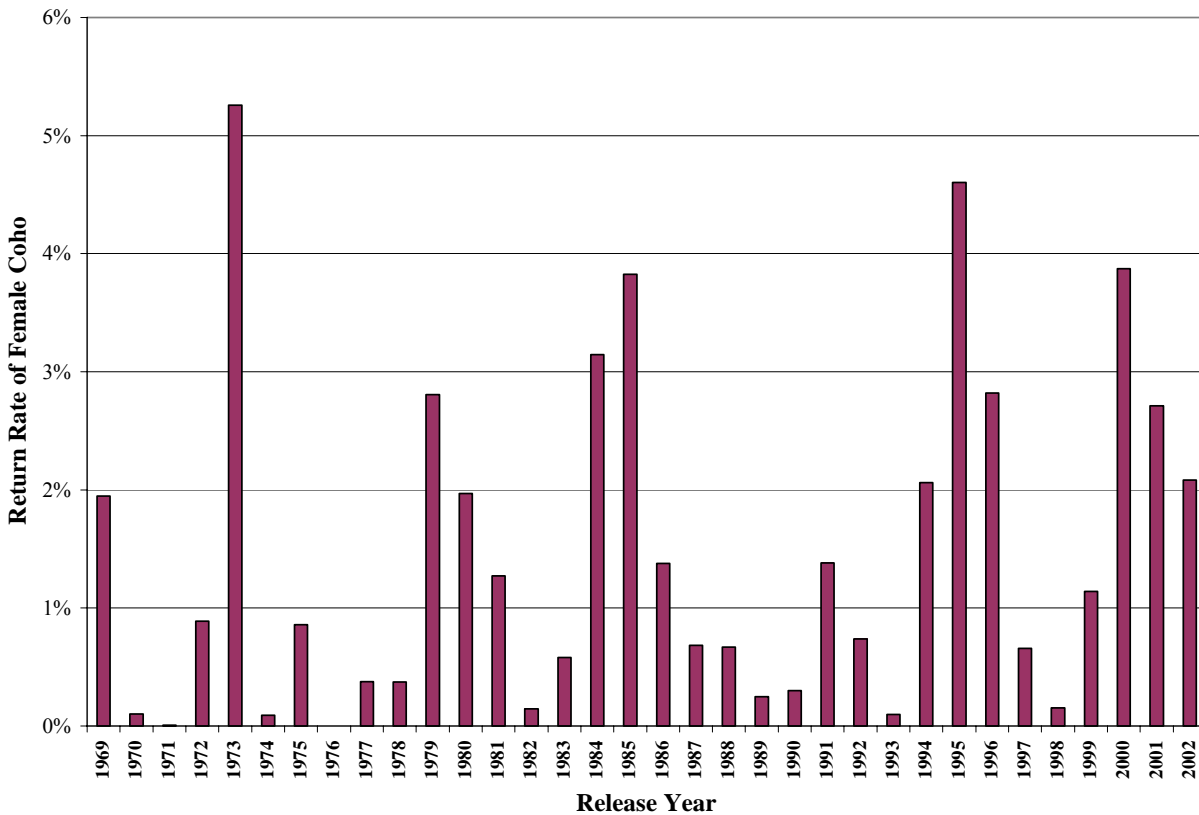


Figure 12. Return rates for female coho salmon (assuming 3-year-olds), by release year, at Iron Gate Hatchery (California Department of Fish and Game), 1969 to 2002 (refer to Appendix B).

Historic Proportions of Grilse

The length-frequency distribution for grilse observed during the 2003 Chinook spawning season does not match the bell curve observed for adults, indicating a lower than normal number of grilse was observed (Fig. 2). In comparison, the length-frequency distribution for male Chinook salmon observed during the 2001 spawning season reflects a normal, bimodal distribution, with one peak for grilse and the other for adults.

During the 2003 spawning season 0.9% of the run were grilse (according to scale analysis; length-frequency analysis yielded approximately 1.1% grilse), compared to 2001 and 2002 where 3.5% and 5.2% of the run were grilse, respectively. 2003 marked the lowest percentage of grilse observed for the entire period from 1978 to 2003 (Fig. 13). The highest percentage of grilse was observed in 1992 (51.1%). The average number of grilse during this 26 year period was 1,085 (9.9%). From 1978 to 1990, at least 10% of the run were grilse in 7 out of 13 years. In contrast, from 1991 to 2003 the proportion of grilse exceeded 10% for only 2 of the 13 years. This proportion is similar to what has been observed in Bogus Creek during those 2 periods of time. 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 2003 the proportion of grilse in Bogus Creek exceeded 10% for only 3 of the 13 years. The average number of grilse in Bogus Creek during this 26 year period was 723 (13.2% of the total run).

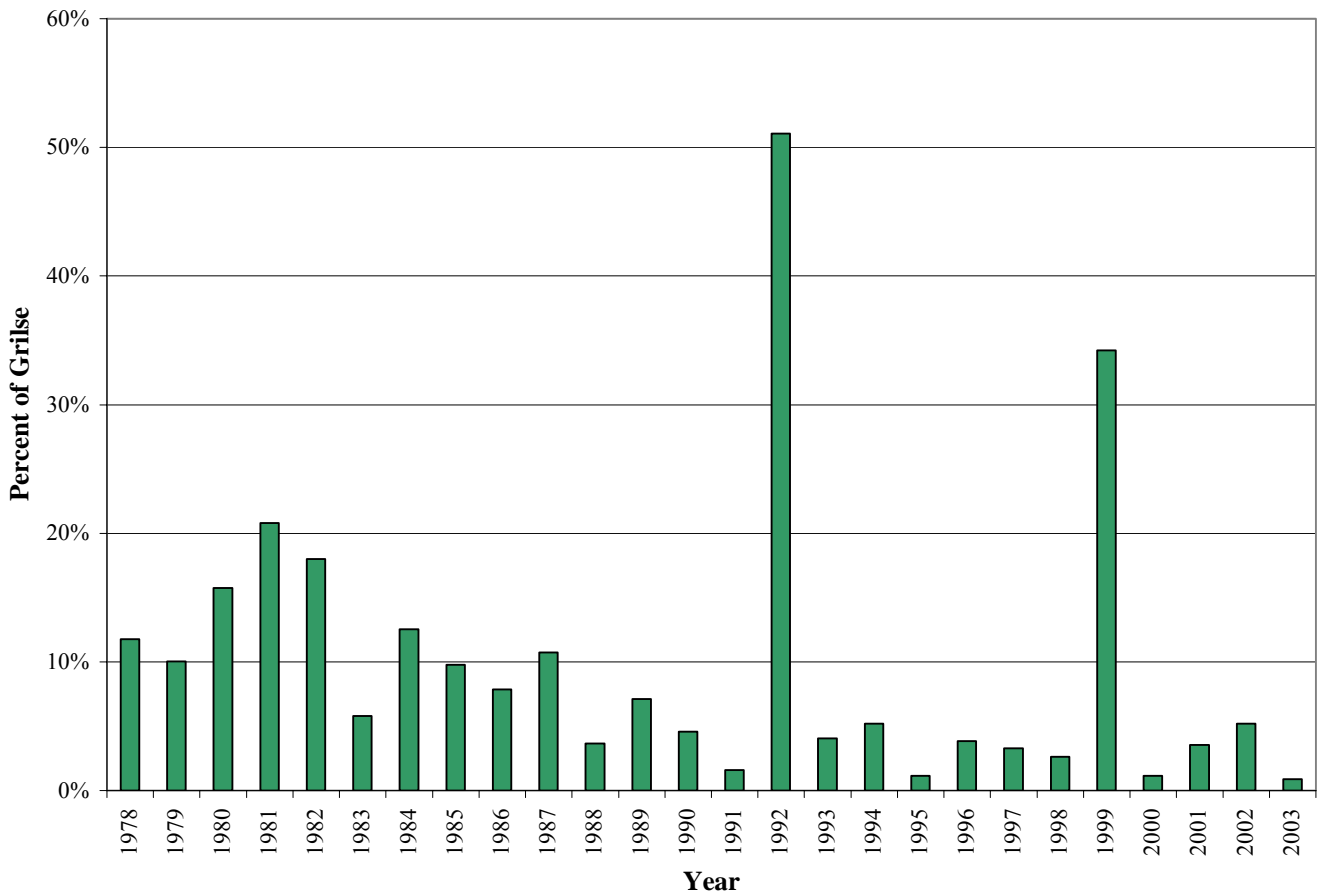


Figure 13. Historical percentages of Chinook grilse observed at Iron Gate Hatchery, Siskiyou County.

Fish Kills

Fish kills on the Klamath River have been documented in several years, most recently in September of 2002. Columnaris (*Flavobacter columnare*) and ICH (*Ichthyophthirius multifiliis*) were responsible for the 2002 fish kill, which resulted in the loss of at least 33,000 adult salmonids (CDFG 2002). The fish kill extended from the mouth of Klamath River to Coon Creek Falls (36 river miles). Low flows coupled with increased water temperature and fish densities (due to the low flows and potentially inadequate fish passage) stressed fish to the point that they were susceptible to the naturally occurring pathogens. If these fish kills had not occurred, the number of Chinook entering IGH during the 2002 spawning season would most likely have been higher than 24,961.

Other recent fish kills include the June 2000 and June 1998 fish kills. The 2000 fish kill occurred in late June (CDFG 2000), in the mainstem of the Klamath River, between Coon Creek and Pecwan Creek (64 river miles). Estimates of the number of fish killed (primarily young-of-the-year) range from 10,000 to 300,000. Direct mortality was believed to be caused by two pathogens, ceratomyxosis (*Ceratomyxa shasta*) and columnaris, which occur naturally in the Klamath River. The presence of unseasonably high air temperatures during the spring and early of summer of 2000 lead to mainstem water temperatures above 24°C (75°F) in June. IGH Chinook tend to be resistant to *C. shasta* at temperatures ≤ 16 °C (61°F), therefore elevated river temperatures appear to exacerbate this disease (Foott et al. 1999). At least 240,000 juvenile Chinook perished during the June 1998 fish kill, caused by columnaris and bacterial septicemia (Williamson and Foott 1998).

Current and Future Studies

Historical IGH CWT returns are included in Appendix A. However, these returns do not include harvest data which still needs to be summarized and combined with IGH returns to complete the CWT contribution rate estimates. The data from various CWT groups will provide information on contribution, return, and straying rates for these groups.

There are several other areas to investigate in regards to Chinook observed at IGH :

1. Is there a relation between flow or water temperature and abundance of salmonids observed at IGH?
2. Has there been a shift in the size of Chinook? (A decrease in the size of coho salmon females has been observed in other areas).
3. Has there been a shift in the run timing for Chinook?

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Appendix A

Table 1. Return rates for BY 1995-98 Fall-run Chinook salmon returning to Iron Gate Hatchery, a comparison of smolt versus yearling returns.

CWT	Release Location	CWT Comments	BY	Release Type	Release Date	Effectively Tagged	Total Release	Production Multiplier	IGH Age at Return					Total Contribution	Percent Survival to IGH	Average for Year
									2	3	4	5	Total			
0601020202	IGH		95	F	6/3/1996	49,886	1,461,424	29.29527322	0	4	3	0	7	205	0.01%	0.05%
0601020203	IGH		95	F	6/3/1996	59,158	1,733,050	29.29527705	0	18	4	0	22	644	0.04%	
0601020204	IGH		95	F	6/3/1996	28,995	849,416	29.2952578	0	17	3	1	21	615	0.07%	
0601020205	IGH		95	F	6/3/1996	53,760	1,574,914	29.2952753	1	32	2	0	35	1,025	0.07%	
0601020206	IGH	reared @ Fall Ck	95	Y	11/12/1996	53,477	233,700	4.370103035	13	317	133	2	465	2,032	0.87%	
0601020207	IGH	IGH + Fall Ck	95	Y	11/12/1996	36,695	170,472	4.645646546	9	318	155	7	489	2,272	1.33%	1.10%
0601020208	IGH		96	F	6/2/1997	49,341	1,324,969	26.85330658	4	21	16		41	1,101	0.08%	0.08%
0601020209	IGH		96	F	6/2/1997	49,708	1,334,824	26.85330329	3	24	26		53	1,423	0.11%	
0601020210	IGH		96	F	6/2/1997	48,435	1,300,639	26.85328791	0	13	12		25	671	0.05%	
0601020211	IGH		96	F	6/2/1997	49,164	1,320,216	26.8533073	0	20	22	1	43	1,155	0.09%	
063830	IGH		96	Y	11/5/1997	48,991	557,476	11.37915127	5	125	165	1	296	3,368	0.60%	
063831	IGH		96	Y	11/5/1997	46,405	528,050	11.37916173	3	125	156	1	285	3,243	0.61%	0.61%
0601020212	IGH		97	F	6/8/1998	57,375	1,514,020	26.38814815	60	590	32		682	17,997	1.19%	1.02%
0601020213	IGH		97	F	6/8/1998	56,339	1,486,682	26.3881503	45	520	47		612	16,150	1.09%	
0601020214	IGH		97	F	6/8/1998	49,400	1,303,574	26.38813765	26	406	48	1	481	12,693	0.97%	
0601020215	IGH		97	F	6/8/1998	30,047	792,885	26.38815855	15	222	15		252	6,650	0.84%	
0601020301	IGH		98	F	6/21/1999	51,641	1,362,333	26.3808408	4	96	38		138	3,641	0.27%	
0601020302	IGH		98	F	6/21/1999	54,373	1,434,348	26.37978408	7	125	54		186	4,907	0.34%	0.28%
0601020303	IGH		98	F	6/21/1999	48,919	1,290,538	26.38111981	6	75	54		135	3,561	0.28%	
0601020304	IGH		98	F	6/21/1999	32,670	861,865	26.38093052	2	40	37		79	2,084	0.24%	

BY = Brood Year (year spawned)

Appendix B

Table 2. Return rates for coho salmon (females) returning to Iron Gate Hatchery, 1969-2002.

Yearling Releases			Coho Runs				Female Coho Returns	
Release Year	Total	*Females	Year	Females	Adult Total	% Female	Release Year	Return Rate
1969	68,848	34,424	1970-71	671	1,387	48%	1969	1.95%
1970	100,080	50,040	1971-72	52	126	41%	1970	0.10%
1971	519,835	259,918	1972-73	18	56	32%	1971	0.01%
1972	47,700	23,850	1973-74	212	413	51%	1972	0.89%
1973	10,000	5,000	1974-75	263	456	58%	1973	5.26%
1974	80,000	40,000	1975-76	37	82	45%	1974	0.09%
1975	185,000	92,500	1976-77	795	1,376	58%	1975	0.86%
1976	none	none	1977-78	159	251	63%	1976	N/A
1977	125,000	62,500	1978-79	236	499	47%	1977	0.38%
1978	151,326	75,663	1979-80	282	495	57%	1978	0.37%
1979	87,000	43,500	1980-81	1,220	1,800	68%	1979	2.80%
1980	51,000	25,500	1981-82	502	904	56%	1980	1.97%
1981	99,812	49,906	1982-83	634	1,133	56%	1981	1.27%
1982	121,856	60,928	1983-84	90	218	41%	1982	0.15%
1983	120,672	60,336	1984-85	350	794	44%	1983	0.58%
1984	78,042	39,021	1985-86	1,228	2,269	54%	1984	3.15%
1985	22,059	11,030	1986-87	422	737	57%	1985	3.83%
1986	179,760	89,880	1987-88	1,238	2,581	48%	1986	1.38%
1987	205,000	102,500	1988-89	700	1,369	51%	1987	0.68%
1988	135,000	67,500	1989-90	451	910	50%	1988	0.67%
1989	143,400	71,700	1990-91	178	378	47%	1989	0.25%
1990	122,962	61,481	1991-92	184	360	51%	1990	0.30%
1991	130,000	65,000	1992-93	897	1,697	53%	1991	1.38%
1992	84,999	42,500	1993-94	314	675	47%	1992	0.74%
1993	144,998	72,499	1994-95	72	172	42%	1993	0.10%
1994	76,999	38,500	1995-96	793	1,501	53%	1994	2.06%
1995	79,506	39,753	1996-97	1,831	3,546	52%	1995	4.61%
1996	74,250	37,125	1997-98	1,047	1,872	56%	1996	2.82%
1997	81,498	40,749	1998-99	268	511	52%	1997	0.66%
1998	79,607	39,804	1999-2000	61	151	40%	1998	0.15%
1999	75,156	37,578	2000-01	428	723	59%	1999	1.14%
2000	77,147	38,574	2001-02	1,494	2,466	61%	2000	3.87%
2001	46,254	23,127	2002-03	627	1,193	53%	2001	2.71%
2002	67,933	33,967	2003-04	708	1,317	54%	2002	2.08%
Average			Average				Average	
111,294			543				1.47%	
55,647			1,012				51%	

*assumed 50% females, therefore restricted returns to 3-year-olds

Appendix C

Table 3. Proportions of clipped and unclipped coho entering Iron Gate Hatchery 1996 to 2003.

1996/1997				1997/1998				1998/1999			
FIN CLIPS	ADULTS	GRILSE	Total	FIN CLIPS	ADULTS	GRILSE	Total	FIN CLIPS	ADULTS	GRILSE	Total
Unmarked	3,545	228	3,773	Unmarked	121	44	165	Unmarked	207	82	289
LM	1	322	323	LM	1,717	253	1,970	LM	303	75	378
RM			0	RM	5		5	RM			0
AD		1	1	AD	24	4	28	AD	1	1	2
ADLM			0	ADLM	5	1	6	ADLM			0
ADRM			0	ADRM			0	ADRM			0
Total Clipped	1	323	324	Total Clipped	1,751	258	2,009	Total Clipped	304	76	380
Total Returns	3,546	551	4,097	Total Returns	1,872	302	2,174	Total Returns	511	158	669

1999/2000				2000/2001				2001/2002			
FIN CLIPS	ADULTS	GRILSE	Total	FIN CLIPS	ADULTS	GRILSE	Total	FIN CLIPS	ADULTS	GRILSE	Total
Unmarked	12	3	15	Unmarked	198	64	262	Unmarked	217	29	246
LM	138	15	153	LM	500	567	1,067	LM	2,054	76	2,130
RM			0	RM	4		4	RM	136	2	138
AD	1		1	AD	13		13	AD	51		51
ADLM			0	ADLM	8		8	ADLM	7		7
ADRM			0	ADRM			0	ADRM	1		1
Total Clipped	139	15	154	Total Clipped	525	567	1,092	Total Clipped	2,249	78	2,327
Total Returns	151	18	169	Total Returns	723	631	1,354	Total Returns	2,466	107	2,573

2002/2003				2003/2004			
FIN CLIPS	ADULTS	GRILSE	Total	FIN CLIPS	ADULTS	GRILSE	Total
Unmarked	216	9	225	Unmarked	575	14	589
LM	916	90	1,006	LM	620	218	838
RM	25	0	25	RM	66	3	69
AD	31	7	38	AD	52	6	58
ADLM	5	2	7	ADLM	2	0	2
ADRM			0	ADRM	2	0	2
Total Clipped	977	99	1,076	Total Clipped	742	227	969
Total Returns	1,193	108	1,301	Total Returns	1,317	241	1,558

Proportion of clipped to unclipped coho			
Season	Clipped	Total	% Clipped
1997/1998	2,009	2,174	92.4%
1998/1999	380	669	56.8%
1999/2000	154	169	91.1%
2000/2001	1,092	1,354	80.6%
2001/2002	2,327	2,573	90.4%
2002/2003	1,076	1,301	82.7%
2003/2004	969	1,558	62.2%
Average	1,144	1,400	79.5%

LM= Iron Gate Hatchery (left maxillary clip) ADLM *

RM = Trinity River Hatchery (right maxillary clip) ADRM *

AD = Cole M. Rivers Hatchery (adipose clip)

*The adipose left maxillary and adipose right maxillary clipped coho are either Cole M. Rivers Hatchery fish without maxillaries due to injury, IGH coho that birds may have dropped into the steelhead ponds prior to steelhead clipping (steelhead are marked with an adipose left maxillary or right maxillary clip, depending on the year), or improperly marked coho.