

BOGUS CREEK SALMON STUDIES

2007



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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 18, 2007 and ended on December 31, 2007 due to high flows. The total number of Chinook salmon that entered Bogus Creek during the 2007 season is estimated to be **4,741** 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 1,882 (39.7%) males and 2,859 (60.3%) females. Based on a grilse cut off of ≤ 51 cm, adults comprised approximately 98.0% (4,646 fish) and grilse comprised 2.0% (95 fish) of the run. Males ranged in fork length from 39cm to 99cm and averaged 68cm. Females ranged in fork length from 48cm to 81cm and averaged 64cm. KRP staff estimated that 859 Chinook salmon (18.1%) were of hatchery origin.

The first adult coho salmon was observed entering Bogus Creek on October 25, 2007 and the last coho salmon was observed on December 30, 2007. A total of 233 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 112 (48.3%) males and 121 (51.7%) females. Based on a grilse cut off of ≤ 52 cm, age three fish comprised approximately 84.5% (197 fish) and age two fish comprised 15.5% (36 fish) of the run. Males ranged in fork length from 35cm to 75cm and averaged 60cm. Females ranged in fork length from 51cm to 71cm and averaged 64cm. Fourteen of the 233 coho salmon observed were caudal clipped and floy tagged indicating that they were unmarked coho salmon that previously entered IGH and were subsequently released after they were tagged and caudal clipped. KRP staff estimated that 84 coho salmon (36.2%) 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.

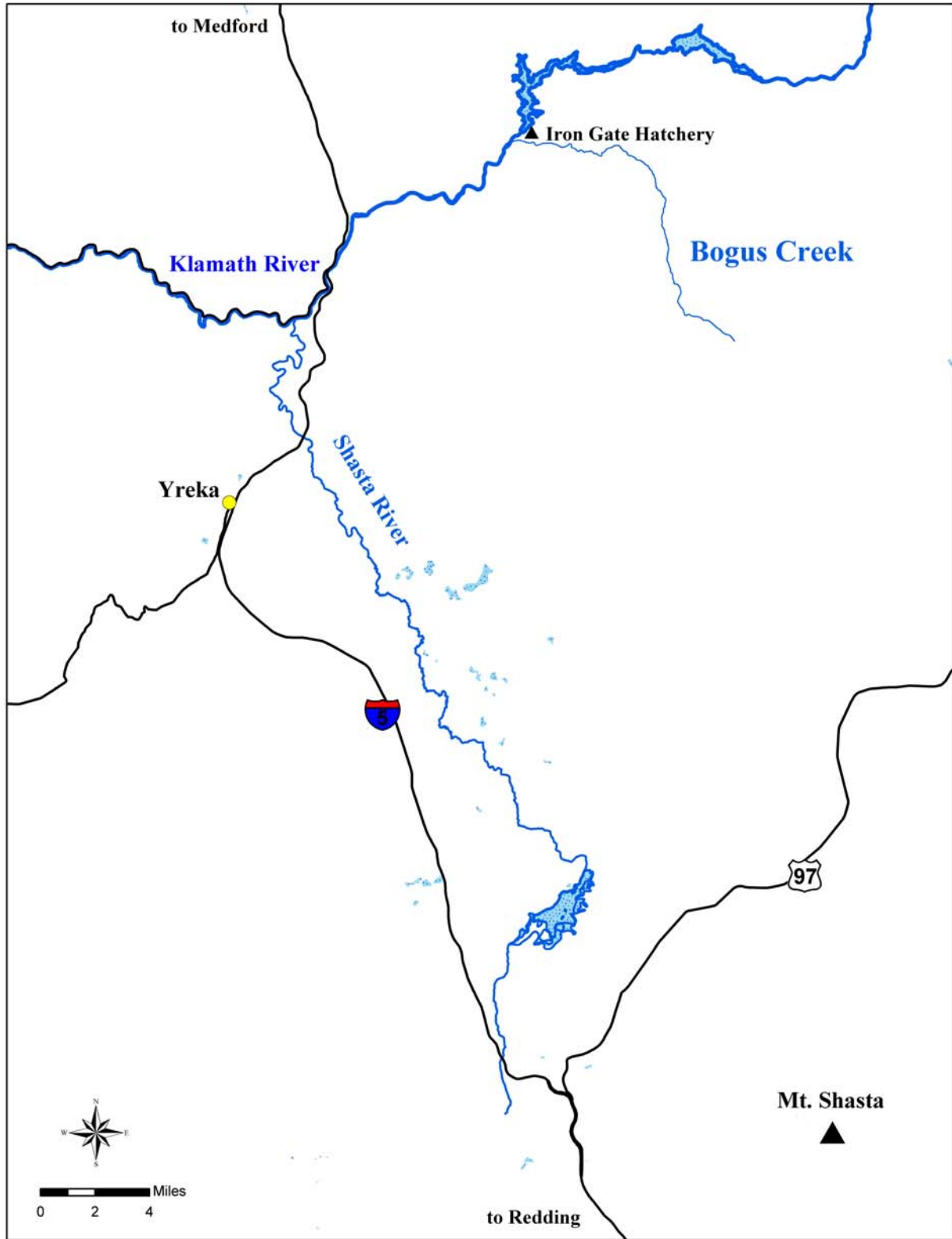


Figure 1. Location of Bogus Creek, tributary to the Klamath River, Siskiyou County.

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 estimate 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 2007 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 18, 2007 at 0550 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 a Sony Time Lapse 168 Video Cassette Recorder (Model SVT-S3100) was used to record the image to SVHS 120 min video tapes. The time lapse VCR was set to record over a 12 hour period and tape changes were made at 0700 hours and 1900 hours.

All tapes were immediately returned to the office where each was subsequently 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 12, 2007 and ending December 4, 2007. Additional surveys were conducted once a week through December 19, 2007 to recover additional information for spawning coho salmon. A total of fifteen surveys were performed during the Chinook salmon spawning season and two additional surveys were conducted once a week during the coho salmon spawning season.

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 carcass examined during the survey. All scale samples were provided to the Yurok Tribal Fisheries Department for analysis each week. Females with greater than 50% of their eggs still remaining in their body cavity were identified as a pre-spawn mortality. 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 were cut in half to prevent potential recounting during later surveys. The same protocol was used for

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

every coho salmon carcass that was recovered during the survey.

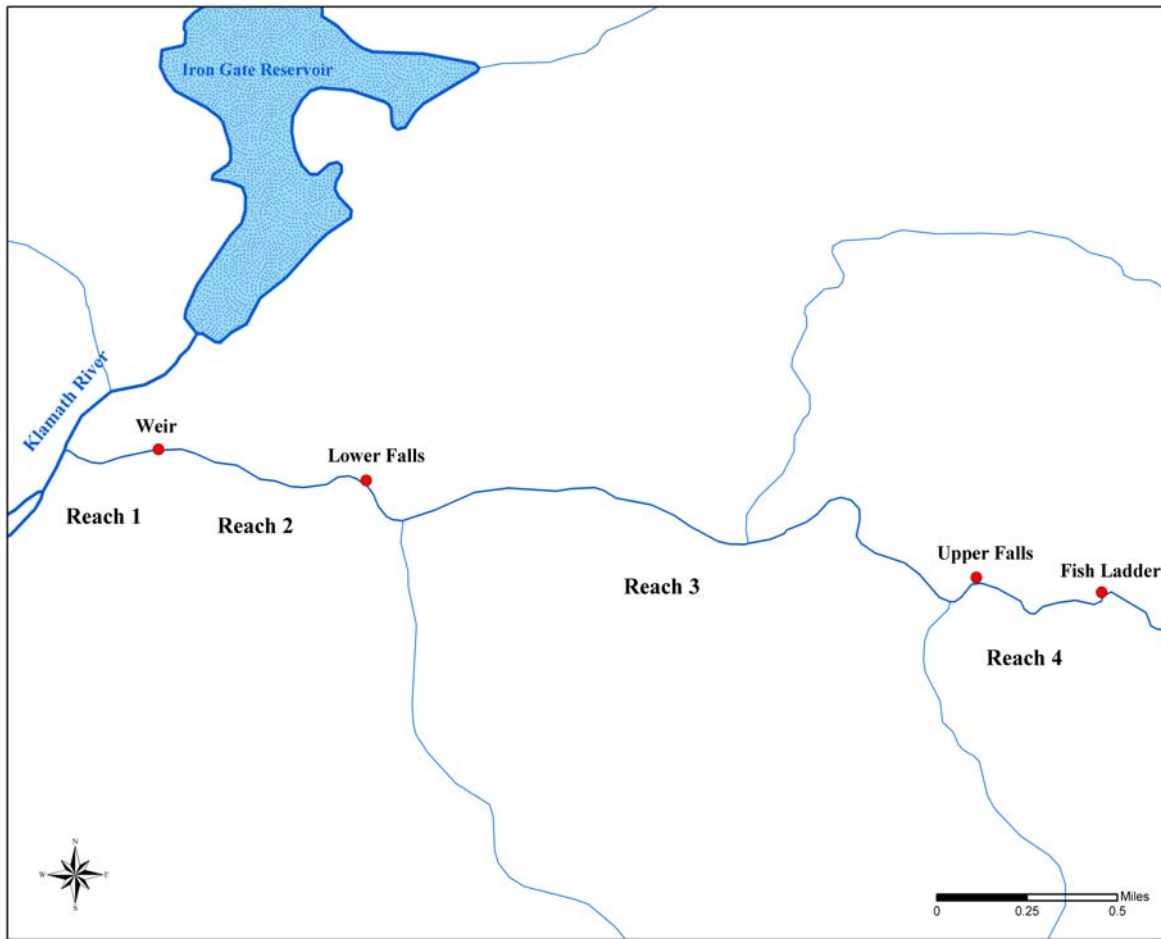


Figure 2. Map of spawning ground survey reaches on Bogus Creek used during the 2007 field season. The weir denotes the location of the Bogus Creek Fish Counting Facility (BCFCF).

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 286 Chinook salmon and 47 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 23 Chinook salmon and 29 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 0550 hours on September 18, 2007. The first Chinook salmon was observed at the BCFCF on September 25, 2007 and the last Chinook salmon was observed on December 13, 2007. The run peaked between October 8, 2007 and October 30, 2007 (Figure 3). The majority of Chinook salmon passed through the BCFCF during daylight hours and peaked in the afternoon after 1600 hours (Figure 4).

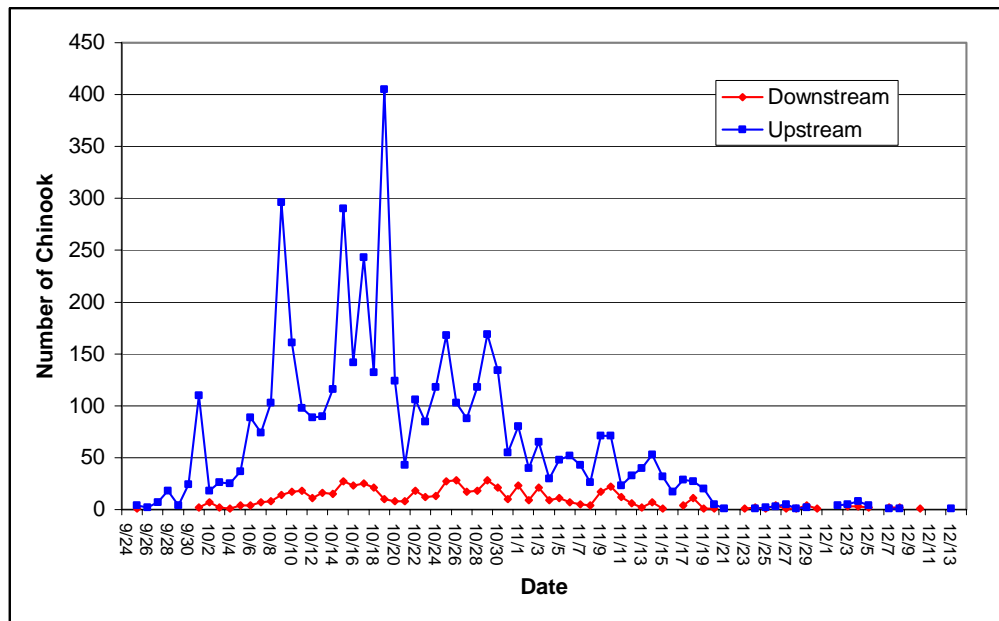


Figure 3. Run timing of Chinook salmon through the BCFCF during the 2007 season. Both upstream and downstream movements through the counting flume are shown.

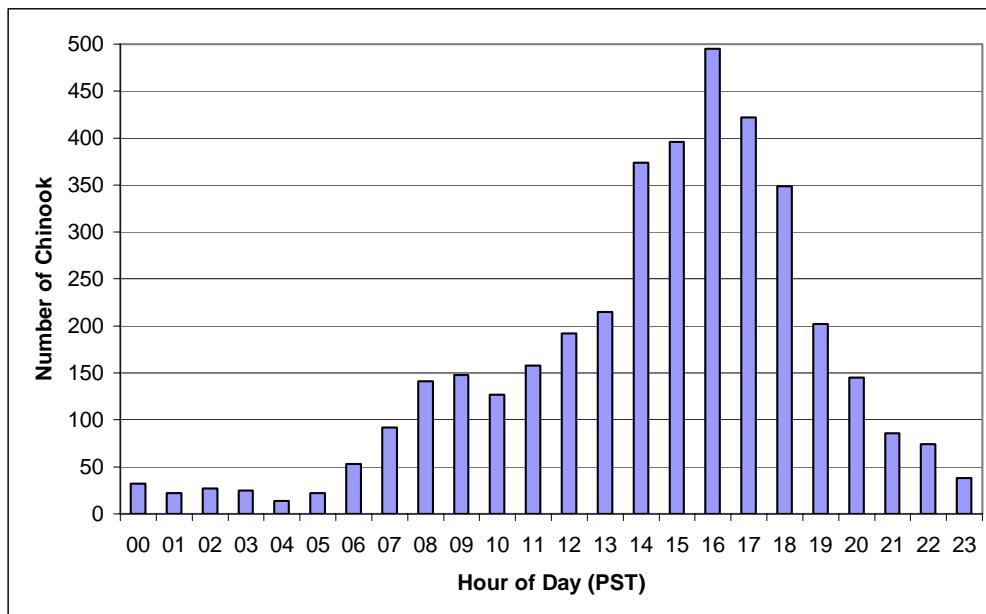


Figure 4. Summary of daily run timing of Chinook salmon observed at the Bogus Creek Fish Counting Facility during 2007.

A total of 4,116 Chinook salmon were estimated to have passed through the BCFCF during the 2007 season, with 4,020 observed through the flume. Another 49 fish were added to the total as an expansion for periods of time when the camera was not functioning. During the storm event of October 19 and 20, 2007 Department staff at the weir site counted an additional 47 migrating adult Chinook salmon. These fish were either netted then placed above the weir or seen jumping successfully above the weir. While the weir site was unattended an unknown number of Chinook salmon may have jumped successfully above the Bogus Creek Weir. A total of 625 Chinook salmon carcasses were counted in Reach 1, downstream of the BCFCF, yielding a total run size estimate of 4,741 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 1,882 (39.7%) males and 2,859 (60.3%) females. Based on a grilse cut off of ≤ 51 cm, adults comprised approximately 98.0% (4,646 fish) and grilse comprised 2.0% (95 fish) of the run.

SPAWNING GROUND SURVEYS

A total of 870 Chinook salmon carcasses were systematically sampled (1 in 4) during the spawning ground survey. Of the 870 Chinook salmon carcasses examined, 525 were females, 345 were male. Males ranged in fork length from 39cm to 99cm and averaged 68.4cm (Figure 5). Based on the length frequency distribution of male Chinook salmon presented on Figure 5, grilse were determined to be ≤ 51 cm in fork length. Females ranged in fork length from 51cm to 81cm and averaged 63.6cm (Figure 6).

A total of 525 Chinook salmon female 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 525 female Chinook salmon carcasses examined, spawning success could not be determined for 25 females due to decomposition or predation. Of the remaining 500 females, 496 females (99.2%) were found to have spawned, and 4 females (0.8%) still contained more than 50% of their spawn and were identified as pre-spawn mortalities.

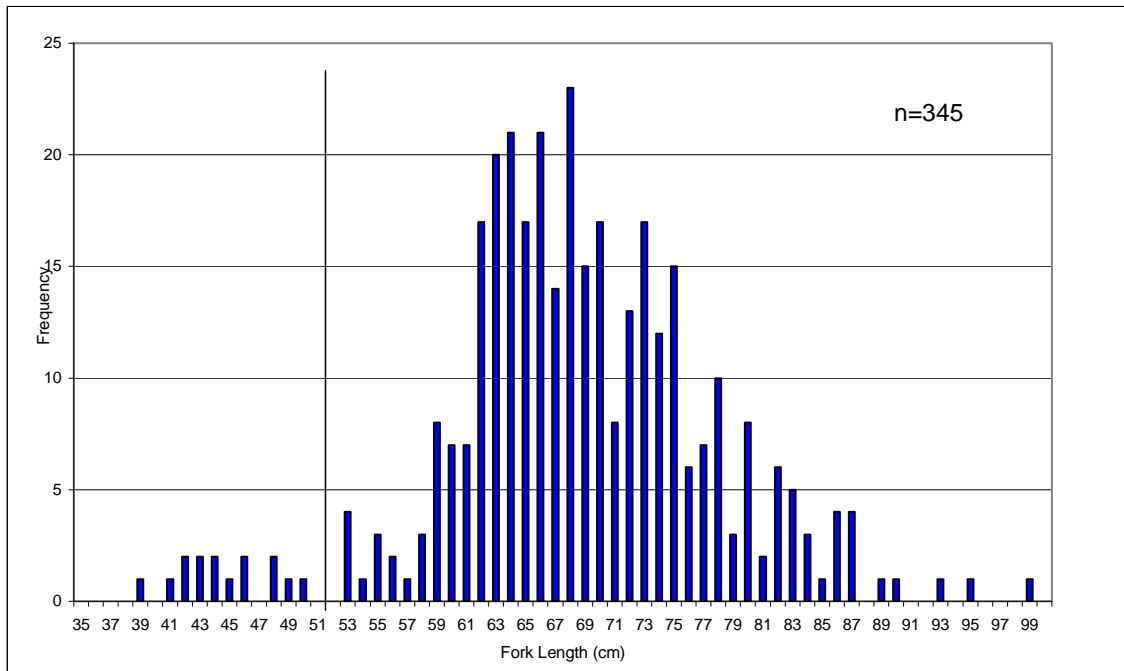


Figure 5. Length Frequency distribution of male Chinook salmon observed during spawning ground surveys in Bogus Creek, 2007 (n = 345).

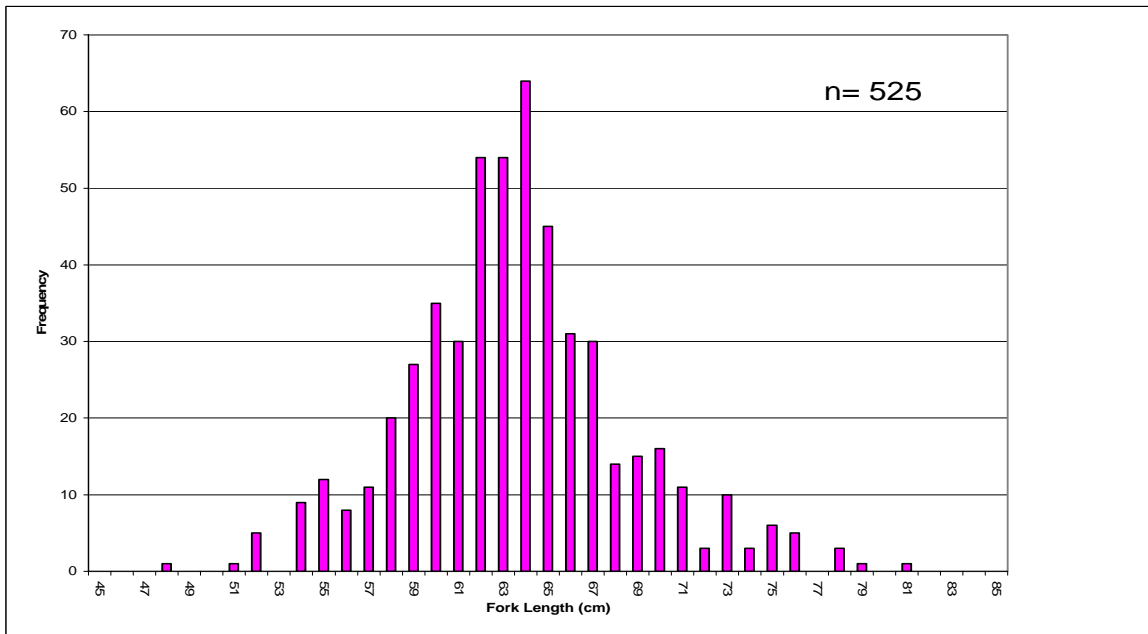


Figure 6. Length frequency distribution of female Chinook salmon observed during spawning ground surveys in Bogus Creek, 2007 (n = 525).

HATCHERY CONTRIBUTION ESTIMATE

A total of 32 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 32 heads that were collected, seven did not contain CWTs and 2 CWTs were lost while being recovered from the head. The remaining 23 heads contained legible CWTs. One of the CWT's recovered was from the Trinity River Hatchery (TRH) and the remaining 22 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 (1.40) based on the inverse of the number of carcasses (2,933) examined upstream of BCFCF during spawning ground surveys divided by the total number of Chinook salmon that was observed passing through the BCFCF (4,116), 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. The estimate is based on coded-wire tags (CWT) recovered from ad-clipped fall run Chinook salmon collected in Bogus Creek during spawning ground surveys in 2007.

Coded Wire Tag	Location	Release Type <i>a/</i>	Brood Year	Age	Sample Number	Production Multiplier <i>b/</i>	Production Estimate	Sample Expansion <i>c/</i>	Total Estimate
Spawning Ground Surveys, Reach 1									
601020502	IGH	Fy	2003	4	1	14.11	14	1	14
601020504	IGH	Ff	2004	3	2	17.12	34	1	34
601020506	IGH	Ff	2004	3	2	34.04	68	1	68
601020507	IGH	Ff	2004	3	1	37.42	37	1	37
601020509	IGH	Fy	2004	3	2	8.01	16	1	16
Sub Total=					8	Sub Total=			170
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
65323	TRH	Ff	2004	3	1	4.06	4	1.4	6
601020505	IGH	Ff	2004	3	2	16.61	33	1.4	47
601020506	IGH	Ff	2004	3	7	34.04	238	1.4	334
601020507	IGH	Ff	2004	3	4	37.42	150	1.4	210
601020607	IGH	Fy	2005	2	1	9.22	9	1.4	13
Sub Total=					15	Sub Total=			608
Estimated contribution of lost and unreadable CWT's					2	Sub Total=			81
Total Estimated Hatchery Contribution=									859
<p><i>a/</i> Release type; Ff=Fall fingerling, Fy=Fall Yearling <i>b/</i> Production Multiplier value is the inverse of the proportion of effectively tagged and total release from IGH <i>c/</i> Sample expansion is the inverse of the number samples during the carcass surveys in reach 2, 3, and 4 divided by the video estimate.</p>									

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 were incorporated into the spawn with marked coho, were released back to the river providing them the opportunity to spawn naturally. Prior to release, each unmarked coho was given an upper lobe caudal clip and an individually numbered Floy tag was applied to the right posterior dorsal area of the body. These marks were 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 125 unmarked coho salmon were released from IGH to the Klamath River during the 2007 season.

The first adult coho salmon was observed entering Bogus Creek on October 25, 2007 and the last coho salmon was observed on December 30, 2007. A total of 233 coho salmon were observed moving upstream through the BCFCF during the season (Figure 7). Of these 12 were caudal clipped, floy tagged individuals indicating that they were unmarked coho salmon that previously entered IGH and were subsequently released after marking.

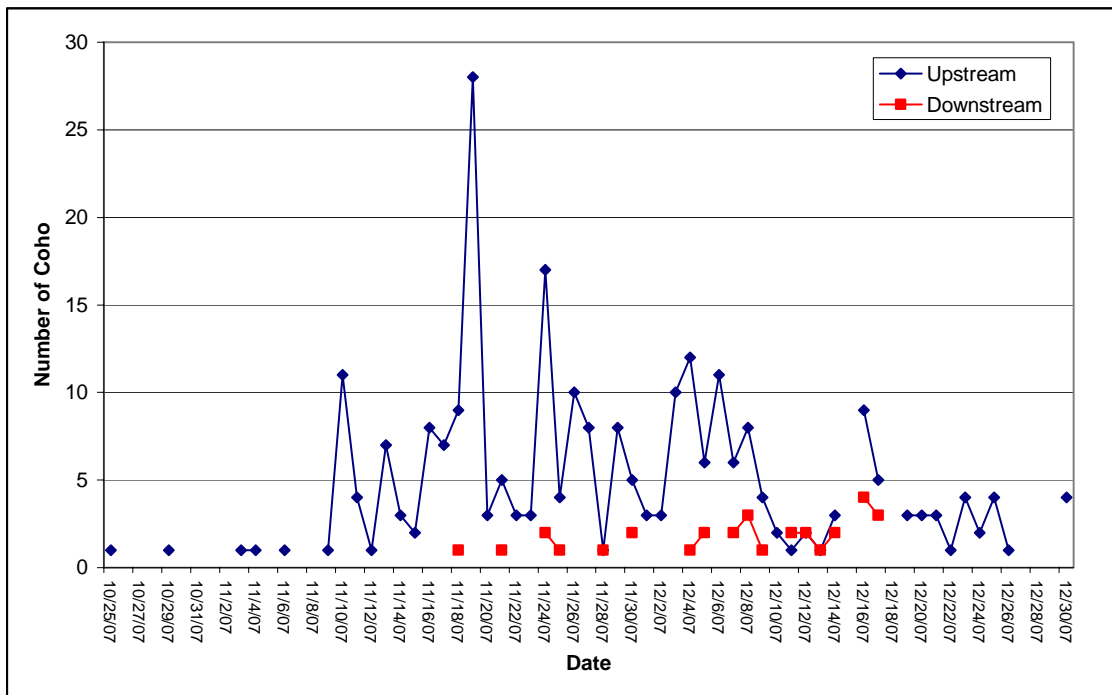


Figure 7. Run timing of coho salmon observed passing through the Bogus Creek Fish Counting Facility during the 2007 season.

Diel movements of coho salmon through the BCFCF were higher in the evening hours and peaked between 1800 hours and 2100 hours (Figure 8). This movement pattern is consistent with observations from previous seasons.

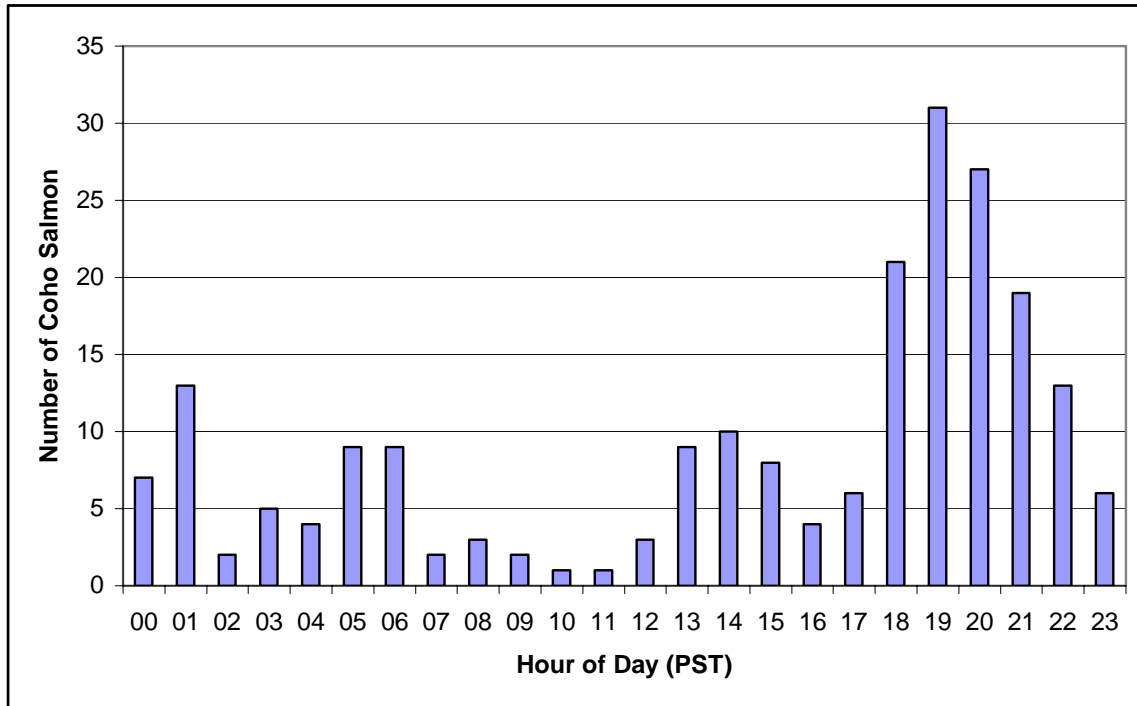


Figure 8. Diel migration patterns of coho salmon observed moving through the Bogus Creek Fish Counting Facility in 2007.

SPAWNING GROUND SURVEYS

A total of 58 coho salmon carcasses were sampled during the spawning ground survey. Of those 30 were females, 28 were males. Males ranged in fork length from 35cm to 75cm and averaged 60.1cm (Figure 9). Based on the length frequency distribution of male Chinook salmon presented on Figure 9, grilse were determined to be ≤ 52 cm in fork length. Females ranged in fork length from 51cm to 71cm and averaged 64.1cm (Figure 10).

Thirty 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 carcasses examined, spawning success could not be determined for one female due to decomposition or predation. Of the remaining twenty nine, 24 (82.8%) were found to have spawned, 5 females (17.2%) still contained more than 50% of their spawn and were identified as pre-spawn mortalities.

Twenty one of the 58 (36.2%) 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 55.6% and 32.7% for age two and age three fish respectively.

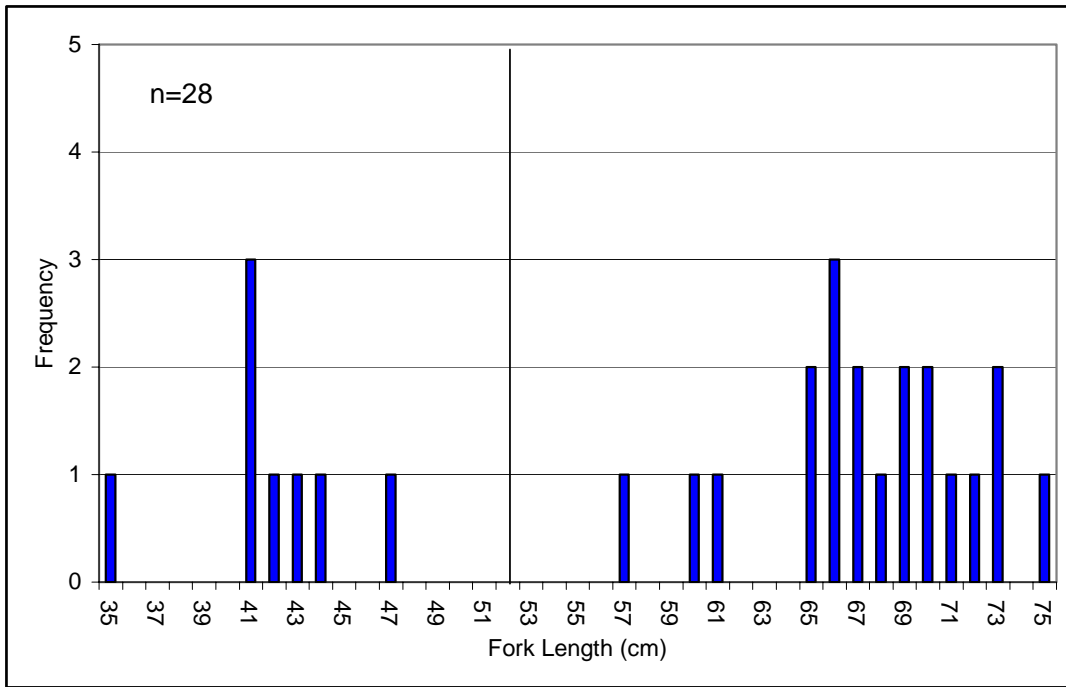


Figure 9. Length Frequency distribution of male coho salmon observed during spawning ground surveys in Bogus Creek, 2007 (n = 28).

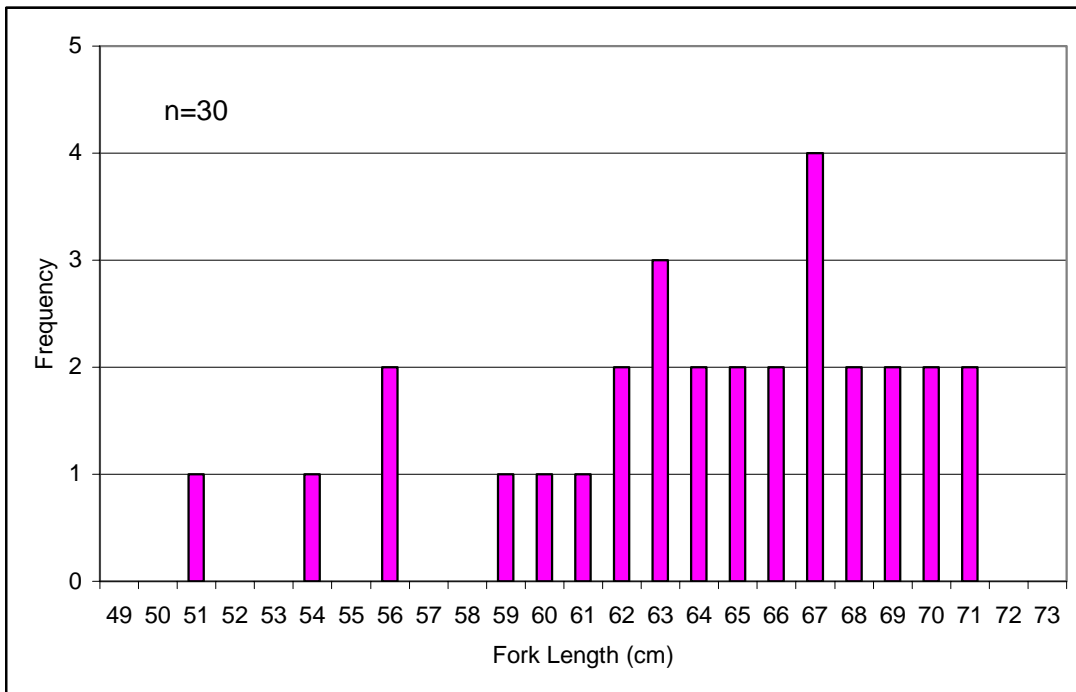


Figure 10. Length Frequency distribution of female coho salmon observed during spawning ground surveys in Bogus Creek, 2007 (n = 30).

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 9,017 fish (Figure 11). The 2007 Chinook salmon run in Bogus Creek ranks nineteenth (4,741 fish) out of 30 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 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.

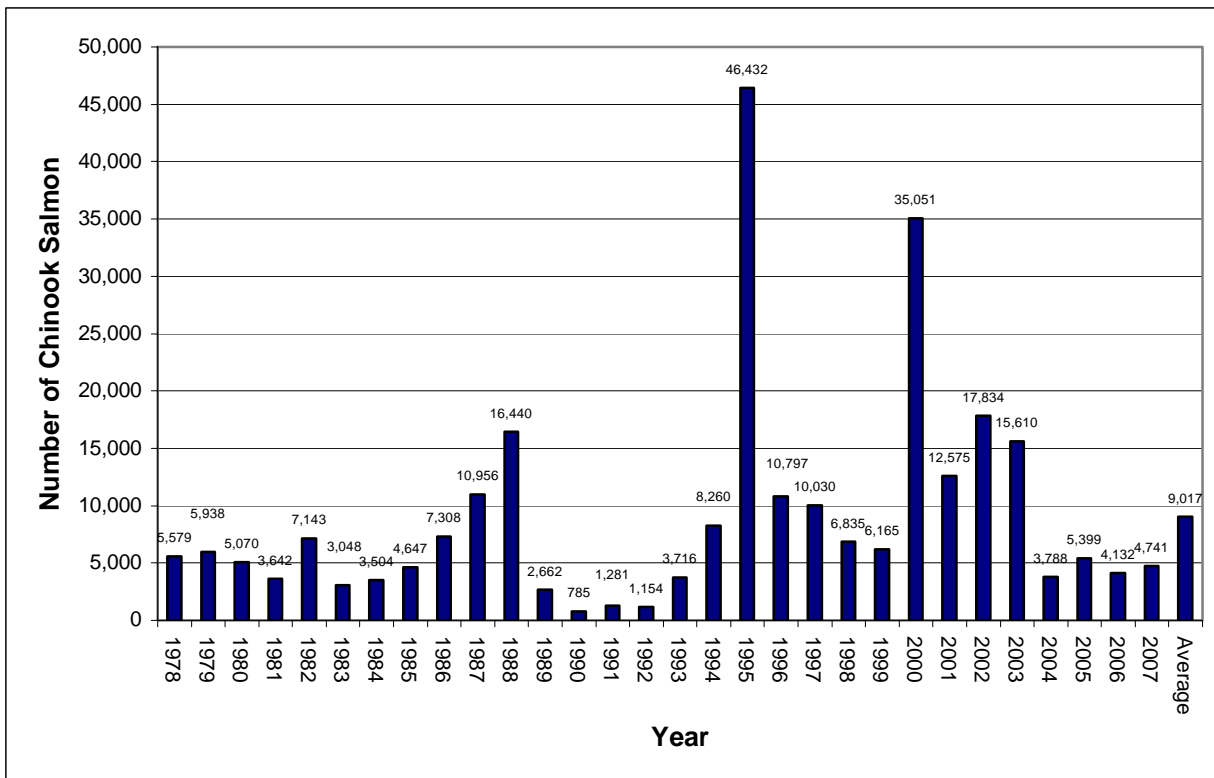


Figure 11. Estimated escapement of adult Chinook salmon returning to Bogus Creek from 1978 to 2007.

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 18.1% of the Chinook salmon that entered Bogus Creek during 2007 were of hatchery origin (Figure 12). One

TRH produced Chinook salmon was recovered in Bogus Creek during 2007 and accounted for 7 of the 859 estimated hatchery origin Chinook salmon for the season. 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 underestimate 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.

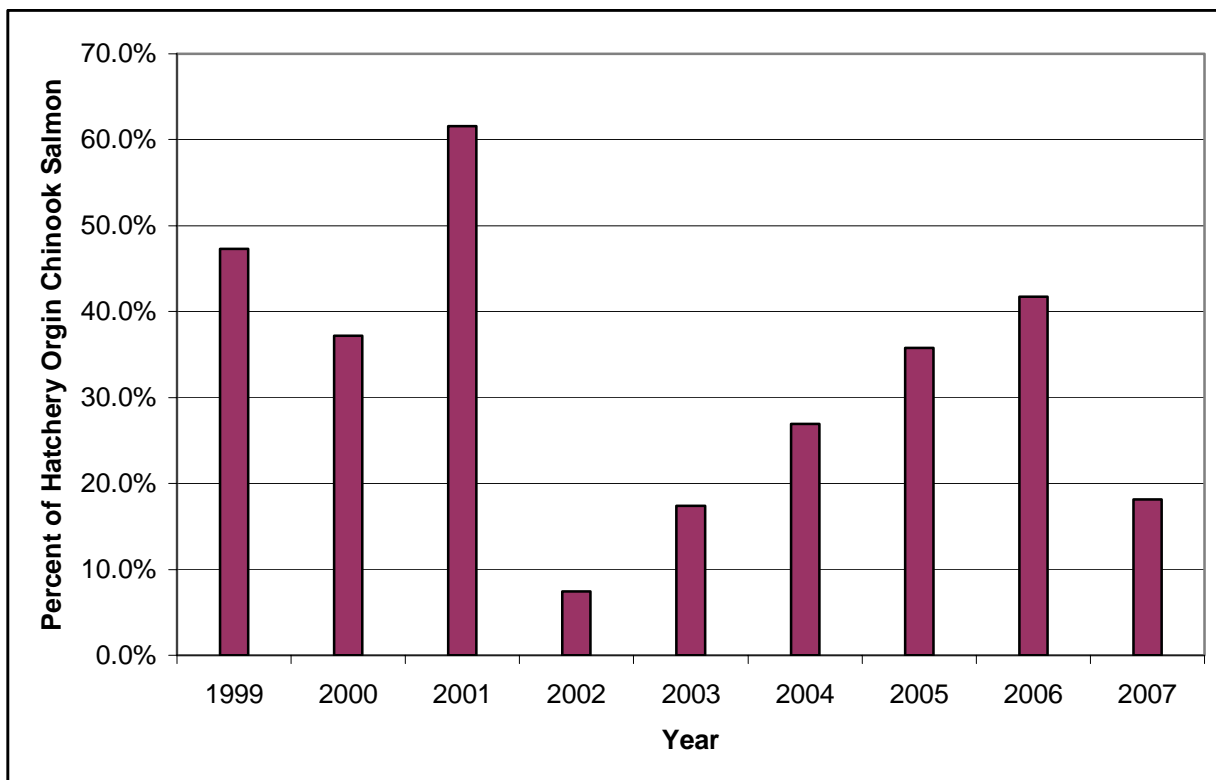


Figure 12. Estimated contribution of hatchery origin Chinook salmon observed in Bogus Creek from 1999 through 2007.

COHO SALMON

Since video operations began in 2004 the number of coho salmon observed has averaged 198 and has been estimated to be 414, 102 and 44 for the 2004, 2005 and 2006 runs respectively. The run size of coho salmon during 2007 was estimated to be 233, well above the four year average. The run size estimate for the 2005 season is believed to be lower than the actual 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. When comparing the number of three year olds returning in 2007 to their parental cohort from 2004 there was a reduction from 395 and 197 fish respectively. The returning adult year class in 2007 is the strongest of the three coho year classes and a reduction in 3-year-old year class strength is concerning. Although the three year old component decreased 50% between 2004 and 2007 the reduction was far less than observed in other Southern Oregon Northern California Coho stocks.

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 Noah Ellis for his assistance in coordinating the volunteer effort of local high school students throughout the season.

