Little Salmon River Chinook Salmon Escapement Survey, 2011

Project CRE 143-11

By

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February, 2012

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ACKNOWLEDGEMENTS

The Little Salmon Chinook salmon escapement survey project is a cooperative and collaborative study among the G. Sandone, Consulting, LLC; Little Salmon Carmacks First Nation (LSCFN), Box 135, Carmacks, Yukon, Canada, YOB 1CO; Yukon Delta Fisheries Development Association (YDFDA) and Department of Fisheries and Oceans (DFO) Canada.

This project was supported by funding from the Yukon River Restoration and Enhancement (R&E) Fund (project CRE-143-11) and YDFDA.

The author would like to acknowledge the work of the Little Salmon Carmacks First Nation (LSCFN) employees, Rebecca Freeman, Dawn Baker, and William Skookum. I would also like to extend my gratitude to the Alaska Department of Fish and Game, and specifically to Toshihide (Hamachan) Hamazaki for his participation in the field portion of this project. The author would also like to thank Trix Tanner (DFO) for her critical review of the conceptual and detailed proposal and also her support for providing data collection procedures and supplies; Elizabeth McDonald (DFO) for her critical review of the draft report; and Robert Moar (LSCFN) for his support of the project and providing the LSCFN employees.

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ABSTRACT

During August, 2011, spawning Chinook salmon were sampled in the upper portion of the mainstem Little Salmon River, located within the Canadian portion of the Yukon River drainage. The sampling conducted the previous year in 2010 was the first escapement sampling conducted on this river in more than 20 years. Sampling was conducted from August 22-26, 2011. Sex, length information, and scales samples for subsequent age determination were obtained from each fish sampled. During this period, 147 live Chinook salmon were captured and retained for sampling. Additionally, 10 carcasses were recovered. The vast majority of the Chinook salmon observed were alive and associated with redds. Accordingly, the vast majority of the fish sampled, 93.6%, were alive and captured by snagging using sport fishing gear. Of the 157 Chinook salmon captured and sampled for ASL, 110, or 70.1%, were aged successfully. Percent age class composition of the aged Chinook salmon sampled was: 1.8% age-1.2; 50.9% age-1.3; 43.6% age-1.4; 3.6% age 1.5. There were no age-2.x fish observed in the sample.. Females comprised 29.9% of the total number of Chinook salmon sampled. However, of the 10 carcasses recovered, 7 were female. A bi-model length frequency distribution was observed from lengths of the sampled salmon. Salmon between 700mm to 750mm, inclusive, comprised 27.4% of the sampled fish and fish between 800 mm and 899mm, inclusive, comprised 32.5% of the sample. Fish equal to or greater than 900 mm comprised 7.6% of the sampled salmon. Female salmon equal to or greater than 800 mm, accounted for 80.9% of the female component. Comparisons between age, sex, length compositions at the Eagle Sonar and the Little Salmon Escapement indicated that characteristics of the male run were significantly different. However, differences among female salmon with regard to length, proportion of large fish and proportion of older aged fish were not significant. Comparisons between the 2010 and 2011 Little Salmon River Chinook salmon escapement samples indicated that the 2011 Chinook salmon escapement sample were larger and older than the 2010 sample. Proportions of male and female salmon greater than 850 mm were greater in 2011 than in 2010. For females, the mean size and the proportion of older aged fish was greater in 2011 than in 2010. The proportion of older aged male salmon was also greater in 2011. Local hiring of fishermen/samplers was accomplished through Little Salmon Carmacks First Nation. This employment provided stewardship experiences by sampling and also provided an understanding of how the escapement sampling provides information to aid the management strategy for Chinook salmon of the Yukon River.

KEY WORDS: Chinook salmon, *Oncorhynchus*, Yukon, Alaska, escapement, run assessment, migratory timing, age, sex, length composition, stewardship

INTRODUCTION

The Yukon River drainage supports widely distributed populations of Chinook salmon *Oncorhynchus tshawytscha*. Spawning populations of Chinook salmon have been documented throughout the Yukon River drainage from Andreafsky River, located approximately 167 km from the mouth, to as far upstream as the headwaters of Nisutlin River in Canada, nearly 3,100 km from the mouth . The Little Salmon River empties into the Yukon River at kilometer (Rkm) 2,548 near the village of Carmacks, Yukon (Figure1). Chinook salmon provide for important aboriginal, subsistence, personal use, commercial, and sport fisheries throughout the Yukon River drainage, as summarized in the most recently published yearly management reports (Bue et al. 2011) and U.S./Canada Joint Technical Committee (JTC) reports (JTC 2011).

Concerns over assumed high exploitation on the older age classes and larger Chinook salmon and the overall decrease in the size of Chinook salmon, in the Yukon River drainage has been discussed in U.S.-Canada Yukon River Panel (Panel) meetings, JTC meetings, Alaska Board of Fisheries (BOF) and Federal Subsistence Board (FSB) meetings, and other forums that involve Yukon River subsistence, aboriginal, commercial, domestic and sport fishers (JTC 2006). In 2006, the Panel directed the JTC to keep them informed of relevant information concerning salmon age, sex, and size trends. Accordingly, the JTC formed a subcommittee to undertake additional examination and analyses of age, sex, weight and length (ASL) trends in Yukon River Chinook salmon. This subcommittee reviewed relevant literature, existing analyses, and discussed potential causes of these trends in their *Potential Causes of Size Trends in River Chinook Salmon Populations* report (JTC 2006). They concluded that evidence that Yukon River Chinook salmon have undergone phenotypic alteration over time is limited, but suggestive.

Over the years, various studies documented a decrease in the weight of commercial harvests (Bigler et al. 1996), a reduction in the prevalence of the largest fish (Hyer and Schleusner 2005) and a decline in the proportion of age-7 fish in the commercial harvest (Hamazaki *In prep*). Bromaghin et al. (2008) investigate the potential long-term effects of large-mesh gill net fisheries on Chinook salmon by stochastic modeling. Their results suggest that long-term, selective exploitation of large Chinook salmon is likely to cause reductions in fish size and maturation age and impair population productivity. More recently, Hamazaki (*In prep*), in his analysis of the commercial harvest from the District 1 unrestricted mesh size periods during the period 1964–2007 also noted: 1) a small increase in the proportion of female Chinook salmon; 2) a small decline in the proportion of large (≥900 mm) fish; 3) no apparent change in the proportion of age-6 Chinook salmon over the time period, but a significant decline in the proportion of age-7 individuals; and 4) declines in length at age for age-6 and age-7 females and males.

Although Chinook salmon escapement has been monitored in various spawning tributaries in the Alaskan portion of the drainage at weirs or through carcass surveys on a regular basis, Chinook salmon ASL escapement sampling in the Canadian portion has been limited since 1990. Recent ASL sampling has occurred continuously at the Whitehorse Fishway and the DFO fishwheels located near the U.S./Canada border through 2008, and more recently from the Big Salmon River and the Blind Creek weir, and intermittently from the Tatchun weir projects. Although some samples of the escapement were taken from the Whitehorse Fishway and from Teslin Village/City in the 1960s and 1970s, most of the historic escapement sampling occurred in the 1980s and 1990s. Based on data in the ADF&G electronic database, it appears most streams were sampled on an infrequent basis, except for the Big Salmon, Nisutlin and Little Salmon Rivers. Chinook salmon carcass surveys on these three rivers were conducted on an annual basis starting in 1980 or 1981 and extending through 1990. Chinook salmon carcasses were also sampled from other spawning tributaries, including: Blind Creek, (1982); Ingersol Islands (1983, 1985, 1988, 1989); Koidern River (1982); McQuesten River (1990); Mitchee Creek, (1980, 1982, 1983); Morley River (1982, 1987, 1989, 1990); Nordenskiold River (1987, 1989, 1990); Ross River (1981, 1982, 1988, 1989); Swift River (1981, 1989); Takhini River (1982, 1988, 1990); Tatchun Creek (1980-1990); Teslin

Village/City (1967, 1968, 1972, 1980, 1981, 1986, 1987); and the Whitehorse Fishway (1968, 1970-1973, 1981, 1984-1986, 1991, 1996) Additionally, ASL samples were collected from the commercial fishers that were prosecuted in Dawson (1966, 1971, 1980- 1985, 1987 and 1999) and Pelly (1966). ASL samples were also collected from the Dawson test fish wheel fishery (1998, 2000) and the Sheep Rock (1988, 1989, 1991-1994, 1996-2008) and White Rock (1989, 1991-1994, 1996-2008) fish wheels that were associated with the DFO mark-recapture project. Age, sex, and length data from the Little Salmon River escapement survey project during 2010 was the first data collected from this drainage in 20 years. We believe that these data were more representative of the spawning population that previous data from carcass surveys. While carcass survey ASL data are considered to be biased toward larger fish (Stuby 2001), fishwheel data are considered to be biased toward smaller fish.

Data from this project, in conjunction with ASL data collected at the Eagle sonar site, will allow a comparison of Chinook salmon ASL between these two projects within the same year. Additionally, these data may be used to determine relationships among the border sonar, border fishwheel, and the Little Salmon escapement databases. Further, these escapement ASL data will also be used to gain insight into and document changes and trends in the ASL composition and the quality of the escapements when compared to the escapement samples collected from the 1981-1990 time period. Further, specific exploratory size at age comparisons between the commercial fishery samples taken in the 1960s and 1970s in Dawson and Pelly along with the earliest Whitehorse Fishway ASL samples may also provide interesting results.

Comparisons of the characteristics of this year's sample from the Little Salmon River Chinook salmon escapement will be compared to last year's escapement characteristics to document changes that may be related to changes in management strategies and regulations.

OBJECTIVES

Accordingly, the specific objectives of this project are to:

1) describe the ASL composition of the Chinook salmon that spawn in the Little Salmon River;
2) collect genetic samples of the Chinook salmon sampled for ASL:
3) build community capacity and foster stewardship through involvement of local rural residents;
4) document specific locations of individual or groups of Chinook salmon redds within the Little Salmon drainage; and
5) compare age, sex, size characteristics between samples taken from the 2011 test fishing activities at Eagle sonar and the 2011 Little Salmon River escapement samples;
6) compare age, sex, and size characteristics between the 2010 and 2011 Little Salmon River Chinook salmon escapement samples.

STUDY AREA

The proposed study area for the 2011 sampling within the Little Salmon River drainage was similar to the 2010 study area, Rkm 26 to Rkm 70, located at the mouth of Little Salmon Lake (Sandone 2011). Known spawning within the Little Salmon River drainage is concentrated from the mouth of Bearfeed Creek downstream for 8 km (Walker et al. 1974). However, because of high and turbid water in the Little Salmon River during the 2011 sampling period, sampling of post-spawning, live Chinook salmon was primarily limited to areas of relatively shallow and/or clear water. Therefore, the vast majority of the sampling effort was located 0.3rkm above and 0.1km below the confluence of Bearfeed Creek and the Little Salmon River (Figure 2).

METHODS

Based on the success of sampling live but post spawning Chinook salmon during the 2010 season (Sandone 2011), the timing of this year's sampling was planned to coincide with the same post spawning period. Because of the overall late run timing of the 2010 Yukon River Chinook salmon run, spawning was delayed approximately 1 week (Sandone 2011). Therefore, the 2011 sampling was scheduled one week earlier than the 2010 sampling. .

Salmon were captured using fishing rods and reels with weighted snagging hooks as terminal tackle. Heavy, 40 pound test, monofilament fishing line was used to minimize line breakage. However, most, if not all of the few salmon that broke the line were recaptured when they returned to the redd. Snagged fish were landed as quickly as possible to minimize stress to the salmon. Snagged salmon were landed with a hand held landing net and place in a tub of water. Because the vast majority of the fish were sampled from the vicinity of the confluence of Bearfeed Creek and the Little Salmon River, specific sampling locations were not identified via GPS downstream of Bearfeed Creek. Additionally, 10 carcasses were retrieved by either hand picking or with jigs. Most of these carcasses were recovered in association with the survey of the river below Bearfeed Creek. GPS information was not noted for the location of the recovered carcasses.

Six scale samples were collected from all Chinook salmon collected from the Little Salmon River for subsequent age determination. A scale smear was taken from each sampled fish from the preferred area with a knife. DFO also provided information on the preferred area that differed from Koo (1955). This information is found on the inside of the front cover of the DFO scale card (Figure 3). However, the smear was taken from an area on left side of the fish, approximately one to two rows above the lateral line on the diagonal that extends down from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin (Koo 1955). The scale smear was transferred to a plastic surface from which scales were immediately selected for mounting on gum cards. DFO processed and read the scales for age determination.

Sex of each sampled Chinook salmon was determined based on the presence of running milt or eggs, or external characteristics. Spawning condition of the salmon was also noted and recorded for each sampled fish. The primary length measurement was taken from mid-eye to fork of tail (MEFT). When the tail appeared to be severely eroded the post orbital to the end of the hyplural plate (POHP) lengths were also measured. In cases where the tail was severely eroded the MEFT measurement was from the mid-eye to the end of the longest remaining caudal ray in the fork of tail area.

Genetic samples were not collected on recommendation from DFO.

Before release of the fish, the adipose fin was cut off as a mark indicating that the fish was sampled. A blank floy tag was inserted through the pterygiophores of the dorsal fin. The blank floy tag was wrapped with yellow duct tape to increase visibility. This eliminated duplicate sampling of the same fish and proved useful in identifying sampled fish in the water. These marks were apparent to the crew and very few fish were snagged repeatedly.

All comparisons of mean Lengths and proportions of sampled Chinook salmon collected in the associated test fish activities at Eagle Sonar and the escapements from the Little Salmon River drainage were conducted using SPC for Excel software (BPI, Consulting, LLC 2012)

Three Little Salmon Carmacks First Nation employees, funded through this project, fully participated in this project. These employees were educated in sampling and handling techniques to avoid undue stress to the salmon. Additionally, ADF&G provided an employee to participate in this project

RESULTS

Escapement Sampling

The 2011 fishing season was the second year that the Chinook salmon escapement was sampled in the Little Salmon River since 1990. Sampling occurred from August 22 through August 26, 2011. All live Chinook salmon were observed in association with redds. Salmon remained in association with redds and susceptible to capture, even though they were disturbed by the sampling. Captured Chinook salmon were sampled for age, sex, and size. However, two fish of the 157 captured and sampled, were inadvertently released before scales were collected. The vast majority of sampled fish, 93.6%, were captured by snagging. Of the total 157 Chinook salmon sampled, the vast majority, 136, or 86.6% of the entire sample and 92.5% of the live fish sample were obtained in the vicinity of the Bearfeed Creek/Little Salmon River confluence (rkm 65) located approximately 5 km below the outlet of Little Salmon Lake (Figure 2). This area has the highest density of spawning salmon within the entire Little Salmon drainage. One female Chinook salmon carcass was also sampled in this area. High water in conjunction with very turbid water entering the Little Salmon River approximately 1 rkm downstream from the Bearfeed Creek/Little Salmon River confluence made sampling the remainder of the study area extremely difficult. Although attempts were made to observe and capture Chinook salmon in the remainder of the study area, live Chinook salmon were sampled from only two additional downstream locations. Only 11 live fish and 9 carcasses were collected below the vicinity of the Bearfeed Creek/Little Salmon confluence.

While nearly all live male Chinook salmon were assessed as “ripe”, 20.0% of the live female Chinook salmon had free flowing eggs. Of these 8 live female salmon, 5 were partially spent (Appendix A1). Interestingly, one of the 10 female Chinook salmon carcasses did not spawn. Inspection of this fish showed no signs of injury or trauma. Appendix A1 provides biological data and the sampling method for each individually sampled Chinook salmon.

Comparison of the number of samples collected with all the other escapement sampling, conducted on the Little Salmon river, indicates that the 157 samples collected this year is very similar to the sample size collected during 2010 (Sandone 2011) and ranks in the middle of all the other years for samples collected (Table 1). However, note that most other sampling efforts in previous years prior to last year, lasted from 1 to 5 days with a median of 2 days. The low capture or collection rate of Chinook salmon in 2011 was most likely due to the high and turbid waters within the Little Salmon River.

Age, Sex and Length Composition

Of the total 157 Chinook salmon sampled from the Little Salmon escapement in 2011 (Table 2), 110, 70.1%, were successfully aged (Table 3 and 4). Partial ages, representing marine age, are available for 87.2% of the scales that could not be aged because the center was regenerated (Appendix A1). The age composition of Chinooks salmon sampled from the Little Salmon River escapement was comprised of 4 age classes (Table 4). Age classes ranged from age-1.2 to age-1.5 and represented four brood years, 2004-2007, that returned as 7, 6, 5, and 4 year old fish, respectively (Table 4). The dominant age classes were age-1.3, 50.9% and age-1.4, 43.6% (Table 4). Age 1.5 salmon comprised 3.6% of the aged sample, while age 1.2 salmon comprised 1.8%. Interestingly, no age 2.x salmon were sampled. It is also interesting to note that the scales that were aged only for marine age, indicated by a "M" followed by the years in the ocean, were similarly distributed, except for M2: M2=12.2%; M3= 51.2%, M4= 36.6% and M5= 0.0%. Overall, the mean age of the spawning Chinook salmon was 5.49 years; the mean male salmon age was 5.27 years; the mean females salmon age was 5.97 years (Table 3). While the male Chinook salmon component consisted mainly of smaller and younger salmon, the female Chinook salmon component tended to be composed of larger and older individuals (Figure 4).

Mean length at age for male salmon was 573 mm for age-1.2; 709 mm for age 1.3; 846 mm for age 1.4, and 878 mm for age 1.5 salmon (Table 4). Mean length at age for female salmon was: 722 mm for age 1.3; 848 mm for age 1.4; and 880 mm for age 1.5 (Table 4). Overall mean length of aged males was 744 mm. Average length of aged females was 838 mm (Table 4). Mean length of unaged males was 686 mm, while the mean length of unaged females was 862 mm (Table 4). Interestingly, the difference between the female aged and unaged mean lengths was not significant (p = 0.2066), while the difference between the male aged and unaged mean lengths was significantly different (p=0.0484). The significant difference was most likely due to the disproportionate number of small males that were not aged (Figure 5).

Two peaks were observed in the length frequency distribution of sampled Chinook salmon (Figure 4). A majority, 52.2% of the sampled Chinook salmon, were 750 mm or less in length (Table 2; Figure 4). However, a substantial portion of the salmon sampled, 40.1% were at least 800 mm in length (Table 2; Figure 4). Chinook salmon greater than 900 mm comprised 7.6% of the sample (Table 2, Figure 4). Overall, female salmon compromised 29.9% of the fish sampled (Table 3). Female Chinook salmon larger than 800 mm, accounted for 80.9% of the female component; female Chinook salmon larger or equal to 900mm accounted for 10.6% of the female component (Table 2; Figure 5).

Genetic Sampling

Little Salmon River Chinook salmon genetic samples were not taken during 2011 based on instructions from DFO.

Comparisons between Eagle Sonar and Little Salmon Age, Sex, Length Data

Overall mean length, proportion of large fish (>=900mm), proportion of older fish (=>age-6 salmon), age 1.4, age 1.5, age 2.3 and age 2.4, and proportion of females were significantly greater at the 2011 Eagle Sonar project than those sampled from the escapement within the Little Salmon River drainage in 2011 (p=0.000, p=0.0001, p=0.0000, p=0.0000, respectively; Table 5). However, differences between sampled female populations regarding length, proportion of large fish and proportion of older aged fish were not significant (p=0.7990, p=0.1058, and p=0.2689, respectively; Table 5). Male salmon sampled from the Eagle Sonar project were larger than male salmon captured from the Little Salmon River (p=0.0000), consisted of a larger proportion of the largest fish (p=0.0010) and consisted of a higher proportion of older aged fish (p=0.0001; Table 5). Interestingly, while the Eagle Sonar project sample contained 1.2% age 2.3 fish and 6.2% age 2.4 fish, the sample from the Little Salmon River escapement contained no 2.x fish. The mean length of age 2.3 salmon, 700 mm, and age 2.4 salmon, 841 mm, within the Eagle Sonar sample were significantly smaller than the age-1.4 salmon, 863mm, (p=0.0000; p=0.0101, respectively). Note that age-2.3 salmon are of the same brood as the age 1.4 salmon with the age 2.4 salmon one year older. However, it also appears that even though the age 1.4 and age 2.4 spend the same amount of time in the ocean, 4 years, the age-2.4 salmon are significantly smaller than the age 1.4 salmon.

It appears that overall difference in overall mean length, proportion of large fish, proportion of older fish, and the proportion of females is at least partial due to the significantly higher percentage of age-1.3 salmon, 50.9%, in the Little Salmon River escapement sample (p=0.0000) (Figures 5 and 6). These differences also become apparent in the comparison of the male population (Table 5), because of the relatively large component of age 1.3 male salmon in the Little Salmon River escapement sample. Most of age-1.3 Chinook salmon are males. In the Little Salmon escapement sample, 94.6% of age-1.3 salmon are male; in the Eagle Sonar sample, 77.4% are male.

Comparisons between 2010 and 2011 Little Salmon River Escapement Age, Sex, Length Data

Overall mean length and proportion of older fish (≥age-6 salmon) were greater in the 2011 Little Salmon Chinook salmon escapement than the 2010 escapement (p=0.0085 and p=0.0000, respectively; Table 6). Differences in proportion of large fish (≥900 mm) and proportion of females were not significant (p=0.5889, p=0.2990, respectively; Table 6; Figure 7). Female salmon were significantly larger (p=0.0332) and the proportion of older, female salmon was significantly greater (p=0.0177) in 2011(Table 6). Interestingly, the difference in the proportion of large female fish between years was not significant (p=0.7203; Table 6). Male salmon captured in 2011 were significantly larger than male salmon captured in 2010 (p=0.0760) and consisted of a higher proportion of older aged male fish (p=0.0000; Table 6). Like the female component, the difference in the proportion of male salmon that were ≥900 mm was not significant (p=0.8128; Table 6). This is somewhat perplexing in that the mean length is larger and there is a higher proportion of older aged fish in 2011 for both sexes. However, interestingly, both male and female proportions of fish greater or equal to 850 mm were significantly larger in 2011 than in 2010 (p0.0015, p=0.0339; Figure 7). This difference explains the significant larger size and the higher proportion of older aged male and female salmon present in 2011 escapement without a significant difference in the presence of the largest, ≥900 Chinook salmon.

Conservation and Stewardship Experience for Rural Local Residents

Local hiring of fishermen was accomplished through the Little Salmon Carmacks First Nation. Three employees participated in capturing and sampling live and dead Chinook salmon. This project provided stewardship experiences in capture and sampling techniques and also provided an understanding the importance of escapement monitoring to the management strategy for Chinook salmon of the Yukon River. The crew quickly became adept at catching the fish, handling the fish to avoid undue stress, and sampling for length, sex identification, and scales. During the project, the two biologists and three crew members camped on the river. Discussions during the work day and occasionally in the evening around the campfire included topics, such as, salmon life history, migrational patterns, and the need to sustain the runs through proper management and achievement of escapement goals. Other discussions focused on the objectives of the international Yukon Salmon Agreement between Canada and the U.S. and role of the Yukon Panel, the JTC, Fist Nations and advisors in the Panel process. On occasion, traditional ecological knowledge was transferred to the professional biologists regarding the salmon, wildlife and habitats. Further, because of the mutual respect for each other, the professional relationship between the LSCFN wildlife manager, Robert Moar, and me, extended beyond the scope of this project

DISCUSSION

A comparison of the percent female over all years sampled indicates that the 2011 female component of the Little Salmon River Chinook salmon escapement was the second lowest on record (Table 1). The lowest percent female, 24.3%, was observed last year, 2010. From 1981 – 1990 the percent female of the sample carcasses ranged from a low of 44.6% in 1990 to 75.6% observed in 1983. However, the 2010 and 2011 sampling efforts were the only two years of record that sampling was primarily directed at live fish. All other previous escapement sampling was accomplished through carcass survey. Carcass surveys are thought to be biased toward larger and female Chinook salmon (Stuby 2001) and they tend to be conducted during a limited time period immediately after the peak die off event. Female salmon are generally larger than males and are easier to see. Additionally, the timing of carcass surveys probably also plays a significant role in affecting the sex ratio and length frequency distribution of the sampled population, which may be substantially different than the spawning population. Therefore, the type of escapement sampling, carcass versus live fish capture, may produce very different results with regard to sex and size composition of fish sampled from the spawning grounds. Note that ADF&G corrects for their observed sex ratio results obtained through carcass samples from previous sex ratio comparisons between results from mark-recapture and carcass survey results (see Appendix B10 in JTC 2011). ADF&G adjusted the proportions of male and female Chinook salmon from carcass surveys based on the average of ratios of unbiased estimates from mark-recapture experiments to estimates from carcass samples of those years when both studies were conducted (JTC 2011).

Biases associated with live fish capture with sport gear would tend to underestimate the smaller-sized salmon because larger fish are easier to see and snag. Additionally, because very few Chinook salmon carcasses were observed during the 2010 and 2011 field season, along with little evidence of bear predation, I believe that most of the Chinook salmon that entered the Little Salmon River were susceptible to capture at the time of live sampling. Further, the relatively low, clear water of the Little Salmon River facilitated locating and snagging Chinook salmon during the 2010 sampling period. Although the high, turbid water experienced in 2011 within the Little Salmon drainage restricted sampling to the extreme upper portion of the drainage, sampling did include the area that has the most concentrated density of spawners in the drainage at the Bearfeed Creek-Little Salmon River confluence. Therefore, I believe that the sample collected in 2011 is an unbiased sample of the escapement. The behavior of spawning and post spawning salmon also facilitated their capture because the salmon tended to remain over redds or return to the immediate vicinity after being disturbed. This is true of both female and male salmon.

Although sample size was small in both years of sampling, n=147 and n=157, respectively, I suspect that the Chinook salmon sampling conducted in 2010 and 2011 was more representative of the actual composition of the spawning escapement than previous carcass surveys. Because of the great disparity in the composition of female Chinook salmon between historic carcass surveys and the present live fish survey on the Little Salmon River, I also suspect that age, sex, size information gained from carcass surveys may have little utility except for determining the presence or absence of the very largest Chinook salmon on the spawning grounds, those $\geq$900 mm.

It is unknown how the data from a carcass sample from the Little Salmon River would have compared to the live fish capture project. However, it may be interesting to compare the run characteristics of Chinook salmon collected in the Big Salmon River carcass survey with the run characteristics of the Eagle sonar and Little Salmon escapement projects. Future research associated with tributary escapements should be conducted to determine if the age, sex, size data collected from Chinook salmon escapement projects, both live capture and carcass surveys, reflect the actual spawning population. This study would aid in selecting future sampling methodology so that project objectives could be better achieved

The comparison between the age, sex, and length characteristics of samples collected from test fish activities associated with Eagle Sonar and the Little Salmon River escapement provide some insight into the differences and similarities between these two data sets. Although the Little Salmon River escapement samples have a higher proportion of smaller male salmon, the characteristics of the female component are not statistically different. The differences in the male proportion may possibly be explained by differences in the intrinsic composition of the Little Salmon River escapement. The Little Salmon River is a smaller river than other rivers in the Yukon River drainage in Canada and may contain smaller males than other spawning populations within the mainstem Yukon River. Another explanation may be that the smaller male salmon are not being caught in proportion to the passage at Eagle Sonar. Further, the sample from the Little Salmon River escapement may not be representative of the entire spawning population because only the extreme upper portion of the Little Salmon River was sampled. However, the similarity between the age and length of fish within the female component of the samples from the Eagle Sonar and Little Salmon River escapement is very encouraging and supports the accuracy of the female composition of the two projects.

Comparisons between the age, sex, and length characteristics of the 2010 and 2011 Little Salmon River escapements indicate that although the proportion of female salmon did not significantly differ between years, it does appear, however, that the 2011 escapement consisted of larger proportion of larger, greater than 850mm, and older male and female salmon. This may be partial explained by differences in age class composition of the two annual runs but may also be partial the result of the new maximum gillnet mesh size regulation that set a maximum gillnet mesh size of 7.5 inches in the Alaskan portion of the drainage and other management actions. The maximum mesh size regulation was specifically enacted to aid in the passage of older and larger Chinook salmon into Canada and escapement throughout the drainage. Additionally, although pulse protection management was conducted in 2011 to ensure that the Agreement Obligations, expressed in number of fish, to Canada were met by the U.S., a secondary effect was to allow a higher proportion of the largest and oldest Chinook salmon to pass into Canada.

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Table 1. Sampling period, method, number sampled and percent female composition of the Chinook salmon sampled during escapement surveys, Little Salmon River, 1981-1990 and 2010-2011.

Year	Sampling Period		Sampling Method	Number Sampled	Female Comp. (%)
1981	29-Aug	30-Aug	carcass	253	69.8
1982	29-Aug	31-Aug	carcass	76[a]	61.2
1983	29-Aug	30-Aug	carcass	197	75.6
1984	29-Aug	30-Aug	carcass	199	56.5
1985	4-Sep	5-Sep	carcass	92	70.5
1986	1-Sep	1-Sep	carcass	66	69.6
1987	24-Aug	28-Aug	carcass	224	67.2
1988	22-Aug	24-Aug	carcass	213	57.3
1989	23-Aug	24-Aug	carcass	67	61.7
1990	27-Aug	27-Aug	carcass	126	44.6
2010	27-Aug	31-Aug	snagging[b]	149	24.3
2011	22-Aug	26-Aug	snagging[c]	157	29.9

[a] 2 fish were collected on August 19.

[b] approximately 95% of the fish were captured by snagging.

[c] approximately 94% of the fish were captured by snagging. Of the 10 carcasses recovered, 7 were female.

Table 2. Length frequency distribution of sampled Chinook salmon from the escapement in the Little Salmon River, August 22-26, 2011.

Length Bins (mm)	Total Sampled		Male Salmon			Female Salmon		
	number	% of total	number	% of total	% of males	number	% of total	% of females
<650	17	10.8	17	10.8	15.5	0	0.0	0.0
650-699	22	14.0	21	13.4	19.1	1	0.6	2.1
700-750	43	27.4	40	25.5	36.4	3	1.9	6.4
751-799	12	7.6	7	4.5	6.4	5	3.2	10.6
800-850	24	15.3	10	6.4	9.1	14	8.9	29.8
851-899	27	17.2	8	5.1	7.3	19	12.1	40.4
900-999	12	7.6	7	4.5	6.4	5	3.2	10.6
≥1,000	0	0.0	0	0.0	0.0	0	0.0	0.0
Total	157	100.0	110	70.1	100.0	47	29.9	100.0
Average length (mm)		766		732			845	

Table 3. Length frequency distribution and mean age by length bins of aged Chinook salmon from the escapement in the Little Salmon River, August 22-26, 2011.

Length Bins (mm)	Total Aged			Aged Male Salmon			Aged Female Salmon		
	number	%	mean age	number	%	mean age	number	%	mean age
<650	10	9.1	4.80	10	9.1	4.80	0	0.0	NA
650-699	16	14.5	5.06	15	13.6	5.07	1	0.9	5.00
700-750	27	24.5	5.06	25	22.7	5.03	2	1.8	5.50
751-799	11	10.0	5.64	6	5.5	5.50	5	4.5	5.80
800-850	18	16.4	5.83	9	8.2	5.67	9	8.2	6.00
851-899	20	18.2	6.15	5	4.5	6.20	15	13.6	6.13
900-999	8	7.3	6.00	6	5.5	6.00	2	1.8	6.00
≥1,000	0	0.0	NA	0	0.0	NA	0	0.0	NA
Total or mean	110	100.0	5.49	76	69.1	5.27	34	30.9	5.97
% aged	70.1			69.1			72.3		
Mean length (mm)		773			744			838	

Table 4. Age and sex composition and mean length (mm) from Chinook salmon sampled from the Little Salmon escapement, 2011.

Season					Brood year (age)													
Sample					2007		2006		2005		2004		Aged		Unaged			
					(1.2)		(1.3)		(1.4)		(1.5)		Total[a]		Total		Total	
Dates		Aged	Total		N	%	N	%	N	%	N	%	N	%	N	%	N	%
22-Aug	26-Aug	110	157	Male	2	1.8	53	48.2	19	17.3	2	1.8	76	69.1	34	21.7	110	70.1
		70.1%		Female	0	0.0	3	2.7	29	26.4	2	1.8	34	30.9	13	8.3	47	29.9
				Total	2	1.8	56	50.9	48	43.6	4	3.6	110	100.0	47	29.9	157	100.0
				Male Mean Length	573		709		846		878		744		686		726	
				SE	28		8		16		8		11		24		11	
				Range	545	600	580	875	750	965	750	965	545	965	75	900	75	965
				n	2		53		19		2		76		34		110	
				Female Mean Length	-		722		848		880		838		862		845	
				SE	-		29		8		0		10		13		8	
				Range	-	-	665	760	750	950	880	880	665	950	730	905	665	950
				n	0		3		29		2		34		13		47	

Table 5. Comparison between Chinook salmon mean length, proportion of large fish, proportion of older fish and proportion of females, and by sex, Eagle Sonar and Little Salmon River Escapement projects, 2011.

Project	All Salmon			
	Mean Length[a] (mm)	$\geq$900mm[a] (prop)	$\geq$Age-6[b] (prop)	Females[a] (prop)
Eagle Sonar	813	0.180	0.558	0.486
Little Salmon River	766	0.076	0.331	0.299
p-value	0.0000	0.0001	0.0000	0.0000

Project	Female Salmon			Male Salmon		
	Mean Length[a] (mm)	$\geq$900mm[a] (prop)	$\geq$Age-6[b] (prop)	Mean Length[a] (mm)	$\geq$900mm[a] (prop)	$\geq$Age-6[b] (prop)
Eagle Sonar	842	0.190	0.742	785	0.172	0.384
Little Salmon River	845	0.106	0.660	732	0.064	0.191
p-value	0.7990	0.1058	0.2689	0.0000	0.0010	0.0001

[a] Calculated from the entire sample, that is, both aged and unaged fish.
[b] Calculated from the aged sample. Includes Age 1.4, age 1.5, age 2.3 and age 2.4 salmon

Table 6. Comparison between Chinook salmon mean length, proportion of large fish, proportion of older fish and proportion of females, and by sex, Little Salmon River Escapement projects, 2010 and 2011.

Project	All Salmon: Mean Length (mm)	≥900mm (prop)	≥Age-6 (prop)	Females (prop)
2010 Little Salmon	736	0.061	0.198	0.247
2011 Little Salmon	766	0.076	0.473	0.299
p-value	0.0085	0.5889	0.0000	0.2990

Project	Female Salmon			Male Salmon		
	Mean Length (mm)	≥900mm (prop)	≥Age-6 (prop)	Mean Length (mm)	≥900mm (prop)	≥Age-6 (prop)
2010 Little Salmon	819	0.083	0.613	710	0.054	0.047
2011 Little Salmon	845	0.106	0.875	732	0.061	0.304
p-value	0.0332	0.7203	0.0177	0.0760	0.8128	0.0000

Figure 1. Map of the Yukon Territory and the Yukon River Drainage in Canada.

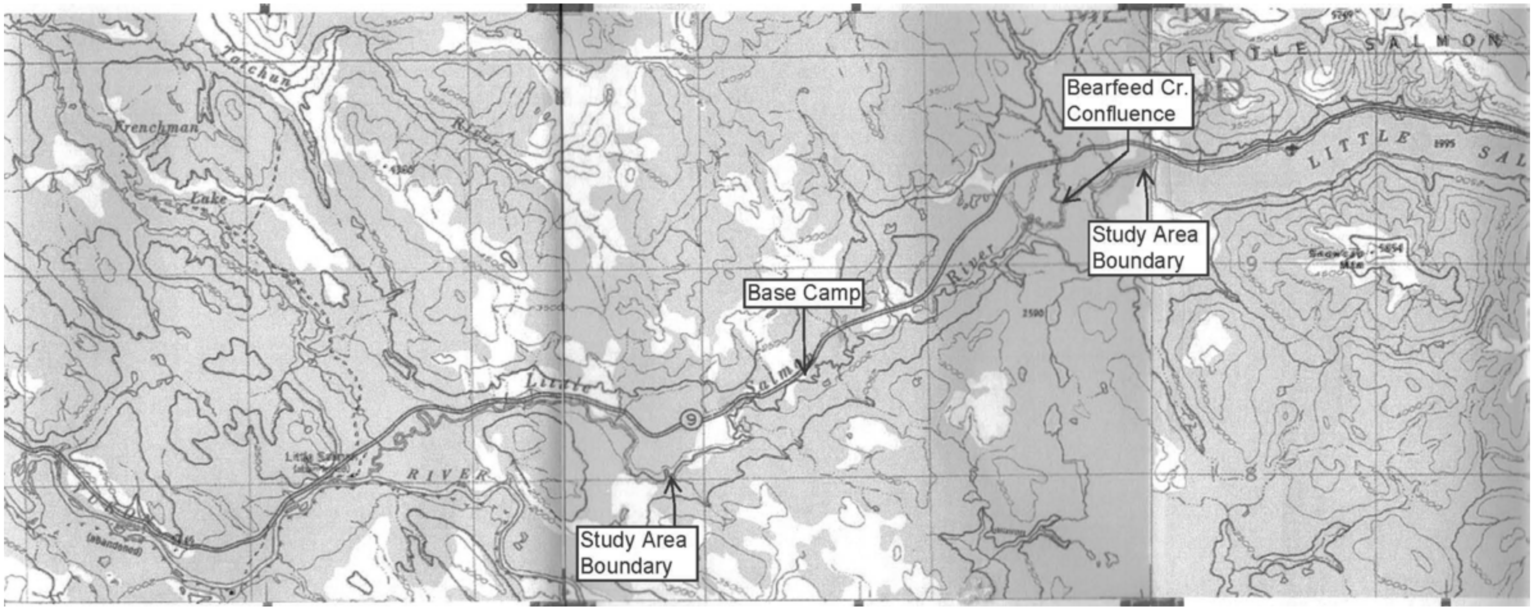

Figure 2. Map of the Little Salmon River drainage, showing Study Area boundaries, 2011

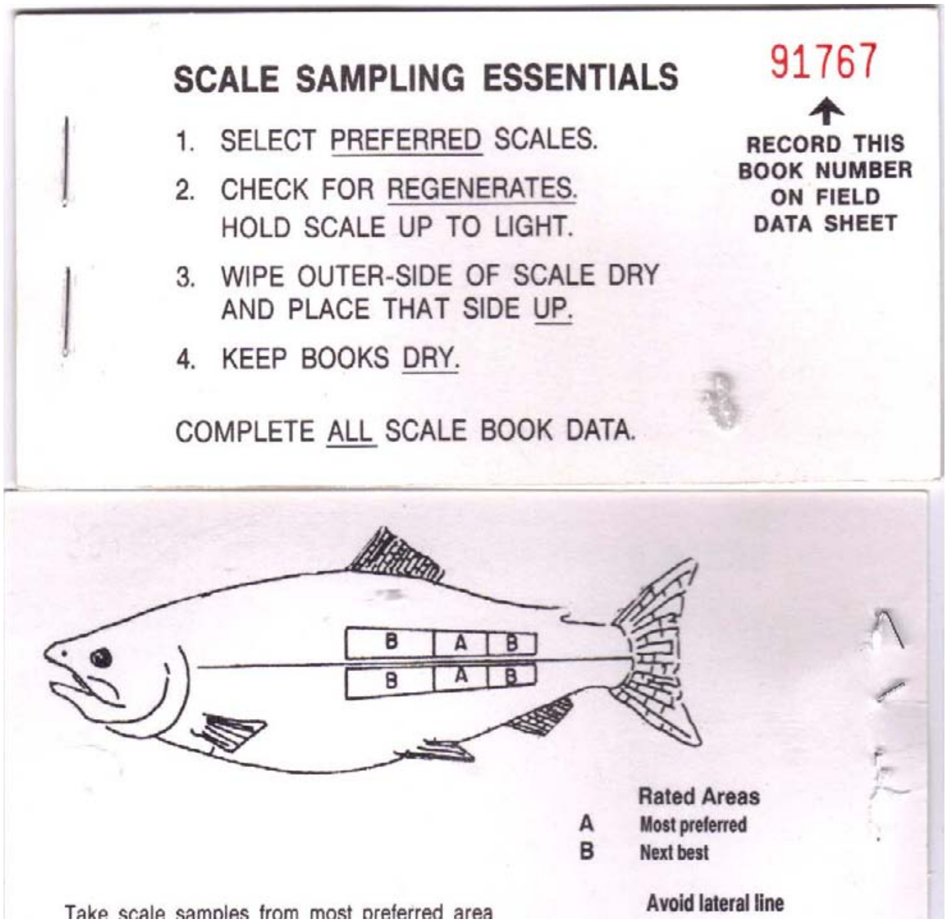

Figure 3. Outside (above) and inside (below) of front cover of DFO scale collecting book. Inside cover shows an illustration of preferred areas for sampling scales from fish.

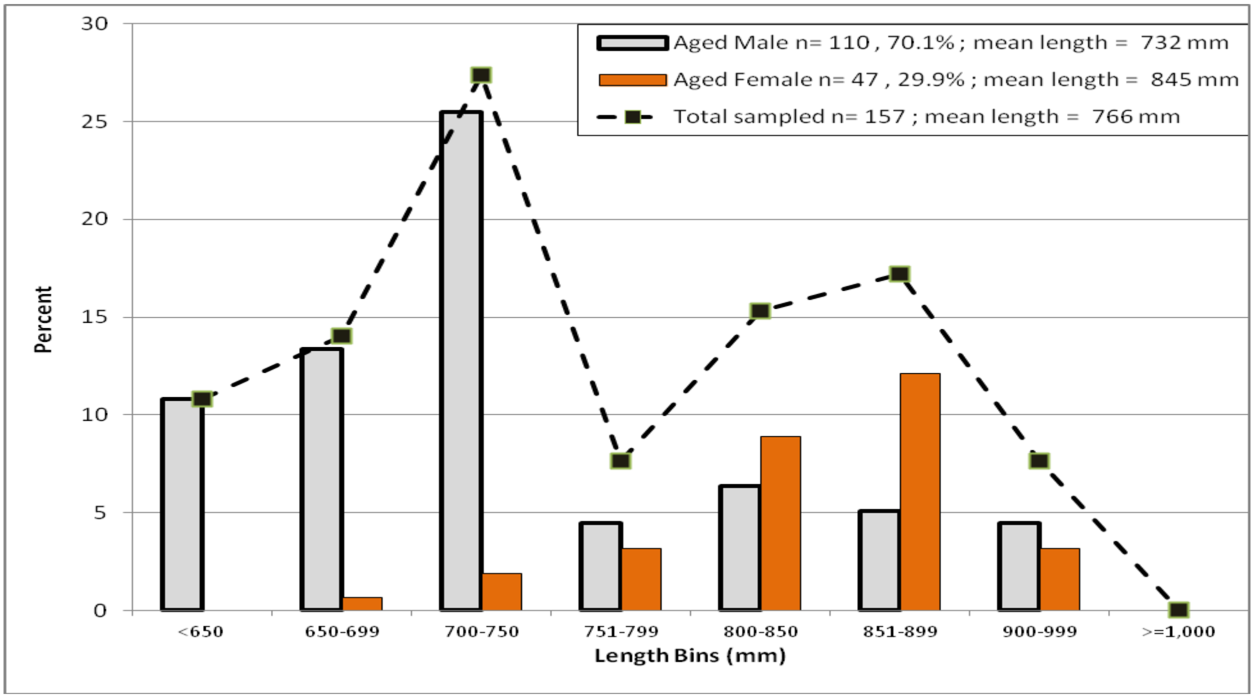

Figure 4. Length frequency distribution of male and female Chinook salmon captured in the Little Salmon River escapement survey project, 2011.

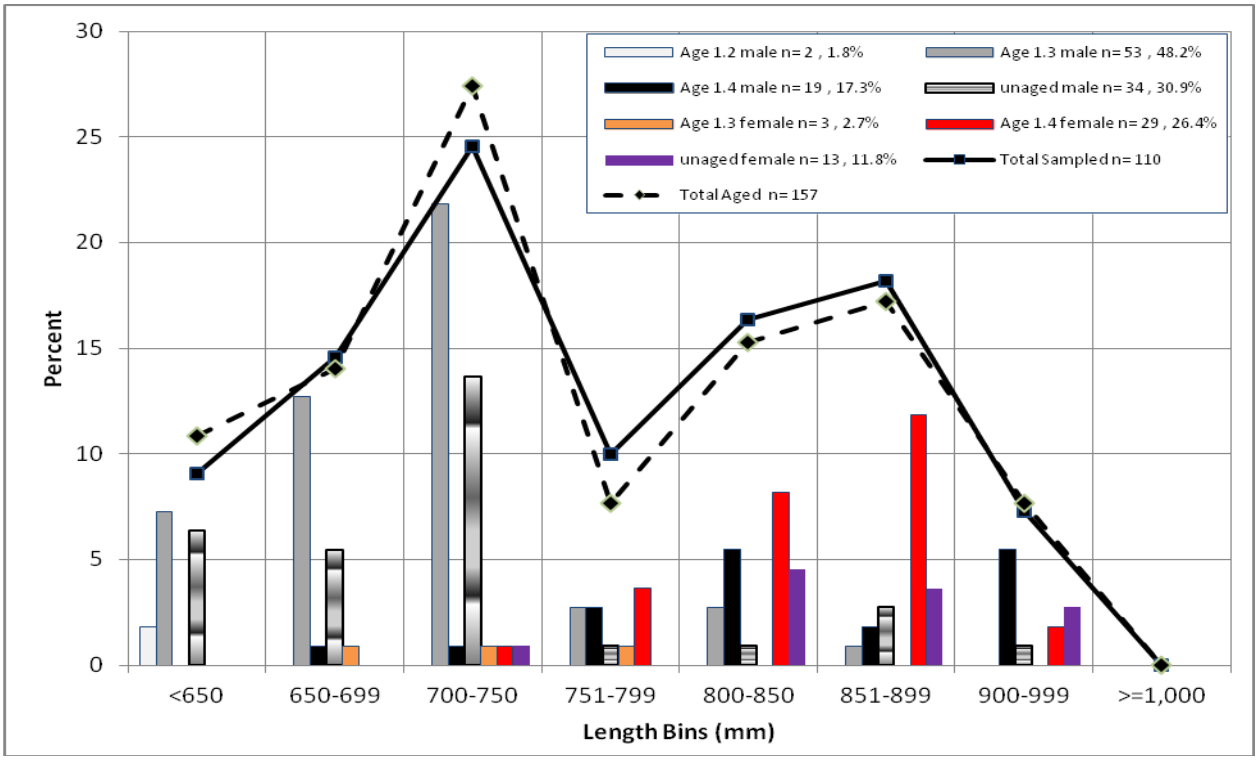

Figure 5. Age, sex and length frequency distribution of Chinook salmon captured in the Little Salmon River escapement survey project, 2011.

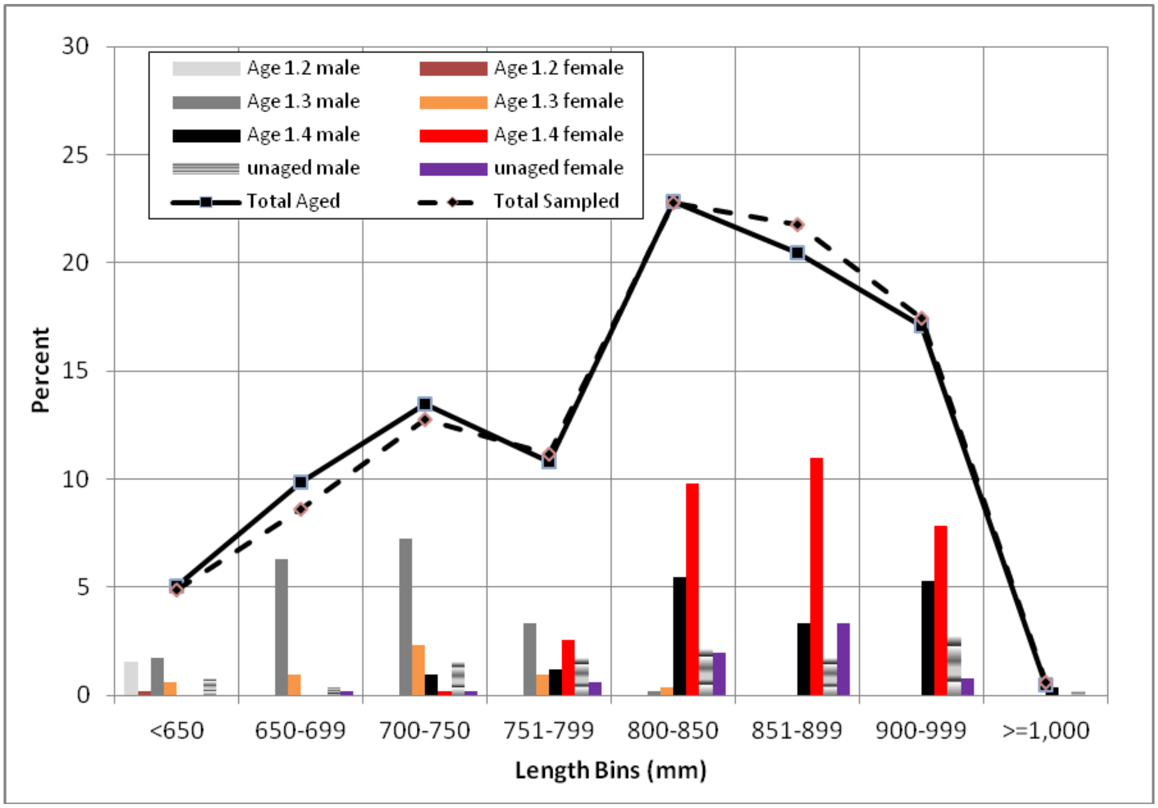

Figure 6 Age, sex and length frequency distribution of Chinook salmon captured in test fish activities at the Eagle Sonar project, 2011.

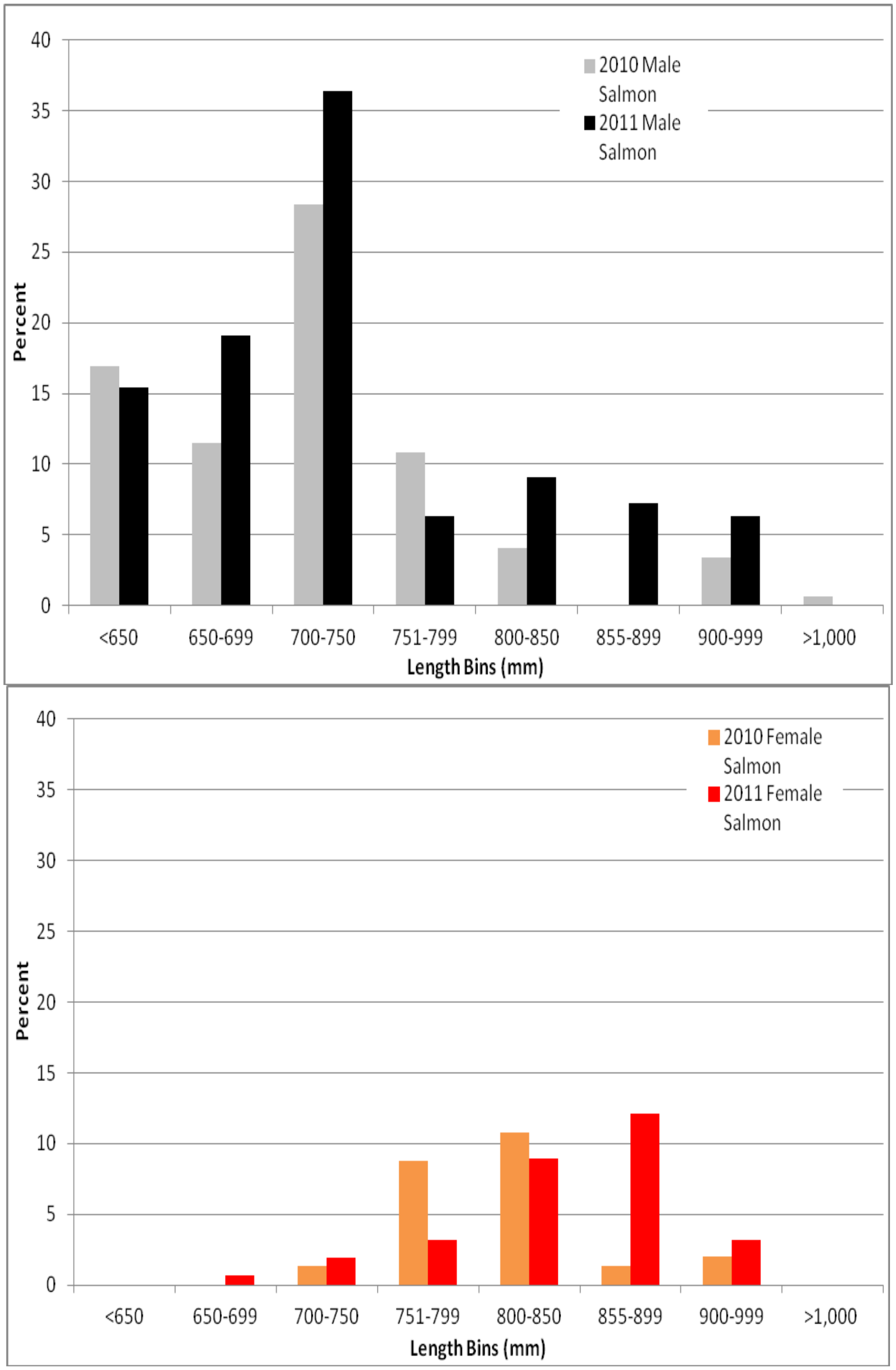

Figure 7. Comparison between male (above) and female (below) length frequency distribution for 2010 and 2011 sampling, Little Salmon River Chinook salmon escapement.

Appendix A 1. Information summary table, Chinook salmon escapement, Little Salmon River, Yukon Canada, 2011.

Date	Scale Card	Fish #	Sex	MEFT[a] length (mm)	POHL[b] length (mm)	Age	Readable Age[c]	Scale Comment	Spawning Condition[d]
22-Aug	95701	1	M	695		1.3			S
22-Aug	95701	2	F	825		1.4			S
22-Aug	95701	3	F	895			M4	RG	R-PS
22-Aug	95701	4	M	745		1.3			R
22-Aug	95701	5	M	725		1.3			R
22-Aug	95701	6	F	880		1.4			S
22-Aug	95701	7	M	645		1.3			S
22-Aug	95701	8	M	695		1.3			R
22-Aug	95701	9	F	950		1.4			S
22-Aug	95701	10	F	945		1.4			S
22-Aug	95703	1	M	750		1.3			R
22-Aug	95703	2	F	900	800		M4	RG	S
22-Aug	95703	3	F	900	800		M4	RG	S
22-Aug	95703	4	M	750	660	1.3			R
22-Aug	95703	5	M	650	570	1.3			R
22-Aug	95703	6	M	960		1.4			R
22-Aug	95703	7	M	800	710		M4	RG	R
22-Aug	95703	8	M	640		1.3			R
22-Aug	95703	9	M	690		1.3			R
22-Aug	95703	10	M	860			M3	RG	R
22-Aug	95704	1	M	700			M3	RG	R
22-Aug	95704	2	M	870		1.5			R
22-Aug	95704	3	M	735			M3	RG	R
22-Aug	95704	4	F	850	740			NS	S
22-Aug	95704	5	M	660		1.3			R
22-Aug	95704	6	F	880		1.4			S
22-Aug	95704	7	M	830		1.4			R
22-Aug	95704	8	M	875		1.4			R
22-Aug	95704	9	M	755		1.3			R
22-Aug	95704	10	M	660		1.4			R
22-Aug	95705	1	M	610			M3	RG	R
22-Aug	95705	2	M	715		1.3			R
22-Aug	95705	3	M	635			M3	RG	R
22-Aug	95705	4	M	750			M3	RG	R

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Date	Scale Card	Fish #	Sex	MEFT [a] length (mm)	POHL [b] length (mm)	Age	Readable Age [c]	Scale Comment	Spawning Condition[d]
22-Aug	95705	5	M	760		1.3			R
22-Aug	95705	6	M	695		1.3			R
22-Aug	95705	7	F	845	740		M4	RG	S
22-Aug	95705	8	F	870	785	1.4			S
22-Aug	95705	9	M	710		1.3			R
22-Aug	95705	10	F	865		1.4			S
22-Aug	95706	1	F	830	750		M3	RG	S-Carcass
23-Aug	95706	2	M	700			M3	RG	R
23-Aug	95706	3	F	665	605	1.3			S
23-Aug	95706	4	F	895			M4	RG	R-PS
23-Aug	95706	5	M	945	820	1.4			R
23-Aug	95706	6	M	725	630	1.3			R
23-Aug	95706	7	M	645		1.3			R
23-Aug	95706	8	M	715		1.3			R
23-Aug	95706	9	M	670	595	1.3			R
23-Aug	95706	10	M	715		1.3			R
23-Aug	95707	1	M	810		1.4			R
23-Aug	95707	2	M	665		1.3			R
23-Aug	95707	3	M	550			M2	RG	R
23-Aug	95707	4	M	730		1.3			R
23-Aug	95707	5	M	845		1.3			R
23-Aug	95707	6	M	585	510			NS	R
23-Aug	95707	7	M	715			M3	RG	R
23-Aug	95707	8	M	835		1.4			R
23-Aug	95707	9	M	640		1.3			R
23-Aug	95707	10	M	770		1.4			R
23-Aug	95708	1	F	860		1.4			R
23-Aug	95708	2	M	705		1.3			R
23-Aug	95708	3	F	860	765	1.4			S
23-Aug	95708	4	F	895			M4	RG	S
23-Aug	95708	5	F	820	745	1.4			S
23-Aug	95708	6	M	725	670	1.3			R
23-Aug	95708	7	F	780	670	1.4			S
23-Aug	95708	8	M	720			M2	RG	R

-continued-

Date	Scale Card	Fish #	Sex	MEFT[a] length (mm)	POHL[b] length (mm)	Age	Readable Age[c]	Scale Comment	Spawning Condition[d]
23-Aug	95708	9	M	640	585	1.3			R
23-Aug	95708	10	M	750		1.3			R
23-Aug	95709	1	M	740	680	1.3			R
23-Aug	95709	2	F	895	810	1.4			S
23-Aug	95709	3	M	715	600	1.3			R
23-Aug	95709	4	M	885			M4	RG	R
23-Aug	95709	5	M	885	800	1.5			R
24-Aug	95709	6	F	860	765	1.4			S
24-Aug	95709	7	M	735		1.3			R
24-Aug	95709	8	M	685			M3	RG	R
24-Aug	95709	9	M	500			M2	RG	R
24-Aug	95709	10	M	705		1.3			R
24-Aug	95710	1	M	630			M2	RG	R
24-Aug	95710	2	M	835		1.3			R
24-Aug	95710	3	F	790		1.4			S
24-Aug	95710	4	M	670	580	1.3			R
24-Aug	95710	5	M	830	740	1.4			R
24-Aug	95710	6	M	710			M3	RG	R
24-Aug	95710	7	M	865			M4	RG	R
24-Aug	95710	8	M	710				MF	R
24-Aug	95710	9	M	700			M3	RG	R
24-Aug	95710	10	F	855		1.4			S
24-Aug	95711	1	F	840		1.4			R-PS
24-Aug	95711	2	M	805		1.3			R
24-Aug	95711	3	M	685			M3	RG	R
24-Aug	95711	4	F	820	750	1.4			S
24-Aug	95711	5	M	785			M3	RG	R
24-Aug	95711	6	F	815		1.4			S
24-Aug	95711	7	M	610		1.3			R
24-Aug	95711	8	M	705		1.3			R
24-Aug	95711	9	M	740		1.3			R
24-Aug	95711	10	F	850		1.4			R
24-Aug	95712	1	F	855	765	1.4			R-PS
24-Aug	95712	2	F	880		1.5			R-PS

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Appendix A1. Page 4 of 5.

Date	Scale Card	Fish #	Sex	MEFT[a] length (mm)	POHL[b] length (mm)	Age	Readable Age[c]	Scale Comment	Spawning Condition[d]
24-Aug	95712	3	M	695		1.3			R
24-Aug	95712	4	F	740	675	1.3			S-Carcass
24-Aug	95712	5	F	890		1.4			S
24-Aug	95712	6	F	850	755		M4	RG	S
25-Aug	95712	7	M	630		1.3			R
25-Aug	95712	8	F	820		1.4			R
25-Aug	95712	9	M	745		1.3			R
25-Aug	95712	10	M	775		1.4			R
25-Aug	95713	1	M	705			M3	RG	R
25-Aug	95713	2	F	815		1.4			S
25-Aug	95713	3	M	750		1.4			S
25-Aug	95713	4	M	555			M2	RG	R
25-Aug	95713	5	M	730		1.3			R
25-Aug	95713	6	M	900		1.4			R
25-Aug	95713	7	M	825		1.4			R
25-Aug	95713	8	M	600		1.2			R
25-Aug	95713	9	M	790		1.3			R
25-Aug	95713	10	M	960		1.4			R
25-Aug	95714	1	F	835			M4	RG	S
25-Aug	95714	2	M	545		1.2			R
25-Aug	95714	3	M	695		1.3			R
25-Aug	95714	4	M	900		1.4			R
25-Aug	95714	5	M	740		1.3			R
25-Aug	95714	6	M	885	765	1.4			R
25-Aug	95714	7	M	665		1.3			R
25-Aug	95714	8	M	720	635	1.3			S-Carcass
25-Aug	95714	9	M	705			M4	RG	R
25-Aug	95714	10	M	710			M3	RG	R
25-Aug	95715	1	M	775		1.4			R
25-Aug	95715	2	M	730	665			NS	R
25-Aug	95715	3	M	695				MF	R
26-Aug	95715	4	F	730	680		M3	RG	S
26-Aug	95715	5	F	905	840		M4	RG	S

-continued-

Date	Scale Card	Fish #	Sex	MEFT[a] length (mm)	POHL[b] length (mm)	Age	Readable Age[c]	Scale Comment	Spawning Condition[d]
26-Aug	95715	6	F	840	770	1.4			S
26-Aug	95715	7	F	880		1.5			S-Carcass
26-Aug	95715	8	F	875		1.4			R-Carcass
26-Aug	95715	9	F	760	690	1.3			S-Carcass
26-Aug	95715	10	F	890	810	1.4			S
26-Aug	95716	1	F	870	750		M4	RG	S
26-Aug	95716	2	M	690	605		M3	RG	S-Carcass
26-Aug	95716	3	M	695			M3	RG	
26-Aug	95716	4	F	790	720	1.4			S-Carcass
26-Aug	95716	5	F	750	670	1.4			S-Carcass
26-Aug	95716	6	M	750				MF	S-Carcass
26-Aug	95716	7	M	655		1.3			R
26-Aug	95716	8	M	650		1.3			R
26-Aug	95716	9	M	700		1.3			R
26-Aug	95716	10	M	825		1.4			R
26-Aug	95717	1	M	660			M3	RG	R
26-Aug	95717	2	M	580		1.3			R
26-Aug	95717	3	M	965		1.4			R
26-Aug	95717	4	M	875		1.3			R
26-Aug	95717	5	M	700			M3	RG	R
26-Aug	95717	6	M	900			M4	RG	R
26-Aug	95717	7	F	795		1.4			S

Salmon spawning condition: R=ripe; S=Spent;
a C=carcass

b MEF= mideye to fork of tail measurement
POHP = Post orbital to end of hypural plate
c measurement

d Scale comments: S2= 1 Freshwater Annulus (Sub-2); 2M= 2 Marine Annuli; 3M=3Marine Annuli; 4M=4Marine Annuli; 5M=5 Marine Annuli; MF=Mixed Fish; NS=No structure; scale;

RG=Regenerated scale (center is missing from scale); RS=Resorbed Scale (growth at scale margin is missing); W=Wet (mounted with too much water, glue in scale ridges).