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## BOGUS CREEK SALMON STUDIES

PROJECT NUMBER: 2001-FP-05  
COOPERATIVE AGREEMENT: 11333-1-G018  
PERIOD COVERED: October 1, 2000 - September 30, 2001

### ABSTRACT

The California Department Fish and Game operated a fish marking weir and conducted carcass surveys on Bogus Creek in the fall of 2000. The primary purpose of the study was to determine the escapement of fall-run chinook salmon and describe the general characteristics of the spawning run. The chinook spawning run began on about 28 September and migration into the creek ended on about 11 November. The peak of the spawning run occurred between the 9<sup>th</sup> and the 21<sup>st</sup> of October. Approximately 35,051 chinook salmon were estimated to have entered Bogus Creek during the 2000 spawning season. Based on length frequency analysis, the run was comprised primarily of adult fish, 34,678 fish or 98.9% of the run. Grilse comprised only 1.1 % (373 fish) of the total run. Females comprised 55.4% of the run and males comprised the remaining 44.6%. The average fork length of adults was 76 cm (ranged, 60-108 cm). Heads were recovered from a total of 212 adipose fin clipped fish that were observed either at the fish marking weir or during carcass survey efforts. Of these, 186 tags originated from Iron Gate Hatchery and 26 tags were either unreadable or could not be recovered. Expansions of the coded wire tags collected indicate that approximately 13,025 or 37% of the chinook salmon that spawned in Bogus Creek were of hatchery origin. No adipose fin clipped grilse chinook salmon were recovered in Bogus Creek during 2000.

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## INTRODUCTION

Bogus Creek is the first major tributary to the Klamath River downstream of Iron Gate Dam and Fish Hatchery and is a major chinook salmon spawning stream. The California Department of Fish and Game (Department) has conducted chinook salmon (*Oncorhynchus tshawytscha*) spawner escapement estimates for the Klamath River Basin since 1978. Approximately 28% (9,809 fish), 37% (6,630 fish), and 31% (3,537 fish) of the total number of adult chinook salmon natural spawners within in the Klamath River, upstream of the Trinity River confluence, were estimated to have entered Bogus Creek to spawn during the 1997, 1998, and 1999 seasons, respectively.

The accuracy of the ocean stock abundance estimates and preseason projections would be compromised if chinook salmon spawner escapement information for Bogus Creek were not developed. In addition, spawner escapement surveys in Bogus Creek also allow for recovery of coded-wire-tag data and other important biological information necessary to describe the annual characteristics of the chinook salmon population. Collection of length, sex, and scale sample data also provide information necessary to accurately describe the growth, age and sex ratio characteristics for each run.

During the spawning season of 2000 the Department again conducted fall chinook salmon surveys on Bogus Creek with the following study objectives:

- a) Determine the in-river run size (escapement) of fall chinook salmon returning to Bogus Creek during the 2000 season.
- b) Determine run timing, spawning distribution, length frequency, and sex ratio for fall chinook salmon in Bogus Creek.
- c) Collect scale samples and recover heads from adipose fin-clipped, presumably coded-wire-tagged salmon.
- d) Record information on coho salmon and steelhead observed during the course of this work

## STUDY AREA

Bogus Creek is located entirely in Siskiyou County and is the first major tributary to the Klamath River downstream of Iron Gate Dam. Bogus creek is fed by several springs throughout its length which contribute cooler water and provide favorable conditions for spawning and rearing salmonids and other resident cool water species. The headwaters of the creek originate in the Klamath National Forest northwest of Willow Creek Mountain at an elevation of 1,599 meters (5,197 ft). The upper reach of the creek, from its headwater to the confluence of Cold Creek, flows in northerly direction through a steep sided canyon for about 15.4 kilometers (9.6 miles) and has an average stream gradient of approximately 49.7 meters per kilometer (259 feet per mile). This upper section provides habitat for steelhead trout and various native and non-native resident species. The steep gradient, smaller channel and reduced stream flows during the spawning season prevents use of this reach by spawning chinook salmon.

From the confluence of Cold Creek downstream, Bogus creek flows in a westerly direction for an additional 7.5 kilometers (4.7 miles) through mostly private lands before entering the Klamath River. Additional tributary accretions, combined with a more gradual stream gradient (14.3 meters per kilometer; 74 feet per mile) and abundant spawning gravels, provide favorable habitat conditions for spawning and rearing chinook salmon. The vast majority of chinook salmon spawning occurs in this lower section of stream. A fish ladder was constructed in this reach during the mid 1900's to provide fish passage over a bedrock waterfall and small dam located at about stream kilometer 5.60 (3.48 miles). The ladder appears to provide adequate passage as adult chinook salmon have been observed upstream of this structure during the spawning season. There is also a small natural waterfall (-4 feet) located at stream kilometer 2.09 (3.36 miles) and adult chinook salmon have little difficulty navigating these falls. There are no other migration obstacles present in the reach.

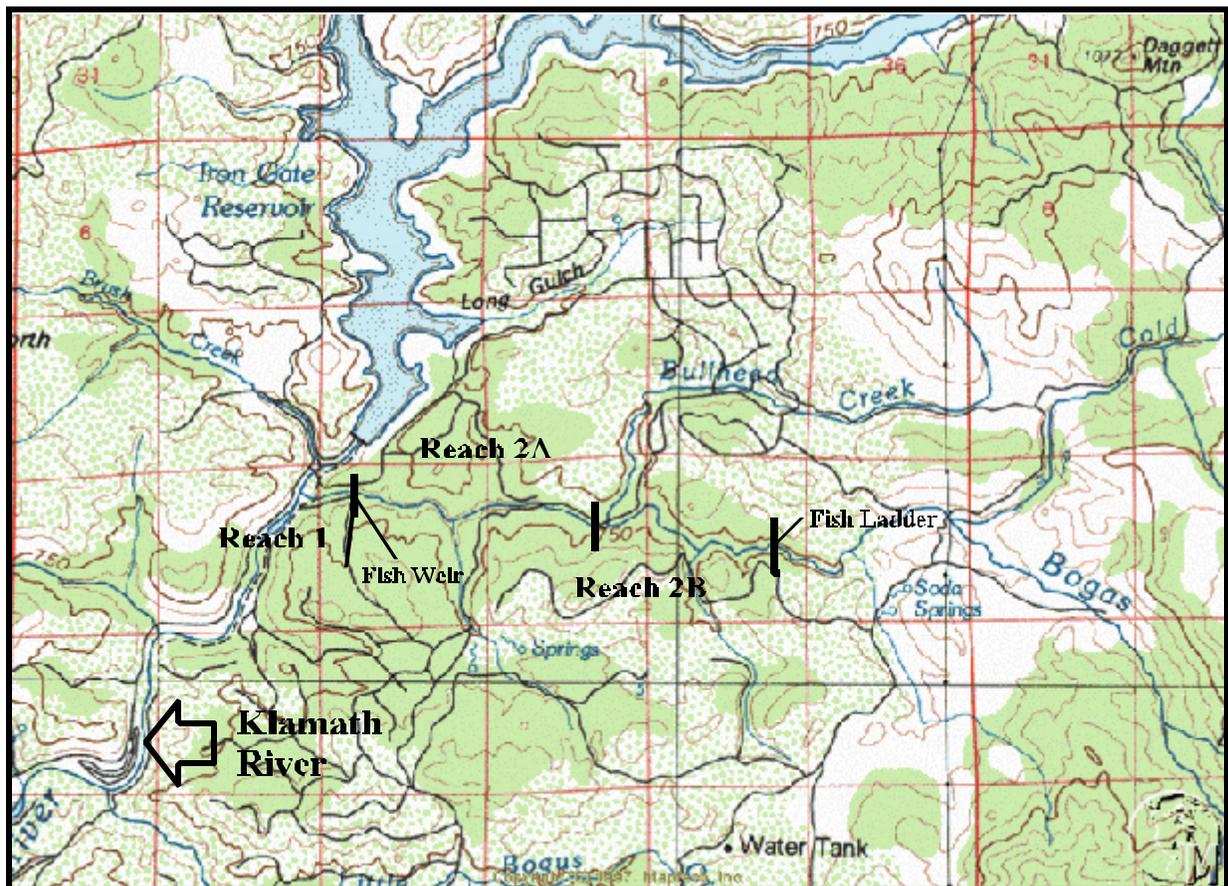
## METHODS

The escapement estimate for Bogus Creek is derived through a combination of data collection methods which include operation of a fish marking weir and collection of mark and recapture carcass survey data for the upper reaches of the creek, and a direct count of the number of spawners observed in the creek downstream of the weir.

The Bogus Creek fish marking weir is located adjacent to the Iron Gate Hatchery, approximately 0.41 kilometers (0.25 miles) upstream from the mouth of Bogus Creek. The weir was installed on 24 September and was operational that same day. The weir was operated during daylight hours (6 to 8 hours) seven days a week throughout the fall chinook salmon run period. All fish trapped at the weir were identified to species, measured to fork length, sexed, and examined for the presence of any tags, fin clips or other abnormal marks and/or scars. All fish examined with an adipose fin clip were sacrificed for later

coded wire tag recovery and analysis. All other fish were marked with a punch to the right operculum and released for later recovery during the carcass survey.

Carcass surveys were conducted from the mouth of Bogus Creek upstream to the weir (Reach 1), from the weir upstream to the natural water fall (Reach 2A), from the natural waterfall upstream to the bottom of the fish ladder (Reach 2B). A map depicting the survey reach boundaries is presented in Figure 1. Permission to access Bogus Creek upstream of the fish ladder could not be obtained in 2000. Therefore, carcass surveys in this upper reach could not be conducted.



**Figure 1.** Map of Bogus Creek showing the location of the fish marking weir and carcass survey reaches sampled during the 2000 chinook salmon spawning season.

Carcass surveys were conducted twice a week throughout the chinook salmon spawning season. The first survey occurred on 16 October and the last survey occurred on 28 November. A total of twelve (12) surveys were conducted during the season. Each survey was conducted by a crew consisting of at least two persons. Every carcass found was identified to species, examined for the presence of marks (opercle punch, adipose fin clip), sexed, and measured to fork length (cm). Heads were collected from all adipose fin clipped fish to recover the coded wire tag for subsequent reading and analysis.

After completion of the survey on 23 October, it became apparent that survey crews would not be able to complete their surveys within the allotted time because of the large numbers of fall chinook salmon that were present in the creek. Therefore, on 26 October, data collection of fork length, sex composition, and scale sampling were limited to every twentieth (20) fish randomly encountered during the survey. All other carcasses were still counted and inspected for presence of an adipose fin clip or an opercule punch.

The spawner escapement for the area upstream of the fish marking weir was calculated using the Petersen mark recapture equation described by Ricker (1975) as follows:

$$\frac{(M+1) \times (C+1)}{(R+1)}$$

Where: M = The number of salmon marked at the weir.  
 C = The number of marked and unmarked salmon examined in the carcass survey and as wash backs at the weir.  
 R = The number of marked salmon recovered in the carcass survey and as wash backs at the weir.

Because Reach 1 is located in the 0.41 kilometers (0.25 miles) of Bogus Creek downstream of the fish marking weir, a Petersen Mark Recapture estimate could not be

calculated for this reach. Therefore, the spawner escapement estimate for this short reach was derived from a direct count of the number of carcasses recovered during the carcass surveys. The entire escapement estimate for the creek is the sum total of the Petersen Mark Recapture estimate for the area upstream of the fish marking weir and the direct count of the number carcasses observed in Reach 1.

To determine the number of grilse and adults present in the spawning run a length frequency histogram was developed from data collected during the carcass survey. Based on the examination of the length frequency distribution observed, biological staff used professional judgement and experience to determine the fork length that was believed to best denote the age class separation between grilse (2 year old fish) and adults (3 year old fish). The resulting proportion between grilse and adult fish observed in the length frequency distribution was then applied to the total population estimate to calculate the number of grilse and adults present in the entire spawning run. This annual estimate is preliminary and may be modified once the Technical Advisory Team to the Klamath Fisheries Management Council completes their analysis of scales collected during the survey effort. Therefore, the preliminary estimate of the number of grilse and adults, which is based on length frequency analysis, and the final determination of the number of grilse and adults, which is based on the results of scale analysis, may differ slightly.

## RESULTS AND DISCUSSION

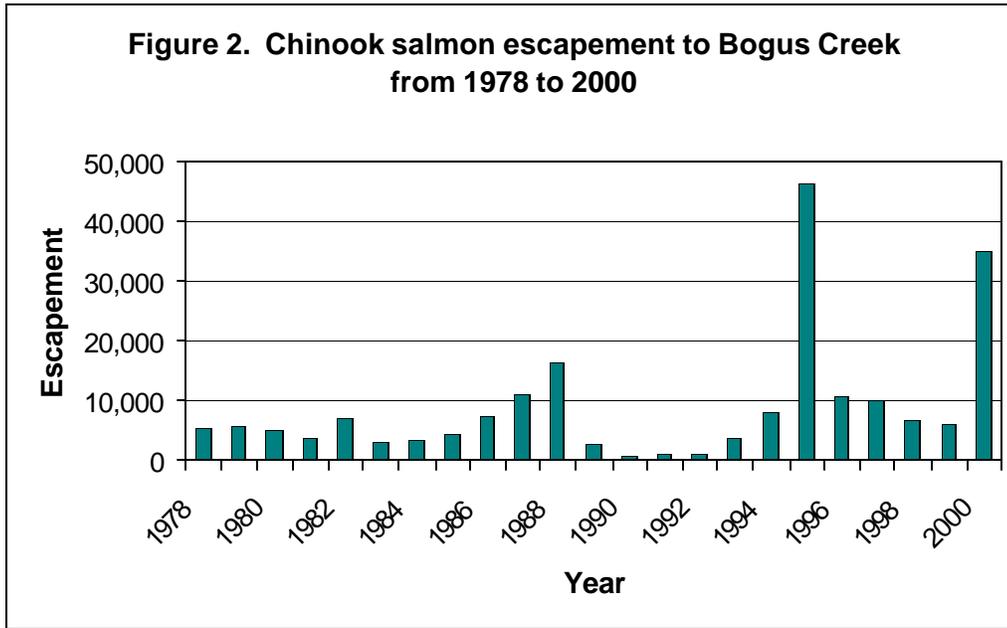
### Run Size and Composition

The fall-run chinook salmon escapement estimate for Bogus Creek in 2000 was 35,051 fish (Appendix 1). The results of the Petersen Mark Recapture estimate for the reach of Bogus Creek upstream of the weir was 32,067 salmon with a 95% lower confidence limit of 29,431 and an upper limit of 34,938 salmon. A direct count of 2,984 fall chinook salmon carcasses were observed in Reach 1. The number of fall chinook salmon spawners in Bogus Creek comprised approximately 56% of the total number of natural spawners that returned to the Klamath River Basin upstream of the Trinity River confluence in 2000. The 2000 spawning run was the second highest run on record since the Klamath River Project began estimating the chinook salmon escapement in 1978 (Figure 2).

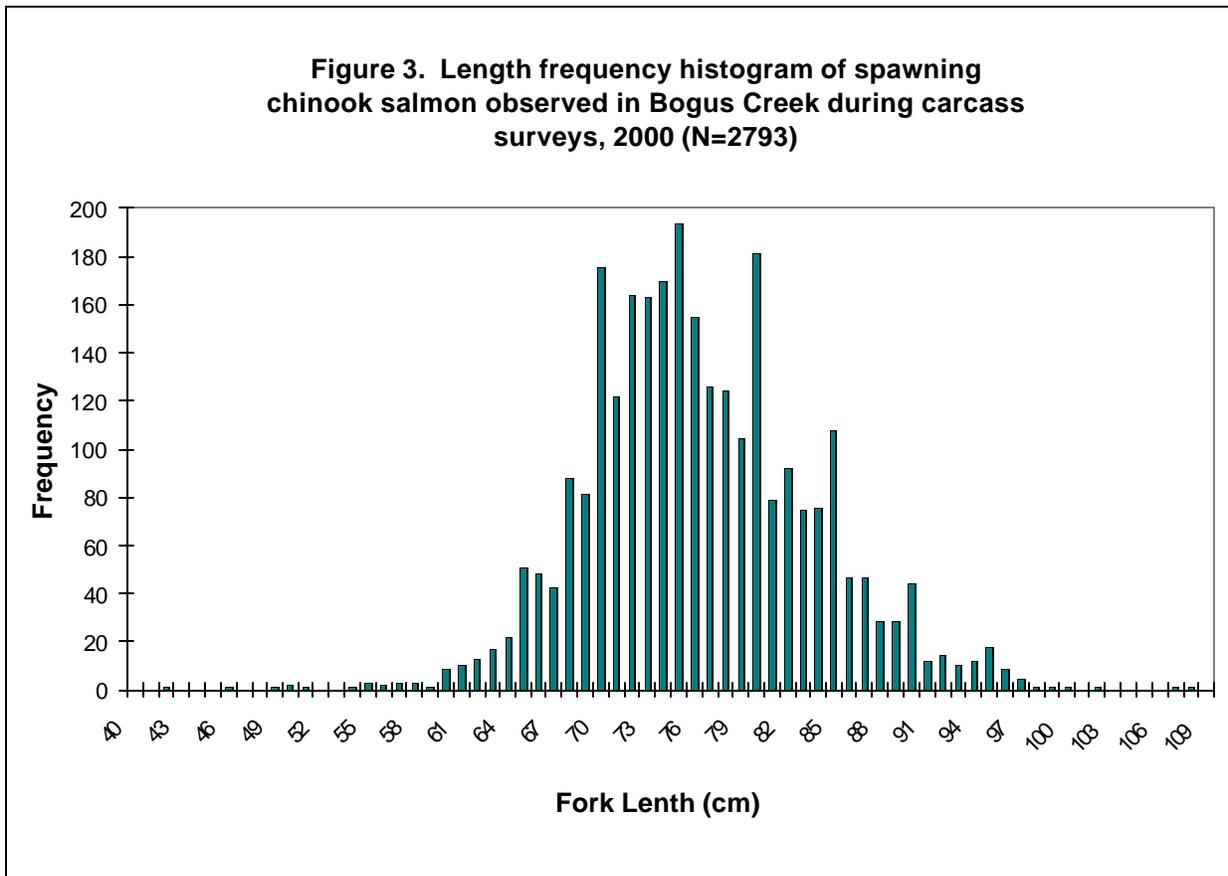
Based on examination of the length frequency histogram developed from the carcass survey data collected, the Department estimated grilse to be # 59 cm fork length and adults to be > 59 cm fork length (Figure 3). Based on this preliminary determination, the total escapement to Bogus was comprised of 373 (1.1%) grilse and 34,678 (98.9%) adults in 2000 (Table 1).

<b>Table 1. Fall chinook salmon spawner escapement for Bogus Creek, 2000</b>		
Grilse	Adults	Total
373	34,678	35,051

**Figure 2. Chinook salmon escapement to Bogus Creek from 1978 to 2000**



**Figure 3. Length frequency histogram of spawning chinook salmon observed in Bogus Creek during carcass surveys, 2000 (N=2793)**



## **Contribution of Hatchery Origin Fall Chinook Salmon**

Heads were recovered from 212 adipose fin-clipped chinook salmon in Bogus Creek during the 2000 season. Of these, 186 fish were chinook salmon progeny originating from Iron Gate Hatchery and 26 tags were either unreadable or could not be recovered. An estimate of the total number of hatchery origin chinook salmon that escaped to Bogus Creek in 2000 was derived based on an expansion of the number coded wire tagged fish estimated to occur in Bogus Creek divided by the percentage of the chinook salmon tagged within each tag group released from Iron Gate Hatchery. (Table 2).

Approximately 13,025 of the 35,051 chinook salmon, or 37% of the fall-run chinook salmon that were estimated to have returned to Bogus Creek in 2000 were of hatchery origin. Of these, approximately 497 (3.8%) were age 4 and 12,528 (96.2%) were age 3. No coded wire tagged grilse were recovered in Bogus Creek during 2000. Yearling releases from the hatchery accounted for approximately 1.8%, and smolt releases accounted for approximately 98.2% of the hatchery contribution observed in Bogus Creek. However, yearlings accounted for nearly half (46%) of the hatchery 4 year old component observed in Bogus Creek.

## **Run Timing**

The first chinook salmon to enter Bogus Creek was observed at the fish marking weir on 28 September. The spawning migration through the fish marking weir peaked between 10 October and 22 October (Figure 4). Operation of the fish marking weir was terminated on 11 November and the last chinook salmon was observed at the weir on 10 November. A total of two thousand fourteen (2,014) chinook salmon, one (1) Steelhead trout, and one (1) coho salmon were processed at the fish marking weir.

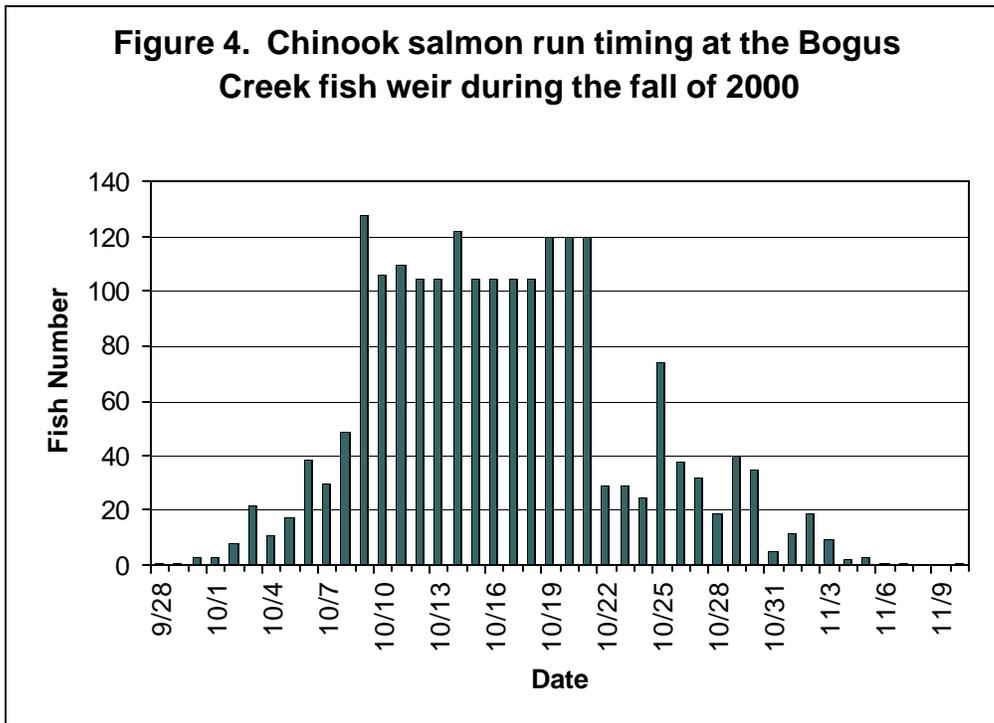
**Table 2. Estimated contribution of Iron Gate Fish Hatchery chinook salmon to Bogus Creek in 2000.**

Tag Code Group	Release Size (#/lb)	Release Date	Expansion Factor	Bogus Creek <sup>1/</sup> CWT Expansion Est.	Estimated Contribution
<b>Age 4</b>					
0601020209	141	06/02/1997	3.72%	0	0
0601020210	104	06/02/1997	3.72%	4	108
0601020211	141	06/02/1997	3.72%	6	161
063830	7.8	11/05/1997	8.76%	18	205
063831	7.8	11/05/1997	8.76%	2	23
<b>Subtotal</b>					<b>497</b>
<b>Age 3</b>					
0601020212	63	06/08/1998	3.78%	141	3,720
0601020213	63	06/08/1998	3.78%	142	3,744
0601020214	63	06/08/1998	3.78%	78	2,052
0601020215	63	06/08/1998	3.78%	53	1,400
10 00 00 <sup>2/</sup>			3.78%	61	1,612
20 00 00 <sup>2/</sup>			3.78%	12	317
<b>Subtotal</b>					<b>12,528</b>
<b>Grilse</b>					
0601020301	84	06/21/1999	3.78%	0	0
0601020302	84	06/21/1999	3.78%	0	0
0601020303	84	06/21/1999	3.78%	0	0
0601020304	84	06/21/1999	3.78%	0	0
<b>Subtotal</b>					<b>0</b>

**Total Estimated Hatchery Contribution 13,025**

<sup>1/</sup> cwt expansion to Bogus Creek was estimated through expansion of cwts observed in the carcass survey plus observed number of cwts recovered at the fish marking weir.

<sup>2/</sup> Ad clipped, but no tag recovered or unreadable tag present. Assumed progeny of IGH and used same expansion rate.



**Spawner Distribution**

The distribution of spawning salmon in Bogus Creek was determined from carcass survey information collected during the season. In addition to collecting information on salmon carcasses, crews also recorded the number of live chinook salmon observed within each reach during the survey. This information allowed for comparison between the distribution of live chinook salmon observed and chinook salmon carcass recovery efforts. Information regarding the distribution of chinook salmon observed in Bogus Creek is presented in Table 3.

**Table 3. Distribution of spawning chinook salmon observed during carcass surveys in Bogus Creek, 1999**

	Reach Number		
	1	2A	2B
Reach Len. (Miles)	0.25	1.83	1.11
Live Chinook	3972	2582	5004
Carcasses	3445	3656	5100
Density of Live Chinook (fish/mile)	15888	1411	4508
Density of Chinook Carcasses (fish/mile)	13780	1998	4596

The density of both live and dead chinook salmon observed in Reach 1, located downstream of the fish marking weir, was much greater than those densities observed in Reaches 2A, and 2B. Reach 1 is located nearest to Iron Gate Hatchery and this likely influenced spawning use in this reach.

### Length Frequency Distribution

Fork length measurements were conducted on 2,793 of the chinook salmon carcasses recovered during carcass surveys. A length frequency histogram was constructed from the this data (see Figure 3). A nadir in the length frequency histogram occurs at 59 cm fork length. For the preliminary determination of the break point between grilse and adults, which is provided to the Klamath River Technical Advisory Team for harvest model development, Project biologists defined grilse as fish # 59 cm fork length.

Therefore, it was determined that grilse comprised only 1.1% of the run and adult chinook salmon comprised approximately 98.9% of the run. The mean forklength for the entire run

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was 76.3 cm. The smallest chinook salmon observed 42 cm and the largest adult sampled was 108 cm.

### **Sex Ratio**

The ratio of male and female chinook salmon was determined from carcass survey data. Of the 2,798 chinook salmon carcasses that were examined, 1,247 were males and 1,551 were females. Females comprised 55.4% of the sample and males comprised the remaining 44.6% of the sample.

### **Coho Salmon and Steelhead Observations**

One female steelhead trout (*O. mykiss*) with a forklength of 63 cm was processed at the fish marking weir on 27 October. A single male coho salmon (*O. kisutch*) with a forklength of 76 cm was also observed passing through the weir on 31 October, 2000. No steelhead or coho salmon were recovered during the spawning ground carcass surveys.

## REFERENCES

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Bulletin of the Fisheries Research Board of Canada, Bulletin 191; Department of Fisheries and Oceans, Ottawa, Canada. 382 pp.

Prepared by: \_\_\_\_\_ Date: \_\_\_\_\_

Mark Hampton  
Associate Biologist and Leader,  
Klamath River Project

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**APPENDIX A**


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**Fall-Run Chinook Salmon Escapement Estimate**
**Bogus Creek, 2000**
Petersen Mark and Recapture estimate results for Bogus Creek, 2000

M = 1,918 = The number of chinook marked at the weir minus the number recovered in Reach 1.

C = 8,705 = The number of chinook carcasses that were examined in survey reaches 2, 3, and in the washback sample.

R = 520 = The number of punched carcasses found in Reaches 2, 3, and in the washback sample.

$$\text{Estimate} = \frac{(M+1)(C+1)}{(R+1)}$$

95% Confidence Intervals of R (From Ricker, 1975):  $x_1 = 566.66$ ;  $x_2 = 477.18$

Escapement Estimate For Reaches 2 and 3 =	32,067
Lower Limit =	29,431
Upper Limit =	34,938

Chinook escapement estimate upstream of weir =	32,067
Plus number of chinook observed in Reach 1 =	2,984

**Total estimated chinook salmon spawner escapement = 35,051**

Based on the spawning ground survey (sgs) sample (n=2,793), grilse were estimated to be less than or equal to 59 cm forklength. Expansion of the estimated run size by grilse

proportion estimated in the sgs yields an escapement estimate comprised of 373 grilse and 34,678 adults.

## **APPENDIX B**

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**Copies of Bogus Creek Computer Data, 2000**

**Spawning Ground Survey Data**

**Fish Marking Weir Data**

**Weir Wash Back Data**