

BOGUS CREEK SALMON STUDIES 2010

FINAL REPORT



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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 7, 2010 and ended on December 14, 2010 due to forecasted high flows. The total number of Chinook salmon that entered Bogus Creek during the 2010 season is estimated to be **3,471** 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 1,534 (44.2%) males and 1,937 (55.8%) females. Based on a grilse cut off of ≤ 61 cm, adults comprised approximately 91.6% (3,179 fish) and grilse comprised 8.4% (292 fish) of the run. Males ranged in fork length from 40cm to 105cm and averaged 76.5cm. Females ranged in fork length from 55cm to 99cm and averaged 74.9cm. KRP staff estimated that 1,003 Chinook salmon (28.9%) were of hatchery origin.

The first adult coho salmon was observed entering Bogus Creek on October 25, 2010 and the last coho salmon was observed on December 14, 2010. A total of 154 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 76 (49.1%) males and 78 (50.9%) females. Based on a grilse cut off of ≤ 54 cm, age three fish comprised approximately 94.7% (146 fish) and age two fish comprised 5.3% (8 fish) of the run. Males ranged in fork length from 43cm to 81cm and averaged 67cm. Females ranged in fork length from 55cm to 78cm and averaged 69cm. Eight of the 58 coho salmon observed (13.8%) were floy tagged indicating that they were coho salmon that previously entered IGH and were subsequently released after they were tagged. KRP staff estimated that 43 coho salmon (28.1%) 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.

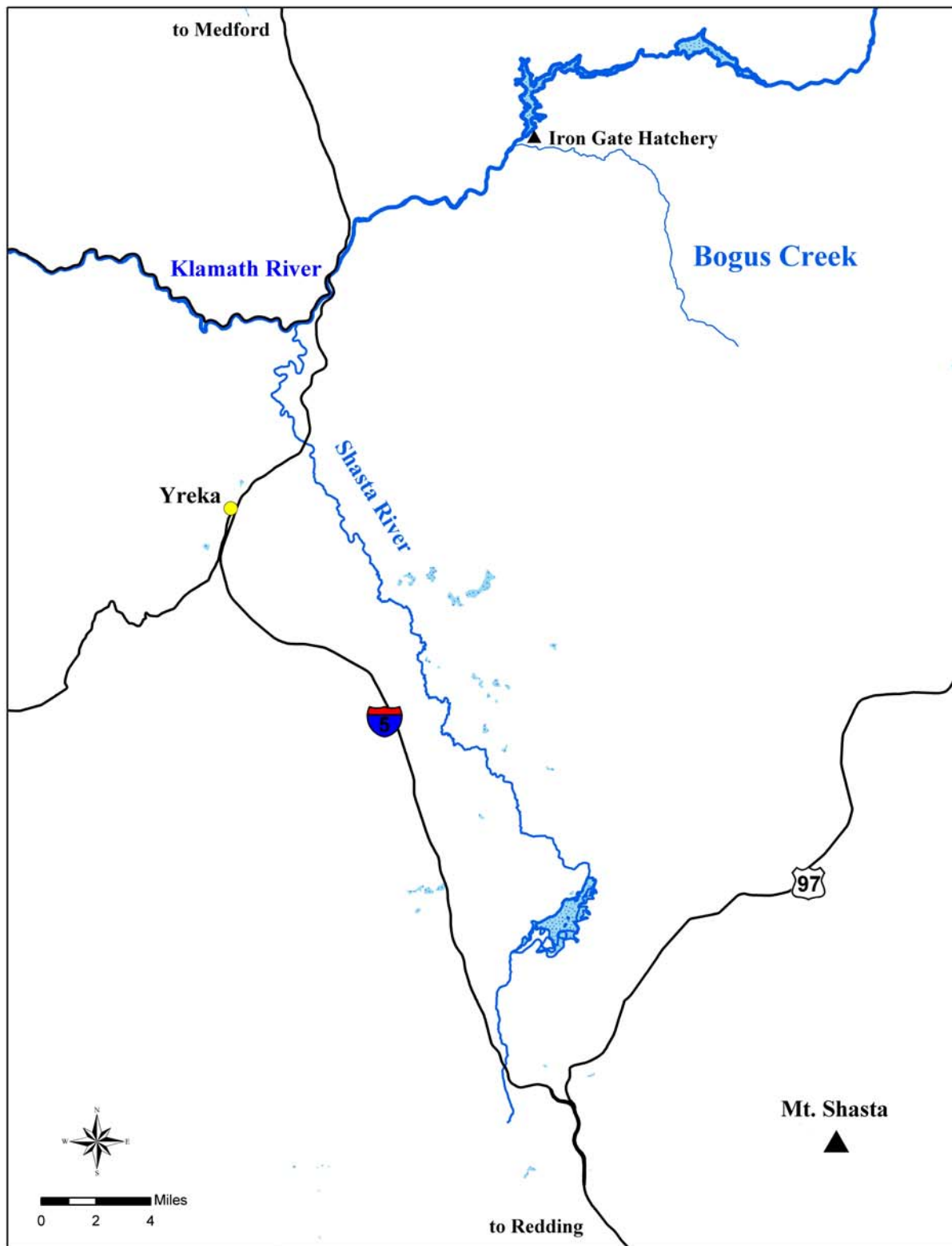


Figure 1. Location of Bogus Creek, tributary to the Klamath River, Siskiyou County.

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 and trap was operated on Bogus Creek to collect biological data, recover heads from adipose fin clipped adults (ad-clipped), and mark Chinook salmon with an opercle punch. The opercle punch was used to generate a Petersen mark and recapture population estimate from recaptures obtained during carcass surveys upstream of the weir. Incorporation of a video counting station in 2003 has greatly improved the accuracy of run size estimates and has eliminated the need to handle migrating salmon during the season. Biological data collection occurs during spawning ground surveys which includes collection of fork lengths, determining sexual composition of the run, assessing pre-spawn mortality, and recovery of coded wire tags (CWT) from ad-clipped salmon encountered during the survey.

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 Klamath River Basin Chinook salmon 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 7, 2010 at 1008 hours Pacific Standard Time (PST). A temporary Alaskan style weir was installed to direct migrating fish into a flume where they pass in front of the camera. The underwater video system consisted of a digital color video camera, water proof camera housing, viewing window, and counting flume which allowed for recording unimpeded fish passage through the facility. The facility was operated 24 hours a day, seven days a week throughout the Chinook salmon migration period. A JVC digital color video camera (Model No TK-C92OU) equipped with a 5 – 50mm 1:1.3 Computar lens¹ was used to collect the photo image and an Ever Focus Digital Video Recorder (DVR; Model EDSR100) was used to record the image to external hard drives. The time lapse DVR was set to record continuously and drive changes were made at least twice a week.

All hard drives were immediately returned to the office where each was subsequently downloaded and reviewed by staff in the video lab. During each review staff recorded the date, time (hour:min:sec), and species of each fish observed. 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 fish. 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, 2010 and ending December 30, 2010. A total of fourteen surveys were performed during the 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 road crossing a distance of approximately 1.6 miles and Reach 4 continues from the road crossing upstream to a larger waterfall (about 20' high) and fish ladder a distance of approximately 1.1 miles. Each survey was conducted by four 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 third Chinook carcass examined during the survey. All scale samples were provided to the Yurok Tribal Fisheries Department for analysis. Females with greater than 50% of their eggs still remaining in their body cavity were identified as pre-spawn mortalities. Heads and scale samples were also collected from all ad-clipped fish (as well as fork length and sex) in order to recover the CWT for subsequent age determination. Once examined, all carcasses were cut in half to prevent potential recounting during later surveys. The same protocol was used for every coho salmon carcass that was recovered during the survey.

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

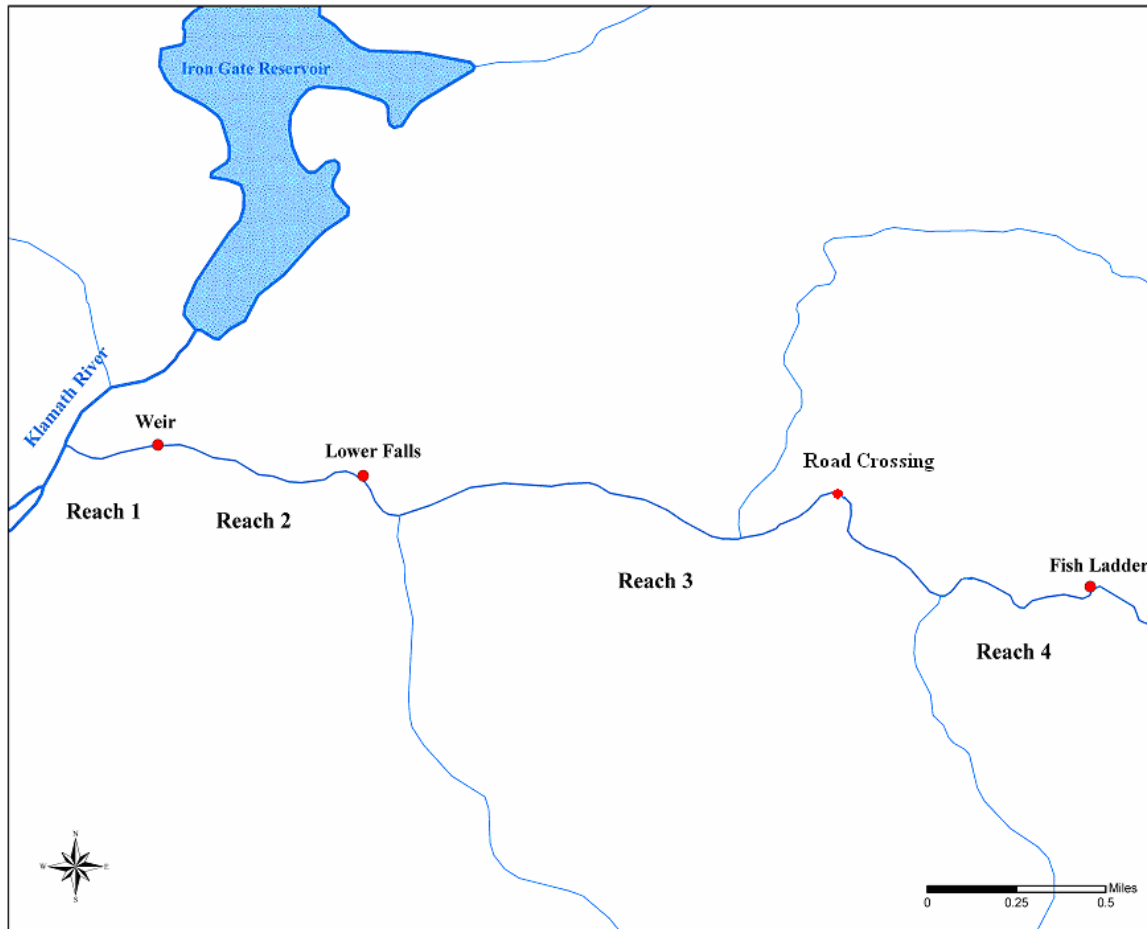


Figure 2. Map of spawning ground survey reaches on Bogus Creek used during the 2010 field season. The weir denotes the location of the Bogus Creek Fish Counting Facility (BCFCF).

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 192 Chinook salmon and 55 coho salmon. All samples were collected following protocols provided by the National Oceanic Atmospheric Administration's (NOAA) Southwest Fisheries Science Center. Tissue samples were sent to the Salmonid Genetic Tissue Repository located at the NOAA Santa Cruz Laboratory for archiving and analysis. Otoliths were collected from 49 Chinook salmon and 55 coho salmon throughout the season and cataloged for future microchemistry analysis. All samples were collected following standard protocols.

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 1008 hours on September 7, 2010. The first Chinook salmon was observed at the BCFCF on September 7, 2010 and the last Chinook salmon was observed on December 11, 2010. The run peaked between October 7, 2010 and November 1, 2010 (Figure 3). 84.4% of Chinook salmon passed through the BCFCF during daylight hours (between 0700 and 1900) and peaked in the afternoon between 1400 and 1800 hours (Figure 4).

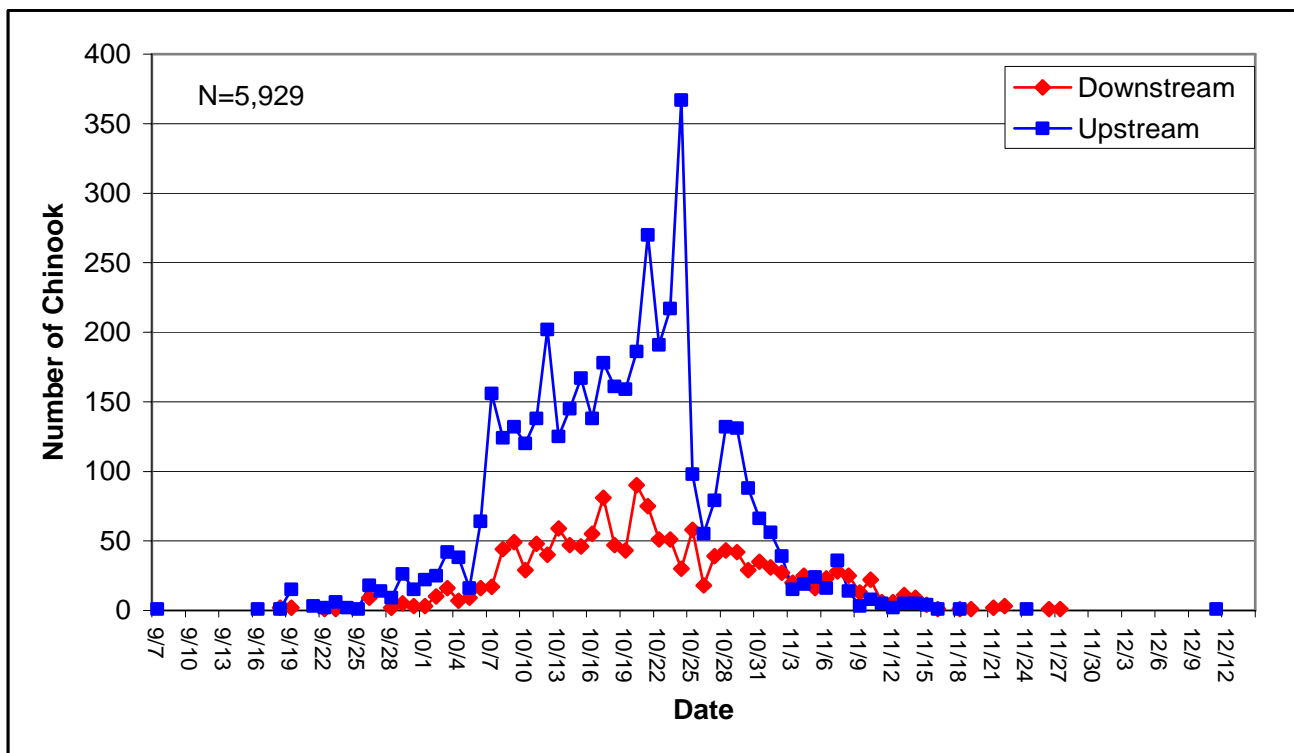


Figure 3. Run timing of Chinook salmon through the BCFCF during the 2010 season. Both upstream and downstream movements through the counting flume are shown.

A total of 2,960 Chinook salmon were estimated to have passed through the BCFCF during the 2010 season. A total of 511 Chinook salmon carcasses were counted in Reach 1, downstream of the BCFCF, yielding a total run size estimate of 3,471 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 1,534 (44.2%) males and 1,937 (55.8%) females. Based on a grilse cut off of ≤ 61 cm, adults comprised approximately 91.6% (3,179 fish) and grilse comprised 8.4% (292 fish) of the run.

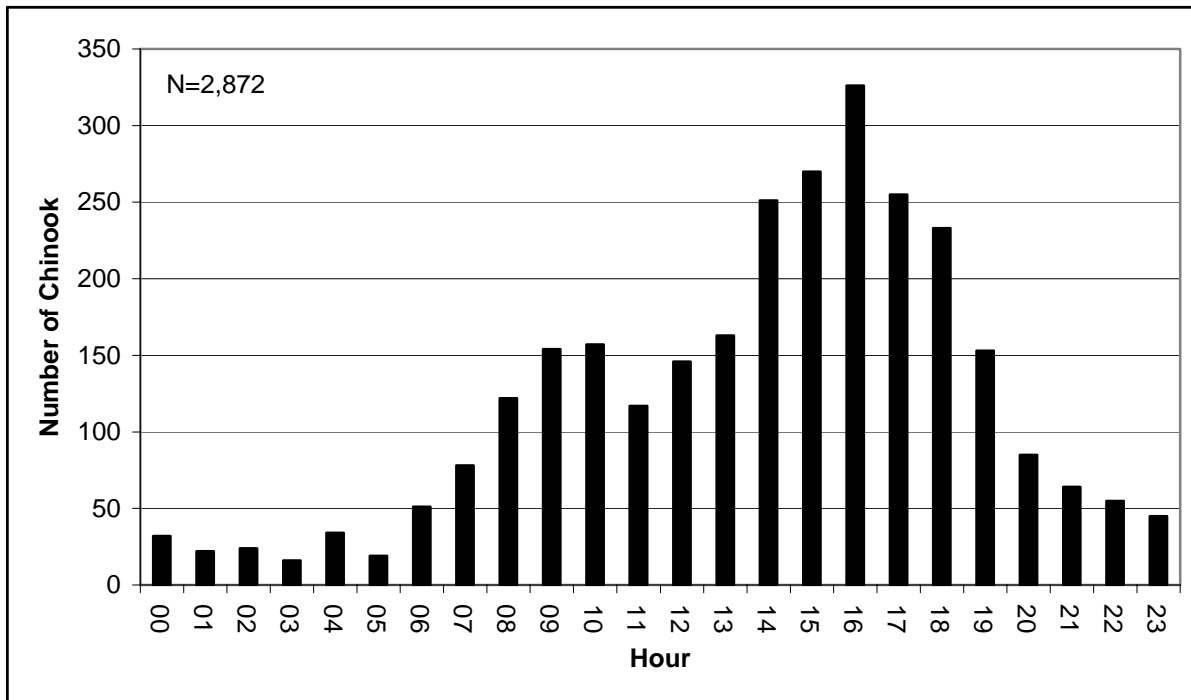


Figure 4. Summary of daily run timing (Net upstream) of Chinook salmon observed at the Bogus Creek Fish Counting Facility during 2010.

SPAWNING GROUND SURVEYS

A total of 835 Chinook salmon carcasses were systematically sampled (1 in 3) during the spawning ground survey. Of the 835 Chinook salmon carcasses examined, 465 were females, 368 were male (two unknown sex). Males ranged in fork length from 40cm to 105cm and averaged 76.5cm (Figure 5). Based on the length frequency distribution of male Chinook salmon presented on Figure 5, grilse were determined to be ≤ 61 cm in fork length. Females ranged in fork length from 55cm to 99cm and averaged 74.9cm (Figure 6).

A total of 465 female Chinook salmon carcasses were systematically sampled (1 in 3) 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 465 female Chinook salmon carcasses examined, 445 females (95.7%) were found to have spawned, and 20 females (4.3%) still contained more than 50% of their spawn and were identified as pre-spawn mortalities.

HATCHERY CONTRIBUTION ESTIMATE

A total of 71 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 do to either natural erosion or decomposition. Of the 71 heads that were collected, twelve did not contain CWTs and 3 CWTs were lost while being recovered from the head and one recovered tag was unreadable. The remaining 55 heads contained legible CWTs. All of the 55 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. The number In addition, a sample expansion (1.44) based on the inverse of the number of carcasses (2,048) examined

upstream of BCFCF during spawning ground surveys divided by the total number of Chinook salmon that were observed passing through the BCFCF (2,959), was applied to all CWT recoveries upstream of the BCFCF (Table 1). KRP staff estimated that 1,003 Chinook salmon in Bogus Creek during the 2010 season (28.9%) were of hatchery origin.

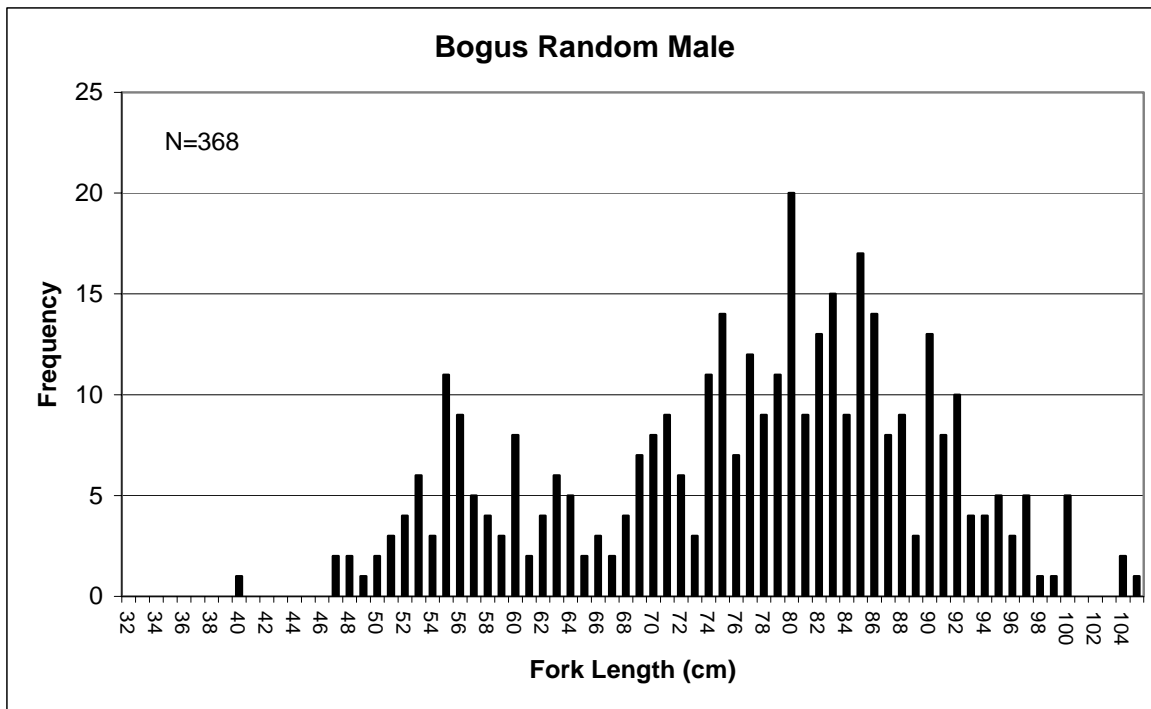


Figure 5. Length Frequency distribution of random male Chinook salmon observed during spawning ground surveys in Bogus Creek, 2010 (n = 368).

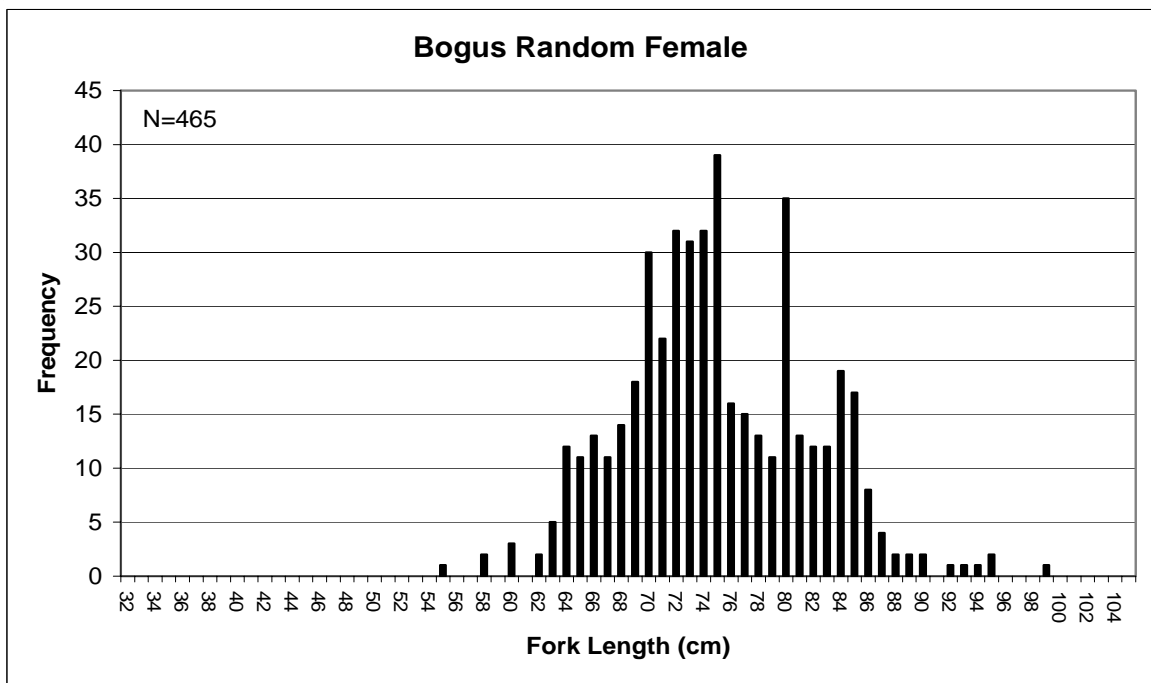


Figure 6. Length frequency distribution of random female Chinook salmon observed during spawning ground surveys in Bogus Creek, 2010 (n = 465).

Table 1. Estimated contribution of hatchery origin fall Chinook salmon in Bogus Creek 2010.

| Spawning Ground Surveys, Reach 1 | | | | | | | | | |
|--|----------|------------------------|------------|-----|---------------|---------------------------------|---------------------|----------------------------|----------------|
| 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 |
| 601020609 | IGH | F | 2006 | 4 | 1 | 15.93 | 16 | 1 | 16 |
| 601020701 | IGH | F | 2006 | 4 | 1 | 16.54 | 17 | 1 | 17 |
| 608020000 | IGH | F | 2007 | 3 | 1 | 19.84 | 20 | 1 | 20 |
| 608020005 | IGH | F | 2007 | 3 | 2 | 17.59 | 35 | 1 | 35 |
| 068643 | IGH | F | 2008 | 2 | 1 | 4.02 | 4 | 1 | 4 |
| Sub Total= | | | | | 6 | Sub Total= | | | 92 |
| Estimated contribution of lost or unreadable CWT's | | | | | 1 | Sub Total= | | | 15 |
| Total= | | | | | | | | 107 | |
| 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 |
| 601020609 | IGH | F | 2006 | 4 | 1 | 15.93 | 16 | 1.44 | 23 |
| 601020701 | IGH | F | 2006 | 4 | 1 | 16.54 | 17 | 1.44 | 24 |
| 601020702 | IGH | F | 2006 | 4 | 1 | 16.65 | 17 | 1.44 | 24 |
| 601020703 | IGH | F | 2006 | 4 | 1 | 18.10 | 18 | 1.44 | 26 |
| 608020000 | IGH | F | 2007 | 3 | 2 | 19.84 | 40 | 1.44 | 57 |
| 608020001 | IGH | F | 2007 | 3 | 2 | 18.10 | 36 | 1.44 | 52 |
| 608020002 | IGH | F | 2007 | 3 | 2 | 15.93 | 32 | 1.44 | 46 |
| 608020003 | IGH | F | 2007 | 3 | 6 | 16.26 | 98 | 1.44 | 141 |
| 608020004 | IGH | F | 2007 | 3 | 4 | 16.66 | 67 | 1.44 | 96 |
| 608020005 | IGH | F | 2007 | 3 | 8 | 17.59 | 141 | 1.44 | 203 |
| 608020006 | IGH | Y | 2007 | 3 | 3 | 10.64 | 32 | 1.44 | 46 |
| 068642 | IGH | F | 2008 | 2 | 1 | 4.02 | 4 | 1.44 | 6 |
| 068643 | IGH | F | 2008 | 2 | 1 | 4.02 | 4 | 1.44 | 6 |
| 068644 | IGH | F | 2008 | 2 | 4 | 4.03 | 16 | 1.44 | 23 |
| 068645 | IGH | F | 2008 | 2 | 5 | 4.02 | 20 | 1.44 | 29 |
| 068646 | IGH | F | 2008 | 2 | 6 | 4.03 | 24 | 1.44 | 35 |
| 068647 | IGH | F | 2008 | 2 | 1 | 4.06 | 4 | 1.44 | 6 |
| Sub Total= | | | | | 49 | Sub Total= | | | 844 |
| Estimated contribution of lost CWT's | | | | | 3 | Sub Total= | | | 52 |
| Total Estimated Hatchery Contribution= | | | | | | | | 1,003 | |

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

COHO SALMON

The first adult coho salmon was observed entering Bogus Creek on October 25, 2010 and the last coho salmon was observed on December 14, 2010. A total of 153 coho salmon were observed moving upstream through the BCFCF during the season (Figure 7). One additional coho salmon was added on November 20th to account for 14:45 hours when the camera was not functioning properly bringing the seasonal total to 154. Diel movements of coho salmon through the BCFCF were higher in the evening hours and peaked between 1800 and 2100 hours (Figure 8).

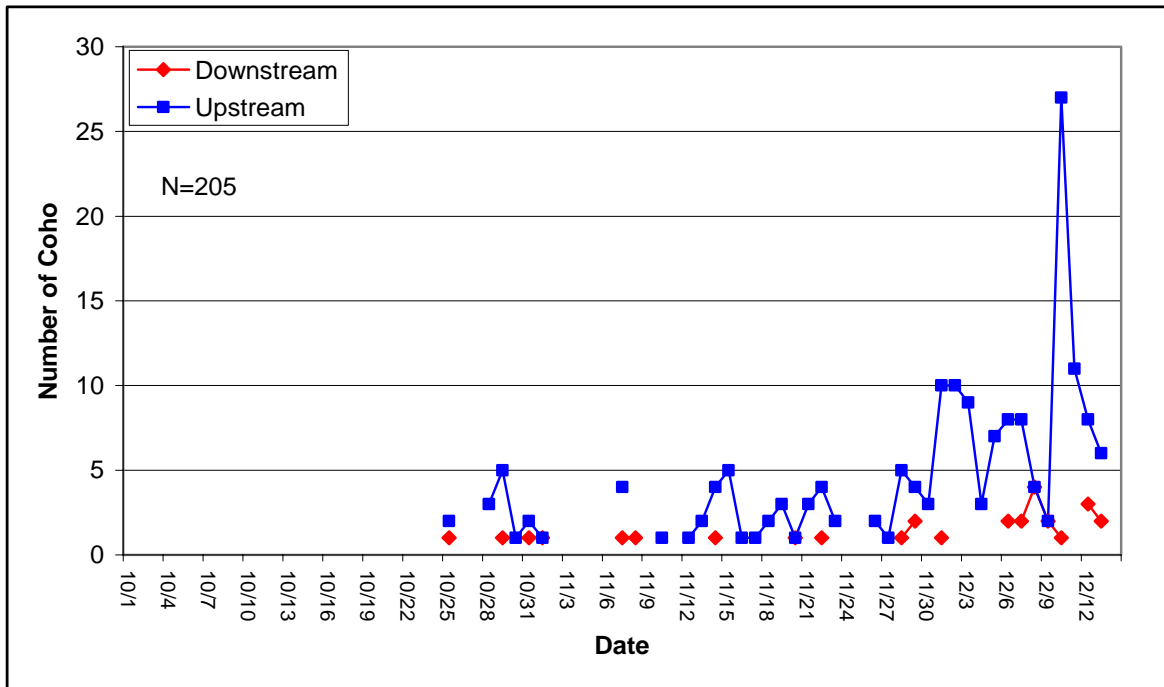


Figure 7. Run timing of coho salmon observed passing through the Bogus Creek Fish Counting Facility during the 2010 season (both upstream and downstream movements are shown).

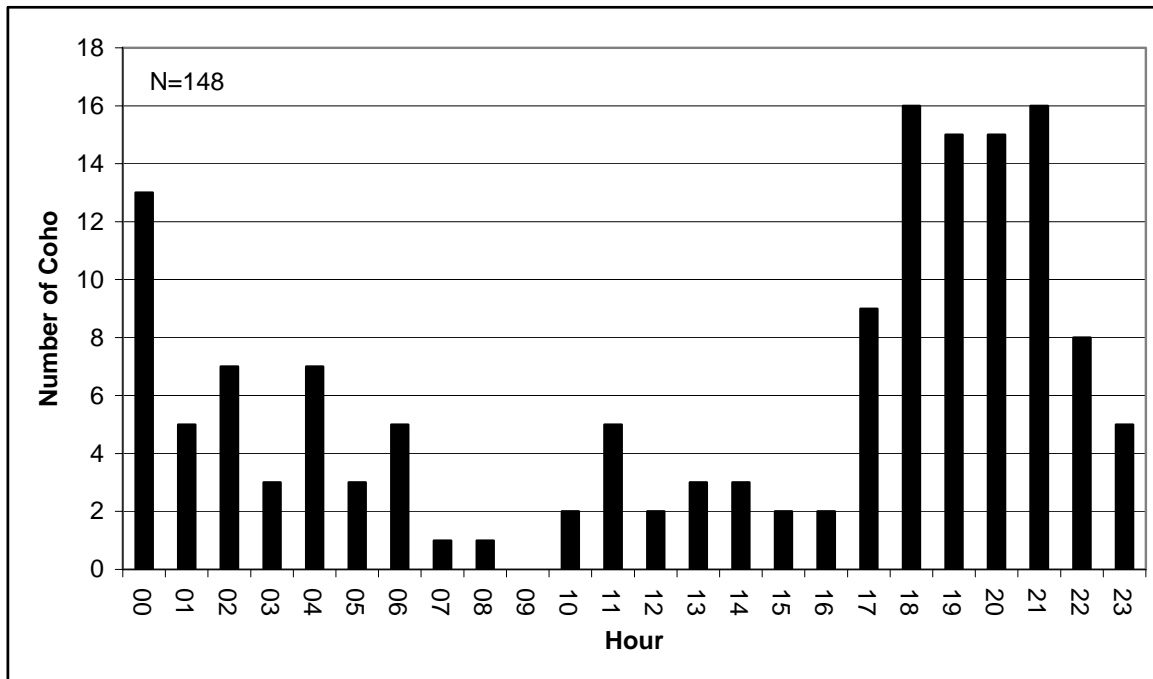


Figure 8. Diel migration patterns of coho salmon observed moving through (Hourly net movement) the Bogus Creek Fish Counting Facility in 2010.

SPAWNING GROUND SURVEYS

A total of 58 coho salmon carcasses were sampled during the spawning ground survey. Of those 29 were females, 28 were males (one sex undetermined). Males ranged in fork length from 43cm to 81cm and averaged 67.0cm (Figure 9). Based on the length frequency distribution of male coho salmon

presented in Figure 9, grilse were determined to be ≤ 54 cm in fork length. Females ranged in fork length from 55cm to 78cm and averaged 68.5cm (Figure 10).

All 29 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 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. Two of the 5 (40%) females recovered that were previously floy tagged and released from IGH were pre-spawn mortalities. For females that had not been floy tagged and released from IGH the observed pre-spawn mortality rate was 12.5% (3 of 24).

Sixteen of the 57 (28%) coho salmon carcasses observed (one undetermined) had left maxillary clips indicating that they were of IGH origin. The proportion of hatchery origin coho in Bogus Creek has been estimated since 2004 it has ranged from 24% to 36% and has averaged 34% (Figure 11) during that period. The proportion of hatchery origin fish has been estimated by applying the observed clip rate from recovered carcasses during the spawning ground survey and applying that rate to the estimated population. Eight of the 58 coho salmon observed (13.8%) in the spawning ground surveys were floy tagged indicating that they were coho salmon that previously entered IGH and were subsequently released. Based on the proportion of carcasses recovered that were released from IGH an estimated 21 fish in Bogus Creek were previously in IGH and subsequently released.

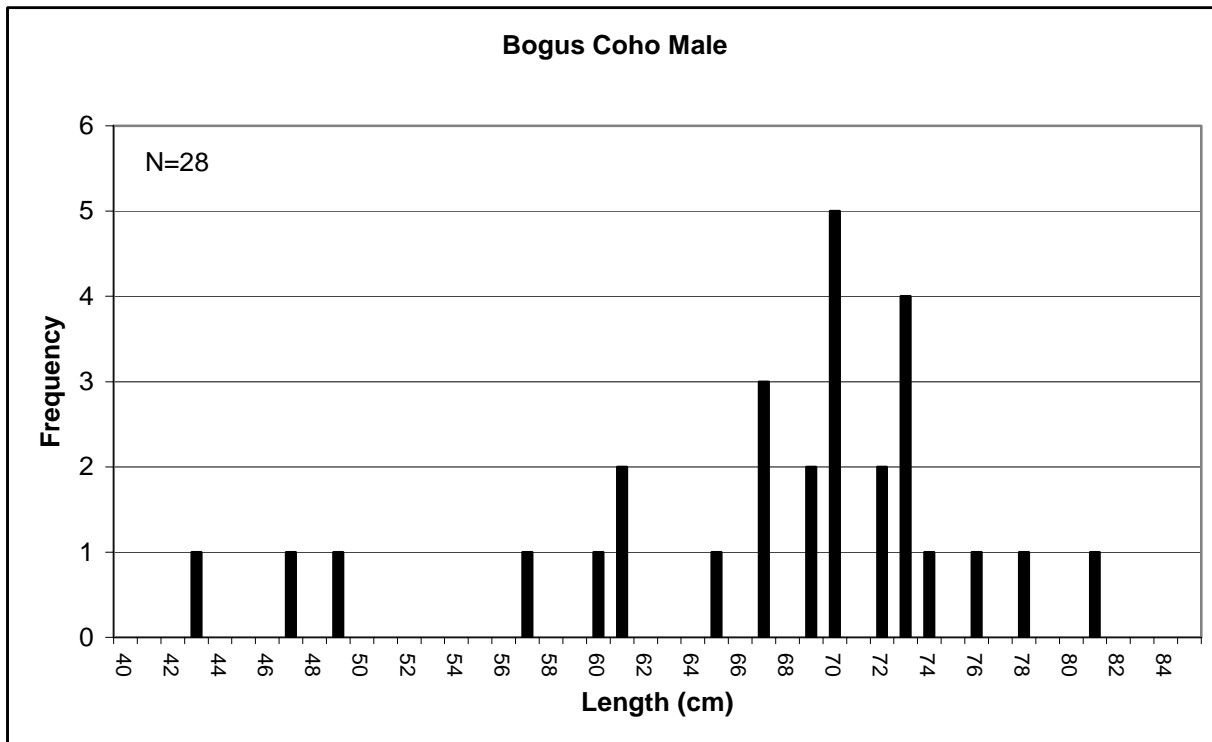


Figure 9. Length frequency distribution of random male Coho salmon observed during spawning ground surveys in Bogus Creek, 2010 (n = 28).

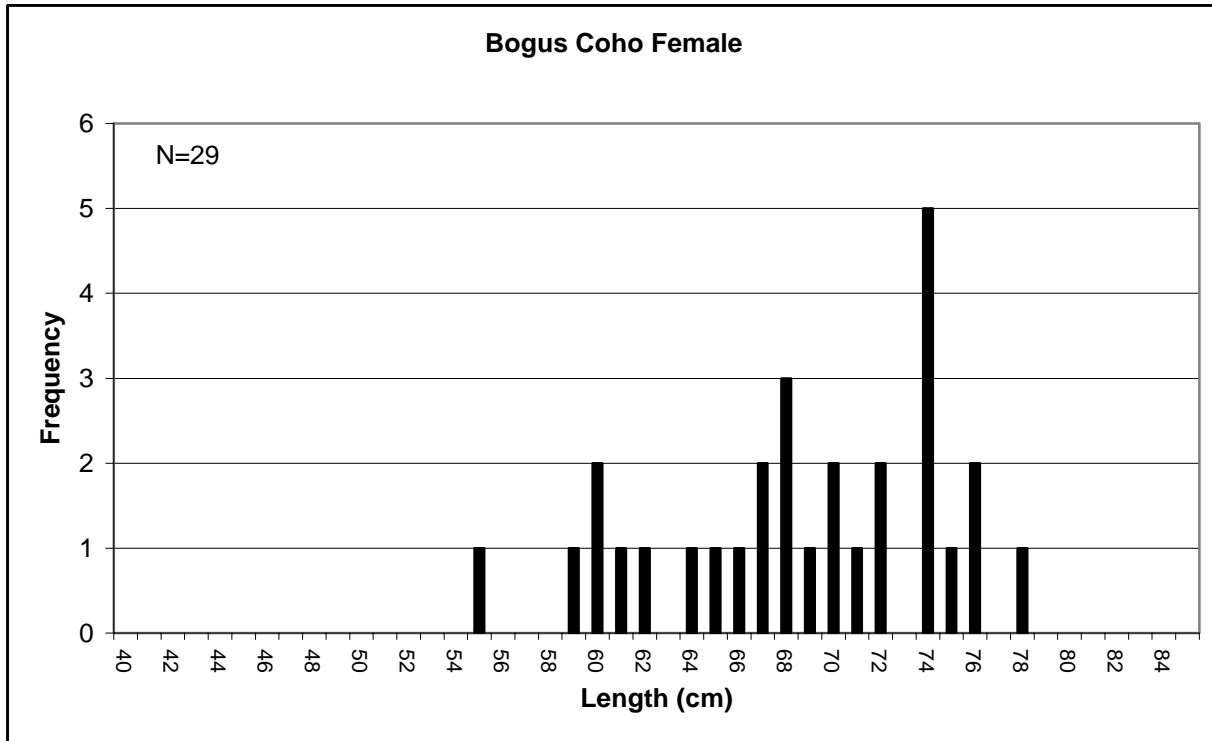


Figure 10. Length frequency distribution of random female Coho salmon observed during spawning ground surveys in Bogus Creek, 2010 (n = 29).

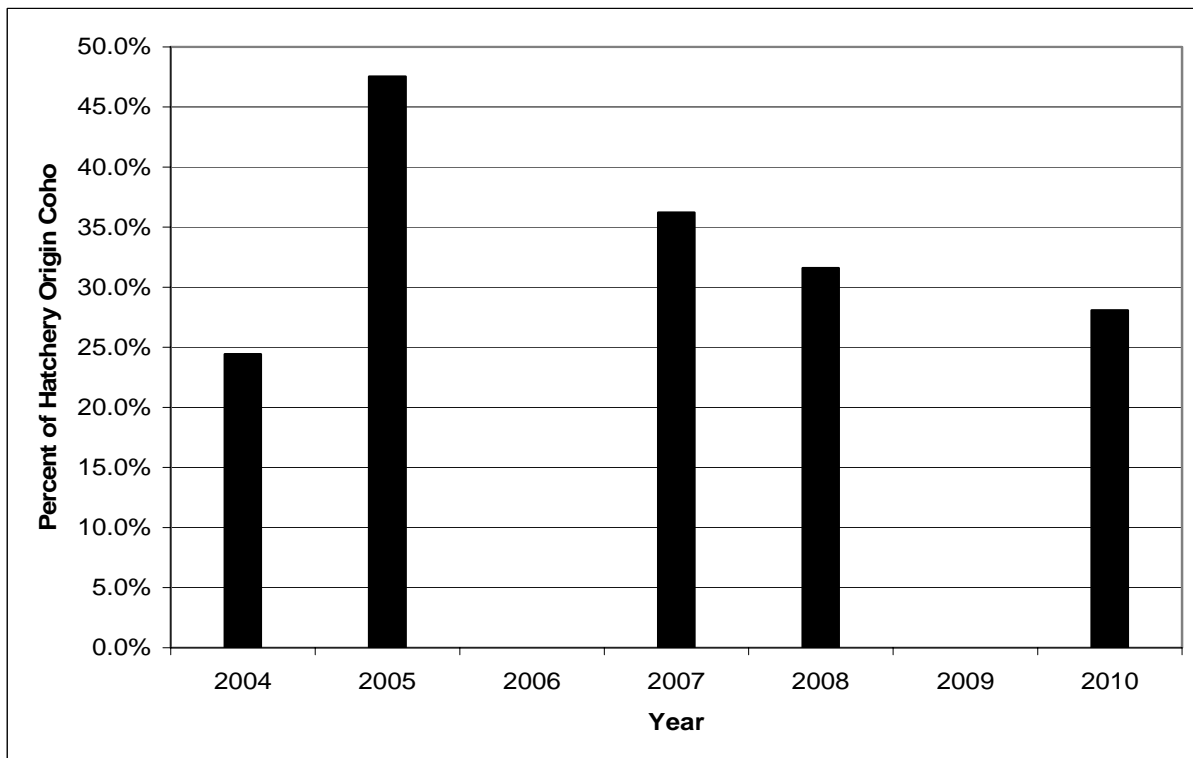


Figure 11. Estimated contribution of hatchery origin Coho salmon observed in Bogus Creek from 2004 through 2010. Due to low carcass recovery in 2006 and 2009 hatchery contribution rates were not estimated in those years.

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 averaged 8,621 fish (Figure 12). The 2010 Chinook salmon run in Bogus Creek ranks twenty-eighth (3,471 fish) out of 33 years of data. The largest run of Chinook salmon within the entire Klamath River basin occurred during the 1995 season when an estimated 245,543 Chinook salmon returned. That same year the ladder gates to IGH were closed after the hatchery met its egg production goal. Therefore, a significant portion of the IGH Chinook salmon that would otherwise have entered IGH either spawned in the main stem or entered tributaries including Bogus Creek. This would account for the large return of Chinook salmon that were observed in Bogus Creek during the 1995 season. As a result, the run size estimates for IGH and Bogus Creek during the 1995 season do not accurately describe the run size that would most certainly have occurred if the ladder gates at IGH were left open during that year. Subsequent to 1995, the hatchery policy was modified to allow all Chinook salmon to enter the hatchery regardless 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.

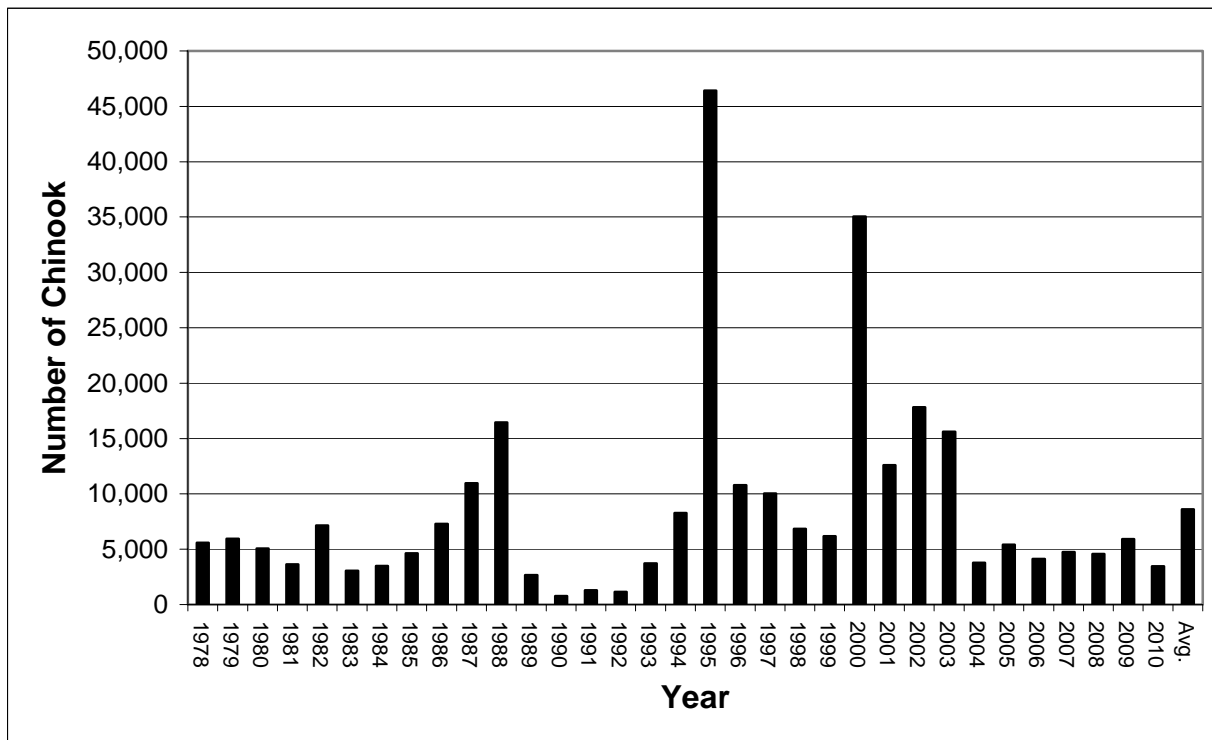


Figure 12. Estimated escapement of adult Chinook salmon returning to Bogus Creek from 1978 to 2010.

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 28.9% of the Chinook salmon that entered Bogus Creek during 2010 were of hatchery origin (Figure 13).

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.

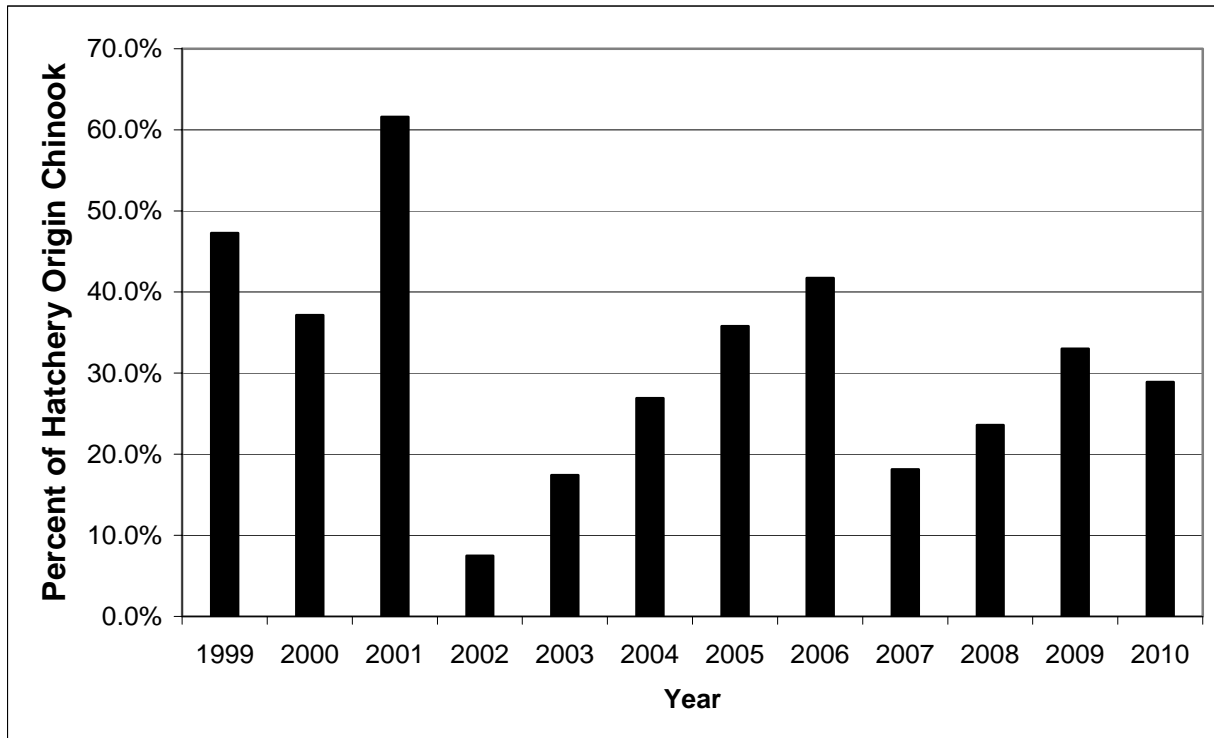


Figure 13. Estimated contribution of hatchery origin Chinook salmon observed in Bogus Creek from 1999 through 2010.

COHO SALMON

Since video operations began in 2004 the estimated escapement of coho salmon in Bogus Creek has averaged 152 fish (Figure 14). The run size of coho salmon during 2010 was estimated to be 154, 1.2% above the seven year average. The run size estimate for the 2005 season is believed to be underestimated due to storms that greatly hindered the Department's ability to effectively monitor the escapement of coho salmon into Bogus Creek that year. Due to the underestimated run size in 2005 there is difficulty when comparing the number of three year olds returning in 2008 to their parental cohort from 2005. The returning adult year class in 2010 is the largest of the three coho year classes, with respect to abundance, and a decrease of 34.0% in cohort strength is concerning (Figure 15, Figure 16 and Figure 17).

ACKNOWLEDGEMENTS

The California Department of Fish and Game would like to thank Siskiyou County High School students who assisted KRP staff (Leandra Darden, Chris Diviney, Kristin Gangl, Sara Olsen, Donn Rehberg, Meiling Roddam, Steel Sims, and Kirsten Underwood) 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.

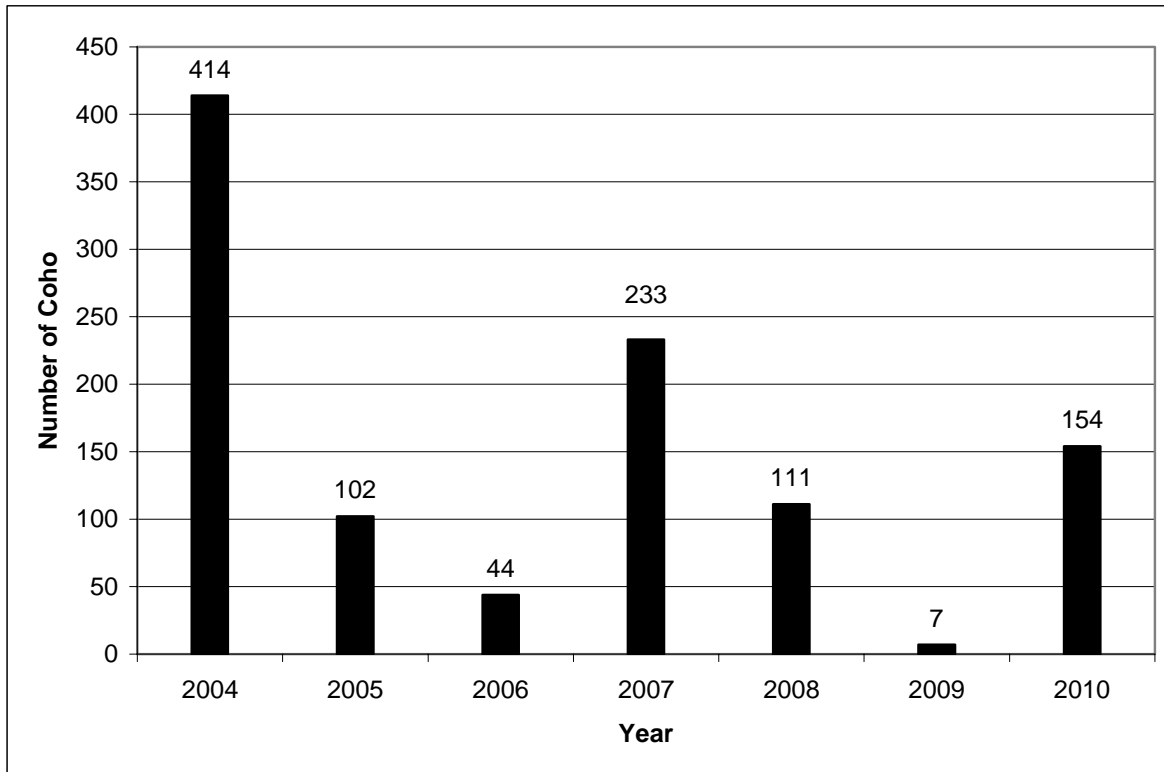


Figure 14. Estimated escapement of adult coho salmon returning to Bogus Creek from 2004 through 2010.

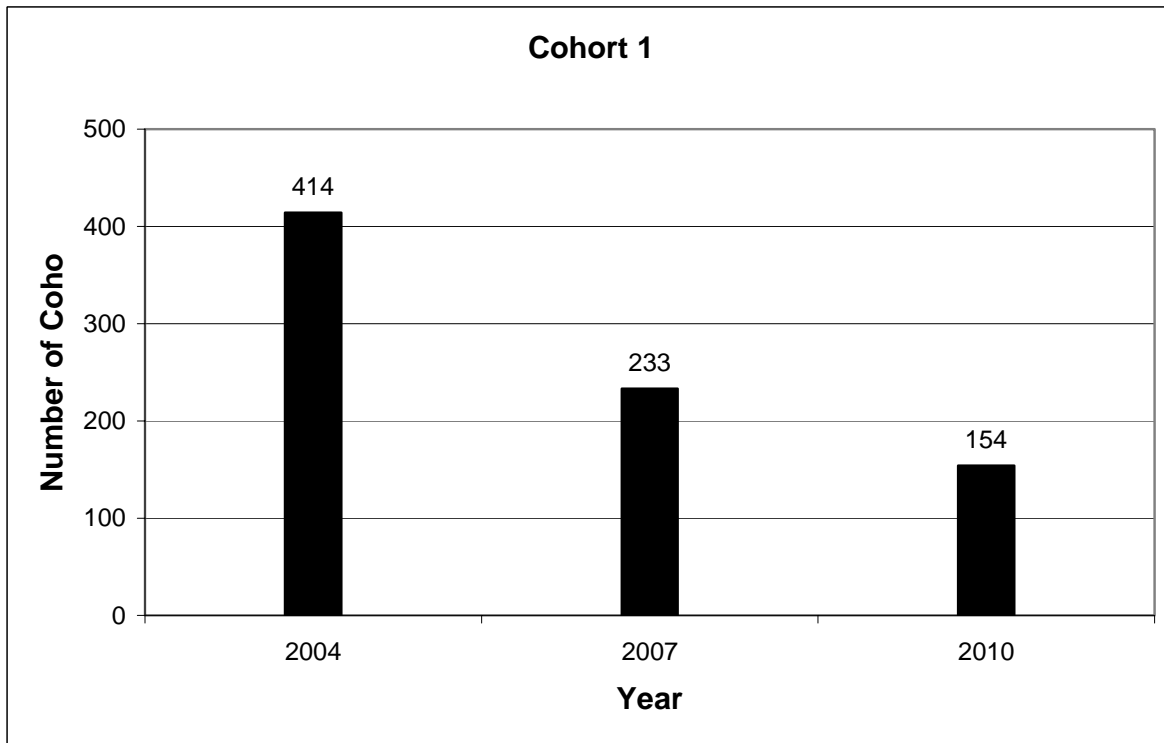


Figure 15. Estimated escapement of adult coho salmon (Cohort 1) returning to Bogus Creek from 2004 through 2010.

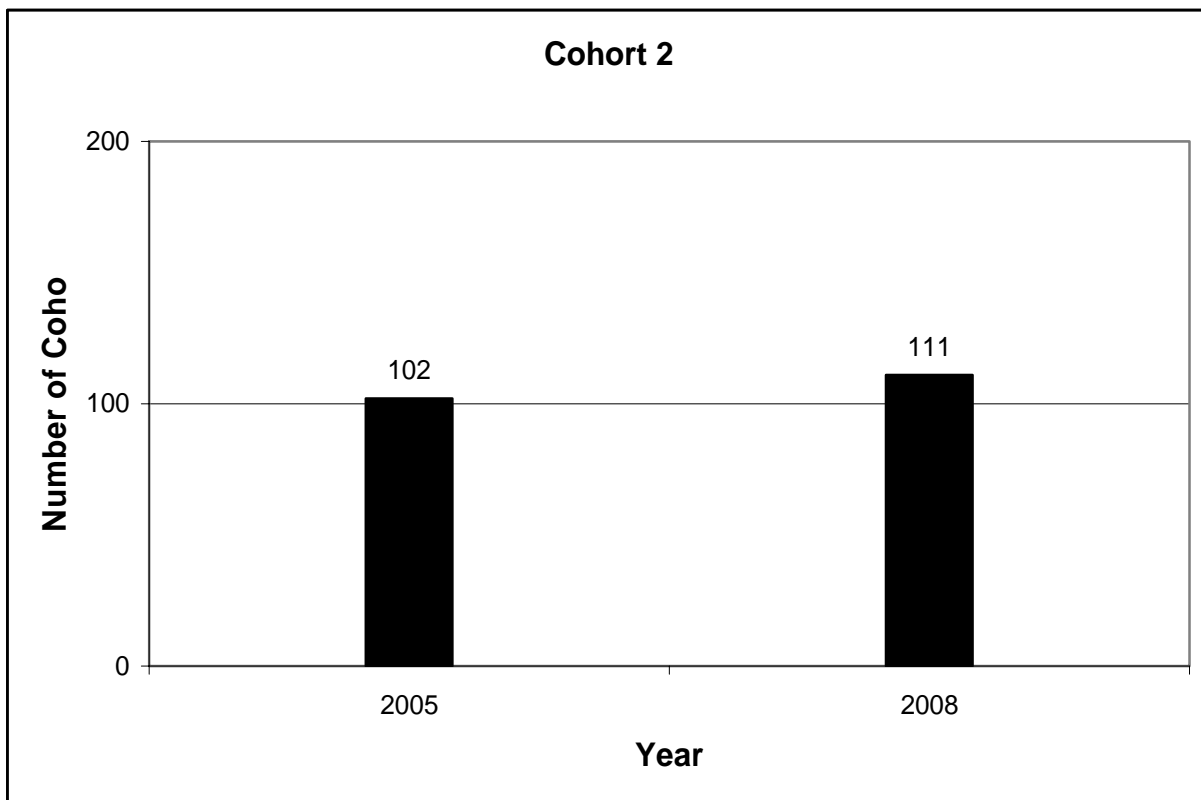


Figure 16. Estimated escapement of adult coho salmon (Cohort 2) returning to Bogus Creek from 2004 through 2010.

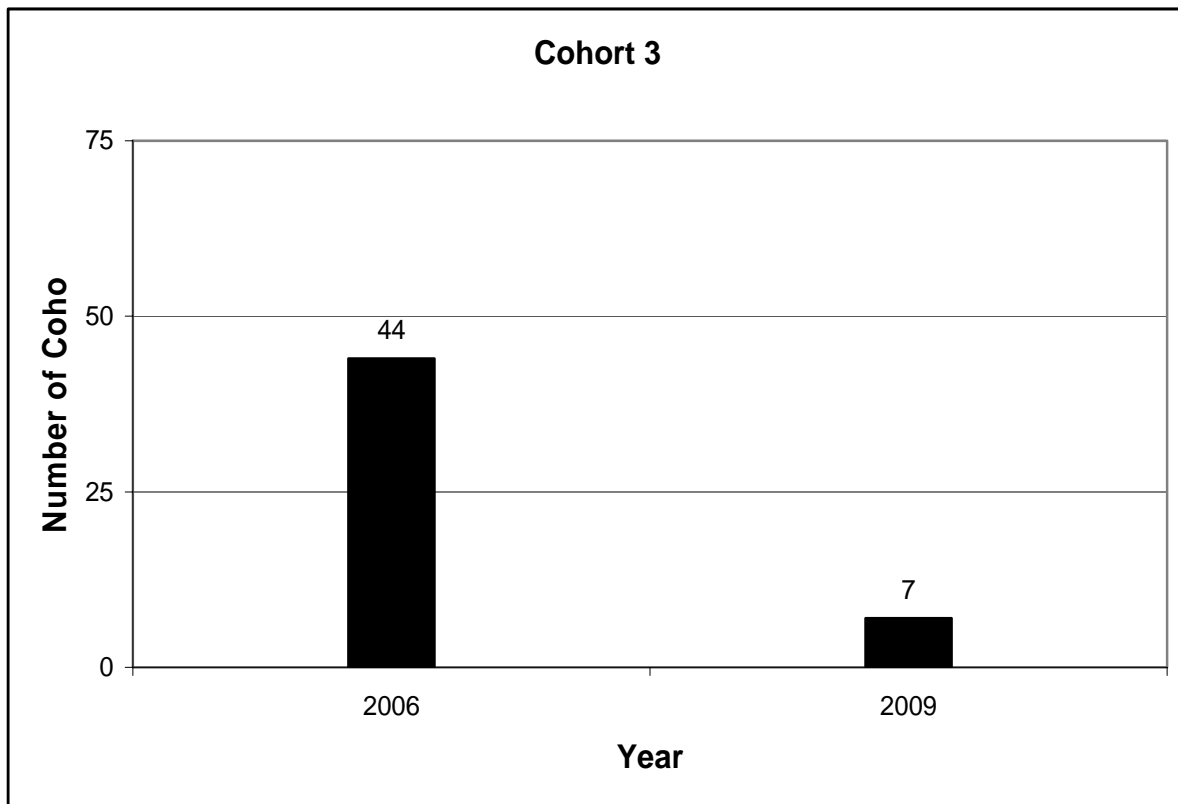


Figure 17. Estimated escapement of adult coho salmon (Cohort 3) returning to Bogus Creek from 2004 through 2010.