

BOGUS CREEK SALMON STUDIES

2008



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ABSTRACT

The California Department of Fish and Game's (Department), Klamath River Project (KRP) operated a video fish counting facility and conducted spawning ground surveys (carcass surveys) on Bogus Creek during the Chinook salmon (*Oncorhynchus tshawytscha*) and coho salmon (*Oncorhynchus kisutch*) spawning season. The purpose of these surveys is to describe the run characteristics of adult fall-run Chinook salmon and coho salmon into Bogus Creek. Video fish counting operations began on September 8, 2008 and ended on December 22, 2008 due to forecasted high flows. The total number of Chinook salmon that entered Bogus Creek during the 2008 season is estimated to be **4,566** fish. Based on the proportion of male and female Chinook salmon that were sampled during the spawning ground surveys the run was comprised of approximately 2,539 (55.6%) males and 2,027 (44.4%) females. Based on a grilse cut off of ≤ 62 cm, adults comprised approximately 65.2% (2,977 fish) and grilse comprised 34.8% (1,589 fish) of the run. Males ranged in fork length from 36cm to 101cm and averaged 64.8cm. Females ranged in fork length from 45cm to 95cm and averaged 73.9cm. KRP staff estimated that 1,077 Chinook salmon (23.6%) were of hatchery origin.

The first adult coho salmon was observed entering Bogus Creek on October 17, 2008 and the last coho salmon was observed on December 22, 2008. A total of 111 coho salmon were observed moving upstream through the Bogus Creek Fish Counting Facility (BCFCF) during the season. Based on the proportion of male and female Coho salmon that were sampled during the spawning ground surveys, the run was comprised of approximately 47 (42.3%) males and 64 (57.7%) females. Based on a grilse cut off of ≤ 57 cm, age three fish comprised approximately 94.7% (105 fish) and age two fish comprised 5.3% (6 fish) of the run. Males ranged in fork length from 39cm to 75cm and averaged 64.4cm. Females ranged in fork length from 63cm to 74cm and averaged 68.7cm. One of the 111 coho salmon observed was caudal clipped and floy tagged indicating that it was an unmarked coho salmon that previously entered IGH and was subsequently released after it was tagged and caudal clipped. KRP staff estimated that 35 coho salmon (31.6%) were of hatchery origin.

INTRODUCTION

STUDY LOCATION AND RUN TIMING

Bogus Creek is located on the south east side of the Klamath River just downstream of Iron Gate Hatchery (IGH) (between river mile 189 and 190) in Siskiyou County, near the Oregon border (Figure 1). Fall-run Chinook salmon return to Bogus Creek to spawn from mid September to early November. The coho salmon spawning run occurs from late October to early January and steelhead run from November to March.

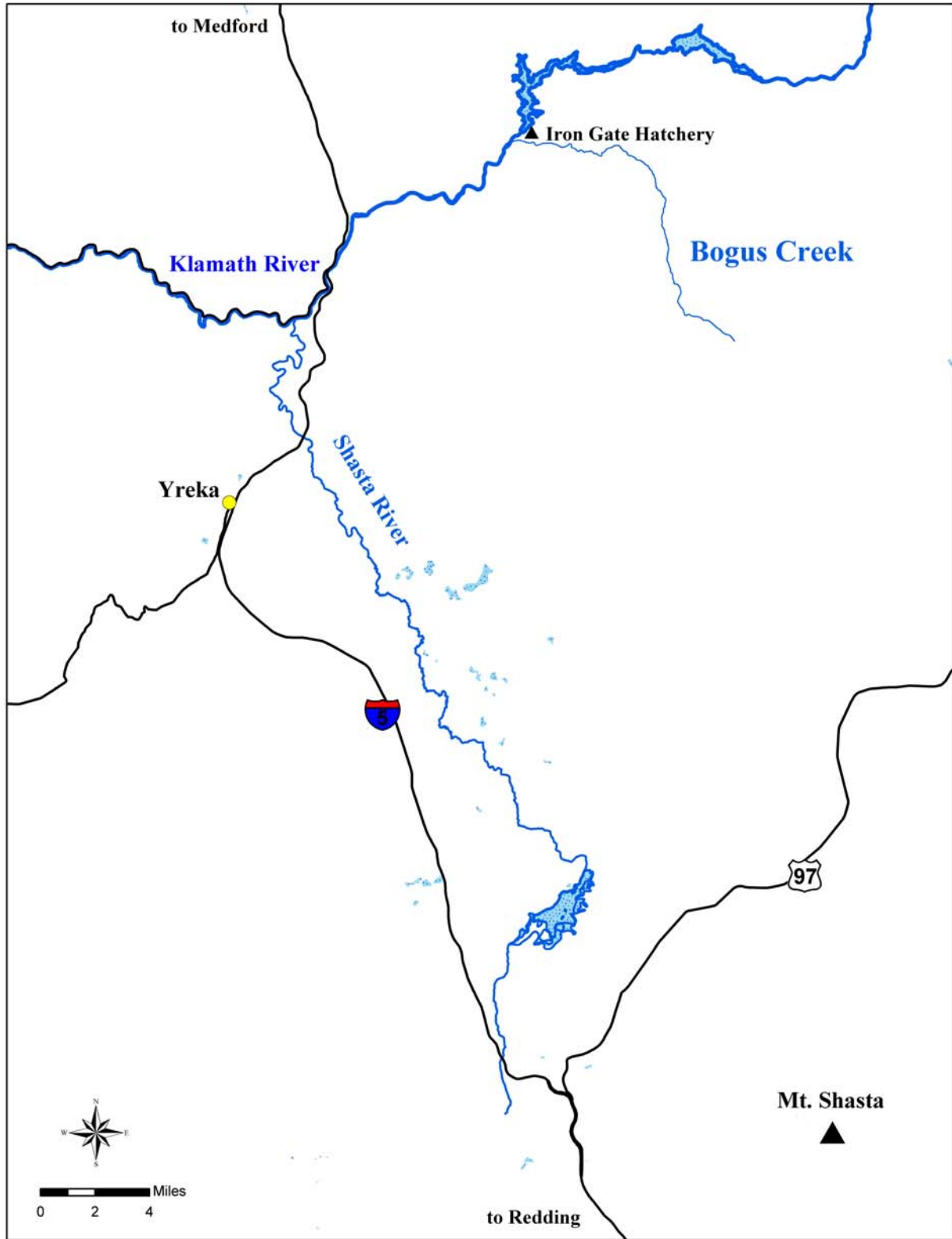


Figure 1. Location of Bogus Creek, tributary to the Klamath River, Siskiyou County.

BOGUS CREEK FISH COUNTING FACILITY

The purpose of the Bogus Creek Fish Counting Facility (BCFCF) is to count the number of adult Chinook salmon that enter Bogus Creek each year. Prior to the 2003 spawning run, a fish marking weir was operated on Bogus Creek to collect biological data, recover heads from adipose fin clipped adults (ad-clipped), and mark Chinook salmon with an opercle punch. The opercle punch was used to generate a Petersen mark and recapture population estimate from recaptures obtained during carcass surveys upstream of the weir. Incorporation of a video counting station in 2003 has greatly improved the accuracy of run size estimates and has eliminated the need to handle migrating salmon during the season. Biological data collection occurs during spawning ground surveys which includes collection of fork lengths, determining sexual composition of the run, assessing pre-spawn mortality, and recovery of coded wire tags (CWT) from marked salmon encountered during the survey. The Department received funds from the Yreka office of the U.S. Fish and Wildlife Service to aid in the operation of the weir and conduct spawning ground surveys on Bogus Creek during the 2008 Chinook salmon spawning season.

KLAMATH RIVER PROJECT AND BOGUS CREEK STUDY

The Bogus Creek study is one component of the KRP (initiated in 1978). The goals of the KRP include obtaining information on species composition, spawning distribution, fork length frequency and sex ratios for salmonids (primarily Chinook salmon) in various tributaries to the Klamath River including the Salmon, Scott, and Shasta rivers, as well as Bogus Creek and a dozen other smaller tributaries. Bogus Creek is particularly important because it is a major salmon spawning tributary, despite its small size. For example, during the 1996-98 spawning seasons, an average of 30.6% (8,914) of the total number of natural area adult spawners above the Trinity River confluence were estimated to have entered Bogus Creek to spawn. Therefore, a significant portion of natural escapement to the Klamath Basin would be unaccounted for if the Bogus Creek studies were not conducted. In addition to providing valuable escapement estimates to the Pacific Fisheries Management Council for the effective management of fall-run Chinook salmon in the Klamath Basin, the Bogus Creek studies provide an additional opportunity to recover CWTs and collect scale samples (which are used in the final determination of age composition).

BOGUS CREEK STUDY OBJECTIVES SUMMARIZED:

- A) Determine the in-river run size (escapement) of Chinook salmon returning to Bogus Creek.
- B) Determine run timing, spawning distribution, length frequency distribution, and sex ratio for Chinook salmon in Bogus Creek.
- C) Collect scale samples and recover heads (containing coded wire tags) from ad-clipped Chinook salmon in order to determine age composition of the run.
- D) Collect biological data for all coho salmon and steelhead observed during the Chinook salmon spawning season.

METHODS

OPERATION OF THE BOGUS CREEK FISH COUNTING FACILITY

The video fish counting system was installed at the Bogus Creek Fish Counting Facility (BCFCF) on September 8, 2008 at 0719 hours Pacific Standard Time (PST). A temporary Alaskan style weir was installed to direct migrating fish into a concrete flume where they pass in front of the camera. The underwater video system consisted of a digital color video camera, water proof camera housing, viewing window, and counting flume which allowed for recording unimpeded fish passage through the facility. The facility was operated 24 hours a day, seven days a week throughout the Chinook salmon migration period. A JVC digital color video camera (Model No TK-C92OU) equipped with a 5 – 50mm 1:1.3 Computar lens¹ was used to collect the photo image and an Ever Focus Digital Video Recorder (DVR; Model EDSR100) was used to record the image to external hard drives. The time lapse DVR was set to record continuously and drive changes were made at least twice a week.

All hard drives were immediately returned to the office where each was subsequently downloaded and reviewed by staff in the video lab. During each review staff recorded the date, time (hour:min:sec), and species of each fish observed on each video tape. If the species could not be determined because of poor visibility or picture quality, staff recorded that observation as fish unknown. Staff also noted any ad-clipped fish observed, recorded the presence of lamprey scars and any other distinguishable marks that were visible on the tape. All video data was then entered into computer files and each data file was subjected to one independent edit prior to commencement of data analysis.

SPAWNING GROUND SURVEYS

Spawning ground surveys were conducted twice a week on Tuesdays and Fridays throughout the Chinook salmon spawning season starting October 10, 2008 and ending December 2, 2008. A total of fifteen surveys were performed during the spawning season. In addition to the fifteen spawning ground surveys a cooperative project (USFWS Fish Health Center, Yurok Tribe, Oregon State University) was conducted on Bogus Creek looking at *Ceratomyxa shasta* spore levels in the lower 1.2 miles of Bogus Creek. Part of the study required conducting daily spawning ground surveys on Reach 1 throughout the Chinook spawning season. The first daily survey on Reach 1 was conducted on October 10, 2008 and the last on November 24, 2008.

For the purpose of the spawning ground surveys, Bogus Creek was divided into 4 reaches (Figure 2). Reach 1 includes the area from the mouth of Bogus Creek upstream to the BCFCF, a distance of approximately 0.3 miles. Reach 2 extends from the BCFCF upstream to a small waterfall a distance of approximately 0.6 miles. Reach 3 begins at the small waterfall and continues upstream to a larger waterfall for approximately 2.0 additional miles and Reach 4 continues from that point upstream to a larger waterfall (about 20' high) and fish ladder for a distance of 0.5 miles. Each survey was conducted by three crews (one crew per reach), consisting of a minimum of two people for each crew. Fork length measurements (cm), scale samples, sex determinations and information regarding female spawning success were systematically collected from every fourth Chinook carcass examined during the survey. All scale samples were provided to the Yurok Tribal Fisheries Department for analysis. Females with greater than 50% of their eggs still remaining in their body cavity were identified as pre-spawn mortalities. Heads and scale samples were also collected from all ad-clipped fish (as well as fork length and sex) in order to recover the CWT for subsequent age determination. Once examined, all carcasses

¹ Use of trade names in this report does not imply endorsement by the Department of Fish and Game.

were cut in half to prevent potential recounting during later surveys. The same protocol was used for every coho salmon carcass that was recovered during the survey.

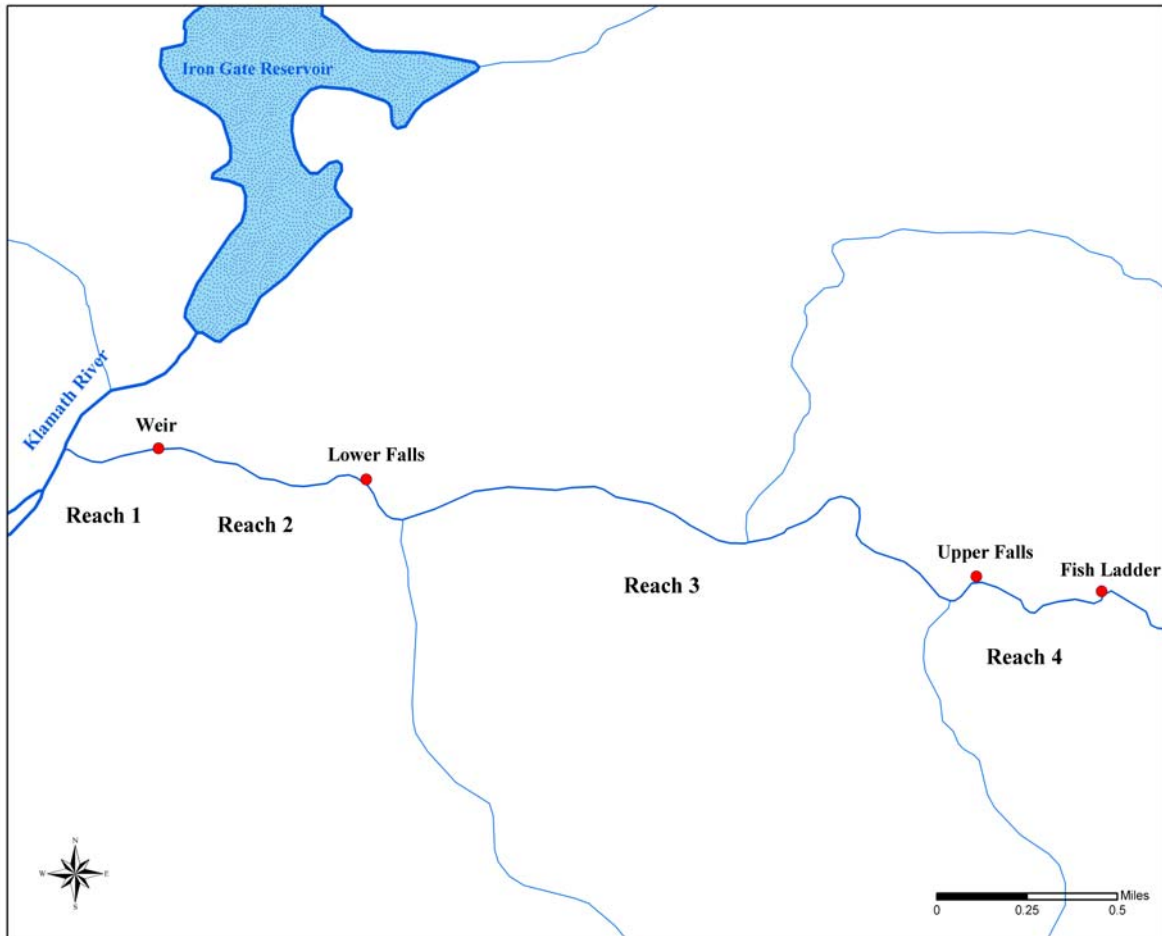


Figure 2. Map of spawning ground survey reaches on Bogus Creek used during the 2008 field season. The weir denotes the location of the Bogus Creek Fish Counting Facility (BCFCF).

To assist in developing stock identification baseline information the KRP collected both genetic tissue and otolith samples during the season. DNA samples were collected from 270 Chinook salmon and 17 coho salmon. All samples were collected following protocols provided by the National Oceanic Atmospheric Administration’s (NOAA) Southwest Fisheries Science Center. Samples were sent to the Salmonid Genetic Tissue Repository located at the NOAA Santa Cruz Laboratory for archiving and analysis. Otoliths were collected from 26 Chinook salmon and 15 coho salmon throughout the season. All otoliths collected were supplied to Rebecca Quinones at the United States Forest Service/University of California at Davis for further microchemistry analysis. All samples were collected following protocols provided by Rebecca Quinones.

POPULATION ESTIMATE

The Chinook salmon spawner escapement for the area of Bogus Creek upstream of the BCFCF was derived from a direct count of all Chinook salmon observed at the video counting facility. To estimate total escapement in Bogus Creek, the number of Chinook salmon carcasses observed downstream of the weir (a direct count for Reach 1) was added to the count of all Chinook salmon that were observed

passing through the video counting facility.

The hatchery contribution rate of Chinook salmon was derived by multiplying the number of CWTs observed for each CWT group by its production multiplier value (the inverse of the proportion of each group of juveniles that were tagged). For Reaches 2, 3, and 4, an additional expansion (the inverse of the number of fish handled during spawning ground surveys divided by the direct count observed at the video counting facility) was applied.

RESULTS

OPERATION OF THE BOGUS CREEK FISH COUNTING FACILITY

The BCFCF began recording fish movements at 0719 hours on September 8, 2008. The first Chinook salmon was observed at the BCFCF on September 8, 2008 and the last Chinook salmon was observed on November 22, 2008. The run peaked between September 29, 2008 and October 28, 2008 (Figure 3). 90.6% of Chinook salmon passed through the BCFCF during daylight hours (between 0700 and 1800) and peaked in the afternoon at 1600 hours (Figure 4).

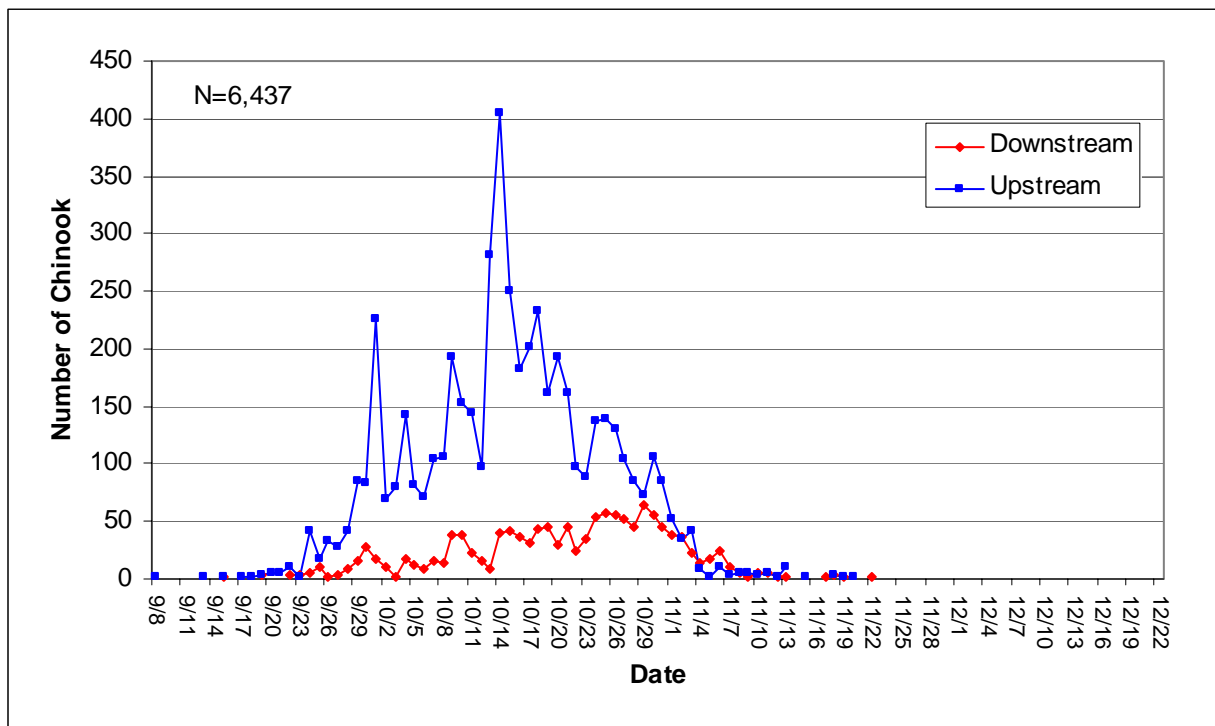


Figure 3. Run timing of Chinook salmon through the BCFCF during the 2008 season. Both upstream and downstream movements through the counting flume are shown.

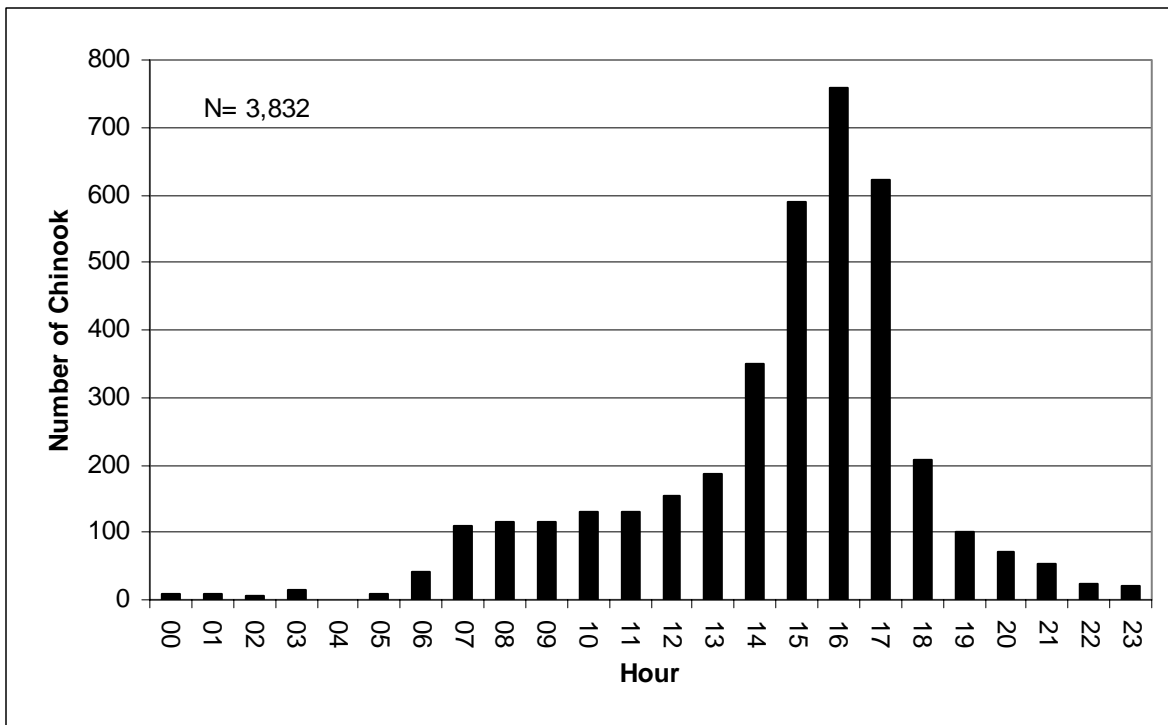


Figure 4. Summary of daily run timing (Net upstream) of Chinook salmon observed at the Bogus Creek Fish Counting Facility during 2008.

A total of 3,909 Chinook salmon were estimated to have passed through the BCFCF during the 2008 season, with 3,829 observed through the flume. Another 80 fish were added to the total as an expansion for periods of time when the camera was not functioning. A total of 657 Chinook salmon carcasses were counted in Reach 1, downstream of the BCFCF, yielding a total run size estimate of 4,566 Chinook salmon. Based on the proportion of male and female Chinook salmon that were sampled during the spawning ground surveys, the run was comprised of approximately 2,539 (55.6%) males and 2,027 (44.4%) females. Based on a grilse cut off of ≤ 62 cm, adults comprised approximately 65.2% (2,977 fish) and grilse comprised 34.8% (1,589 fish) of the run.

SPAWNING GROUND SURVEYS

A total of 680 Chinook salmon carcasses were systematically sampled (1 in 4) during the spawning ground survey. Of the 680 Chinook salmon carcasses examined, 301 were females, 378 were male (one unknown sex). Males ranged in fork length from 36cm to 101cm and averaged 64.8cm (Figure 5). Based on the length frequency distribution of male Chinook salmon presented on Figure 5, grilse were determined to be ≤ 62 cm in fork length. Females ranged in fork length from 45cm to 95cm and averaged 73.9cm (Figure 6).

A total of 301 female Chinook salmon carcasses were systematically sampled (1 in 4) during the spawning ground survey. Each of these was examined to determine if they had spawned prior to death. Females with approximately 50% or more of their eggs still present in the body cavity when examined were identified as a pre-spawn mortality. Of the 301 female Chinook salmon carcasses examined, 289 females (96.0%) were found to have spawned, and 12 females (4.0%) still contained more than 50% of their spawn and were identified as pre-spawn mortalities.

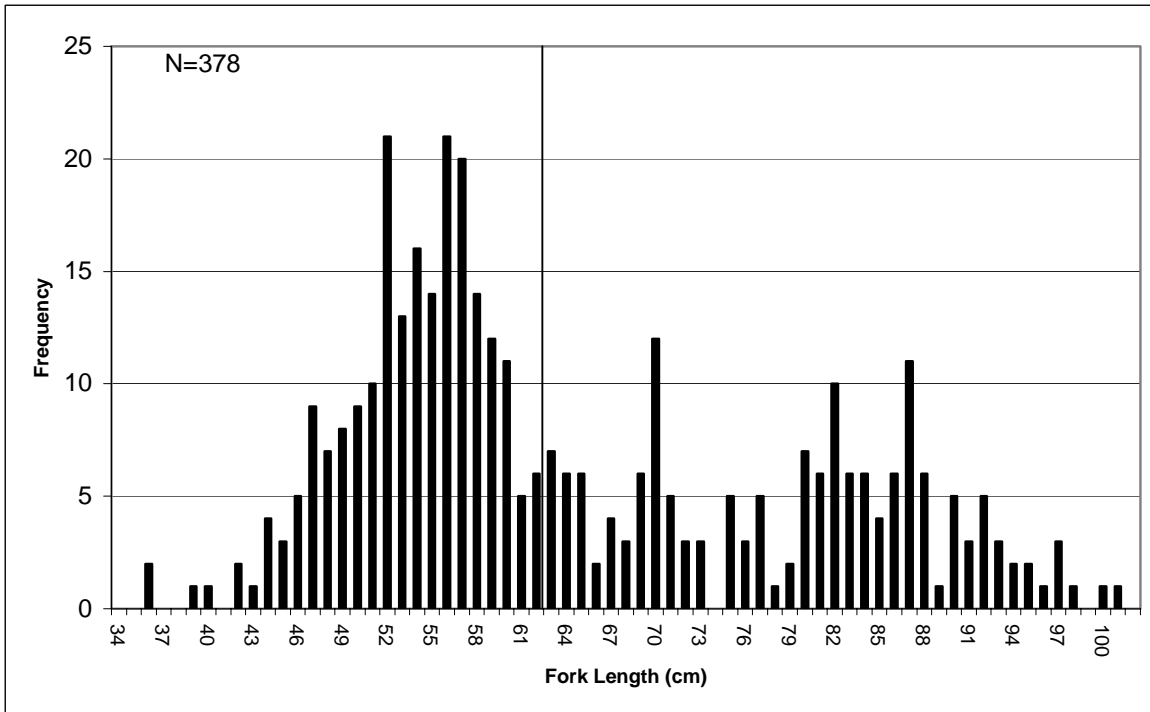


Figure 5. Length Frequency distribution of random male Chinook salmon observed during spawning ground surveys in Bogus Creek, 2008 (n = 378).

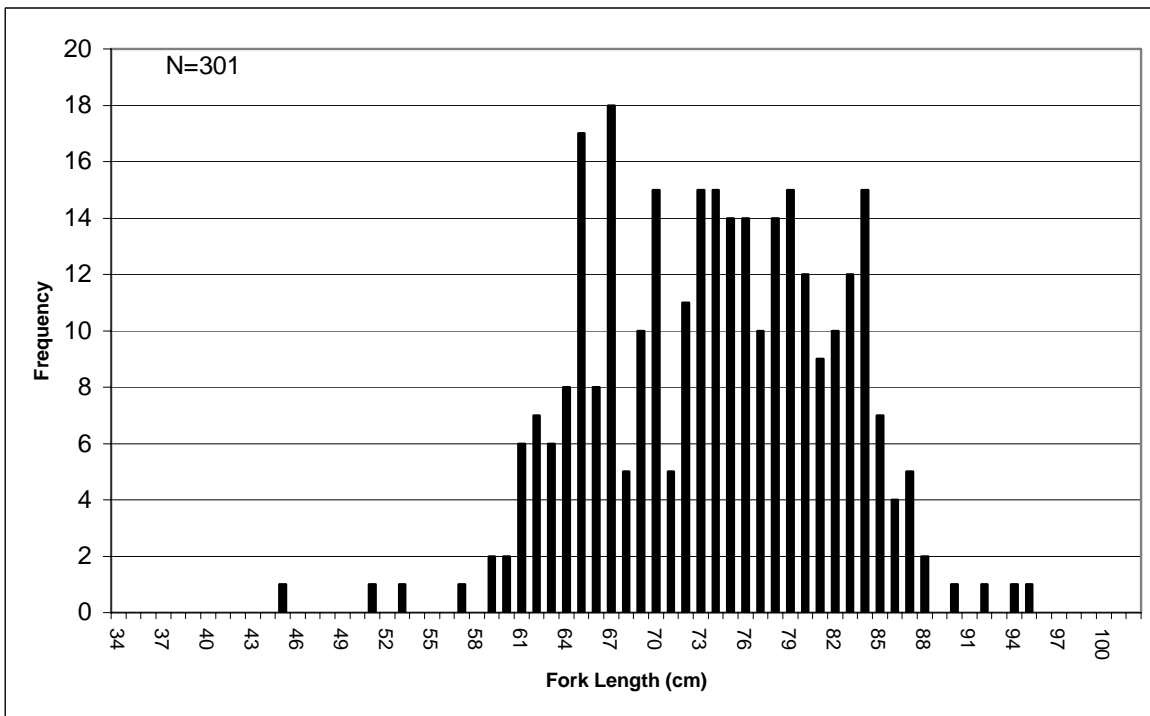


Figure 6. Length frequency distribution of random female Chinook salmon observed during spawning ground surveys in Bogus Creek, 2008 (n = 301).

HATCHERY CONTRIBUTION ESTIMATE

A total of 51 heads were collected from ad-clipped Chinook salmon. These included Chinook salmon with full and partial ad-clips as well as those carcasses where the presence of an ad-clip was uncertain due to either natural erosion or decomposition. Of the 51 heads that were collected, five did not contain CWTs and 2 CWTs were lost while being recovered from the head. The remaining 44 heads contained legible CWTs. All of the 44 CWT's recovered were from IGH releases. To estimate the total hatchery contribution the number of recoveries for each CWT was multiplied by the production multiplier derived at the time of release from IGH. In addition, a sample expansion (1.77) based on the inverse of the number of carcasses (2,203) examined upstream of BCFCF during spawning ground surveys divided by the total number of Chinook salmon that were observed passing through the BCFCF (3,909), was applied to all CWT recoveries upstream of the BCFCF (Table 1).

Table 1. Estimated contribution of hatchery origin fall Chinook salmon in Bogus Creek 2008.

Spawning Ground Surveys, Reach 1									
Coded Wire Tag	Location	Release Type a/	Brood Year	Age	Sample Number	Production Multiplier b/	Production Estimate	Sample Expansion c/	Total Estimate
601020504	IGH	F	2004	4	1	17.12	17	1	17
601020505	IGH	F	2004	4	3	16.61	50	1	50
601020506	IGH	F	2004	4	1	34.04	34	1	34
601020507	IGH	F	2004	4	1	37.42	37	1	37
601020509	IGH	Y	2004	4	1	8	8	1	8
601020602	IGH	F	2005	3	3	18.01	54	1	54
601020603	IGH	F	2005	3	1	18.67	19	1	19
601020606	IGH	Y	2005	3	1	9.25	9	1	9
601020607	IGH	Y	2005	3	4	9.22	37	1	37
601020608	IGH	F	2006	2	1	20.82	21	1	21
601020702	IGH	F	2006	2	2	18.11	36	1	36
Sub Total=					19	Sub Total=			322
Estimated contribution of lost CWT's					0	Sub Total=			0
								Total=	322
Spawning Ground Surveys, Reach 2, 3, and 4									
Coded Wire Tag	Location	Release Type	Brood Year	Age	Sample Number	Production Multiplier	Production Estimate	Sample Expansion	Total Estimate
601020505	IGH	F	2004	4	1	16.61	17	1.77439855	29
601020508	IGH	Y	2004	4	1	9.10	9	1.77439855	16
601020602	IGH	F	2005	3	2	18.01	36	1.77439855	64
601020603	IGH	F	2005	3	2	18.67	37	1.77439855	66
601020604	IGH	F	2005	3	1	37.01	37	1.77439855	66
601020605	IGH	F	2005	3	1	46.33	46	1.77439855	82
601020606	IGH	Y	2005	3	4	9.25	37	1.77439855	66
601020607	IGH	Y	2005	3	6	9.22	55	1.77439855	98
601020608	IGH	F	2006	2	1	20.82	21	1.77439855	37
601020609	IGH	F	2006	2	2	15.93	32	1.77439855	57
601020700	IGH	F	2006	2	3	16.61	50	1.77439855	88
601020701	IGH	F	2006	2	1	16.54	17	1.77439855	29
Sub Total=					25	Sub Total=			699
Estimated contribution of lost CWT's					2	Sub Total=			56
								Total Estimated Hatchery Contribution=	1077

a/ Release type; Ff=Fall fingerling, Fy=Fall Yearling
b/ Production Multiplier value is the inverse of the proportion of effectivly tagged and total release from IGH
c/ Sample expansion is the inverse of the number samples during the carcass surveyeys in reach 2, 3, and 4 divided by the video estimate.

COHO SALMON

In the fall of 2004, the Department, in collaboration with NOAA Fisheries, initiated a new program intended to reduce potential take of unmarked coho salmon that enter IGH. Under this program all unmarked coho, with the exception of 10 coho salmon that are incorporated into the spawn with marked coho, are released back to the river providing them the opportunity to spawn naturally. Prior to release, each unmarked coho is given an upper lobe caudal clip and an individually numbered Floy tag is applied to the right posterior dorsal area of the body. These marks are applied to allow the Department and others to track the movements of these fish after release from the hatchery. The caudal clip provided a means to easily identify these fish should they pass through one of the video fish counting facilities which are operated by the Department on Bogus Creek the Scott River and the Shasta River. A total of 15 unmarked coho salmon were released from IGH to the Klamath River during the 2008 season.

The first adult coho salmon was observed entering Bogus Creek on October 17, 2008 and the last coho salmon was observed on December 22, 2008. A total of 111 coho salmon were observed moving upstream through the BCFCF during the season (Figure 7). Of these 1 was a caudal clipped, floy tagged individual indicating that it was an unmarked coho salmon that previously entered IGH and was subsequently released after marking.

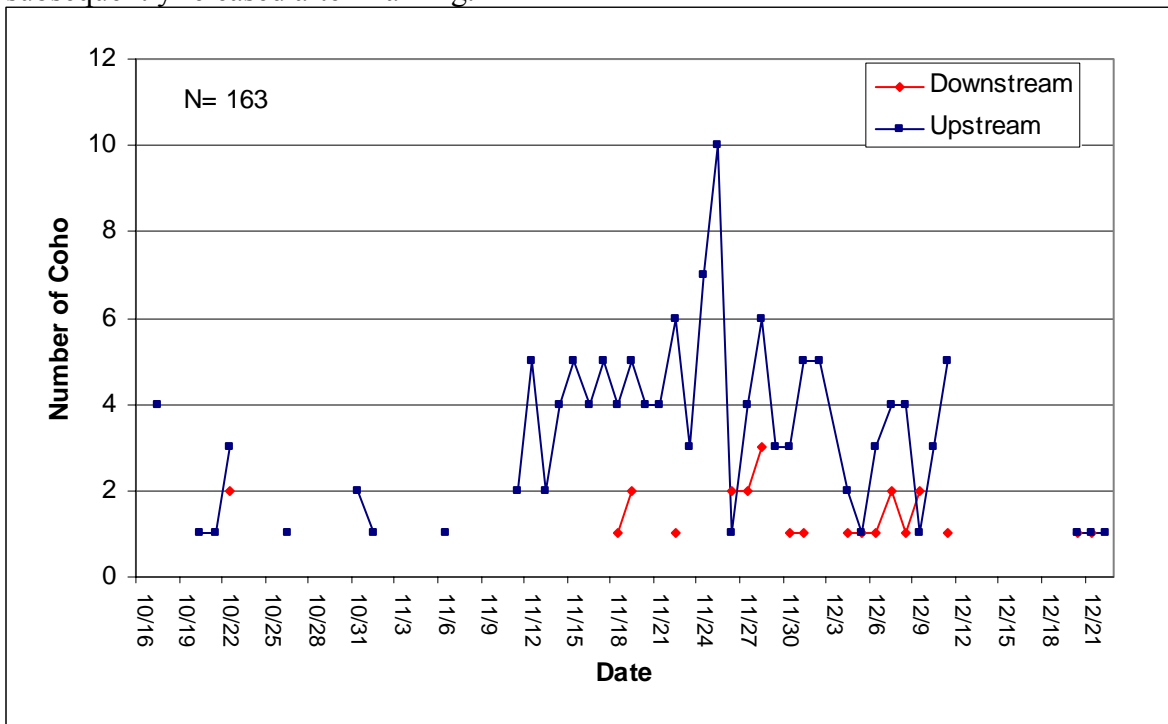


Figure 7. Run timing of coho salmon observed passing through the Bogus Creek Fish Counting Facility during the 2008 season.

Diel movements of coho salmon through the BCFCF were higher in the evening hours and peaked between 1300 hours and 2200 hours (Figure 8). This movement pattern is consistent with observations from previous seasons.

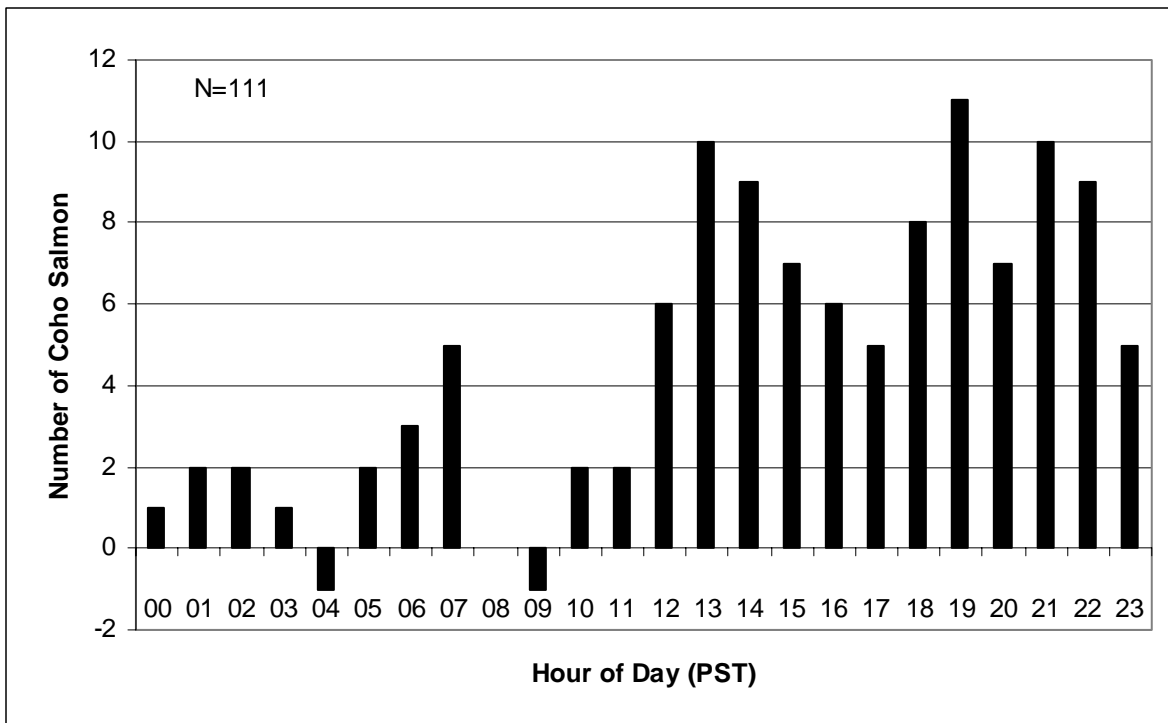


Figure 8. Diel migration patterns of coho salmon observed moving through (Net upstream) the Bogus Creek Fish Counting Facility in 2008.

SPAWNING GROUND SURVEYS

A total of 19 coho salmon carcasses were sampled during the spawning ground survey. Of those 11 were females, 8 were males. Males ranged in fork length from 39cm to 75cm and averaged 64.4cm (Figure 9). Based on the length frequency distribution of male coho salmon presented in Figure 9, and coho returning to IGH, grilse were determined to be ≤ 57 cm in fork length. Females ranged in fork length from 63cm to 74cm and averaged 68.7cm (Figure 10).

All eleven female coho salmon carcasses were examined to determine if they had spawned prior to death. Females with approximately 50% or more of their eggs still present in the body cavity when examined were identified as a pre-spawn mortality. Of the eleven, 7 (63.6%) were found to have spawned, 4 females (36.4%) still contained more than 50% of their spawn and were identified as pre-spawn mortalities.

Six of the 19 (31.6%) coho salmon carcasses observed had left maxillary clips indicating that they were of IGH origin. The estimated hatchery components by age of the coho salmon run were 0.0% and 33.3% for age two and age three fish respectively.

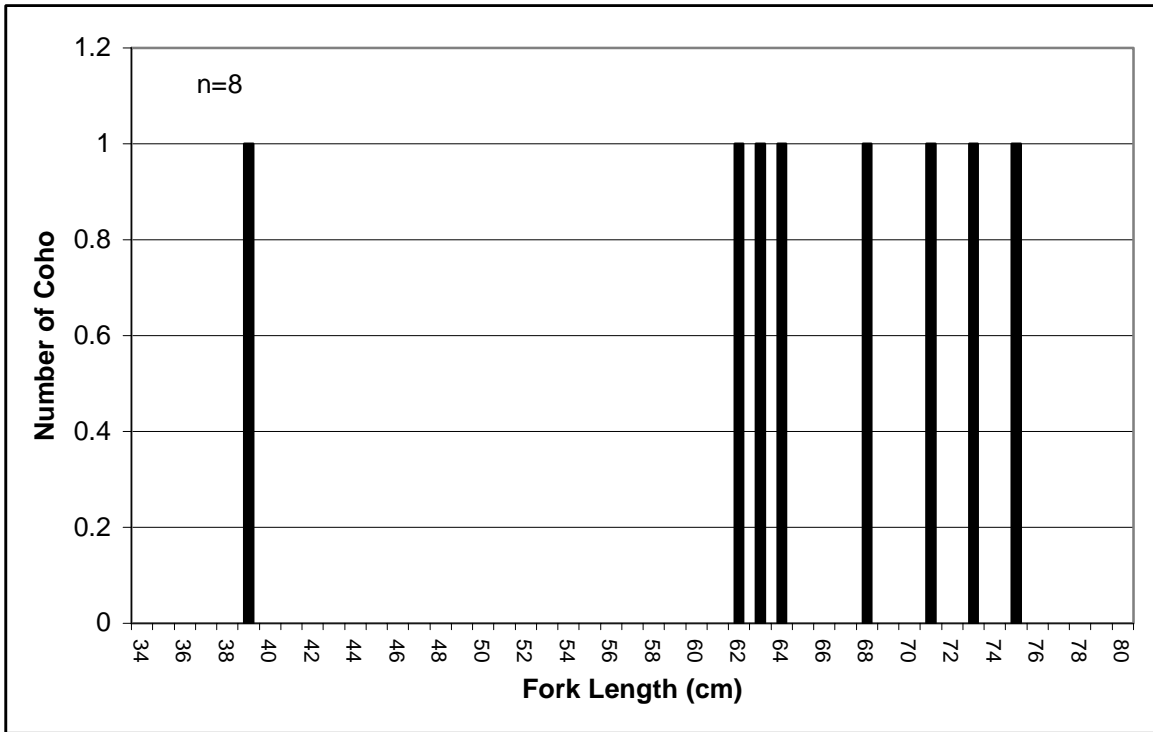


Figure 9. Length Frequency distribution of male coho salmon observed during spawning ground surveys in Bogus Creek, 2008 (n = 8).

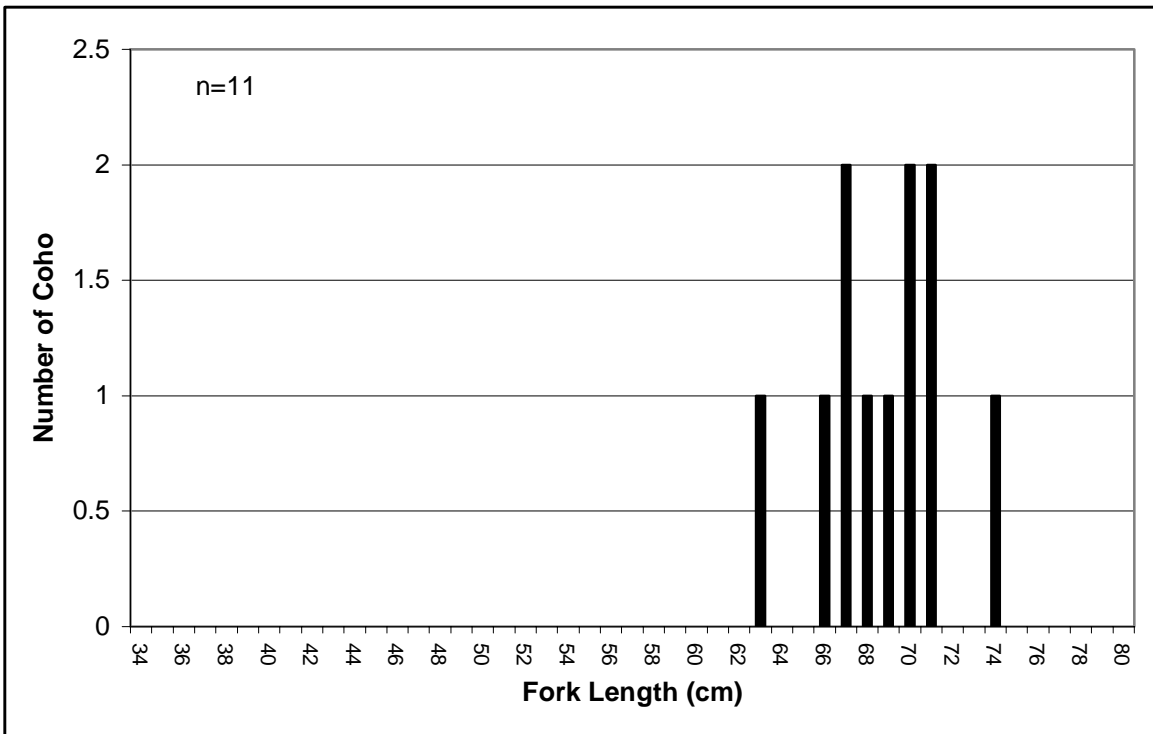


Figure 10. Length Frequency distribution of female coho salmon observed during spawning ground surveys in Bogus Creek, 2008 (n = 11).

DISCUSSION

HISTORIC CHINOOK SALMON RUNS

Since 1978 the Chinook salmon run in Bogus Creek has ranged from 46,432 fish (1995) to 785 fish (1990) and has averaged 8,874 fish (Figure 11). The 2008 Chinook salmon run in Bogus Creek ranks twenty-first (4,566 fish) out of 31 years of data. Since monitoring began in 1978 the largest run of Chinook salmon within the entire Klamath River basin occurred during the 1995 season when an estimated 245,543 Chinook salmon returned. That same year the ladder gates to IGH were closed after the hatchery met its egg production goal. Therefore, a significant portion of the IGH Chinook salmon that would otherwise have entered IGH either spawned in the main stem or entered tributaries including Bogus Creek. This would account for the large return of Chinook salmon that were observed in Bogus Creek during the 1995 season. As a result, the run size estimates for IGH and Bogus Creek during the 1995 season do not accurately describe the run size that would most certainly have occurred if the ladder gates at IGH were left open during that year. Subsequent to 1995, the hatchery policy was modified to allow all Chinook salmon to enter the hatchery irregardless of the numbers of fish that may return. This policy change allows for better monitoring of natural and hatchery components within the Chinook salmon run at IGH and in natural areas. In addition the current policy reduces the potential for hatchery stocks to spawn in natural areas and in turn reduces the potential interactions between hatchery and natural area produced Chinook salmon populations within the basin.

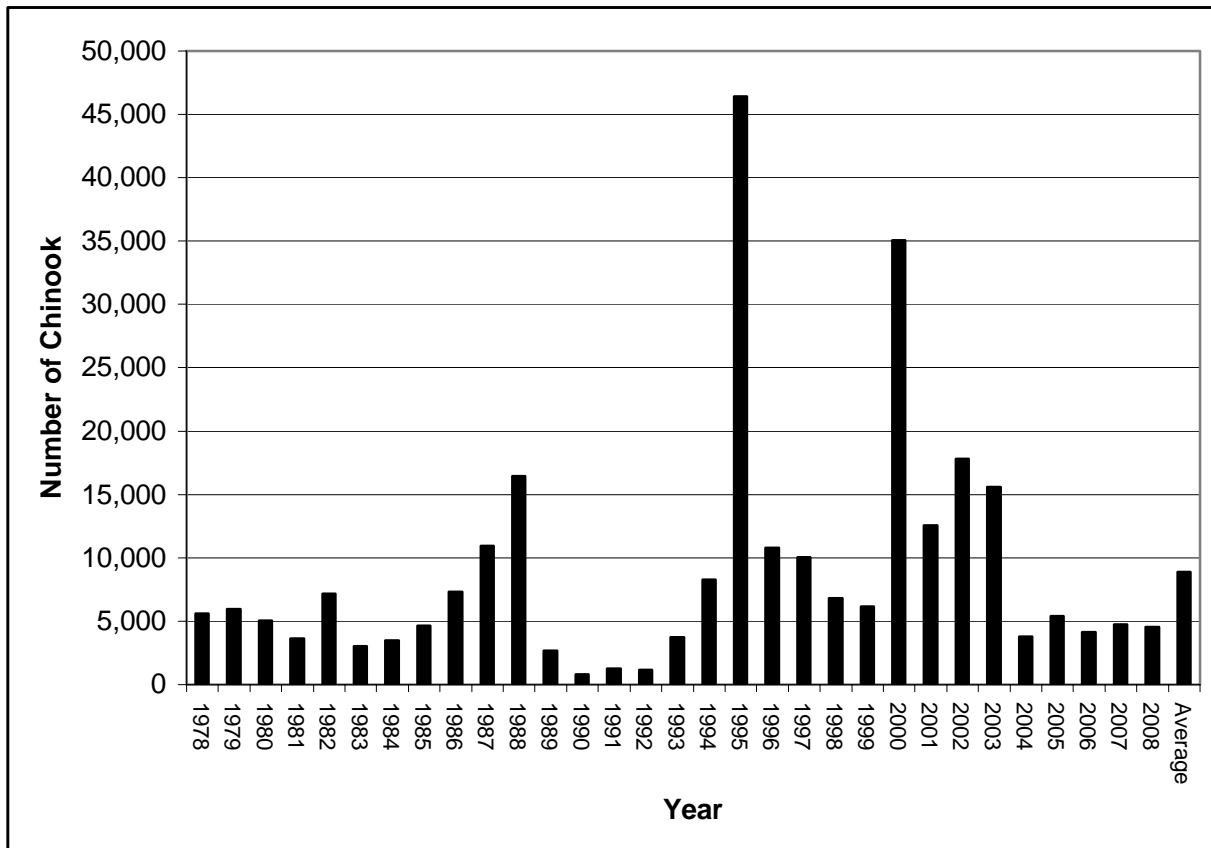


Figure 11. Estimated escapement of adult Chinook salmon returning to Bogus Creek from 1978 to 2008.

HATCHERY CHINOOK SALMON CONTRIBUTIONS

The KRP has estimated the contribution of hatchery origin Chinook salmon in Bogus Creek since 1999.

Over that period of time the contribution of hatchery Chinook salmon in relation to the total Chinook salmon run in Bogus Creek has fluctuated greatly, ranging from 61.6% to 7.5%. An estimated 23.6% of the Chinook salmon that entered Bogus Creek during 2008 were of hatchery origin (Figure 12). Yearling Chinook salmon released from IGH in 1998 (Brood Year 1997) and 1999 (Brood Year 1998) were not tagged prior to release due to budgetary constraints. Without tags it is impossible to determine contribution rates on these yearling releases, and therefore the hatchery estimates presented for Bogus Creek do not account for potential hatchery returns from these two release groups. Three year old returns from these two yearling brood years would have occurred during the 2000 and 2001 seasons. The 2002 return would have been the last year that untagged yearlings from the 1998 brood year would have returned as four year old fish. As a result, the hatchery contribution estimates for Bogus Creek from 1999 to 2002 likely under estimate the total hatchery contribution to Bogus Creek by an unknown number. Even without accounting for these untagged yearling releases, a large proportion of the 2000 (37.2%) and 2001 (61.6%) Chinook salmon run that returned to Bogus Creek originated from IGH.

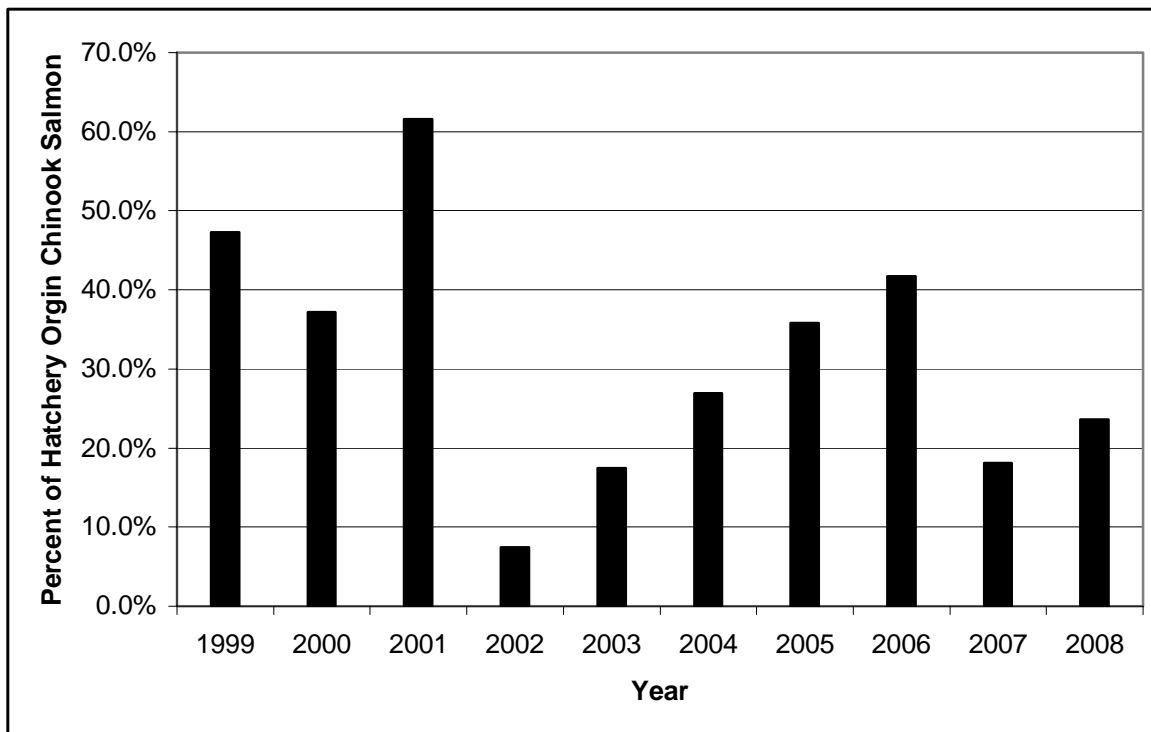


Figure 12. Estimated contribution of hatchery origin Chinook salmon observed in Bogus Creek from 1999 through 2008.

COHO SALMON

Since video operations began in 2004 the estimated escapement of coho salmon in Bogus Creek has averaged 181 fish (Figure 13). The run size of coho salmon during 2008 was estimated to be 111, 38.7% below the four year average. The run size estimate for the 2005 season is believed to be lower than the reported escapement since several early storms during the 2005 season greatly hindered the Departments ability to effectively monitor the escapement of coho salmon into Bogus Creek that year. Due to the underestimated run size in 2005 there is difficulty when comparing the number of three year olds returning in 2008 to their parental cohort from 2005. The returning adult year class in 2008 is in the middle of the three coho year classes, with respect to abundance, and a slight increase in cohort strength is encouraging. Although the run size increased 8.8% between 2005 and 2008, if the 2005 estimate was more accurate (higher) most likely there would have been a decrease in cohort strength observed in 2008.

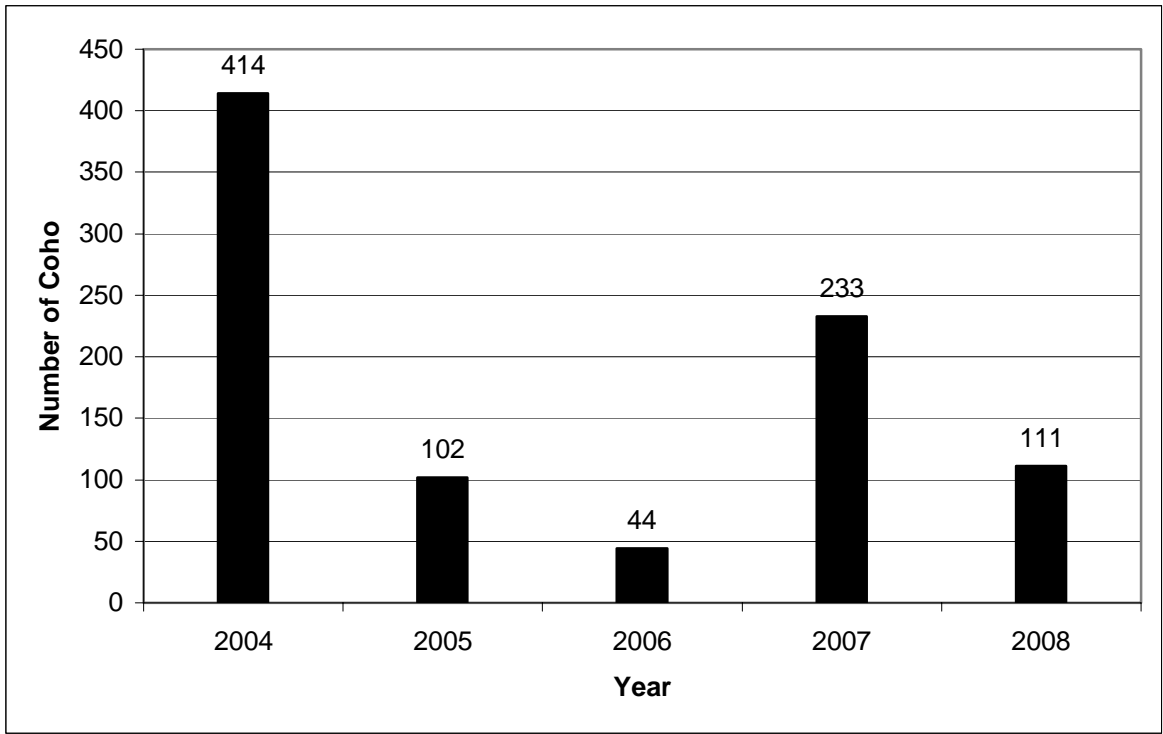


Figure 13. Estimated escapement of adult coho salmon returning to Bogus Creek from 2004 through 2008.

ACKNOWLEDGEMENTS

The California Department of Fish and Game would like to thank Siskiyou County High School students who assisted KRP staff in completing spawning ground surveys on Bogus Creek. Their contribution was integral to the success of the project. We would also like to express our appreciation to the various landowners who have graciously provided permission to access Bogus Creek on their lands.

The KRP would also like to express their sincere gratitude to the Yreka Fish and Wildlife Service Office for their funding and assistance in completing this study. A special thank you goes to Donn Rehberg for his assistance in coordinating the volunteer effort of local high school students throughout the season.