2013 CHINOOK SALMON SONAR ENUMERATION ON THE BIG SALMON RIVER

CRE-41-13

Prepared for: The Yukon River Panel
Restoration and Enhancement Fund

Prepared by: B. Mercer and J.K. Wilson

J. Wilson & Associates
31 Donjek Road
Whitehorse, Yukon
Y1A 3P8

March, 2014

TABLE OF CONTENTS

TABLE OF CONTENTS i

LIST OF FIGURES ii

LIST OF TABLES ii

LIST OF APPENDICES ii

ABSTRACT iii

INTRODUCTION 1

- Study Area 1
- Objectives 2

METHODS 2

- Site selection 2
- Permits 2
- Camp and Sonar Station Set-up 3
- Weir construction 4
- Sonar and Software Configuration 4
- Sonar Data Collection 6
- Precision of Fish Count Data 7
- Cross Section Distribution 7
- Carcass Pitch 7

RESULTS 8

- Chinook Salmon Counts 8
- Precision of Fish Count Data 8
- Cross Section Distribution 9
- Above border Chinook spawning escapement estimates 9
- Carcass Pitch 10

DISCUSSION 11

ACKNOWLEDGEMENTS 14

REFERENCES 15

LIST OF FIGURES

Figure 1. Big Salmon River Watershed and location of the 2013 Big Salmon sonar station........ 3
Figure 2. Aerial view of sonar station camp and partial weirs, (photo from 2006 project)........... 4
Figure 3. Construction of partial weir on south side of river.. 5
Figure 4. Sonar transducer unit and mounting stand in position. 6
Figure 5. Schematic diagram of river cross section profile and sonar and weir configuration. 6
Figure 6. Daily counts of Chinook salmon passing the Big Salmon River sonar station in 2005 through 2013. 8
Figure 7. 2010 - 2013 Big Salmon River Chinook range/frequency in cross section profile........ 9
Figure 8. Length/frequency histogram of Big Salmon Chinook sampled in 2013. 10
Figure 9. Big Salmon sonar counts and above border escapement estimates 2005 – 2013......... 11
Figure 10. GSI based expansion of Big Salmon sonar counts and the JTC above border escapement estimates, 2005 – 2013... 12
Figure 11. Big Salmon sonar counts and the JTC above border escapement estimates, 2005 – 2013.. 12

LIST OF TABLES

Table 1. Age, length, and sex of Chinook sampled from the Big Salmon River, 2013.............. 10

LIST OF APPENDICES

Appendix 1. Sonar beam depth at tilt angles 0° – 45° and with start window lengths 6.67m and 7.5m. 16
Appendix 2. 2013 daily and cumulative counts of Chinook salmon at the Big Salmon River sonar site. 17
Appendix 3. Daily and average Chinook counts in the Big Salmon River, 2005-2013. 18
Appendix 4. Estimated proportion of Big Salmon River Chinook and Yukon River Chinook border escapement, 2002 through 2013. 19
Appendix 5. Age, sex, and length of sampled Chinook on the Big Salmon River, 2013........... 20
Appendix 6. 2013 Big Salmon River water and weather conditions.. 22

ABSTRACT

A long range dual frequency identification sonar (DIDSON) was used to enumerate the Chinook salmon (*Onchorynchus tshawytscha)* escapement to the Big Salmon River in 2013. The sonar was operated on the Big Salmon River for its ninth year at the same site used for the 2005 to 2012 projects; approximately 1.5 km upstream of the confluence of the Yukon River. Sonar operation began on July 16 and continued without interruption through to August 25. A total of 3,231targets identified as Chinook salmon was counted during the period of operation. Extrapolation of the final 4 days of the run yielded an additional 11 fish to bring the total estimated escapement to 3,242. The first Chinook salmon passing the Big Salmon sonar station was observed on July 21. The peak daily count of 264 fish occurred on August 3, at which time 33% of the run had passed the sonar station; 90% of the run had passed the station on August 14. The 2013 Big Salmon Chinook escapement of 3,242 was 66% of the 8 year average escapement of 4,947 into the system. 2013 genetic stock identification sampling indicated the Big Salmon River stock group comprised 6.6% (sd=2.7%) of upper Yukon River Chinook escapement.

A carcass pitch was conducted over approximately 145 km of the Big Salmon River, yielding 74 sampled Chinook. Of these, 45 (61%) were female and 29 (39%) were male. The mean fork length of females and males sampled was 833 mm and 823 mm, respectively. All sampling data and scale cards were submitted to DFO Whitehorse stock assessment upon completion of the project. The DFO scale lab determined ages from 52 Chinook sampled. Age-6 (79%) was the dominant age class, followed by age-5 fish (15%). Age-4 and age-7 fish represented 4% and 2% of the sample, respectively.

INTRODUCTION

A project to enumerate the Chinook salmon escapement into the Big Salmon River drainage was initiated in 2005 using a DIDSON™ (Dual frequency Identification SONAR). The 2013 project is the ninth year Chinook enumeration has been conducted on this system. The DIDSON units have been found to be reliable, do not require extensive operator training, and provide accurate counts of migrating salmon (Enzhofer et al. 2010, Holmes et al. 2006, Mercer & Wilson 2006 - 2013). Due to high flows and wilderness recreation use of the Big Salmon River, the utilization of traditional salmon weir techniques on this river is not feasible. For these reasons the DIDSON sonar was selected as a relatively low impact, non-intrusive method of accurately enumerating annual Chinook escapements to the Big Salmon River system. The use of sonar allows for enumeration of migrating Chinook salmon while minimizing negative impacts on fish behaviour and providing un-restricted recreational use of the river.

Based on the 2005 – 2013 sonar operations, the Big Salmon River has been shown to be a significant contributor to upper Yukon River Chinook production. The 2005 -2013 average sonar count is 4,770 with a range from 1,329 (2008) to 9,261 (2009). These counts represented an average of 10.5% of the total upper Yukon River spawning escapement point estimate for these years (Unpublished DFO Whitehorse data).

The goal of the program is to provide stock assessment information that will enhance the ability of salmon management agencies to manage Yukon River Chinook salmon. Quantifying Chinook escapement into upper Yukon River index streams allows for independent (from Pilot station and Eagle sonar project estimates) assessment of total above border Chinook escapements. Accurate Chinook escapement enumeration of select tributaries combined with stock composition information could generate upper Yukon River Chinook spawning escapement estimates within quantified statistical parameters.

In addition to the sonar operation, carcass sampling was conducted to obtain age, sex and length data from the 2013 Big Salmon Chinook escapement. This information provides important biological baseline data on the health of the stocks as well as information used in constructing future pre-season run forecasts.

A proposal to continue sonar operations and a Chinook carcass pitch on the Big Salmon River was submitted by J. Wilson and Associates to the Yukon River Panel Restoration and Enhancement (R&E) fund in January 2013. The proposal was accepted and financial support was received from the R&E fund. This report is a summary of the 2013 project.

Study Area

The Big Salmon River flows in a north-westerly direction from the headwaters at Quiet and Big Salmon lakes to its confluence with the Yukon River (Figure 1). The river and its tributaries drain an area of approximately 6,760 km^2, predominantly from the Big Salmon Range of the Pelly Mountains. Major tributaries of the Big Salmon River include the North Big Salmon River and the South Big Salmon River. The Big Salmon River can be accessed by boat either from Quiet Lake along the Canol Road, from the Yukon River on the Robert Campbell and Klondike

Highways, or from Lake Laberge via the Thirty Mile and Yukon rivers. The sonar site is approximately 130 air kilometers from Whitehorse.

Objectives

The objectives of the 2013 Big Salmon River sonar project were:

1. To provide an accurate count of the total Chinook salmon escapement in the Big Salmon River using a high resolution DIDSON sonar unit.

2. To conduct a carcass pitch on the Big Salmon River to obtain age-sex-length (ASL) data from as many post-spawned Chinook as possible with a target goal of 5% of the total run.

METHODS

Site selection

Sonar operations were set up at the same site used since 2005. This site, located approximately 1.5 km upstream from the confluence with the Yukon River (Figure 1), was initially selected for the following reasons:

- It is a sufficient distance upstream of the mouth to avoid straying or milling Chinook salmon destined for other headwater spawning sites.
- The site is in a relatively straight section of the river and far enough downstream from any bends in the river so that recreational boaters using the river have a clear view of the in-stream structures.
- The river flow is laminar and swift enough to preclude milling or ‘holding’ behaviour by migrating fish.
- Bottom substrates consist of gravel and cobble evenly distributed along the width of the river.
- The stream bottom profile allows for complete ensonification of the water column.
- The site is accessible by boat and floatplane.

The characteristics of the river at this site have not changed over the 9 years of sonar operation. It is anticipated that this site will continue to be used as long as the sonar program operates.

Permits

A five year licence of occupation (with option of renewal) was granted in 2009 by the Yukon Territorial Government (YTG) Lands Branch for the sonar camp on the lower Big Salmon River. This precluded the requirement of annual land use permits and allowed for the construction of upgraded and more permanent facilities at this site.

An application was submitted in 2005 to Transport Canada (Marine Branch), Navigable Waters Protection for approval to install partial fish diversion fences in a navigable waterway. Approval was granted for ongoing annual sonar operations as described in the original application.

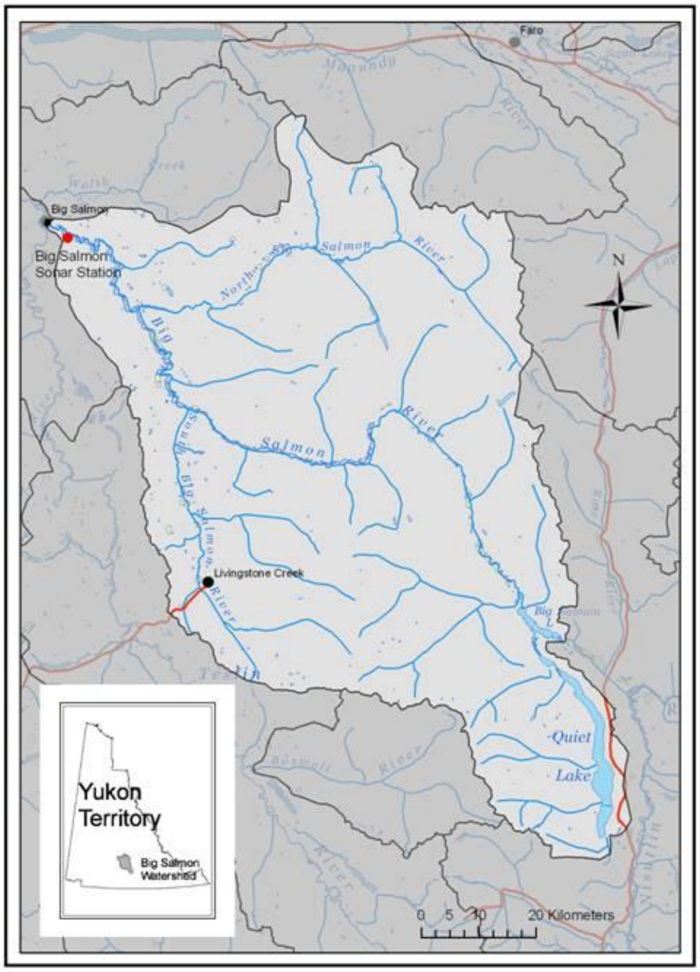

Figure 1. Big Salmon River Watershed and location of the 2013 Big Salmon sonar station.

Camp and Sonar Station Set-up

Construction of the camp and sonar station was initiated on July 15. Due to forest fires and road closures the usual embarkation point at Little Salmon village was not used in 2013. Initial access to the project site and transportation of associated equipment and supplies was by boat from the south end of Lake Laberge. Other supplies and personnel were transported from Whitehorse via floatplane. Subsequent camp access, crew changes, and delivery of supplies and fuel were accomplished either by riverboat or floatplane.

As in previous years, the camp was comprised of two wall tents: one to house a kitchen/eating area and computer station and another for sleeping quarters. The kitchen and computer station was located 6 m from the south bank of the river and constructed using a 5m x 5m "weatherall" free standing wall tent placed on a plywood platform. The sleeping quarters was situated 30 m from the south bank and constructed using a 14' X 16' canvas wall tent placed on a plywood platform and wooden frame (Figure 2).

In 2010, construction of a cabin was initiated at the sonar site to replace the wall tents. The cabin was clad to weather at the end of the 2011 season which enabled secure storage of some camp equipment on site. Cabin construction continued during the 2013 season and is expected to be completed and usable by personnel during the 2014 season if the project continues.

Weir construction

At the onset of the project, fence structures were placed in the river to divert shoreline migrating Chinook salmon into a 36 m migration corridor in the center of the river (Figure 2). Weir construction was initiated on July 16 and completed by July 17. Fence structures were constructed as in previous years using conduit panels and metal tripods stored on site (Figure 3).

Figure 2. Aerial view of sonar station camp and partial weirs, (photo from 2006 project). Blue outline denotes ensonified portion of the river.

Sonar and Software Configuration

The sonar unit was placed next to the south bank at the site used in previous sonar operations (Figure 4). The configuration of the DIDSON sonar support apparatus was similar to that used in previous years at this site. The unit was mounted on an adjustable stand constructed of 2-inch steel galvanized pipe similar in design to those used at other DIDSON sonar projects (Galbreath and Barber 2005). The stand consisted of two T-shaped legs 120 cm in height connected by a 90 cm crossbar. The sonar unit was bolted to a steel plate suspended from the cross bar that was connected to the stand with adjustable fittings (Kee Klamps™). The adjustable clamps allowed the sonar unit to be raised or lowered according to fluctuating water levels as well as enabling rotation of the transducer lens to adjust the beam angle.

Figure 3. Construction of partial weir on south side of river. (Photo 2011)

A concentrator lens has been attached to the sonar unit during its operation since 2009. This lens reduces the vertical ensonified field from 14° to 8°, thus increasing the resolution of all target images. The DIDSON sonar produces an ensonified field 29° wide in the horizontal plane and with the concentrator lens, 8° deep in the vertical plane. The DIDSON transducer lens was positioned at a depth of approximately 12 cm below the surface of the river and angled downward approximately 3º from horizontal resulting in the ensonified field of view remaining parallel to the surface of the river (Figure 5).

Using an 8° lens on a sonar unit deployed horizontally results in a beam depth of 1.05 m at a distance of 7.5 m from the sonar. The average water levels encountered in 2013 allowed for use of the concentrator lens throughout the project. A table was used from simple trigonometry formulae to enable the sonar operators to determine the beam depth for given water depths and sonar window start lengths (Appendix 1).

Once the sonar was in place and positioned, the primary sonar unit settings and software were configured. The receiver gain was set at –40 dB, the window start at 5.86 m, window length at 40 m, and auto frequency enabled for the duration of the project. The recording frame rate was typically set at 4 frames per second, which was the highest frame rate the computers could process with a window length setting of 40 m. Two laptop computers were used for the project, one recording the DIDSON files and one for reviewing the files. All files were saved and placed on a backup 500 GB external hard drive.

The sonar system was powered by two sets of 6 gel cell batteries connected in two parallel circuits to create a 12 volt power source. The battery banks were charged by six 80 watt solar panels and a backup 2.0 kW generator. An 800 watt inverter was used to obtain 110 volt AC from the batteries to supply power for the computers and the sonar unit. A rotating solar panel platform allowed the panels to be manually rotated to directly face the sun thereby increasing the efficiency of the solar panel array.

Figure 4. Sonar transducer unit and mounting stand in position. (Photo 2011)

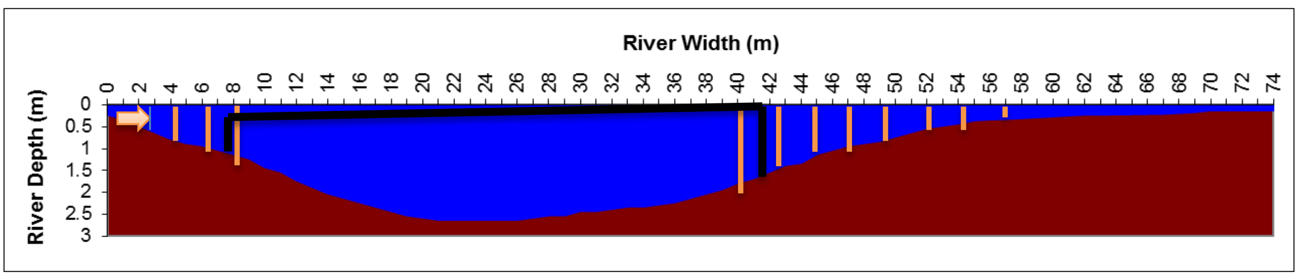

Figure 5. Schematic diagram of river cross section profile and sonar and weir configuration. Orange bars denote weir structures, arrow the sonar and the area outlined in black the ensonified portion of the water column. Note: Not to scale.

Sonar Data Collection

Sonar recording began on July 16 and continued until August 25. Sonar data was collected continuously and stored automatically in pre-programmed, 20 minute date stamped files. This resulted in an accumulation of 72 files over a 24 hour period. These files were subsequently reviewed the following day and stored on the active PC as well as backed up on the external hard drive.

To optimize target detection during file review, the background subtraction feature was used to remove static images such as the river bottom and weir structures. The intensity (brightness) was set at 40 dB and threshold (sensitivity) at 3dB. The playback speed depended on the preference and experience of the observer, but was generally set between 40 and 50 frames per second, approximately 8 to 10 times the recording rate. When necessary, the recording was stopped when a fish was observed and replayed at a slower rate for positive identification. Chinook salmon images were visually counted using a hand counter and the total count from each file was entered into an excel spreadsheet. A record of each 20 minute file count as well as hourly, daily and cumulative counts was maintained throughout the run.

The target measurement feature of the DIDSON software was used when required to estimate the size of the observed fish. All fish 50 cm and larger were categorized as Chinook. The smallest sampled Big Salmon Chinook during the 2013 carcass pitch was 53 cm. Only two of the 74 sampled fish (2.7%) had a MEF length less than 60 cm. The largest target categorized as a resident fish based on size and swimming behaviour was approximately 30 cm.

Fish moving downstream identified as live Chinook were subtracted from each file total. It is assumed Chinook migrating downstream were strays. Straying of migrating salmon is not unusual and temporary[1] straying has been documented in telemetry studies of Yukon River Chinook (Eiler et al. 2006). The number of assumed strays detected is typically low and in 2013 amounted to 34 or 1.1% of the total run.

Precision of Fish Count Data

In order to determine the precision and accuracy of the fish counts, comparisons were made of the fish counts between observers reading the files. Files for review were randomly selected from each day of sonar operation. Approximately 10% of the total files were reviewed by a second observer. The variance between the two readers was quantified and recorded for each file reviewed.

Cross Section Distribution

The position of each Chinook observed within the cross section profile of the river was recorded in 5 m increments. This provided a range frequency histogram illustrating the cross sectional pattern of migrating Chinook.

Carcass Pitch

The upper reaches of the Big Salmon River were accessed using a 6.0 m open skiff powered by a 60 hp outboard jet motor. The crew made one extended trip upriver on August 26 through 28 searching for dead and moribund Chinook. Carcass pitch efforts extended from the camp approximately 145 river kilometers to the first logjam located 20 km downstream from Big Salmon Lake.

The carcass pitch involved collecting dead and moribund Chinook using a spear and sampling each fish. Carcass sampling consisted of collecting five scales per fish and placing them in prescribed scale cards. The sex and mid-eye-fork and post-orbital hypural lengths (to the nearest 0.5cm) were also recorded for each recovered fish.

---

[1] Radio tagged Chinook were documented entering a tributary and subsequently retreating to the mainstem river and continuing their migration further up the system. Since the sonar station is located 1.5 km upstream from the confluence of the Yukon River the presence of straying Chinook could be expected.

RESULTS

Chinook Salmon Counts

The first Chinook salmon was observed on July 21 at 4:00 p.m. The peak daily count of 264 fish occurred on August 3, at which time 33% of the run had passed the sonar station; 90% of the run had passed the station on August 14. Daily and cumulative counts are presented in Appendix 2 and Figure 6. A total of 3,231 targets identified as Chinook salmon was counted past the sonar station from July 18 through to August 25. Because the sonar was removed before the run was totally complete, the counts were estimated for an additional 4 days through extrapolation of the previous 12 days of the sonar counts based on the regression $y = - 39.9 \ln(x) + 102.78$. This added 11 fish to bring the total count to 3,242.

The daily counts exhibited a normal distribution. The run timing was similar to the average run timing observed in the previous 8 years (Figure 6). Daily counts from 2005 through 2013 are in Appendix 3.

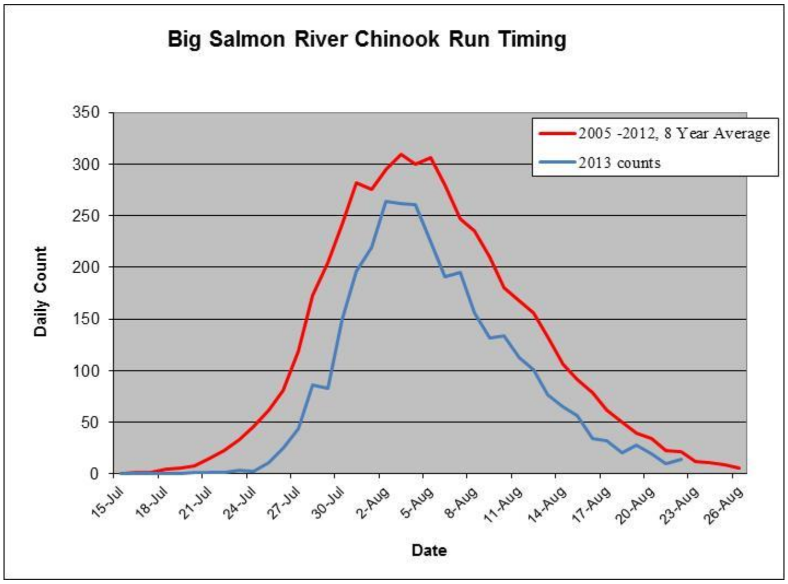

Figure 6. Daily counts of Chinook salmon passing the Big Salmon River sonar station in 2005 through 2013.

Precision of Fish Count Data

Of the 2,733 sonar files recorded and analysed, a total of 326 (12%) were reviewed by a second observer. Of the 326 files reviewed, a total of 10 files (3%) exhibited a discrepancy between readers. Of the 10 files that exhibited inconsistencies between readers, a total of 8 fish were missed and 2 unidentified objects were misidentified as Chinook. This would yield a net gain of 6 fish for the 326 files that were reviewed by a second observer. Expansion of this subset of files to cover the total run would result in an additional 44 Chinook that may not have been observed and counted.

Cross Section Distribution

The cross sectional distribution pattern of the migrating Chinook as detected by the sonar is presented in Figure 7. The largest proportion of fish migrated near the south bank in deeper water at a distance of 15-20 meters from the sonar. The distribution of migrating Chinook in 2013 was similar to the previous 3 years except for 2011. The water levels experienced in 2013 were considered average which may account for the typical migration pattern. It should be noted the distribution likely does not reflect the typical in-river migration pattern as the weir structures channel the fish into the 36 m wide opening.

Above border Chinook spawning escapement estimates

The 2013 Eagle sonar project on the Yukon River downstream of the Canada/U.S. border yielded a spawning escapement[2] estimate of 28,669 Chinook salmon (DFO Whitehorse unpublished data 2013). Genetic stock identification (GSI) samples were also obtained at this site using drift nets. The GSI data provides information on the stock composition of the total above border Chinook escapement. The 2013 mean un-weighted proportional contribution of the Big Salmon River stock to the Chinook border escapement based on analysis of the GSI samples was 6.6%, SD 2.7 (DFO Whitehorse unpublished data). Using Big Salmon sonar counts and the proportion of Big Salmon origin stock derived from the GSI sampling, the 2013 expanded Chinook border escapement estimate would be 49,136 (95% CI: 27,483 – 247,935). The 2013 Big Salmon Chinook contribution to the above border Chinook escapement based on GSI sampling is within the range of the Eagle sonar count. However, given the low GSI based stock proportion (6.6%) and relatively large SD (2.7), the expanded escapement estimate based solely on the Big Salmon data has a very large 95% CI and has limited value for stock assessment purposes.

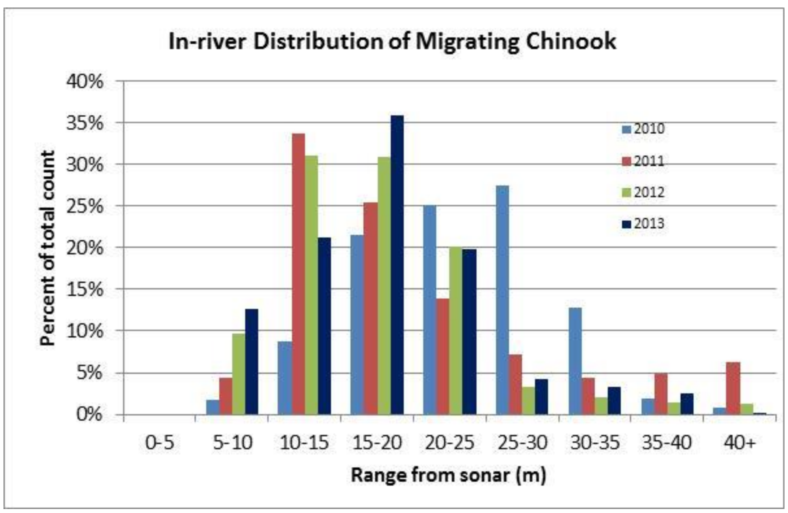

Figure 7. 2010 - 2013 Big Salmon River Chinook range/frequency in cross section profile.
Note: The 0 – 7m range from the sonar has a deflection fence in place.

It is possible to obtain a Chinook border escapement with better precision based on analysis of the GSI samples and sonar counts from both the Big Salmon and Teslin sonar projects. The 2013 Teslin sonar project counted a Teslin origin escapement of 9,916 Chinook (Mercer 2014). The total combined sonar count of these systems is 13,158. The aggregate Big Salmon and

[2] Spawning escapement is the Eagle sonar count minus the catches in the U.S. above the sonar station and in the Canadian fisheries.

Teslin GSI stock proportion based on the 2013 Eagle sampling is 32.5% (SD = 5.4) (Unpublished data, DFO – PBS Nanaimo genetics lab) . Using the aggregate stock proportions, the expanded 2013 Chinook border escapement estimate would be 40,486 (95% CI = 30,540 – 60,038).

Carcass Pitch

A total of 74 dead or moribund Chinook was recovered during the carcass pitch. Of the fish sampled, 45 (61%) were female and 29 (39%) were male. The mean fork length of females and males sampled was 833 mm and 823 mm, respectively. The length frequency of Chinook sampled is presented in Figure 8. Complete age data[3] was determined from 52 of the Chinook sampled; the remaining 22 samples yielded partial ages or no ages due to regenerate scales. Age-6 (1.4)[4] was the predominant age class comprising 78.8% of the sample, followed by age-5 (1.3) fish (15.4%). Age-4 (1.2) and age-7 (1.5) represented 3.8% and 1.9%, respectively. Mean length at age data for male and female Chinook sampled is presented in Table 1. Complete age, length and sex data is presented in Appendix 5.

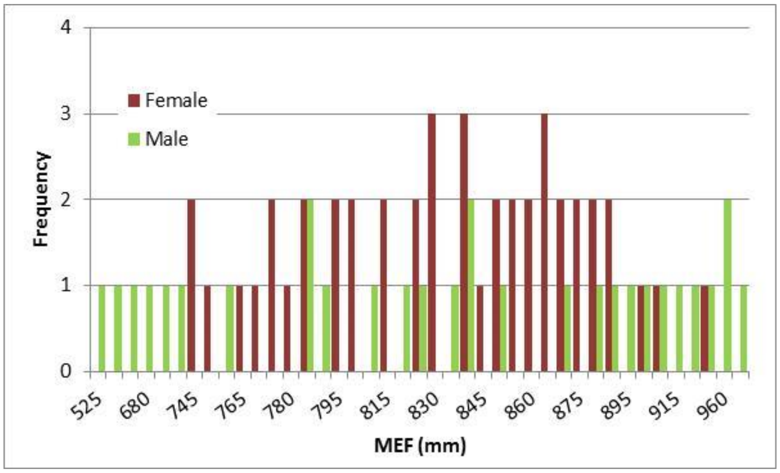

Figure 8. Length/frequency histogram of Big Salmon Chinook sampled in 2013.

Table 1. Age, length, and sex of Chinook sampled from the Big Salmon River, 2013

SEX	AGE *	Mean MEF (mm)	Count of Sex	%
Female	1.3	807	5	9.6%
	1.4	828	22	42.3%
F Total		824	27	51.9%
Male	1.2	538	2	3.8%
	1.3	730	3	5.8%
	1.4	859	19	36.5%
	1.5	820	1	1.9%
M Total		816	25	48.1%
Grand Total		820	52	100.0%

[3] Scale age analysis was conducted for DFO Whitehorse by the Pacific Biological Station, fish ageing lab in Nanaimo, British Columbia.
[4] European age format; e.g. 1.3 denotes a 5 year old fish with 1+ years freshwater residence and 3 years marine residence.

DISCUSSION

The 2013 Big Salmon sonar project was successful in enumerating the Chinook salmon passing the station and there is a high level of confidence the sonar count accurately reflects the Chinook escapement into the system. Water levels were moderate throughout most of the season and the migration corridor of 36 m was maintained throughout the sonar operation. The LR DIDSON sonar and related power and computer equipment functioned well throughout the duration of the project. Short interruptions in sonar recording due to maintenance or power interruptions resulted in a total of 48 minutes recording loss over the course of the project.

The 2013 expanded Chinook border escapement point estimate using Big Salmon sonar counts and the proportion of Big Salmon origin stock derived from the GSI sampling is 49,136 (95% CI: 27,483 – 247,935). This point estimate is significantly larger than the Eagle sonar estimate of 28,669. However, as noted above, the 2013 Big Salmon GSI based stock proportion is low at 6.6% (SD = 2.7) with a relatively large measure of uncertainty. As detailed above, using both the Teslin and Big Salmon sonar counts and aggregate GSI stock proportions yields an above border escapement estimate of 40,486 (95% CI = 30,540 – 60,038). This estimate is closer and has a greater degree of precision, however, it is still significantly larger than the Eagle sonar derived estimate which is outside of the 95% CI range.

Figure 9 illustrates the relationship between the Big Salmon sonar counts and the JTC above border escapement estimates from 2005 to 2013. There is a relationship between above border escapement estimates and Big Salmon sonar counts but it is non- significant (R^2= 0.73) at a level that would provide predictive value (Figure 10). It is worth noting that 2013 and 2008 are outlier years and the removal of these two years from the data set results in a significant predictive relationship (R^2= 0.87). Although 2008 was a year of high water there is no indication the Big Salmon sonar count was not reflective of the escapement and, as noted above, there is a high degree of confidence in the 2013 Big Salmon sonar count.

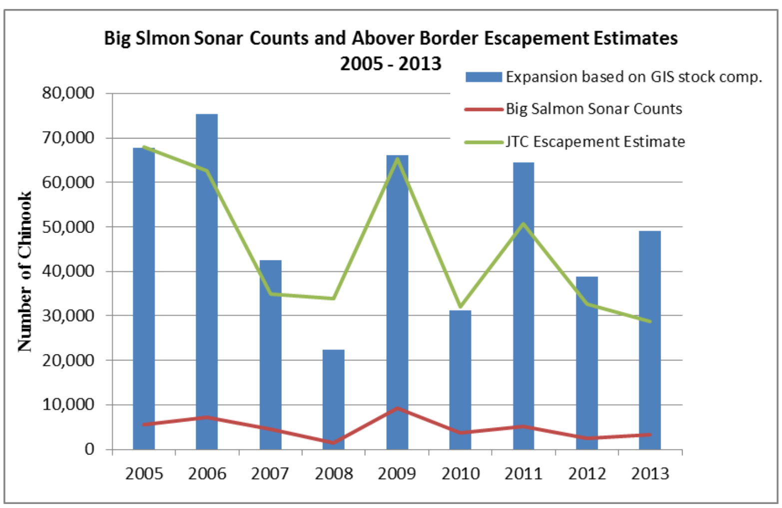

Figure 9. Big Salmon sonar counts and above border escapement estimates 2005 – 2013.

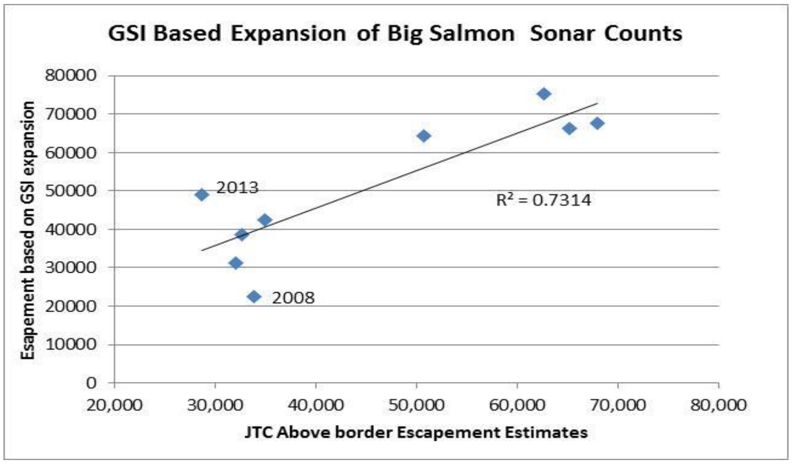

Figure 10. GSI based expansion of Big Salmon sonar counts and the JTC above border escapement estimates, 2005 – 2013.

Figure 11 illustrates the relationship between the Eagle sonar counts and the Big Salmon sonar counts from 2005 through 2013. As expected there is a relationship between the sonar count and JTC estimates, but the relationship is non-significant (R^2= 0.69). The weak relationship is most likely due to the inter- annual variance in the contribution of the Big Salmon stock group to the total above border escapement (Appendix 1).

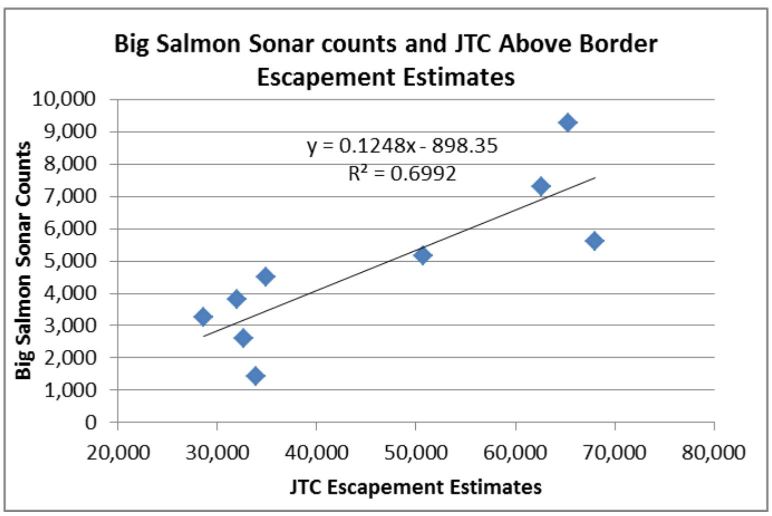

Figure 11. Big Salmon sonar counts and the JTC above border escapement estimates, 2005 – 2013.

There is a positive correlation between the Big Salmon Chinook sonar counts and the Big Salmon escapement estimates derived from the Eagle sonar count and GSI proportions, however, the relationship is not robust (R^2= 0.73) and has limited predictive value. The correlation described above does not yield sufficient precision to be used as an escapement index or to monitor long term trends for the system. Hence neither the Big Salmon nor the Eagle sonar counts could be considered redundant in this context. More years of data and the elimination of suspected outlier years may increase the predictive precision of this method.

The normal distribution of daily sonar counts exhibited in 2013 suggests the probability is low that other co-migrating fish species misidentified as Chinook were present in the system when the sonar was in operation. Resident fish species (as well as other aquatic organisms such as waterfowl and beaver) are readily distinguished from migrating Chinook based on size, form, and behaviour. Due to similar migratory behaviour and size overlap with smaller Chinook, the only likely species that could be confused with Chinook are Chum salmon. The presence of co-migrating fall Chum salmon entering the system at the end of the Chinook migration period would be problematic and would decrease the accuracy of the Chinook escapement estimate. However, as noted in previous reports (Mercer and Wilson 2006 -2013) the presence of Chum salmon has not been documented in the Big Salmon system and the run timing observed at the Eagle sonar would preclude the presence of Chum during the Chinook sonar project.

The comparison of the counts of files reviewed by two different individuals exhibited a high degree of precision between both reviewers[5]. Repeated counts of the files were observed to produce the same counts 97% of the time for all files read. Because 8 of the 10 file reader inconsistencies involved missed fish it can be surmised that the sonar counts may be biased low by approximately 1.5%. Through expansion of these potentially missed fish it was determined the accuracy[6] of the total counts was within 1.5% of the total. The variance between readers was not factored into the daily counts and the resultant potentially missed fish (44) were not added to the total sonar count.

The number of samples collected in the 2013 carcass pitch was lower than expected, due in part to the below average escapement. If the project continues in 2014 the carcass pitch component of the project will be expanded in an effort to obtain a larger sample size.

The Big Salmon program has been ongoing for nine consecutive years. There is value in maintaining an upper Yukon Chinook escapement monitoring project that provides accurate data over a long time series. The rationale for continuing this project is:

- It has proven to be a viable and consistent means of obtaining accurate escapement counts as well as age, sex and length data of Chinook salmon returning to the Big Salmon River.
- The Big Salmon stock comprises on average approximately 11% of the total upper Yukon Chinook escapement; the fourth highest stock composition behind the Yukon Mainstem, the Pelly and the Teslin systems.
- The Big Salmon stock is discrete, genetically identifiable and separates out relatively well within the upper Yukon Chinook GSI database.
- There is now one full generation of escapement data for the Big Salmon stock. Continuation of the project will provide ensuing recruitment information on those escapements. The development of biologically based escapement goals is typically based on stock recruitment modelling. These models are based on escapement estimates incorporating a long time series. The importance of long time series and continuous data sets related to escapement monitoring cannot be over emphasized. The data from this project has been an investment for the YRP and management agencies to date. To halt the project now will diminish the value of the investment the YRP and management agencies have put into the project to date.

[5] Precision refers to the repeatability of a count between different individuals reading the same sonar file.
[6] Accuracy refers to the similarity of the sonar count and the actual number of Chinook passing the sonar station.

- Big Salmon escapement information coupled with stock composition data can provide an independent annual estimate of the total above border Chinook spawning escapement.
- A drainage wide Chinook telemetry project is proposed for the Yukon River in 2015. Obtaining accurate tagged/untagged ratios from large segments of the Chinook population is vital for maximizing the quality of the information from this telemetry project. Accurate enumeration of Chinook escapements into selected tributaries along with counts of radio tagged fish entering the tributaries is the best and most cost effective means by which this information would be acquired.

ACKNOWLEDGEMENTS

Several people contributed to the 2013 Big Salmon River sonar project. Bob Gransden, Matthew Fry and Jesse McEwen worked as technicians on the project. Bob Gransden and Matthew Fry played an especially valuable role during camp and cabin construction and demobilization and freighting of materials. The carcass pitch was ably conducted by Bob Gransden and Jesse McEwen .

REFERENCES

Eiler, J.H., R. Spencer, J.J. Pella, and M.M. Masuda. 2006. Stock composition, run timing, and movement patterns of Chinook salmon returning to the Yukon River Basin 2004. U.S. Dept. of Commerce, NOAA Technical Memorandum NMFS-AFSC-165.

Enzenhofer, H.J., Cronkite, G.M.W., and Holmes, J.A. 2010. Application of DIDSON imaging sonar at Qualark Creek on the Fraser River for Enumeration of adult pacific salmon: An operational manual. Can. Tech. Rep. Fish. Aquat. Sci. 2869: iv + 37 p.

Galbreath, P.F. and P.E. Barber. 2005. Validation of Long-Range Dual Frequency Identification Sonar for Fish Passage Enumeration in the Methow River. Unpublished report for the PSC Southern Fund project.

Holmes, J. A., Cronkite, G. M. W., Enzenhofer, H. J., and Mulligan, T. J. 2006. Accuracy and precision of fish-count data from a ‘‘dual-frequency identification sonar’’ (DIDSON) imaging system. ICES Journal of Marine Science, 63: 543e555.

JTC (Joint Technical Committee of the Yukon River US/Canada Panel). 2012. Yukon River Salmon 2010 Season Summary and 2011 Season Outlook. Alaska Department of Fish and Game, Division of Commercial Fisheries Information Report No. 3A10-01, Anchorage.

Mercer, B. 2005. Distribution and Abundance of Radio Tagged Chinook Salmon in the Canadian Portion of the Yukon River Watershed as Determined by 2004 Aerial Telemetry Surveys. CRE project 77-04, Yukon River Panel.

Mercer, B. and J Eiler, 2004. Distribution and Abundance of Radio Tagged Chinook Salmon in the Canadian Portion of the Yukon River Watershed as Determined by 2003 Aerial Telemetry Surveys. CRE project 77-03, Yukon River Panel.

Mercer, B. 2014. 2013 Teslin River Chinook Sonar Project. Unpublished Report for the Yukon River Panel, CRE-01N-13.

Mercer B. and J. Wilson, years 2006 - 2013. Chinook Salmon Sonar Enumeration on the Big Salmon River. CRE project 41-xx, Unpublished reports for the Yukon River Panel.

Osborne, C.T., B. Mercer, and J.H. Eiler, 2003. Radio Telemetry Tracking of Chinook Salmon in the Canadian Portion of the Yukon River Watershed – 2002. CRE project 78-02, Yukon River Panel.

Appendix 1. Sonar beam depth at tilt angles 0° – 45° and with start window lengths 6.67m and 7.5m.

8 Degree Lens								
Horizontal Beam			6.67 m start window			7.5 m start window		
Distance From Sonar (m)	Depth of Beam (m)	Width of Beam (m)	Tilt Degree @ 6.67m from sonar	Depth Added (m)	TOTAL DEPTH @ 6.67m (m)	Tilt Degree @ 7.5m from sonar	Depth Added (m)	TOTAL DEPTH @ 7.5m (m)
2.00	0.28	1.03	1.00	0.06	0.99	1.00	0.07	1.00
3.00	0.42	1.55	2.00	0.12	1.05	2.00	0.14	1.07
4.00	0.56	2.07	3.00	0.18	1.11	3.00	0.20	1.13
5.00	0.70	2.59	4.00	0.24	1.17	4.00	0.27	1.20
6.00	0.84	3.10	5.00	0.30	1.23	5.00	0.34	1.27
6.67	0.93	3.45	6.00	0.36	1.29	6.00	0.41	1.34
7.00	0.98	3.62	7.00	0.42	1.35	7.00	0.48	1.41
7.50	1.05	3.88	8.00	0.48	1.41	8.00	0.55	1.48
8.00	1.12	4.14	9.00	0.55	1.48	9.00	0.61	1.54
9.00	1.26	4.66	10.00	0.61	1.54	10.00	0.68	1.61
10.00	1.40	5.17	11.00	0.67	1.60	11.00	0.75	1.68
11.00	1.54	5.69	12.00	0.73	1.66	12.00	0.82	1.75
12.00	1.68	6.21	13.00	0.80	1.73	13.00	0.90	1.83
13.00	1.82	6.72	14.00	0.86	1.79	14.00	0.97	1.90
14.00	1.96	7.24	15.00	0.92	1.85	15.00	1.04	1.97
15.00	2.10	7.76	16.00	0.99	1.92	16.00	1.11	2.04
16.00	2.24	8.28	17.00	1.05	1.98	17.00	1.19	2.12
17.00	2.38	8.79	18.00	1.12	2.05	18.00	1.26	2.19
18.00	2.52	9.31	19.00	1.19	2.12	19.00	1.34	2.27
19.00	2.66	9.83	20.00	1.26	2.19	20.00	1.41	2.34
20.00	2.80	10.34	21.00	1.32	2.25	21.00	1.49	2.42
21.00	2.94	10.86	22.00	1.39	2.32	22.00	1.57	2.50
22.00	3.08	11.38	23.00	1.46	2.39	23.00	1.65	2.58
23.00	3.22	11.90	24.00	1.54	2.47	24.00	1.73	2.66
24.00	3.36	12.41	25.00	1.61	2.54	25.00	1.81	2.74
25.00	3.50	12.93	26.00	1.68	2.61	26.00	1.89	2.82
26.00	3.64	13.45	27.00	1.76	2.69	27.00	1.98	2.91
27.00	3.78	13.97	28.00	1.83	2.76	28.00	2.06	2.99
28.00	3.92	14.48	29.00	1.91	2.84	29.00	2.15	3.08
29.00	4.06	15.00	30.00	1.99	2.92	30.00	2.24	3.17
30.00	4.20	15.52	31.00	2.07	3.00	31.00	2.33	3.26
31.00	4.34	16.03	32.00	2.16	3.09	32.00	2.42	3.35
32.00	4.48	16.55	33.00	2.24	3.17	33.00	2.52	3.45
33.00	4.62	17.07	34.00	2.33	3.26	34.00	2.62	3.55
34.00	4.76	17.59	35.00	2.42	3.35	35.00	2.72	3.65
35.00	4.89	18.10	36.00	2.51	3.44	36.00	2.82	3.75
36.00	5.03	18.62	37.00	2.60	3.53	37.00	2.92	3.85
37.00	5.17	19.14	38.00	2.70	3.63	38.00	3.03	3.96
38.00	5.31	19.65	39.00	2.79	3.72	39.00	3.14	4.07
39.00	5.45	20.17	40.00	2.89	3.82	40.00	3.26	4.19
40.00	5.59	20.69	41.00	3.00	3.93	41.00	3.37	4.30
41.00	5.73	21.21	42.00	3.11	4.04	42.00	3.49	4.42
42.00	5.87	21.72	43.00	3.22	4.15	43.00	3.62	4.55
43.00	6.01	22.24	44.00	3.33	4.26	44.00	3.75	4.68
44.00	6.15	22.76	45.00	3.45	4.38	45.00	3.88	4.81
45.00	6.29	23.28						

Appendix 2. 2013 daily and cumulative counts of Chinook salmon at the Big Salmon River sonar site.

DATE	DAILY COUNT	CUMULATIVE	COMMENTS
Jul-16	0	0	start sonar
Jul-17	0	0	weirs in
Jul-18	0	0	
Jul-19	0	0	
Jul-20	0	0	
Jul-21	1	1	First Chinook
Jul-22	1	2	
Jul-23	2	4	
Jul-24	4	8	
Jul-25	3	11	
Jul-26	11	22	
Jul-27	25	47	
Jul-28	44	91	
Jul-29	86	177	
Jul-30	83	260	
Jul-31	150	410	
Aug-01	196	606	
Aug-02	220	826	
Aug-03	264	1090	
Aug-04	262	1352	
Aug-05	261	1613	
Aug-06	225	1838	
Aug-07	191	2029	
Aug-08	195	2224	
Aug-09	156	2380	
Aug-10	132	2512	
Aug-11	134	2646	
Aug-12	113	2759	
Aug-13	101	2860	
Aug-14	77	2937	
Aug-15	65	3002	
Aug-16	57	3059	
Aug-17	34	3093	
Aug-18	32	3125	
Aug-19	21	3146	
Aug-20	28	3174	
Aug-21	20	3194	
Aug-22	10	3204	
Aug-23	14	3218	
Aug-24	11	3229	
Aug-25	2	3231	sonar pulled 8:00 a.m.

Appendix 3. Daily and average Chinook counts in the Big Salmon River, 2005-2013.

DATE	Daily Count 2005	Daily Count 2006	Daily Count 2007	Daily Count 2008	Daily Count 2009	Daily Count 2010	Daily Count 2011	Daily Count 2012	Daily Count 2013	Daily Average
13-Jul	0									**0**
14-Jul	0									**0**
15-Jul	2	1								**2**
16-Jul	12	0	2	0					0	**3**
17-Jul	13	1	0	0			2		0	**3**
18-Jul	23	0	2	0	0		7	0	0	**4**
19-Jul	13	0	5	1	11		13	0	0	**5**
20-Jul	23	1	5	0	22	0	15	0	0	**7**
21-Jul	36	3	7	0	47	7	24	0	1	**14**
22-Jul	58	8	11	0	68	14	24	0	1	**20**
23-Jul	92	11	18	1	85	12	43	0	2	**29**
24-Jul	130	21	26	2	135	7	44	0	4	**41**
25-Jul	158	20	52	1	201	12	50	1	3	**55**
26-Jul	204	53	88	3	226	14	56	1	11	**73**
27-Jul	219	95	153	5	346	27	105	1	25	**108**
28-Jul	287	146	237	9	498	46	160	3	44	**159**
29-Jul	290	230	287	9	532	83	192	15	86	**192**
30-Jul	299	321	337	29	594	123	218	12	83	**224**
31-Jul	279	368	400	21	808	141	218	23	150	**268**
01-Aug	333	357	435	23	578	159	260	62	196	**267**
02-Aug	346	379	331	18	715	182	313	76	220	**287**
03-Aug	303	358	304	16	725	216	417	138	264	**305**
04-Aug	292	413	258	31	595	226	426	156	262	**295**
05-Aug	331	496	210	51	559	215	396	196	261	**302**
06-Aug	214	490	178	55	452	221	400	228	225	**274**
07-Aug	188	464	147	78	364	227	317	192	191	**241**
08-Aug	232	464	59	61	295	242	294	235	195	**231**
09-Aug	234	360	74	70	270	248	243	183	156	**204**
10-Aug	203	349	90	98	209	183	160	154	132	**175**
11-Aug	124	348	82	122	183	207	170	106	134	**164**
12-Aug	126	324	98	107	146	174	143	130	113	**151**
13-Aug	125	243	77	109	118	181	100	110	101	**129**
14-Aug	72	196	74	89	117	134	85	81	77	**103**
15-Aug	57	180	66	78	65	114	89	80	65	**88**
16-Aug	40	172	56	70	55	82	63	94	57	**77**
17-Aug	53	104	40	49	63	80	35	70	34	**59**
18-Aug	47	69	64	45	55	53	20	50	32	**48**
19-Aug	35	87	37	17	43	40	18	44	21	**38**
20-Aug	29	59	47	18	35	24	21	38	28	**33**
21-Aug	26	45	11	15	28	18	11	27	20	**22**
22-Aug	19	50	16	16	14	38	2	19	10	**20**
23-Aug	17	12	23	9	4	24	2	19	14	**14**
24-Aug	13	10	17	2		20		14	11	**12**
25-Aug	9		14	1		17		9	6	**9**
26-Aug	6		14			6		6	4	**7**
27-Aug	4		13					5	2	**6**
28-Aug	2		11					3	1	**4**
29-Aug			9					2		**6**
30-Aug			8					1		**5**
31-Aug			6							**6**
01-Sep			4							**4**
02-Sep			3							**3**
TOTAL:	**5618**	**7308**	**4506**	**1329**	**9261**	**3817**	**5156**	**2584**	**3242**	

Note: dotted values were obtained through extrapolation of counts from previous 12 days.
Shaded areas denote start and end of sonar recording

Appendix 4. Estimated proportion of Big Salmon River Chinook and Yukon River Chinook border escapement, 2002 through 2013.

Year	Method	Estimated % proportion of border escapement based on telemetry or GSI sampling	Big Salmon sonar count	Escapement based on Eagle sonar count or mark/recapture	Escapement based on Big Salmon sonar count and GSI stock proportion
2002	Telemetry	9.2	n/a	n/a	n/a
2003	Telemetry	15.1	n/a	n/a	n/a
2004	Telemetry	10.0	n/a	n/a	n/a
2005	Fishwheel GSI Sampling	10.8	5,618	67,985 [c]	52,019
2006	Fishwheel GSI Sampling	9.7	7,308	62,630 [c]	75,340
2007	Fishwheel GSI Sampling	10.6	4,506	34,904 [b]	42,509
2008	Fishwheel GSI Sampling	9.3	1,431	33,883 [b]	15,387
2009	Gillnet GSI Sampling	16.9	9,261	65,278 [b]	54,799
2010	Gillnet GSI Sampling	11.7	3,817	32,010 [b]	32,624
2011	Gillnet GSI Sampling	9.2	5,156	50,780 [a]	56,043
2012	Gillnet GSI Sampling	6.7	2,594	32,658 [a]	38,104
2013	Gillnet GSI Sampling	6.6	3,239	28,669	49,136
Mean		11.3	4,770	45,422	45,853
Std. Dev.		3	2,278	15,259	15,900

[a] Eagle sonar above border spawning escapement estimate (DFO Whitehorse, unpublished data).
[b] Eagle sonar estimate (JTC 2012 and Unpublished DFO Whitehorse data).
[c] Mark/recapture estimate (JTC 2012).
Sources: Osborne et al. 2003; Mercer and Eiler 2004; Mercer 2005; JTC reports 2005 through 2012; unpublished DFO Whitehorse data.

Appendix 5. Age, sex, and length of sampled Chinook on the Big Salmon River, 2013.

DATE	FISH #	SEX	MEF (mm)	POHL (mm)	AGE*
26-Aug	1	M	900	775	1.4
26-Aug	2	F	945	825	1.4
26-Aug	3	M	705	620	RG
26-Aug	4	F	745	660	1.4
26-Aug	5	M	820	740	1.5
26-Aug	6	F	785	680	M4
26-Aug	7	M	790	690	1.3
26-Aug	8	F	875	775	1F
26-Aug	9	M	895	775	1.4
26-Aug	10	M	1040	900	M4
26-Aug	11	M	880	760	1.4
26-Aug	12	F	880	770	M4
26-Aug	13	F	900	795	M4
26-Aug	14	M	730	630	1.3
26-Aug	15	M	550	475	1.2
26-Aug	16	M	670	555	1.3
26-Aug	17	F	800	710	M4
26-Aug	18	F	815	730	M4
26-Aug	19	F	865	780	1.4
26-Aug	20	F	780	700	1.4
26-Aug	21	F	775	700	1.3
26-Aug	22	F	800	725	1.4
26-Aug	23	M	915	825	1.4
26-Aug	24	F	845	760	1.4
26-Aug	25	F	860	785	1F
26-Aug	26	F	830	750	1.3
26-Aug	27	F	855	775	M4
26-Aug	28	F	775	690	1.4
27-Aug	29	F	795	700	1.4
27-Aug	30	F	830	745	1.4
27-Aug	31	F	865	765	M3
27-Aug	32	M	920	790	1.4
27-Aug	33	F	880	770	M4
27-Aug	34	F	840	740	1.4
27-Aug	35	F	770	680	1.3
27-Aug	36	M	525	455	1.2
27-Aug	37	F	885	785	1.4
27-Aug	38	F	825	735	M4
27-Aug	39	F	870	770	M4
27-Aug	40	F	870	765	RG
27-Aug	41	M	840	725	1F
27-Aug	42	M	825	730	1.4
27-Aug	43	F	850	750	1.4
27-Aug	44	M	945	820	1.4
27-Aug	45	M	785	685	1.4
27-Aug	46	F	795	690	1.4
27-Aug	47	M	760	650	1.4

DATE	FISH #	SEX	MEF (mm)	POHL (mm)	AGE*
24-Aug	48	M	860	765	M4
24-Aug	49	M	710	620	M4
24-Aug	50	M	905	800	1.4
24-Aug	51	M	930	820	1.4
24-Aug	52	M	710	605	RG
24-Aug	53	F	785	680	1.3
24-Aug	54	F	835	750	1.4
24-Aug	55	M	810	710	1.4
24-Aug	56	F	905	795	1.4
24-Aug	57	M	830	720	1.3
24-Aug	58	F	875	775	1.4
24-Aug	59	F	860	770	1.4
24-Aug	60	F	775	675	1.4
24-Aug	61	M	710	625	1.4
24-Aug	62	M	835	715	RG
24-Aug	63	F	845	750	1.4
24-Aug	64	M	715	625	M4
24-Aug	65	F	885	795	1.4
24-Aug	66	F	855	750	1.4
24-Aug	67	F	820	720	1.4
25-Aug	68	M	670	585	1.4
25-Aug	69	M	630	555	1.4
25-Aug	70	M	870	760	1.4
25-Aug	71	F	860	770	1.4
25-Aug	72	F	895	685	1.4
25-Aug	73	F	840	750	RG
25-Aug	74	F	850	760	1.4

*European age format; e.g. 1.3 denotes a 5 year old fish with 1+ years freshwater residence and 3 years marine residence

No Ages:
RG = regenerate scale (center is missing from scale)
Partial Ages:
M=marine stage
F=freshwater stage

Appendix 6. 2013 Big Salmon River water and weather conditions.

DATE	TIME	AIR TEMP. (ºC)	WATER TEMP. (ºC)	WATER LEVEL (cm)	COMMENTS
16-Jul	-	-	-	-	mostly sunny, smokey
17-Jul	-	-	-	-	very smokey
18-Jul	-	-	-	22	Rain previous night, mix of sun and cloud
19-Jul	800 AM	11.0	13.5	23	Mix of sun and cloud, small thunder shower late in day a hint of smoke
20-Jul	810 AM	11.0	13.0	22	Cloudy with sunny breaks, rain developing in evening heavy overnight
21-Jul	800AM	10.0	12.5	28	Cloudy with rain ending in evening. Heavy downpour in afternoon.
22-Jul	815AM	10.0	12.0	70	Cloudy with sunny breaks, river peaks at 111 cm starts to fall in late evening.
23-Jul	800AM	8.0	11.5	71	Mostly sunny, with clouds late in day, clearing.
24-Jul	800AM	7.0	11,5	55	Sunny all day, thunder shower and rain in evening
25-Jul	810AM	9.0	12.0	45	Cloudy with sunny breaks, small showers in evening
26-Jul	800AM	11.0	12.0	39	Mix of sun and cloud
27-Jul	805AM	10.0	12.0	37	Mix of sun and cloud
28-Jul	800AM	9.0	12.0	33	Mix of sun and cloud
29-Jul	800AM	9.0	13.0	31	Mostly sunny
30-Jul	800AM	10.0	14.0	26	Mostly sunny
31-Jul	810AM	11.0	14.0	23	Mix of sun and cloud with thunder shower and high winds late in the day
01-Aug	800AM	11.0	14.0	28	Mix of sun and cloud, thunder showers nearby
02-Aug	800AM	10.0	13.0	40	Sunny all day
03-Aug	810AM	9.0	13.0	36	Sunny with clouds developing in the evening.
04-Aug	800AM	13.0	14.0	30	Cloudy with occasional sunny break
05-Aug	800AM	11.0	14.0	26	Sun and cloud with light rain in evening and into the night
06-Aug	800AM	10.0	13,5	24	Mostly sunny during day with showers at night
07-Aug	810AM	10.0	14.0	24	Mostly cloudy with small showers at night
08-Aug	800AM	13.0	14.0	23	Mostly cloudy clearing in evening
09-Aug	800AM	8.0	13.0	21	Sunny, with high clouds developing in the evening
10-Aug	802AM	10.0	13.5	24	Sunny all day
11-Aug	804AM	6.0	13.0	21	Sunny all day
12-Aug	800 AM	6.0	13.0	18	Sunny all day
13-Aug	803AM	7.0	14.0	15	Sunny with local thundershowers in early evening
14-Aug	805AM	7.0	14.0	13	Sunny with smoke to the west.
15-Aug	805AM	6.0	13.0	12	Sunny with thunderstorms and very light showers developing late in the day
16-Aug	801AM	7.0	13.0	13	Mostly cloudy clearing in evening
17-Aug	800AM	4.0	12.0	15	Cloudy with showers in evening and at night
18-Aug	804AM	7.0	12.0	13	Cloudy with showers mostly at night
19-Aug	810AM	8.0	11.0	13	Clearing in the morning to a mostly sunny day
20-Aug	805AM	7.0	11.0	11	Cool and cloudy with showers
21-Aug	801AM	6.0	10.0	12	Cloudy with sunny breaks and showers clearing at night
22-Aug	800AM	4.0	10.0	19	Cloudy with showers all day, periods of rain at night
23-Aug	800AM	7.0	10.0	19	Cloudy with showers
24-Aug	800AM	8.0	10.0	23	Cloudy with showers
25-Aug	800AM	8.0	10.0	43	Cloudy
26-Aug	800AM	7.0	10.0	38	Rain off and on all day heavy at times clearing in the evening