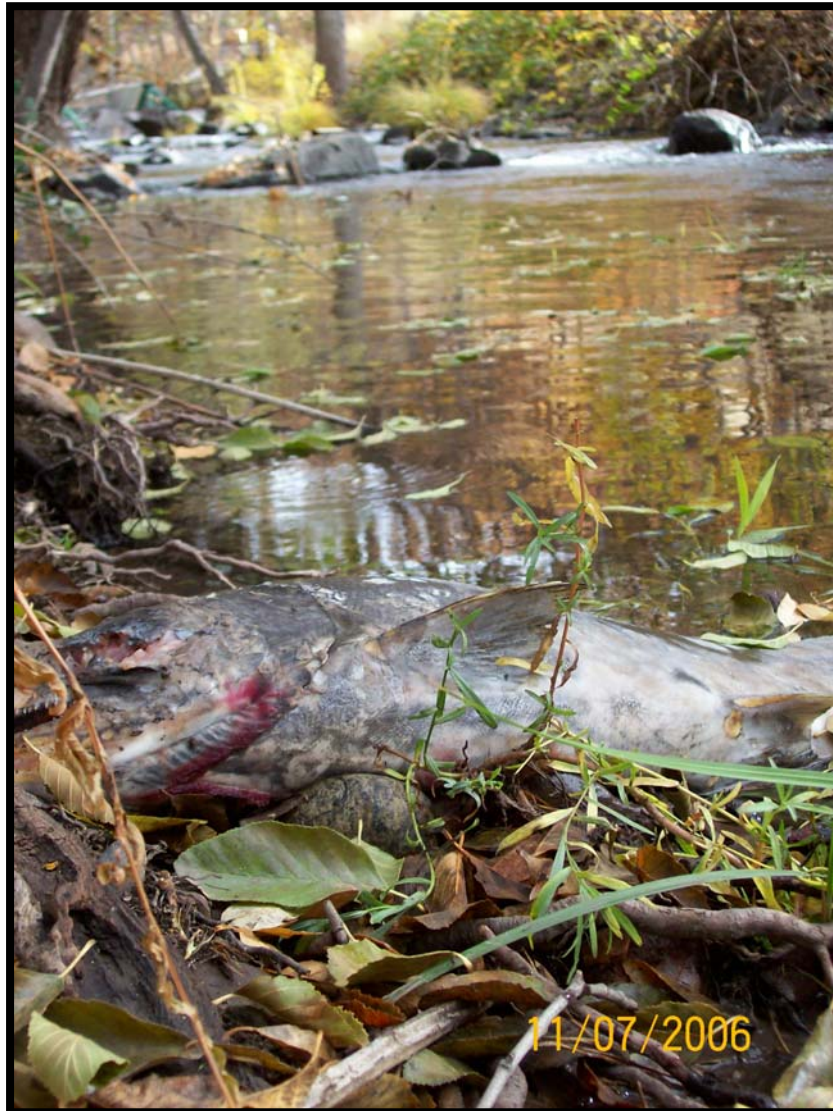


BOGUS CREEK SALMON STUDIES

2006



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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 and coho salmon into Bogus Creek. Video fish counting operations began on September 14th and ended on December 13th due to high flows. The total number of Chinook salmon that entered Bogus Creek during the 2006 season is estimated to be **4,133** 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 1,970 (47.7%) males and 2,163 (52.3%) females. Based on a grilse cut off of ≤ 58 cm, adults comprised approximately 84.7% (3,499 fish) and grilse comprised 15.3% (634 fish) of the run. Males ranged in fork length from 30cm to 100cm and averaged 70cm. Females ranged in fork length from 51cm to 90cm and averaged 73cm. KRP staff estimated that 1,724 Chinook salmon or 41.7% of the entire run was comprised of fish originally released from Iron Gate Hatchery.

The first adult coho salmon was observed entering Bogus Creek on October 23rd and the last coho salmon was observed on December 11th. A total of 46 coho salmon were observed moving upstream through the Bogus Creek Fish Counting Facility (BCFCF) during the season (Figure 7). Three of the 46 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. Those three coho were observed on November 10th, 21st, and 25th.

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 (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.

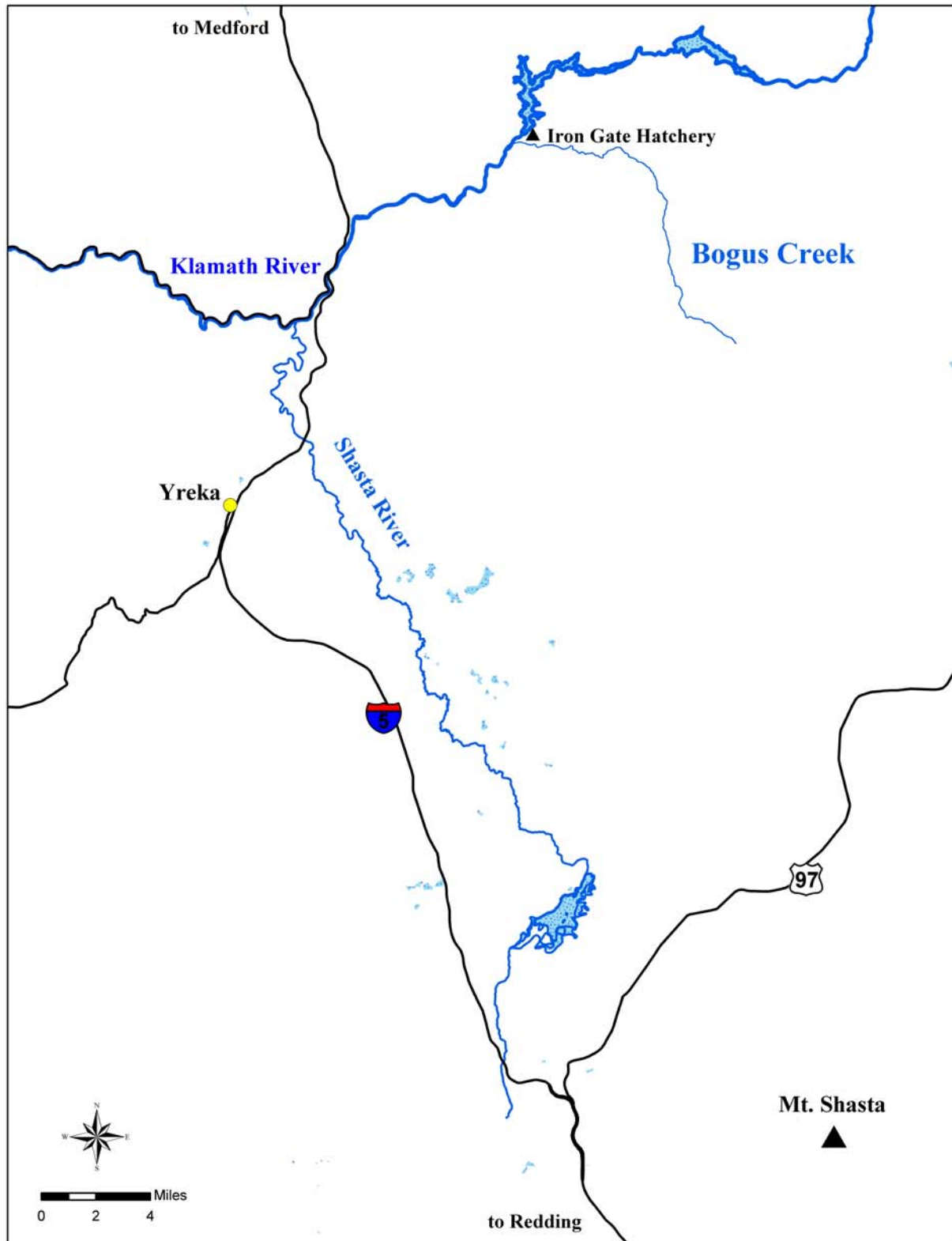


Figure 1. Location of Bogus Creek, tributary to the Klamath River, Siskiyou County.

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, and mark Chinook 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. 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 CWTs from marked salmon encountered during the survey. The CDFG 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 2006 Chinook salmon spawning season.

KLAMATH RESTORATION PROGRAM

The Klamath River Basin Conservation Area Restoration Program was established in 1986 by the Klamath Act (Public Law 99-552). The purpose of this 20-year program is to restore anadromous fish in the Klamath River basin, primarily salmon and steelhead. The Klamath Act established two federal advisory committees: the Klamath River Basin Fisheries Task Force (Task Force) and the Klamath Fishery Management Council (KFMC). The KFMC and the Task Force consist of members from various stakeholder groups including commercial and recreational fishermen, Native American tribes, as well as state and federal agencies. The goal of the KFMC and the Task Force was to ensure continued viable populations of anadromous fish in the Klamath Basin by managing in-river and ocean harvest of Klamath Basin anadromous fish and providing funding for restoration projects. The Klamath Act expired on September 30th of 2006. In its absence, the various agencies and tribes continued to conduct monitoring of adult salmon escapement into the Klamath Basin during the 2006 season. An ad-hoc committee of these groups was formed to continue the work the Klamath River Technical Advisory Team in developing age specific run size estimates for Chinook salmon to provide data critical for harvest management.

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) 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 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 KFMC and 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 fall Chinook salmon returning to Bogus Creek.
- B) Determine run timing, spawning distribution, length frequency distribution, and sex ratio for fall Chinook in Bogus Creek.
- C) Collect scale samples and recover heads (containing coded wire tags) from adipose fin-clipped Chinook in order to determine age composition of the run.
- D) Collect biological data for all coho salmon and steelhead observed during the Chinook 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 14th, 2006 at 11:43 hrs 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 includes a water proof camera housing, viewing window, and counting flume which allowed for unimpeded 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-C920U) 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 Pacific Standard Time.

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 on picture quality, staff recorded that observation as fish unknown. Staff also noted any adipose fin clips (ad-clips) observed, and recorded the presence of lamprey scars or 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, every Tuesday and Friday throughout the Chinook salmon spawning season (October 13th to November 21st) and then additional surveys were conducted once a week through December 5th to recover additional information for spawning coho salmon. A total of twelve surveys were performed twice a week 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).

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

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 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 spawning success for females 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 coded wire tag for subsequent age determination. Once examined, all carcasses were cut in half to prevent potential recounting during later surveys. Every coho salmon carcass that was recovered during the survey was sampled using the same protocol.

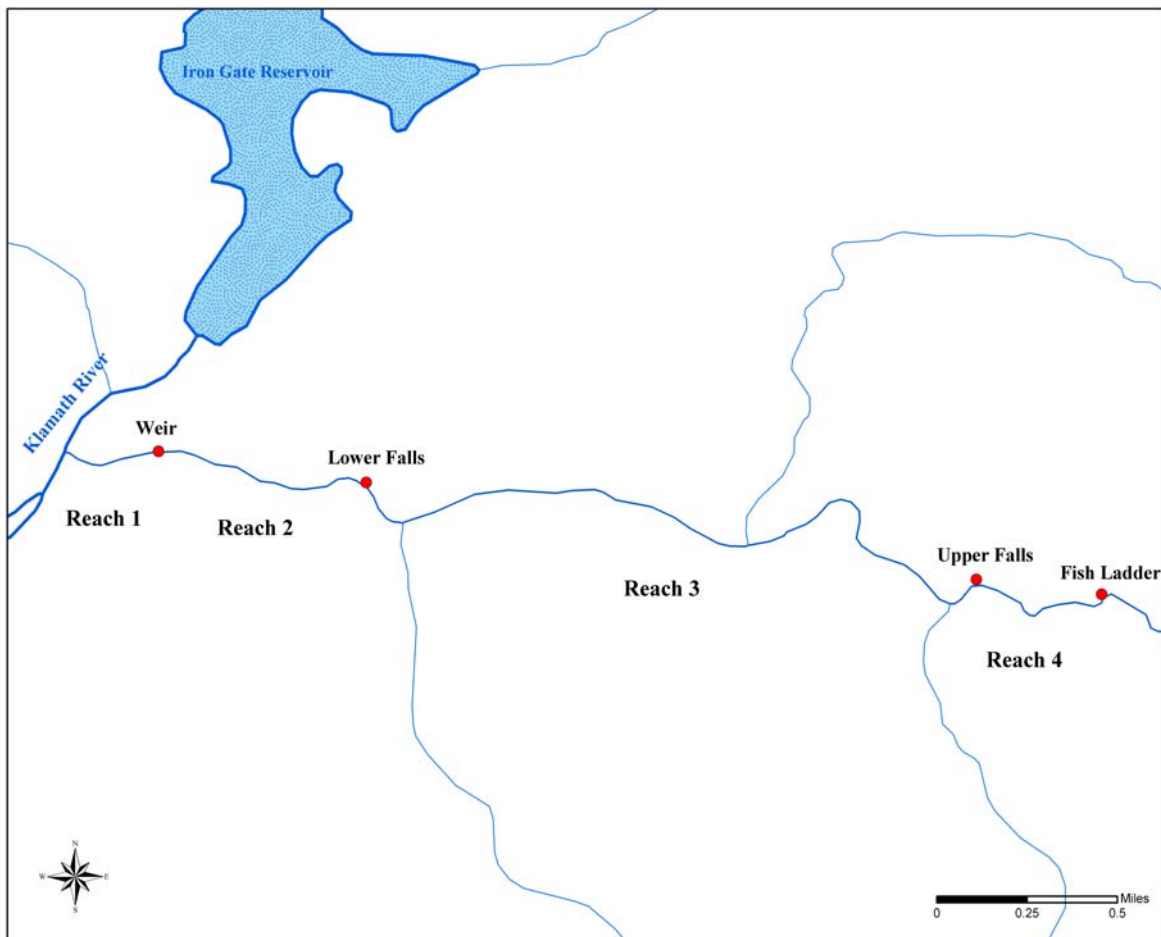


Figure 2. Map of spawning ground survey reaches on Bogus Creek used during the 2006 field season. The weir denotes the location of the Bogus Creek Fish Counting Facility (BCFCF).

To assist in developing genetic baseline information for use in future harvest management monitoring efforts in the ocean and in river fishery the KRP collected genetic tissue samples from 167 Chinook salmon and 5 coho salmon. All samples were collected following protocols provided by NOAA

Southwest Fisheries Science Center. Samples were sent to Salmonid Genetic Tissue Repository located at the NOAA Santa Cruz Laboratory for archiving and analysis.

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.

Hatchery contribution of Chinook 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 11:43 hrs PST on September 14th, 2006. The first Chinook salmon was observed at the BCFCF on September 18th and the last Chinook was observed on November 25th. The run peaked between October 5th and October 19th (Figure 3). The majority of Chinook salmon passed through the BCFCF during daylight hours and peaked in the afternoon after 16:00 hrs (Figure 4).

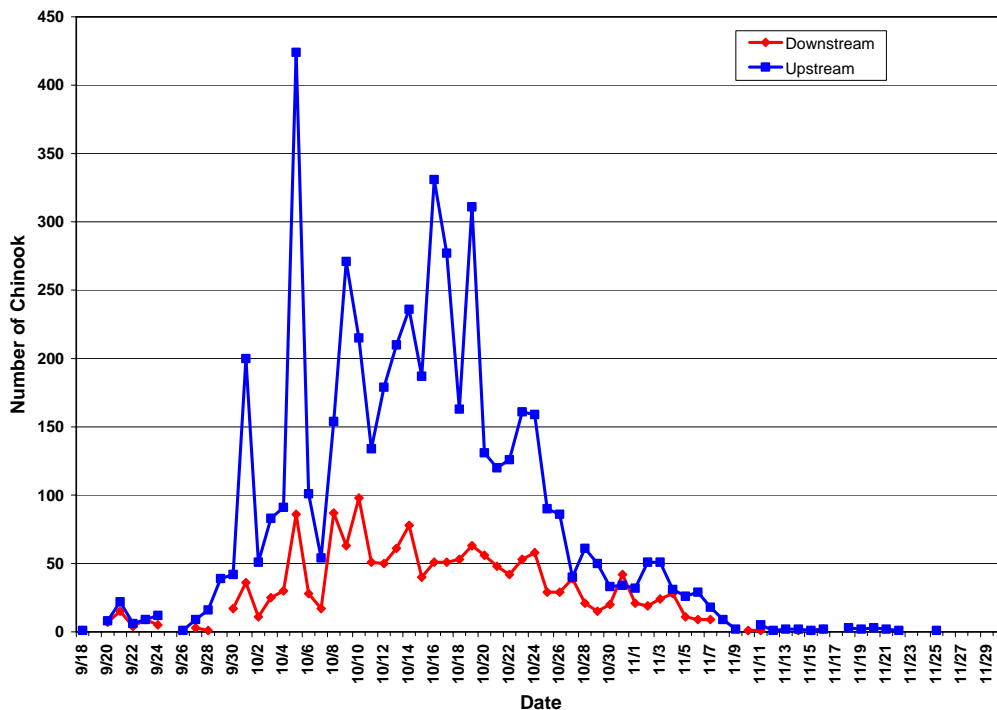


Figure 3. Run timing of Chinook salmon through the BCFCF during the 2006 season. Both upstream and downstream movements through the counting flume are shown.

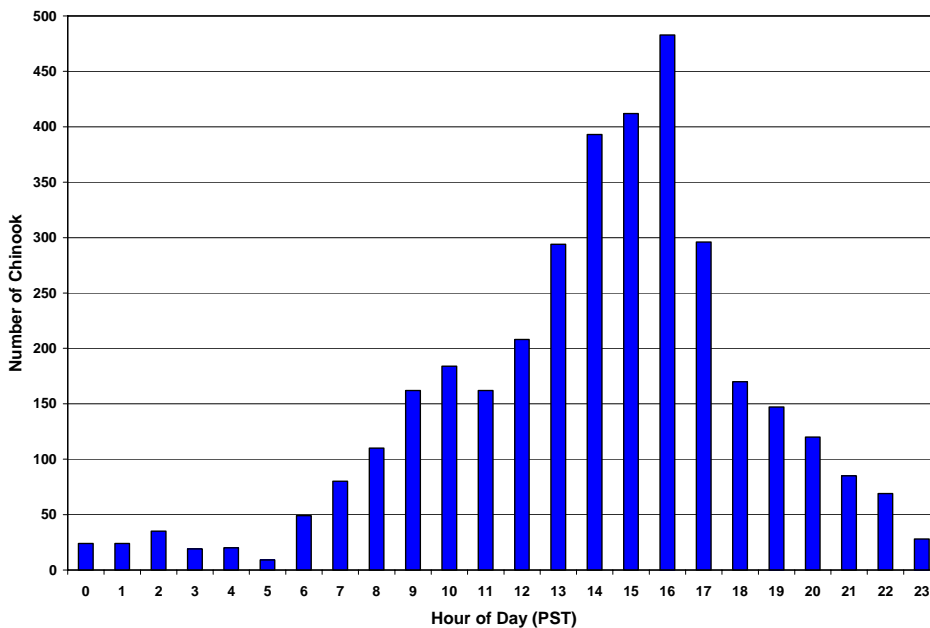


Figure 4. Summary of daily run timing of Chinook salmon observed at the Bogus Creek Fish Counting Facility during 2006. Both upstream and downstream movements through the counting flume are shown.

A total of 5,202 Chinook salmon were observed swimming upstream through the BCFCF and 1,619 were observed swimming downstream, leaving a net of 3,583 Chinook salmon in Bogus Creek upstream of the BCFCF. A total of 550 Chinook salmon were sampled during the spawning ground surveys in Reach 1, downstream of the BCFCF. Thus a total of **4,133** Chinook salmon were present in Bogus Creek during the 2006 spawning season. Based on the proportion of male and female Chinook salmon that were sampled during the spawning ground surveys, the run was comprised of approximately 1,970 (47.7%) males and 2,163 (52.3%) females. Based on a grilse cut off of $\leq 58\text{cm}$, adults comprised approximately 84.7% (3,499 fish) and grilse comprised 15.3% (634 fish) of the run.

Spawning Ground Surveys

A total of 600 Chinook salmon carcasses were systematically sampled (1 in 4) during the spawning ground survey. Of the 600 Chinook salmon carcasses examined, 314 were females, 286 were male. Males ranged in fork length from 30cm to 100cm and averaged 70cm (Figure 4). Based on the length frequency distribution of male Chinook salmon presented on Figure 5, grilse were determined to be $\leq 58\text{cm}$ in fork length. Females ranged in fork length from 51cm to 90cm and averaged 73cm (Figure 6).

A total of 314 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 $\frac{1}{2}$ or more of their eggs still present in the body cavity when examined were identified as a pre-spawn mortality. Of the 314 female Chinook carcasses examined, spawning success could not be determined for 3 females due to decomposition or predation. Of the remaining 311 females, 308 females (99.0%) were found to have spawned, and 3 females (1.0%) still contained more than $\frac{1}{2}$ of their spawn and were identified as pre-spawn mortalities.

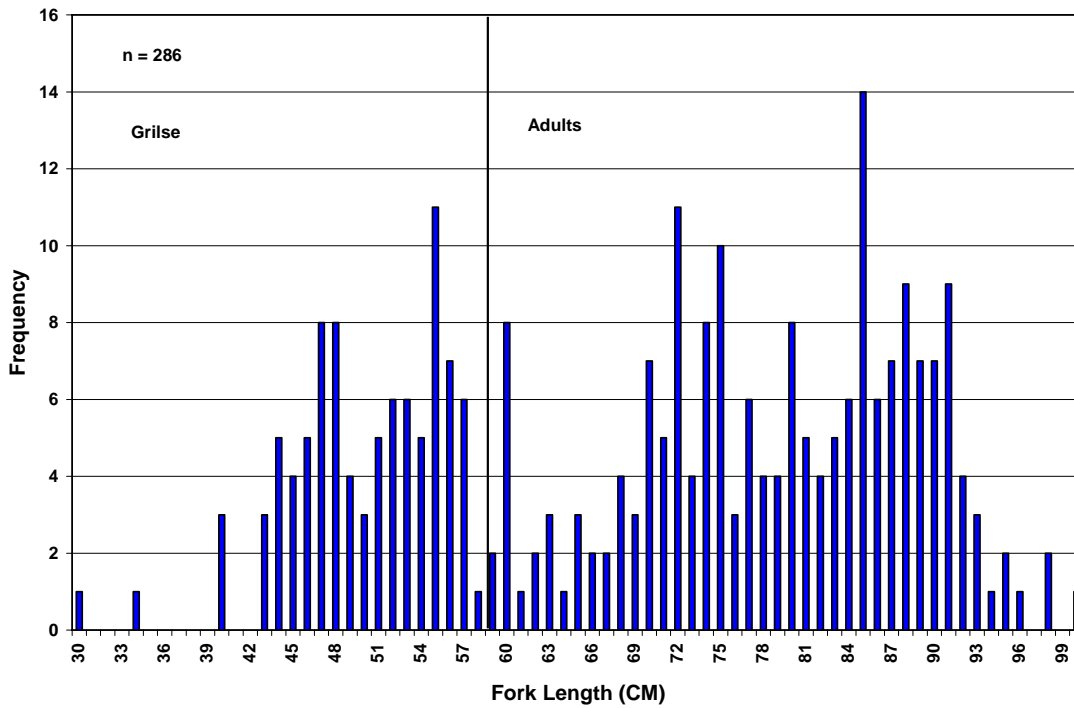


Figure 5. Length Frequency distribution of male Chinook salmon observed during spawning ground surveys in Bogus Creek, 2006 (n = 286).

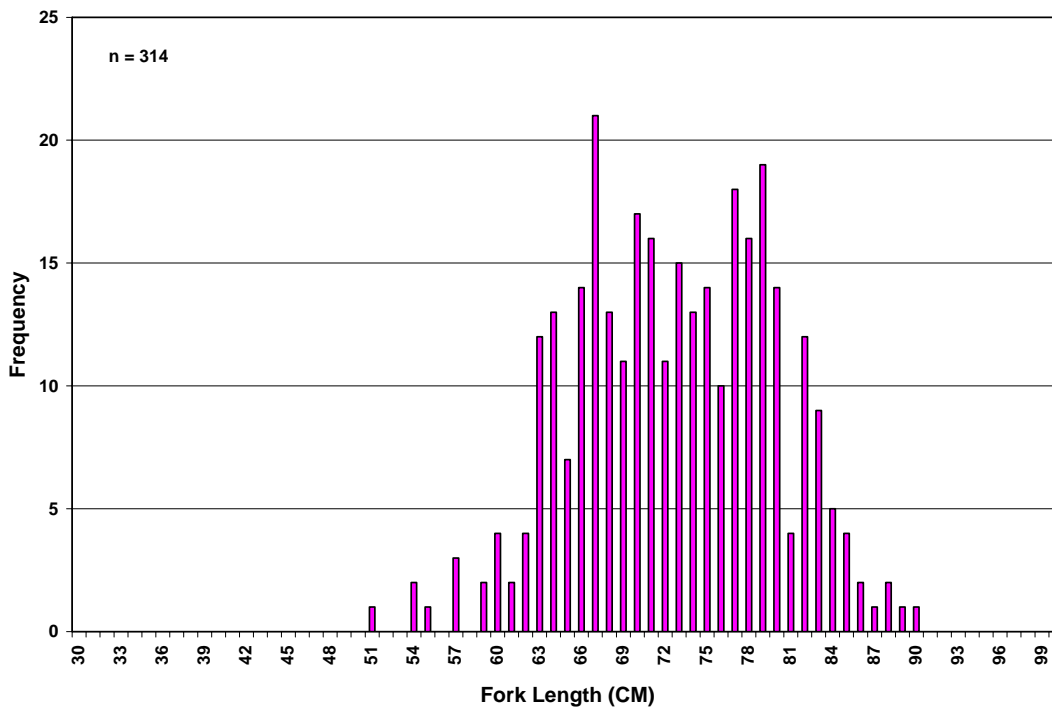


Figure 6. Length frequency distribution of female Chinook salmon observed during spawning ground surveys in Bogus Creek, 2006 (n = 314).

Hatchery Contribution Estimate

A total of 93 heads were collected from Chinook salmon that appeared to be adipose fin-clipped. These included Chinook with full and partial ad-clips as well as those carcasses where the presence of an ad-clip was uncertain do to either natural erosion or decomposition. Of the 93 heads that were collected, thirty two (32) of the heads collected did not contain CWTs and 2 CWTs were lost while being recovered from the head. Six of the heads collected were lost prior to dissection. The remaining 50 heads contained legible CWTs . All of the CWTs 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 (1.87) based on the inverse of the number of carcasses (1,912) examined upstream of BCFCF during spawning ground surveys divided by the total number of Chinook salmon that was observed passing through the BCFCF (3,583), 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 2006.

Coded Wire Tag	Release Location	Release Type	Brood Year	Age	Sample Number	Production Multiplier	Production Estimate	Sample Expansion	Total Estimate
Spawning Ground Surveys, Reach 1									
66356	IGH	Y	2001	5	1	10.55	11	1	11
66359	IGH	Y	2002	4	1	9.00	9	1	9
66360	IGH	Y	2002	4	1	6.99	7	1	7
601020404	IGH	F	2002	4	1	17.32	17	1	17
601020405	IGH	F	2002	4	3	16.74	50	1	50
601020406	IGH	F	2002	4	1	33.97	34	1	34
601020408	IGH	F	2003	3	1	19.20	19	1	19
601020409	IGH	F	2003	3	1	19.28	19	1	19
601020501	IGH	F	2003	3	1	20.34	20	1	20
Sub Total =					11	Sub Total =			187
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
66358	IGH	Y	2002	4	1	9.52	10	1.87	18
66359	IGH	Y	2002	4	2	9.00	18	1.87	34
66360	IGH	Y	2002	4	4	6.99	28	1.87	52
601020404	IGH	F	2002	4	6	17.32	104	1.87	194
601020405	IGH	F	2002	4	4	16.74	67	1.87	125
601020406	IGH	F	2002	4	1	33.97	34	1.87	64
601020407	IGH	F	2002	4	2	29.47	59	1.87	110
601020408	IGH	F	2003	3	8	19.20	154	1.87	287
601020409	IGH	F	2003	3	2	19.28	39	1.87	72
601020501	IGH	F	2003	3	2	20.34	41	1.87	76
601020505	IGH	F	2004	2	6	16.61	100	1.87	186
601020507	IGH	F	2004	2	1	37.42	37	1.87	70
Sub Total =					39	Sub Total =			1289
Estimated contribution of lost and unreadable CWTs					8	Subtotal =			248
Total Estimate Hatchery Contribution =									1,724
Release Type: Y = Yearling; F = Fingerling									
Unknown CWTs: 200000 = CWT lost during removal from head, 300000 = head lost, 400000 = CWT unreadable.									
The production multiplier value is the inverse of the proportion of effectively tagged and total release from IGH.									
Sample expansion equals the inverse of the number sampled during carcass surveys 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 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 and the Shasta River. A total of 53 unmarked coho salmon were released from IGH to the Klamath River in the 2006 season. Because of Bogus Creek's proximity to IGH, it was anticipated that unmarked coho salmon released from IGH would enter Bogus Creek.

The first adult coho salmon was observed entering Bogus Creek on October 23rd and the last coho salmon was observed on December 11th. A total of 46 coho salmon were observed moving upstream through the BCFCF during the season (Figure 7). Of these 3 were caudal clipped and floy tagged indicating that they were unmarked coho salmon that previously entered IGH and were subsequently released after marking. Those three coho were observed on November 10th, 21st, and 25th.

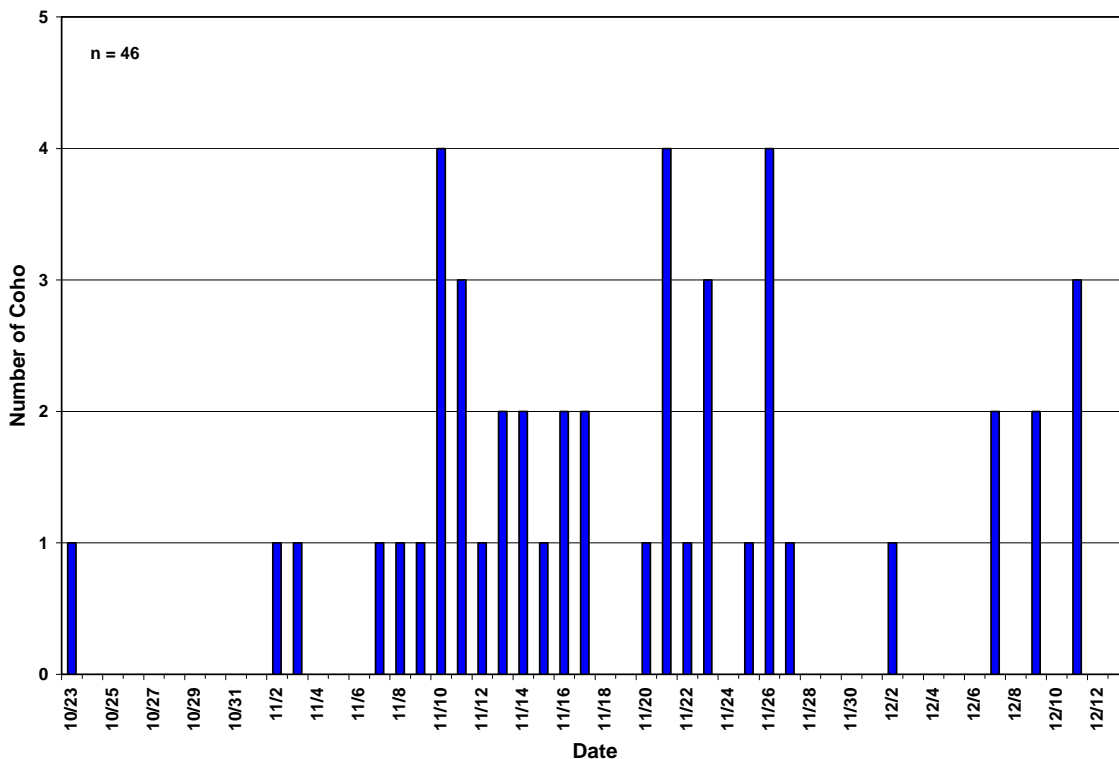


Figure 7. Run timing of coho salmon observed passing through the Bogus Creek Fish Counting Facility during the 2006 season.

Diel movements of coho salmon through the BCFCF were slightly higher in the evening hours and peaked between 23:00hrs and midnight (Figure 8). This movement pattern is consistent with observations during previous seasons.

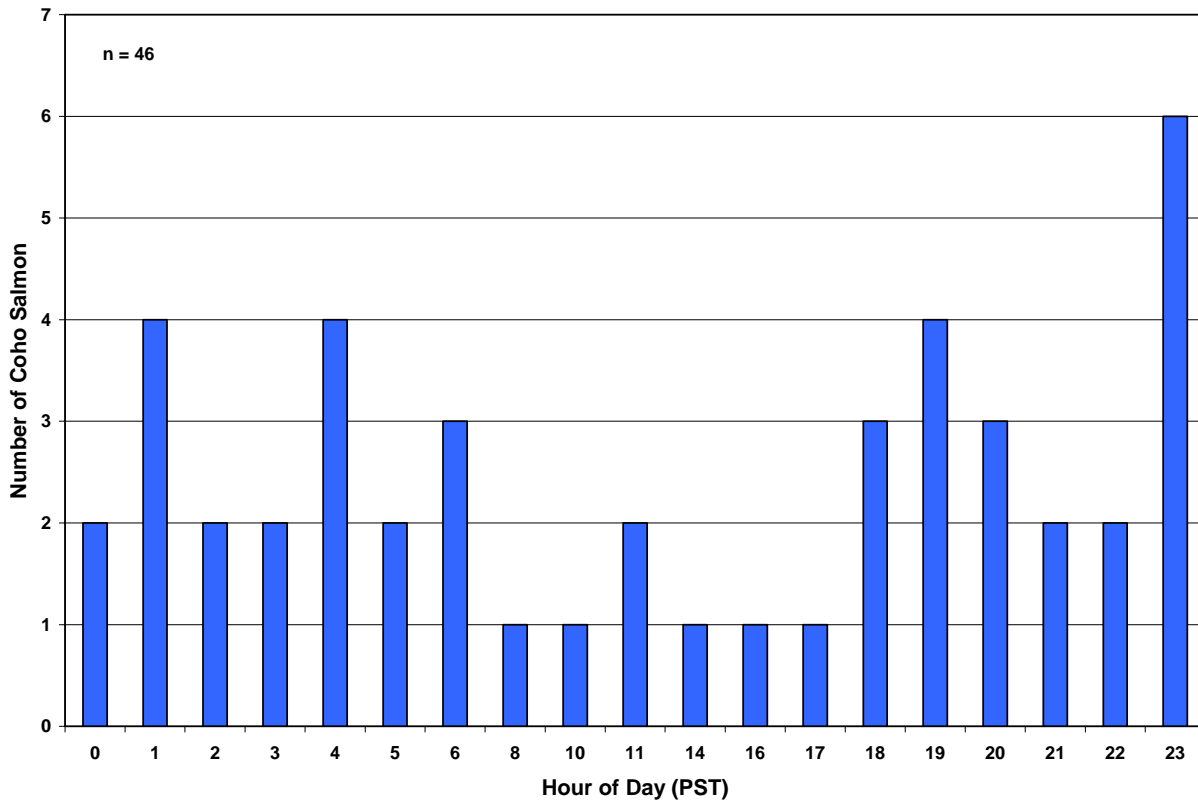


Figure 8. Diel migration patterns of coho salmon observed moving through the Bogus Creek Fish Counting Facility in 2006.

Spawning Ground Surveys

Only 5 coho salmon carcasses were examined during spawning ground surveys (Table 2). Two of the carcasses were males with fork lengths of 74cm and 76cm. The remaining three carcasses were females with fork lengths of 52cm, 62cm and 71cm. All three appear to have spawned successfully based on the lack of eggs present in the body cavity. The 62cm female carcass sampled in Reach 4 on November 21st was Floy tagged and caudal clipped. Based on the tag number (1561), this fish returned to IGH on November 9th, was unmarked, and was subsequently tagged, caudal clipped and released to the Klamath River on the same day.

Table 2. Summary of coho salmon carcasses sampled during the spawning ground surveys in Bogus Creek, 2006.						
Date	Reach	Fork Length (CM)	Sex	Fin Clips	Floy TAG	Notes
11/21/2006	4	76	M	No		
11/21/2006	4	62	F	Caudal	1561	Spawned Released from IGH 11/9
11/21/2006	3	71	F	No		Spawned
11/28/2006	4	74	M	No		
11/28/2006	3	57	F	No		Spawned

DISCUSSION

HISTORIC CHINOOK RUNS

Since 1978 the Chinook salmon run in Bogus Creek has ranged from 46,432 fish (1995) to 785 fish (1990) and has averaged 9,165 fish (Figure 9). The 2006 Chinook salmon run in Bogus Creek ranks 20th (4,133 fish) out of 29 years of data since the beginning of the Klamath River Project in 1978. The largest run of fall Chinook salmon within the entire Klamath River basin occurred during the 1995 season when a total of 245,543 Chinook salmon were estimated. In that same year the ladder gates to IGH were shut 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 probably accounts for the large return of Chinook salmon that were observed in Bogus 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 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 annually, and also reduces the potential for hatchery stocks to spawn naturally thus reducing potential interactions between hatchery and natural Chinook salmon populations within the basin.

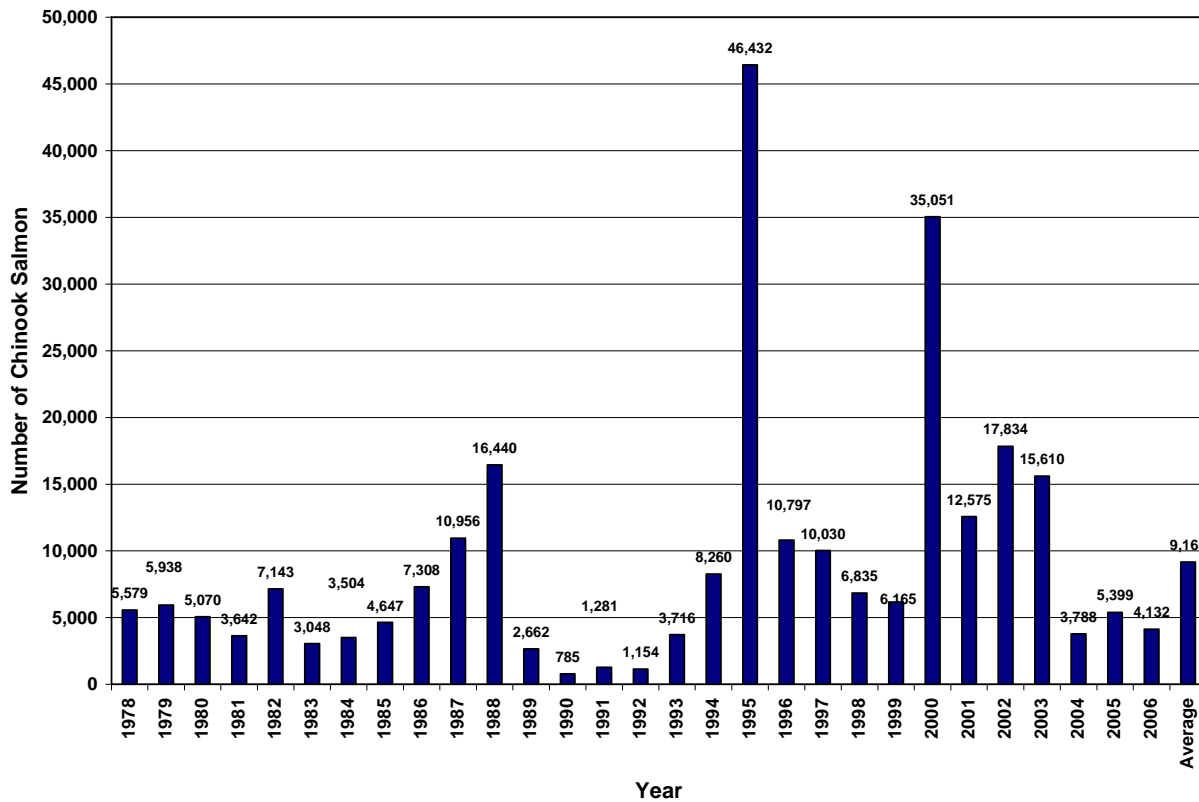


Figure 9. Total Chinook salmon escapement levels estimated to have returned to Bogus Creek from 1978 to 2006.

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 in relation to the total Chinook salmon run in Bogus Creek has fluctuated greatly, ranging between 61.6% and 7.5% (Figure 10). 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.

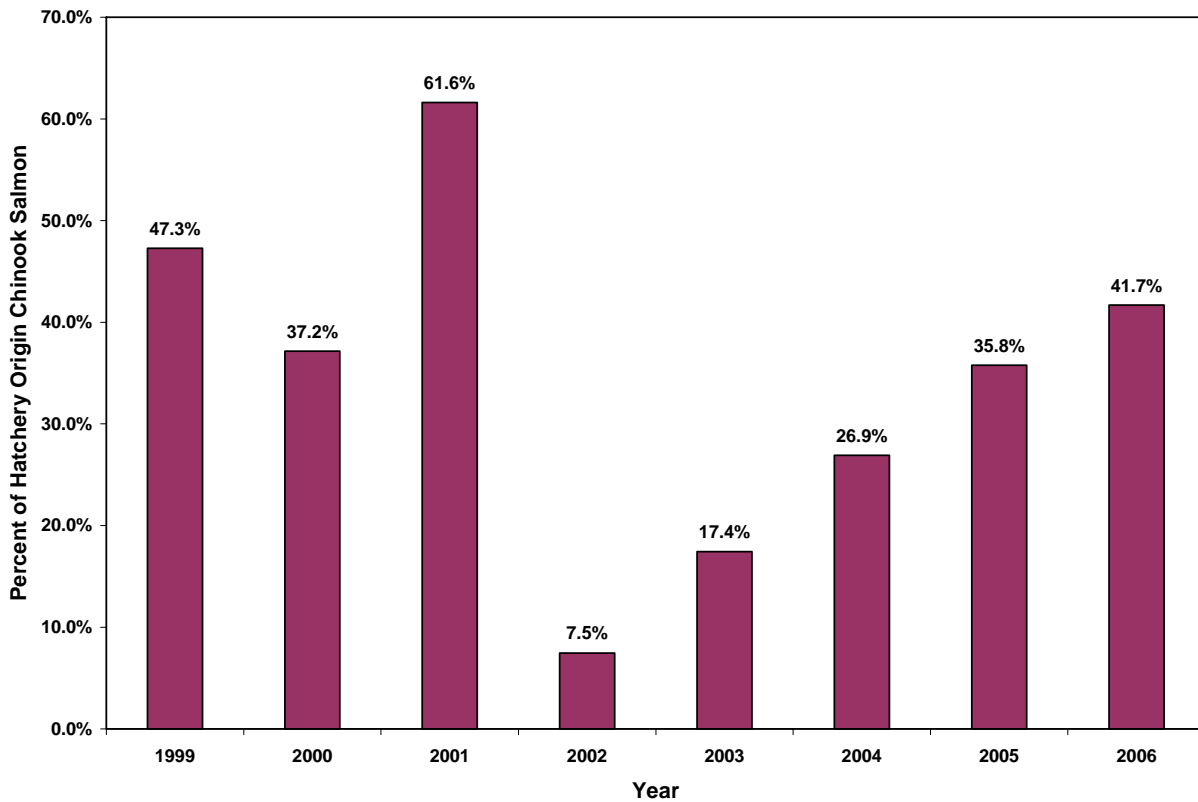


Figure 10. Estimated contribution of hatchery origin Chinook salmon observed in Bogus Creek from 1999 through 2006.

COHO SALMON

The number of coho salmon observed in 2006 was substantially lower than the numbers which have been observed at the BCFCF since video operations began in 2004. The run size of 46 coho salmon observed in 2006 compares to 414 coho salmon observed in 2004 and 102 coho salmon observed in 2005. In addition, 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. Consistent with findings elsewhere in the basin, the coho salmon run in Bogus has decreased substantially over the last three years. Reasons for this may be related to low flows and poor rearing conditions present during the 2003 and 2004 water years. Disease infections are also believed to have been severe during those two years and the combination of these factors may be responsible for the poor returns observed during the 2006 spawning run.

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 Jennifer Plank for her assistance in coordinating the volunteer effort of local high school students throughout the season.

