BOGUS CREEK SALMON STUDIES

PROJECT NUMBER: 2002-FP-01

COOPERATIVE AGREEMENT: 11333-2-G015

PERIOD COVERED: October 1, 2001 - September 30, 2002

ABSTRACT

The California Department Fish and Game operated a fish marking weir and conducted carcass surveys on Bogus Creek in the fall of 2001. 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 9 November. The peak of the spawning run occurred between the 16th and the 31st of October. Approximately 12,575 chinook salmon were estimated to have entered Bogus Creek during the 2001 spawning season. Based on length frequency analysis, the run was comprised of 11,927 adult fish (94.8%) and 648 grilse (5.2%). Females comprised approximately 59% (7,419 fish) and males comprised the remaining 41% (5,156 fish). Female chinook salmon exhibited an average fork length of 77 cm and ranged in fork length from 49 cm to 99 cm. Male chinook salmon exhibited an average fork length of 79 cm, and ranged in fork length from 33 cm to 108 cm. Heads were recovered from 66 adipose fin-clipped chinook salmon. Of these, 40 fish were progeny originating from Iron Gate Hatchery and 26 fish had tags that were either unreadable or could be not be recovered. Based on expansion of coded wire tag data, the Klamath River Project (KRP) estimates that approximately 7,747 of the 12,575 chinook salmon, or 61.6% of the fall-run Chinook salmon run were of hatchery origin from IGH. Of these, approximately 1,665 (21.5%) were age 4 and 6,055 (78.2%) were age 3. Only one adipose fin-clipped grilse was recovered in Bogus Creek during 2001. One female coho salmon and three steelhead trout were observed at the fish marking weir during the study. No coho salmon or steelhead trout were recovered during spawning ground surveys.

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. Over that time period, the number of naturally spawning fall chinook salmon observed in Bogus Creek ranged from 785 fish in 1990 to 46,432 fish in 1995. On average, Bogus Creek has contributed approximately 26.6% of the naturally spawning fall Chinook salmon population in the Klamath River basin, excluding the Trinity River. The location of Bogus Creek, adjacent to Iron Gate Hatchery, is one of the primary factors for the large run of Chinook salmon observed in this small tributary stream. However, the accuracy of the ocean stock abundance estimates and pre-season projections would be significantly compromised if Chinook salmon spawner escapement information for Bogus Creek were not developed. In addition, spawner escapement surveys in Bogus Creek also allow for the 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 provides information necessary to accurately describe the growth, age, and sex ratio characteristics for each run.

During the 2001 spawning season 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 2001 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 (Figure 1). Bogus Creek is fed by several springs throughout its length which contribute cooler water and provide favorable conditions for salmonids and other resident cool water species. The headwaters of the creek originate in the Klamath National Forest northwest of Willow Creek Mountain (Township 46 N, Range 4 W, Section 23 MDBM) 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 flow 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 in the early 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, 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 Iron Gate Hatchery, approximately 0.41 kilometers (0.25 miles) upstream from the mouth of Bogus Creek. The weir was installed on 18 September, 2001, and became 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 small hole punch in 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 (Figure1; Reach 1), from the weir upstream to the natural water fall below the Bullhead Creek confluence (Figure1; Reach 2), and from this natural waterfall upstream to the bottom of the fish ladder (Figure1; Reach 3). Permission to access Bogus Creek upstream of the fish ladder could not be obtained in 2001. Therefore, carcass surveys in this upper reach could not be conducted. Carcass surveys were conducted twice a

week throughout the Chinook salmon spawning season. The first survey occurred on 15 October and the last survey occurred on 19 November. A total of eleven (11) surveys were conducted during the season. Each survey was conducted by up to three crews, with each crew consisting of at least two persons. Volunteers from local Siskiyou County schools also participated in the survey effort. Each 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 5 November, 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 carcasses that were present in the creek. Therefore, beginning on 8 November, data collection of fork length, sex composition, and scale sampling were limited to every tenth (10th) fish randomly encountered during the survey. All other carcasses were still counted and inspected for presence of an adipose fin clip or an opercle punch.

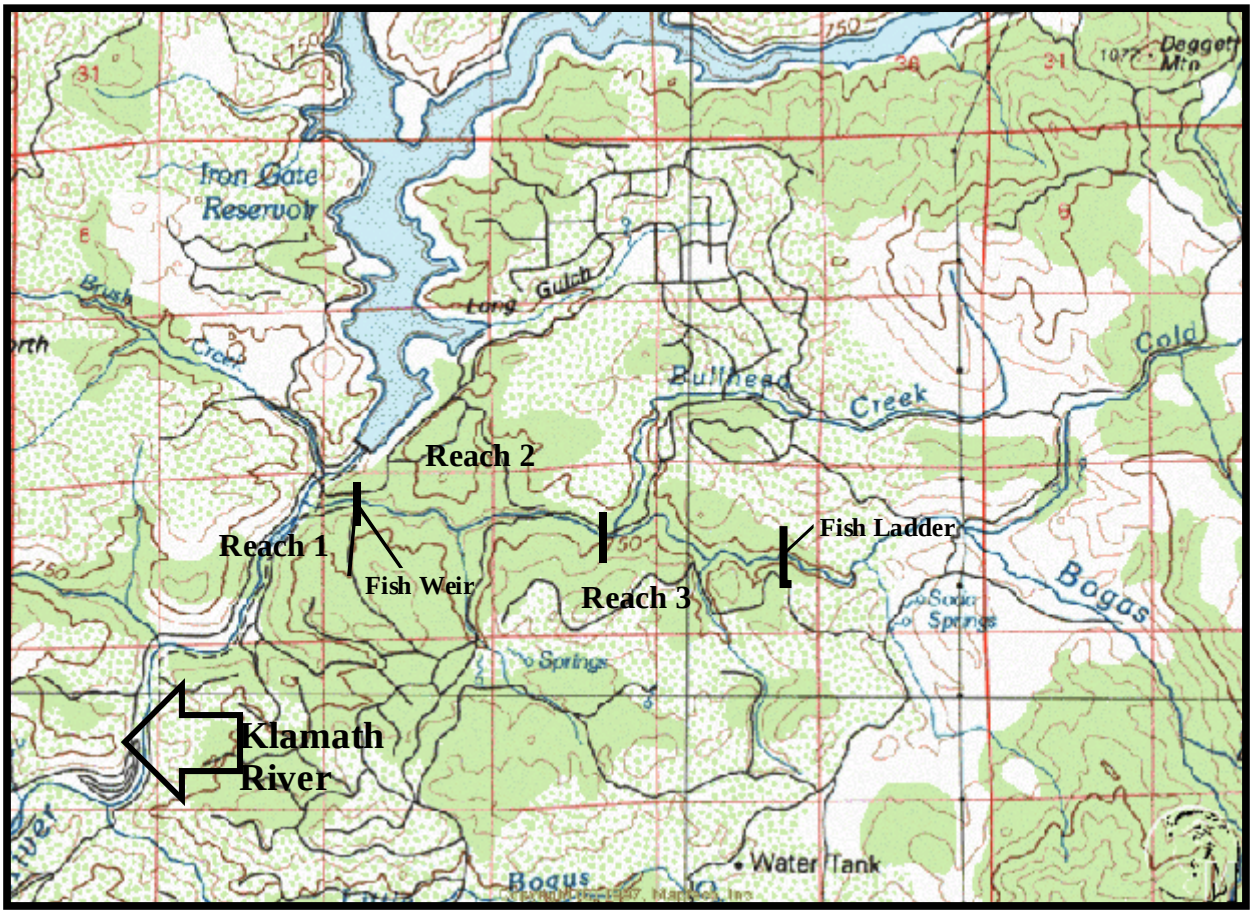

Figure 1. Map of Bogus Creek showing the location of the fish marking weir and carcass survey reaches sampled during the 2001 Chinook salmon spawning season.

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 returning to Bogus Creek a length-frequency histogram was developed from data collected during the carcass survey. Based on the examination of the length-frequency distribution of male salmon 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 in Bogus Creek. 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 2001 was 12,575 fish (Table 1). The results of the Petersen Mark-Recapture estimate for the reach of Bogus Creek upstream of the weir was 10,901 salmon with a 95% lower confidence limit of 9,931 and an upper limit of 11,966 salmon (Appendix A). A direct count of 1,674 fall chinook salmon carcasses were observed in Reach 1. The number of fall Chinook salmon spawners in Bogus Creek comprised approximately 30% of the total number of natural spawners that returned to the Klamath River Basin upstream of the Trinity River confluence in 2001. The 2001 spawning run in Bogus Creek was the fourth 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 for male Chinook salmon recovered during the carcass survey, the Department estimated grilse to be #63 cm fork length and adults to be >63 cm fork length (Figure 3). Based on this preliminary determination, the total escapement to Bogus was comprised of 648 grilse (5.2%) and 11,927 adults (94.8%) in 2001.

Table 1. Fall Chinook salmon spawner escapement for Bogus Creek, 2001

Grilse	Adults	Total
648	11,927	12,575

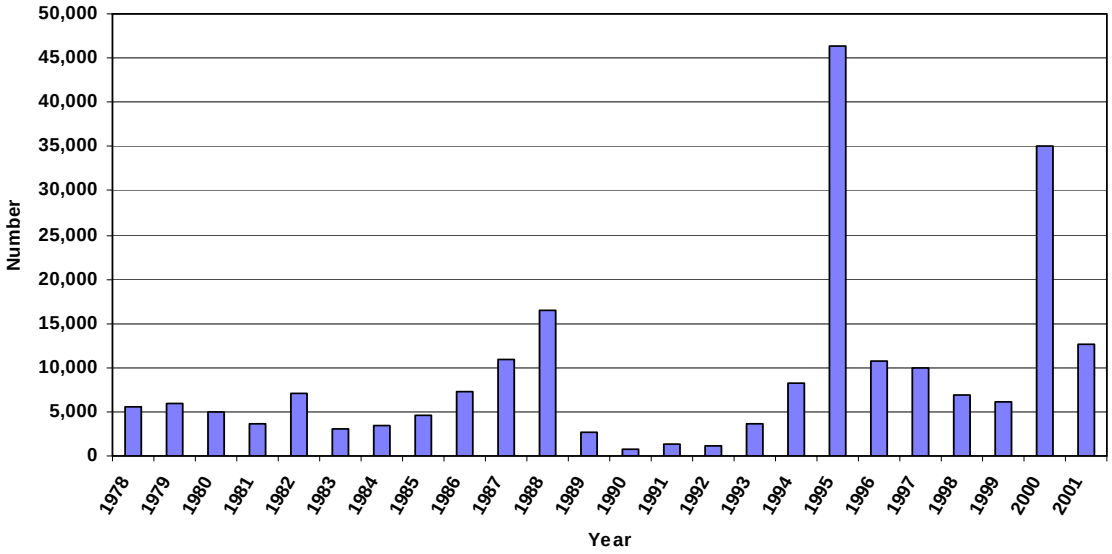

Figure 2. Chinook salmon escapement estimate to Bogus Creek from 1978 to 2001

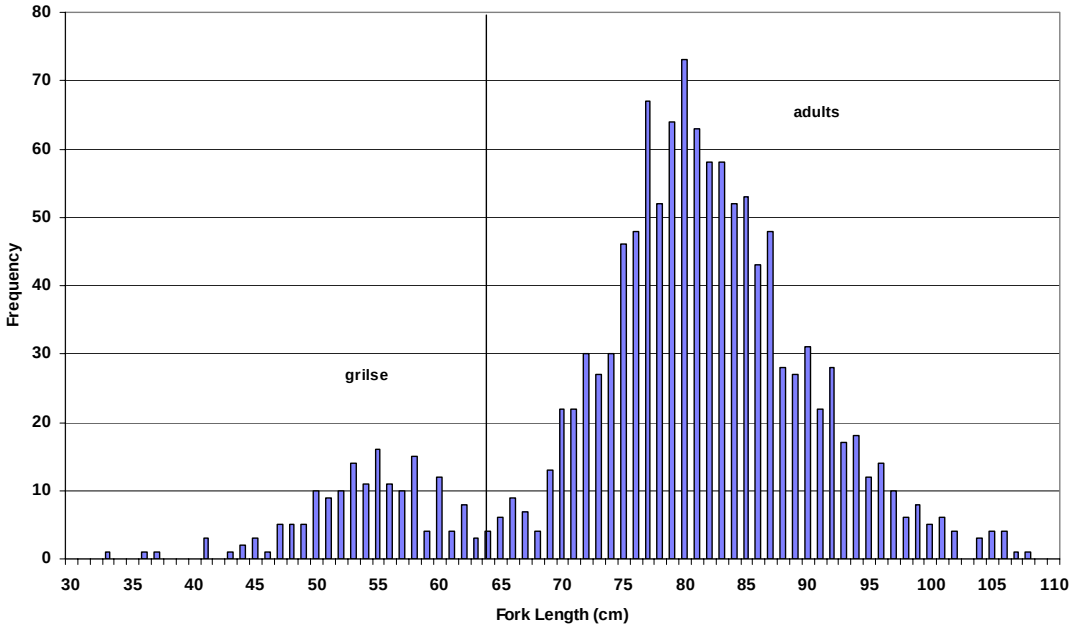

Figure 3. Length-frequency distribution of male Chinook salmon observed during carcass surveys in Bogus Creek, 2001 (n=1,313).

Contribution of Hatchery Origin Fall Chinook Salmon

Heads were recovered from 66 adipose fin-clipped chinook salmon in Bogus Creek during the 2001 season. Of these, 40 fish were Chinook salmon progeny originating from Iron Gate Hatchery and 26 fish had tags were either unreadable or could be not be recovered. An estimate of the total number of hatchery origin Chinook salmon that escaped to Bogus Creek in 2001 was derived based on an expansion of the number of 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 7,747 of the 12,575 Chinook salmon, or 61.6% of the fall-run Chinook salmon that were estimated to have returned to Bogus Creek in 2001 were of hatchery origin. Of these, approximately 1,665 (21.5%) were age 4 and 6,055 (78.2%) were age 3. Only one adipose fin-clipped grilse was recovered in Bogus Creek during 2001. Based on the results of those coded wire tags that were recovered and readable (n=40), smolt releases accounted for all of the hatchery origin fish recovered in the 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 16 October and 31 October (Figure 4). The last Chinook salmon was observed at the weir on 9 November. Operation of the fish marking weir was terminated on 11 November. A total of 2,014 Chinook salmon, one steelhead trout, and one coho salmon were processed at the fish marking weir.

Table 2. Estimated contribution of Iron Gate Fish Hatchery Chinook salmon to Bogus Creek in 2001.

Tag Code Group	Release Size (#/lb)	Release Date	Expansion Factor	Bogus Creek 1/ CWT Expansion Est.	Estimated Contribution
Age 4					
0601020212	63	06/08/1998	3.78%	17	449
0601020213	63	06/08/1998	3.78%	15	396
0601020214	63	06/08/1998	3.78%	21	555
0601020215	63	06/08/1998	3.78%	10	264
				Subtotal	**1,665**
Age 3					
0601020301	84	06/21/1999	3.78%	19	503
0601020302	84	06/21/1999	3.78%	54	1,429
0601020303	84	06/21/1999	3.78%	19	503
0601020304	84	06/21/1999	3.78%	15	397
10 00 00 2/			3.78%	122	3,223
				Subtotal	**6.055**
Grilse					
0601020309	95	06/09/2000	3.62%	0	0
0601020310	95	06/09/2000	3.62%	0	0
0601020311	95	06/09/2000	3.62%	0	0
0601020312	95	06/09/2000	3.62%	0	0
10 00 00 2/			3.62%	1	28
				Subtotal	**28**
Total Estimated Hatchery Contribution					**7,747**

1/ 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.

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

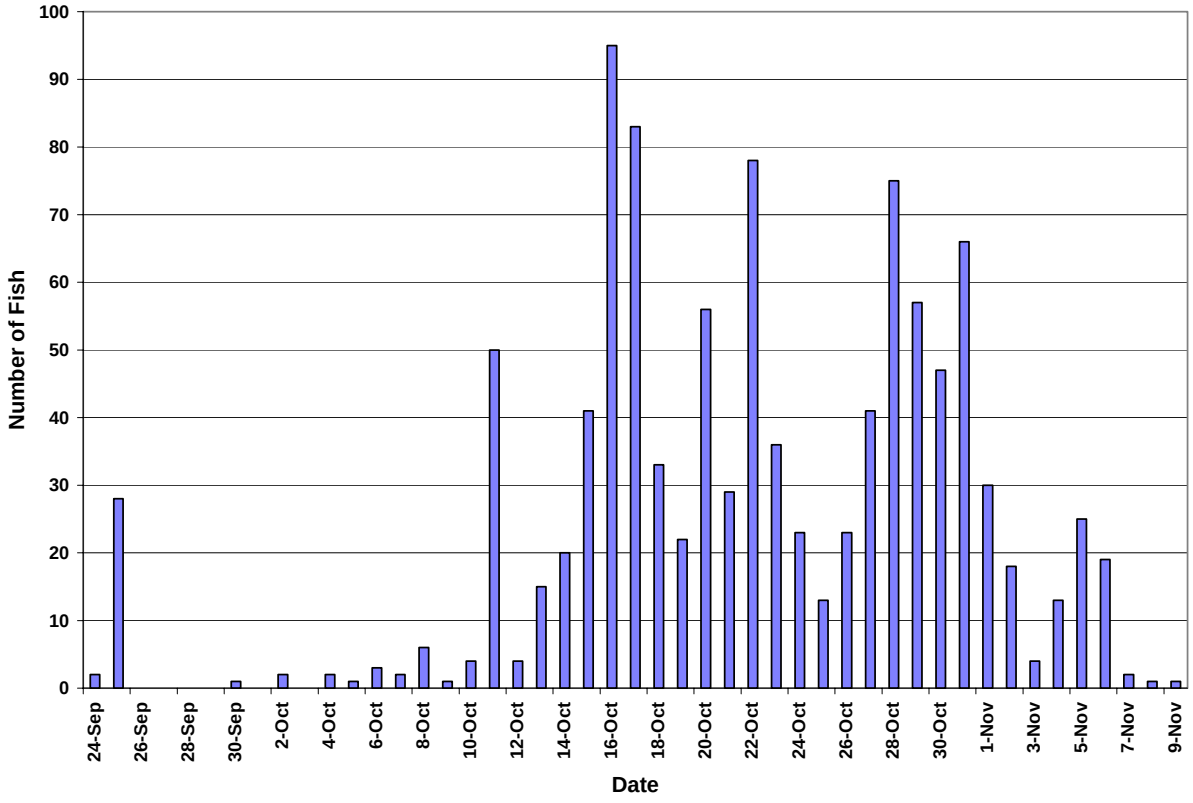

Figure 4. Chinook salmon run timing through the Bogus Creek weir in 2001.

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, 2001.			
	Reach Number		
	1	2	3
Reach Len. (Miles)	0.25	1.83	1.11
Live Chinook	3,833	4,247	3,978
Carcasses	1,257	1,996	2,678
Density of Live Chinook (fish/mile)	15,332	2,321	3,584
Density of Chinook Carcasses (fish/mile)	5,028	1,268	2,413

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 2, and 3. The close proximity of Iron Gate Hatchery to Bogus Creek likely influences use of Reach 1 by large numbers of fall Chinook salmon.

Length Frequency Distribution

Fork length measurements were conducted on 3,206 of the Chinook salmon carcasses recovered during carcass surveys. Length frequency histograms were constructed for both male and female salmon recovered. Male Chinook salmon exhibited an average fork length of 78.5 cm (n = 1,313) and fork lengths of female chinook salmon averaged 77.0 cm (n = 1,893).

A nadir in the male length-frequency histogram for Bogus Creek fall Chinook salmon occurs at approximately 63 cm fork length (see Figure 3). 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 ≤ 63 cm fork length. Therefore, it was estimated that grilse comprised only 5.2% (648 fish) of the run and adult Chinook salmon comprised approximately 94.8% (11,927 fish) of the run. The mean fork length for the entire run was 76.3 cm. The smallest Chinook salmon observed on Bogus Creek was 33 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 3,215 chinook salmon carcasses that were examined and sex could be determined, 1,316 were males and 1,894 were females. Thus, we estimated that females comprised 59% (7,419 fish) of the run and males comprised 41% (5,156 fish) of the run.

Coho Salmon and Steelhead Observations

One female coho salmon (*O. kisutch*), approximately 58 cm in fork length, was sampled at the fish marking weir on 23 October. No other coho salmon were observed during the study.

A total of three female steelhead trout (*O. mykiss*) were processed at the fish marking weir. These fish were observed on the 31st of October, and the 1st and 4th of November. Fork lengths of these three fish were 66 cm, 71 cm, and 66 cm. No steelhead (live or carcasses) were observed 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:

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APPENDIX A

Fall-Run Chinook Salmon Escapement Estimate
Bogus Creek, 2001

Petersen Mark and Recapture estimate results for Bogus Creek, 2001

M = 1,036 = The number of chinook marked at the weir minus the number recovered in Reach 1.

C = 4,635 = The number of chinook carcasses that were examined in survey reaches 2, 3, and in the washback sample.

R = 440 = 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): $x_1 = 483.08$; $x_2 = 400.76$

Escapement Estimate For Reaches 2 and 3 =	10,901
Lower Limit =	9,931
Upper Limit =	11,966

Chinook escapement estimate upstream of weir = 10,901

Plus number of chinook observed in Reach 1 = 1,674

Total estimated chinook salmon spawner escapement = 12,575

Based on the spawning ground survey (sgs) sample of male chinook observed (n=1,313), grilse were estimated to be less than or equal to 63 cm forklength. Expansion of the estimated male chinook run size by grilse proportion estimated in the sgs yields an escapement estimate comprised of 648 grilse and 11,927 adults.

APPENDIX B

Copies of Bogus Creek Computer Data, 2001

Spawning Ground Survey Data

Fish Marking Weir Data

Weir Wash Back Data