# 2010 CHINOOK SALMON SONAR ENUMERATION ON THE BIG SALMON RIVER

CRE-41-10

Prepared For: The Yukon River Panel
Restoration and Enhancement Fund

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## TABLE OF CONTENTS

## LIST OF FIGURES



## LIST OF TABLES



## LIST OF APPENDICES

**ABSTRACT**

A long range dual frequency identification sonar was used to enumerate the Chinook salmon escapement to the Big Salmon River in 2010, as well as determine associated run timing and diel migration patterns. This was the sixth year of sonar operation at this site. The sonar site was located on the Big Salmon River at the same location as in previous years, approximately 1.5 km upstream of the confluence with the Yukon River. The transport of equipment, placement of a partial weir and camp setup began on July 18. Sonar operation began on July 21 and operated continuously through to August 26. A total of 3,817 targets identified as Chinook salmon was counted past the sonar station between July 21 and August 26, 2010. The peak daily count of 248 fish occurred on August 9, at which time 63% of the run had passed the sonar station; 90% of the run had passed the station on August 16. A carcass pitch was conducted over approximately 120 km of the Big Salmon River, which yielded 71 Chinook carcasses. Of the 71 fish sampled, 33 (46%) were female and 38 (54%) were male. The mean fork length of females and males sampled was 815 mm and 735 mm, respectively. Age data was determined from 56 fish sampled. Age 1.3 (46.4%) was the dominant age class, followed by age 1.4 (39.3%) fish. Age 1.5 and age 1.2 fish represented 10.7% and 3.6% of the sample, respectively.

# INTRODUCTION

In 2005, a sonar enumeration program was initiated on the Big Salmon River using a DIDSON™ (Dual frequency Identification SONAR). Enumeration of the Big Salmon River Chinook salmon escapements provides a valuable escapement index and assists in the management of Yukon River Chinook. This is the sixth year of sonar operation at this site. In 2005, 2006, 2007, 2008 and 2009, the Big Salmon River sonar counts were 5,618, 7,308, 4,452, 1,431 and 9,261. These counts represented 18%, 20%, 10.6%, 9.3% and 16.9% of the total upper Yukon River spawning escapement point estimate for these years (JTC 2010).

Researchers have found the DIDSON apparatus to be superior to other sonar systems for many applications aimed at enumerating migrating salmon (Galbreath and Barber 2005, Holmes et al. 2005). In general, the DIDSON units have been found to be reliable, require a minimum of operator training, and provide accurate counts of migrating salmon (Holmes et al. 2006, Mercer & Wilson 2006, 2007, 2008 and 2009).

Due to high flow rates and wilderness recreation utilization of the Big Salmon River, the use of traditional salmon weir techniques on this river is not feasible. For these reasons the DIDSON sonar was considered as a relatively low impact, non-intrusive method of 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.

In addition, the Big Salmon River escapement count combined with GSI sampling information collected at the Eagle sonar project increases the accuracy of the post season upper Yukon River Chinook run re-construction. The goal of the project is to provide additional stock assessment information that will enhance the ability of the relevant salmon management agencies to manage Yukon River Chinook salmon.

In conjunction with sonar enumeration, a carcass sampling program was conducted to obtain age, length and sex data from the 2010 Big Salmon Chinook escapement. This information assists managers in post run re-construction as well as facilitating future pre-season Yukon River Chinook forecasts.

A proposal to continue sonar operations on the Big Salmon River using a DIDSON sonar unit as well as conduct a Chinook carcass pitch was submitted by J. Wilson and Associates to the Yukon River Panel Restoration and Enhancement (R&E) fund in January 2010. The proposal was accepted and financial support was received from the R&E fund. This report is a summary of the 2010 project.

## *Study Area*

The Big Salmon River flows in a northwesterly direction from its headwaters at the Quiet and Big Salmon lakes chain 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 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.

### *Objectives*

The objectives of the 2010 Big Salmon River sonar project were:

1. To operate a sonar station on the Big Salmon River to enumerate the Chinook salmon escapement and obtain information on run timing and diel migration patterns.

2. To conduct spawning ground sampling for age-sex-length data from post-spawn fish.

## 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 detection of straying 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.

### *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. Construction plans for a cabin were submitted to YTG Lands Branch in May 2010.

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.

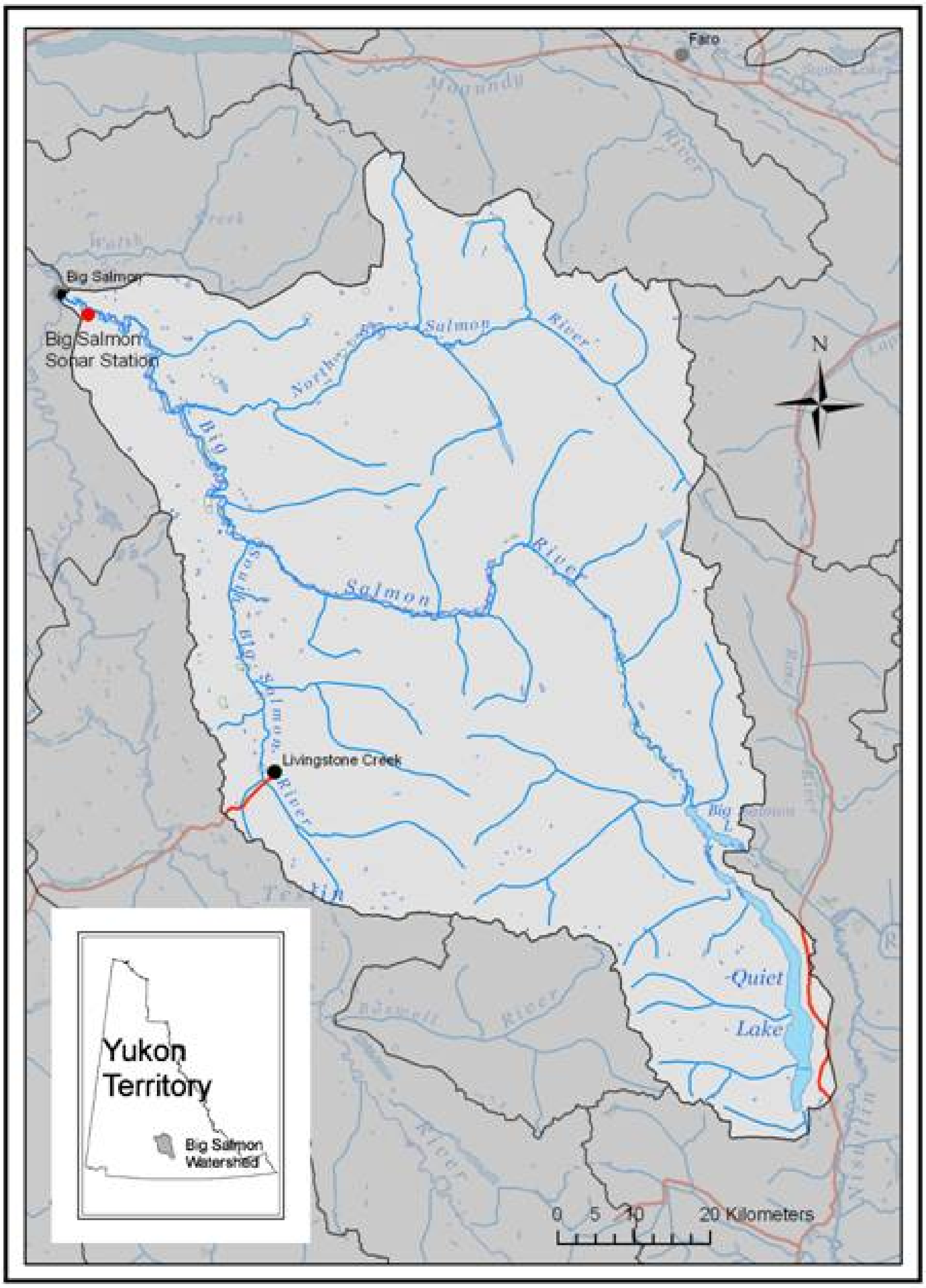


Figure 1. Big Salmon River Watershed and location of the 2010 Big Salmon sonar station.

### *Camp and Sonar Station Set-up*

Construction of the camp and sonar station was initiated on July 19. An initial load of camp materials was transported to the site by riverboat departing from Lake Laberge. All subsequent supplies were transported by truck from Whitehorse and loaded onto the boat and floatplane from a pullout along the Robert Campbell Highway near Little Salmon Village. Subsequent camp access, crew changes, and delivery of supplies was also accomplished via riverboat and supplemented by floatplane from Whitehorse.

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 70 m from the shore and constructed using a 14' X 16' canvas wall tent placed on a plywood platform and wooden frame (Figure 3).

### *Weir Construction*

Construction of partial weirs on either side of the river to divert shoreline migrating Chinook salmon into the mid section of the river was initiated on July 21 and completed by July 22. The diversion weirs were constructed as in previous years (Figures 2 and 3) using materials stored on site from previous operations. Prefabricated panels of electrical conduit were placed on the tripod structures to create the diversion fence. Light activated flashing beacon lights were secured to each diversion fence to mark the in-stream extent of weirs. A warning sign was also posted 200 m upstream of the station to alert boaters of the partial obstruction ahead in accordance with Transport Canada, Navigable Waters Protection requirements.

### *Sonar and Computer Software Configuration*

The configuration of the DIDSON sonar unit 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 (Figure 4). 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 2. Partial weirs and 36 m opening for fish passage viewed from the south bank.

Figure 3. Aerial view of sonar station camp and partial weirs.

Figure 4.  Sonar transducer unit and mounting stand.

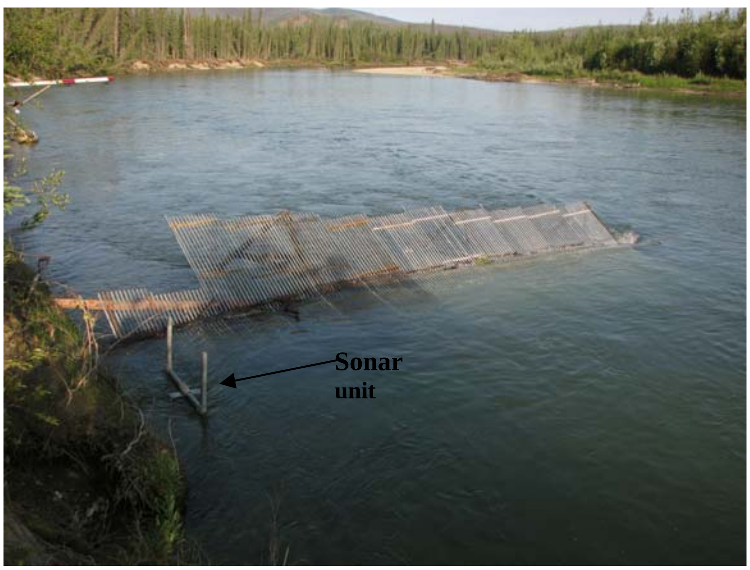


Figure 5.  Sonar transducer unit and mounting stand in position.

As in 2009, an 8° concentrator lens was again used for the 2010 project. The 8° concentrator lens reduces the vertical ensonified field from 14° to 8°.  The reduced field size increases the acoustic energy reflected from the targets in the field and reduces interference from surface and bottom reverberation. This results in an increase in the resolution of all target images and more importantly increases the resolution and detection of targets in the outer range of the ensonified area where reflected acoustic energy is lower.

The mounted sonar unit and stand was placed next to the south bank immediately upstream of the diversion fence in approximately 1.0 m of water (Figure 5).  The “feet” of the stand were secured to the stream bottom using sandbags.  A 6 mm stainless steel safety cable was affixed to the sonar unit and fastened to a buried anchor onshore.

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 2° from horizontal resulting in the ensonified field of view remaining parallel to the surface of the river (Figure 6).

Once the sonar was in place and properly positioned, the primary sonar unit settings and software were configured. These settings included the window start length, the ensonified window length, and the frame rate. 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. Threshold settings were set at 3 dB and intensity at 40 dB. 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

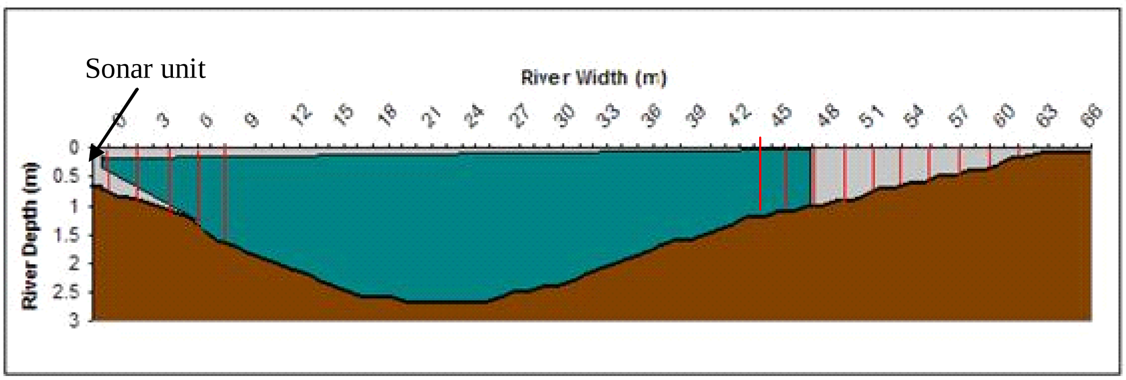


Figure 6. Schematic diagram of river profile and sonar and weir configuration.
Red bars denote weir structures and blue bars the ensonified portion of the water column.
Note: Vertical scale is exaggerated.

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 6 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.

***Sonar Data Collection***

After the weir structure and sonar unit was installed, 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. This allowed observers to quickly review files, particularly during long periods when no targets were observed. When necessary, the recording was stopped when a fish was observed and replayed at a slower rate for positive identification. The target measurement feature of the DIDSON software was used when required to estimate the size of the observed fish. The minimum size used to identify Chinook salmon was approximately 50 cm, although there was some subjective interpretation regarding identification and categorization of the smaller fish observed. Past reviews of the data files indicate that approximately 1% of the targets that could be Chinook salmon were in the 50 cm or less size range. 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.

Fish moving downstream identified as live Chinook were subtracted from each file total. 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 identified strays detected is typically low and in 2010 amounted to 147 or 3.9% of the total run.

### *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 two extended trips upriver on August 22-24 and August 27-29 searching for spent Chinook and carcasses. Carcass pitch efforts extended from the camp approximately 120 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 lengths (to the nearest 0.5cm) were also recorded for each recovered fish.

[1] Radio tagged Chinook were documented entering a drainage 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 and Run Timing*

The first Chinook salmon was observed on July 21 at 24:00. The peak passage was on August 7, and 90% of the run had passed the station on August 16. Daily and cumulative counts are presented in Table 1. A total of 3,817 targets identified as Chinook salmon was counted past the sonar station from July 21 through to August 26. The peak daily count of 248 fish occurred on August 9 at which time 63% of the run had passed the sonar station. The daily counts did not exhibit a pronounced peak and the run timing was approximately 5 days later than the average run timing in previous years (Figure 7). The cumulative daily run pattern exhibited a similar pattern to that observed during the period 2005 through 2009 (Figure 8).

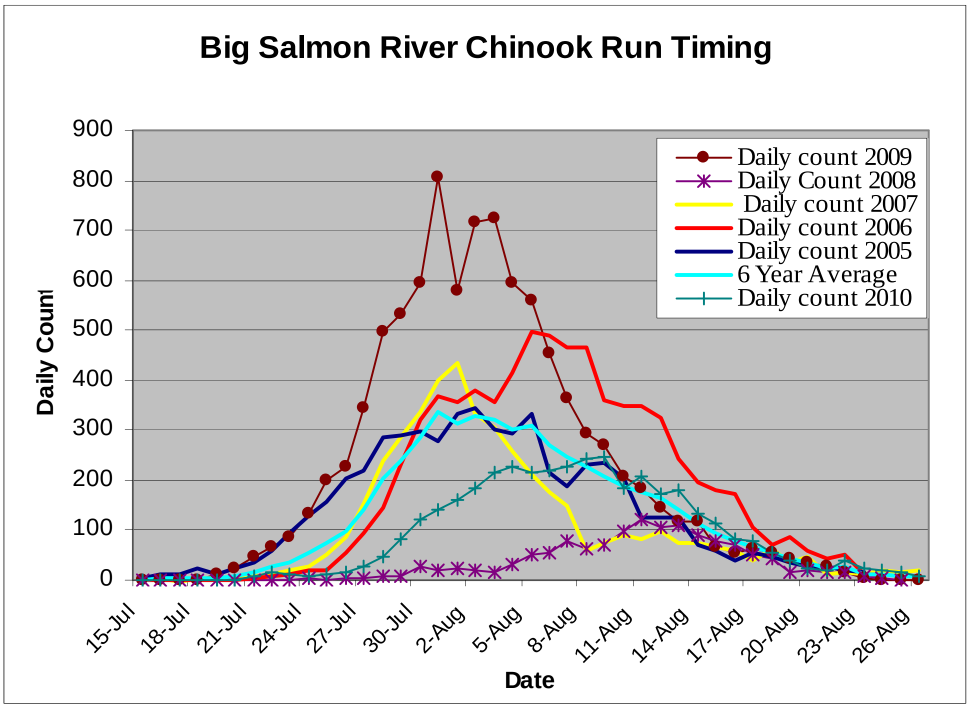


Figure 7. Daily counts of Chinook salmon passing the Big Salmon River sonar station in 2005 through 2010.

### *Diel Migration*

As occurred in previous years at this site, there was no significant diel migration pattern observed in the 2010 Chinook salmon migration in the Big Salmon River (Single factor ANOVA, tested for homogeneity of variance: df=23, F=0.56, F*crit.* = 1.54, $\alpha$=0.05, *p*=0.95) (Figure 9). The previous 6 years of 24 hour temporal migration data has shown the collective mean hourly variance decreasing. This strongly suggests that with successive years of data there will be no diel Chinook migration pattern evident at the Big Salmon sonar site.

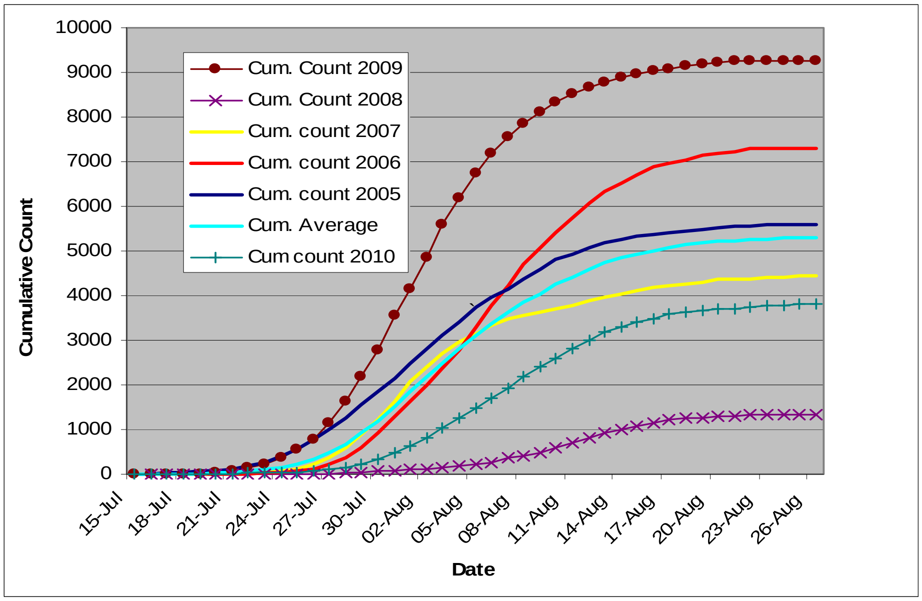


Figure 8. Cumulative counts of Chinook salmon passing the Big Salmon River sonar station in 2005 through 2010.

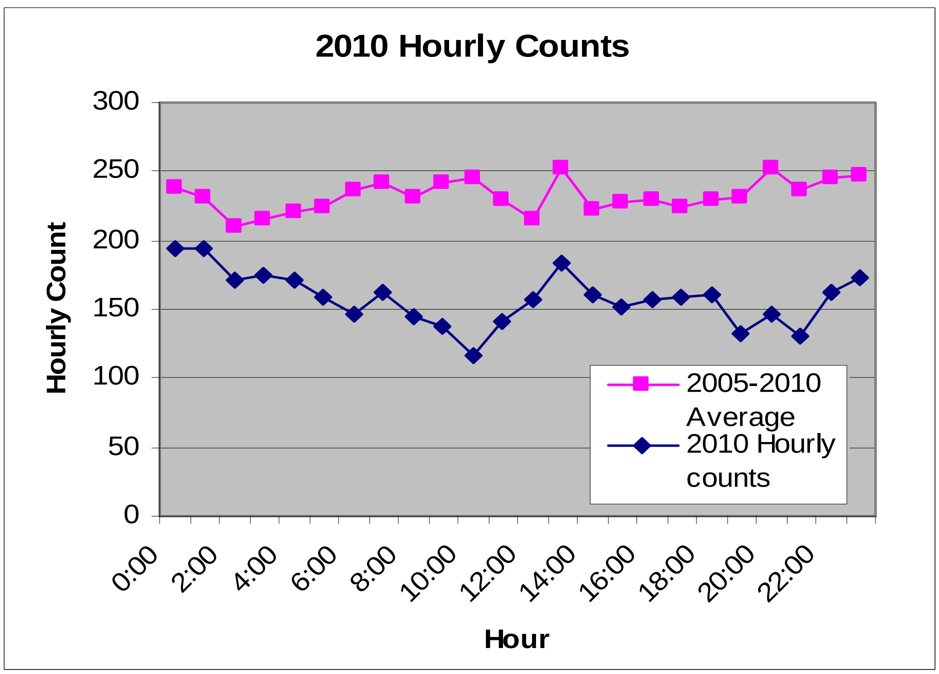


Figure 9. Total hourly counts of Chinook salmon passing the Big Salmon River sonar station in 2010 and the 2005 – 2010 average.

Table 1. 2010 daily and cumulative counts of Chinook salmon at the Big Salmon River sonar site.

| DATE | DAILY COUNT | CUMULATIVE | SONAR OPERATION TIME/COMMENTS |
|---|---|---|---|
| July 20 | 0 | 0 | Sonar starts recording 11:00 p.m. |
| 21 | 7 | 7 | |
| 22 | 14 | 21 | |
| 23 | 12 | 33 | |
| 24 | 7 | 40 | |
| 25 | 12 | 52 | |
| 26 | 14 | 66 | |
| 27 | 27 | 93 | |
| 28 | 46 | 139 | |
| 29 | 83 | 222 | |
| 30 | 123 | 345 | |
| 31 | 141 | 486 | |
| Aug-01 | 159 | 645 | |
| 2 | 182 | 827 | |
| 3 | 216 | 1043 | |
| 4 | 226 | 1269 | |
| 5 | 215 | 1484 | |
| 6 | 221 | 1705 | |
| 7 | 227 | 1932 | |
| 8 | 242 | 2174 | |
| 9 | 248 | 2422 | |
| 10 | 183 | 2605 | 3 hours sonar inoperative extrapolated from 160 to 183 |
| 11 | 207 | 2812 | Adjusted from 203 to 207 for 30 minutes sonar inoperative |
| 12 | 174 | 2986 | |
| 13 | 181 | 3167 | |
| 14 | 134 | 3301 | |
| 15 | 114 | 3415 | |
| 16 | 82 | 3497 | |
| 17 | 80 | 3577 | |
| 18 | 53 | 3630 | |
| 19 | 40 | 3670 | 4 hours sonar inoperative extrapolated from 34 to 40 |
| 20 | 24 | 3694 | |
| 21 | 18 | 3712 | |
| 22 | 38 | 3750 | |
| 23 | 24 | 3774 | |
| 24 | 20 | 3794 | |
| 25 | 17 | 3811 | |
| 26 | 6 | 3817 | Sonar stops recording 10:00 a.m. |

### *Cross section distribution*

The distribution pattern of the migrating Chinook as detected by the sonar is presented in Figure 10. The cross section pattern approximated a normal distribution with the largest proportion of fish located in the center of the river at a distance of 35 meters from the south bank (location of sonar). The distribution is somewhat skewed to the deeper water located near the south bank.  This distribution likely does not reflect the typical in-river migration pattern as the weir structures channel a portion of the fish into the 36 m wide opening.

### *Carcass Pitch*

A total of 71 dead or moribund Chinook was recovered during the carcass pitch.  Of these, 33 (46%) were female and 38 (54%) were male.  Age, length, and sex data are summarized in Table 2.  The mean mid-eye fork length of females and males sampled was 815 mm and 735 mm, respectively with an overall average of 773 mm.  Complete age data was determined from 56 fish sampled; the other 15 samples yielded partial ages or no ages due to regenerate scales.  Age 1.3[2] (46.4%) was the dominant age class, followed by age 1.4 (39.3%) fish.  Age 1.5 and age 1.2 represented 10.7% and 3.6% of the sample, respectively.  Complete age, length and sex data from these fish are presented in Appendix 2.

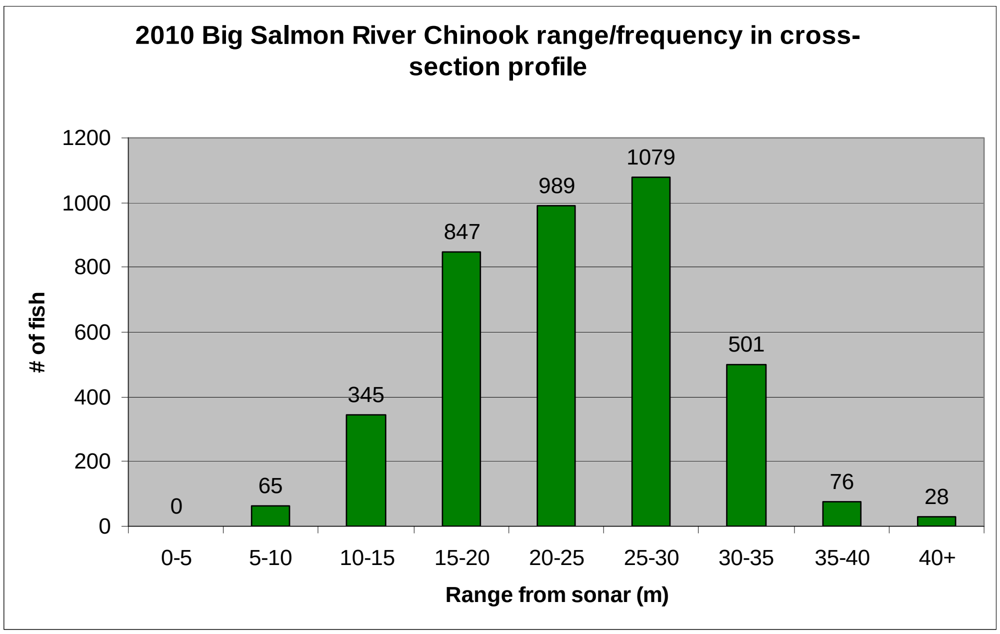


Figure 10.  2010 Big Salmon River Chinook range/frequency in cross section profile.

Table 2.  Age, length, and sex of Chinook sampled from the Big Salmon River, 2010.

| SEX | AGE | Data | Total | % of M/F |
|---|---|---|---|---|
| Female | 1.4 | Average of MEF (mm) | 818 | 62 |
| | | Count of AGE | 17 | |
| | 1.3 | Average of MEF (mm) | 740 | 19 |
| | | Count of AGE | 5 | |
| | 1.5 | Average of MEF (mm) | 875 | 19 |
| | | Count of AGE | 5 | |
| Female Average MEF (mm) | | | 815 | |
| Number of females | | | 33 | |

[2] European age format; e.g. 1.3 denotes 1 year freshwater residence and 3 year marine residence.

| | | | | |
|---|---|---|---|---|
| Male | 1.2 | Average of MEF (mm) | 580 | 7 |
| | | Count of AGE | 2 | |
| | 1.3 | Average of MEF (mm) | 707 | 72 |
| | | Count of AGE | 21 | |
| | 1.4 | Average of MEF (mm) | 820 | 17 |
| | | Count of AGE | 5 | |
| | 1.5 | Average of MEF (mm) | 1005 | 3 |
| | | Count of AGE | 1 | |
| Male Average MEF (mm) | | | 735 | |
| Number of males | | | 38 | |
| Average MEF both sexes (mm) | | | 735 | |
| Number samples aged | | | 71 | |

Note: The total sample size was 71 but only 56 were fully aged. Partial ages were determined from 13 samples and were not included in the above data. Scales from 2 sampled fish had regenerated and could not be aged.

## DISCUSSION

The 2010 Eagle sonar project on the Yukon River downstream of the Canada/U.S. border yielded a preliminary spawning[3] escapement estimate of 32,010 Chinook salmon (DFO Whitehorse unpublished data 2010). The mean weighted proportional contribution of the Big Salmon River stock to the border escapement based on GSI samples obtained from drift net sampling at the Eagle sonar site was 11.7%, (SD 2.4) (DFO Whitehorse unpublished data 2010). Using Big Salmon sonar counts and the proportion of Big Salmon origin stocks derived from the Eagle GSI sampling, the expanded border escapement would be 32,624 (95% CI +/- 9,350). As an independently derived border escapement estimate, this point estimate is very similar to the 2010 Chinook spawning escapement based on the Eagle sonar count.

The 2010 Big Salmon origin contribution to the Chinook border escapement based on the Eagle GSI sampling (11.7%, (SD 2.4)) is in the range of proportions observed over the period 2002 through 2010 (2002 – 2010 mean = 11.5%; Appendix 3).

The 2010 project did not encounter any significant operational problems. Water levels were relatively low throughout the duration of the project. The weir structures rebuilt in 2009 functioned well throughout the season. Using weir materials salvaged from the 2008 flood event with the rebuilt structures, it was possible to narrow the migration corridor to approximately 36 m. This excluded the outermost range of the ensonified field where the target resolution is lowest in the operational field of view.

The sonar was inoperative for a total of 7 hours and 30 minutes on August 10, 11, and 19 as a result of signal loss from the topside box to the recording computer. The cause of the signal loss was initially unclear but was later attributed to a faulty ethernet cable connection on the top box. This problem was temporarily remedied; however, the top box connection will have to be professionally repaired prior to the 2011 season. As per

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

the manufacturer’s suggestion, the sonar unit including the top box will be sent to the manufacturer (Sound Metrics Corp.) for repair in March/April 2011. Sound Metrics Corporation recommends DIDSON units be calibrated and serviced every 3-5 years.

The carcass pitch in 2010 resulted in the retrieval and sampling of fewer fish than anticipated. This may have been due in part to a later than average peak run timing into the Big Salmon watershed. The timing of the first carcass recovery trip this year was based on previous years which have indicated significant die-off beginning August 21. Unfortunately the first recovery trip conducted on August 22 -24 was prior to a significant die-off of spawned out fish in 2010. A second recovery trip on August 27 –29 resulted in the recovery of considerably more fish.

The Big Salmon program has been ongoing for six consecutive years. It has proven to be a viable and consistent means of obtaining accurate counts of Chinook salmon returning to the Big Salmon River basin. In addition, it has provided valuable index counts as well as ASL information for upper Yukon River Chinook escapements. Moreover, the Big Salmon escapement information coupled with GSI sampling provides an independent annual estimate of total Chinook salmon border escapements.

A licence of occupation for the Big Salmon sonar camp was obtained from the Yukon Territorial Government Lands Branch in 2009. This precluded the requirement of annual land use permits and allowed for the construction of upgraded and more permanent facilities at this site. In 2010, the project proponents initiated the construction of a cabin that will replace the wall tents used in previous years. It is anticipated that this cabin will be completed by the end of the 2011 season. This structure will reduce the logistical constraints of freighting and storage, mitigate the potential damage from high water events, and provide more comfortable and secure accommodation for personnel and equipment.

## ACKNOWLEDGEMENTS

Several people contributed to the 2010 Big Salmon River sonar project. Jim Mercer and Brittany McNarland worked as technicians on the project and played an especially valuable role during camp and cabin construction and demobilization and freighting of materials. Marcus Leijon, Bob Gransden and Lowell Tait assisted with the carcass pitch.

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Appendix 1. 2010 Big Salmon River water and weather conditions.

| DATE | TIME | AIR TEMP. (ºC) | WATER TEMP. (ºC) | WATER LEVEL (cm) | COMMENTS |
|---|---|---|---|---|---|
| 23-Jul | 10:00 AM | 13.0 | 13.0 | - | Thermometers set up |
| 24-Jul | 1:00 PM | 14.0 | 13.0 | 67 | Staff gauge installed. |
| 25-Jul | 10:00 AM | 12.0 | 12.0 | 71 | Sunny with some cloud |
| 26-Jul | 9:00 AM | 8.0 | 13.0 | 76 | Sunny with some cloud |
| 27-Jul | 9:00 AM | 13.0 | 13.0 | 69 | 70% cloud, warm day |
| 28-Jul | 9:00 AM | 13.0 | 14.0 | 64 | Sunny and clear, warm |
| 29-Jul | 9:00 AM | 9.0 | 14.0 | 61 | Clear cool morning |
| 30-Jul | 9:00 AM | 13.0 | 15.0 | 59 | 20% cloud, mostly sunny warm day |
| 31-Jul | 10:00 AM | 14.0 | 15.0 | 56 | Overcast but warm |
| 01-Aug | 10:00 AM | 15.0 | 15.0 | 55 | Clear sunny day |
| 02-Aug | 9:00 AM | 15.0 | 15.0 | 53 | Warm day, some cloud |
| 03-Aug | 10:00 AM | 12.0 | 15.0 | 51 | Clear skies |
| 04-Aug | 10:00 AM | 14.0 | 15.0 | 49 | Clear skies, hot |
| 05-Aug | 9:00 AM | 17.0 | 16.0 | 48 | Overcast, warm |
| 06-Aug | 9:00 AM | 14.0 | 16.0 | 46 | Overcast and windy |
| 07-Aug | 10:00 AM | 13.0 | 15.0 | 45 | Mixed sun and cloud |
| 08-Aug | 10:00 AM | 10.0 | 13.0 | 45 | Overcast and rainy |
| 09-Aug | 9:00 AM | 9.0 | 13.0 | 45 | Overcast and rainy |
| 10-Aug | 9:00 AM | 12.0 | 13.0 | 46 | Cool morning, mixed sun and cloud |
| 11-Aug | 10:00 AM | 14.0 | 13.0 | 44 | Clear with breeze |
| 12-Aug | 9:00 AM | 5.0 | 11.0 | 44 | Cold morning, clear skies |
| 13-Aug | 9:00 AM | 10.0 | 11.0 | 44.5 | Clear cool morning |
| 14-Aug | 10:00 AM | 13.0 | 12.0 | 42 | Overcast |
| 15-Aug | 9:00 AM | 11.0 | 14.0 | 40 | Clear skies |
| 16-Aug | 8:00 AM | 8.0 | 13.0 | 38 | Clear skies |
| 17-Aug | 10:00 AM | 13.0 | 14.0 | 37 | Clear skies |
| 18-Aug | 10:00 AM | 12.0 | 13.0 | 35.5 | Overcast, sprinkles of rain in morning |
| 19-Aug | 8:00 AM | 6.0 | 13.0 | 41 | Rainy, overcast day |
| 20-Aug | 9:00 AM | 8.0 | 11.0 | 49 | 80% cloud cover |
| 21-Aug | 9:00 AM | 3.0 | 10.0 | 60 | Overcast cool morning |
| 22-Aug | 9:00 AM | 5.0 | 10.0 | 57 | Overcast cool morning |
| 23-Aug | 9:00 AM | 5.0 | 10.0 | 53 | Cold morning, some clear sky |
| 24-Aug | 9:00 AM | 6.0 | 10.0 | 51 | Cold morning, overcast |
| 25-Aug | 9:00 AM | 5.0 | 10.0 | 51 | Cold morning, cloudy, sunny patches |
| 26-Aug | 9:00 AM | 4.0 | 9.0 | 52 | Cool morning, mostly sunny |

Appendix 2. Age*, sex, and length of sampled Chinook on the Big Salmon River, 2010.

| DATE | FISH # | SEX | MEF (mm) | POHL (mm) | AGE ** |
|---|---|---|---|---|---|
| 22-Aug | 1 | M | 660 | 570 | 1.3 |
| 22-Aug | 2 | F | 710 | 625 | M3 |
| 22-Aug | 3 | F | 820 | 710 | 1.4 |
| 22-Aug | 4 | F | 745 | 660 | 1.3 |
| 22-Aug | 5 | F | 935 | 825 | 1.4 |
| 22-Aug | 6 | F | 870 | 780 | 1.5 |
| 22-Aug | 7 | F | 785 | 705 | 1.4 |
| 23-Aug | 8 | F | 745 | 660 | 1.3 |
| 23-Aug | 9 | F | 860 | 750 | 1.4 |
| 23-Aug | 10 | M | 690 | 590 | M3 |
| 23-Aug | 11 | F | 825 | 725 | 1.4 |
| 27-Aug | 12 | F | 780 | 700 | 1.3 |
| 27-Aug | 13 | F | 730 | 655 | 1.3 |
| 27-Aug | 14 | M | 745 | 840 | 1.4 |
| 28-Aug | 15 | M | 715 | 615 | 1.3 |
| 28-Aug | 16 | F | 810 | 725 | 1.4 |
| 28-Aug | 17 | M | 730 | 630 | 1.3 |
| 28-Aug | 18 | F | 700 | 630 | 1.3 |
| 28-Aug | 19 | M | 895 | 785 | M4 |
| 28-Aug | 20 | M | 650 | 570 | 1.3 |
| 28-Aug | 21 | M | 615 | 535 | 1.2 |
| 28-Aug | 22 | M | 715 | 625 | M3 |
| 28-Aug | 23 | F | 800 | 705 | 1.4 |
| 28-Aug | 24 | M | 765 | 680 | 1F |
| 28-Aug | 25 | M | 650 | 565 | 1.3 |
| 28-Aug | 26 | M | 690 | 605 | 1.3 |
| 28-Aug | 27 | M | 795 | 695 | 1.3 |
| 28-Aug | 28 | F | 860 | 785 | 1.4 |
| 28-Aug | 29 | F | 865 | 765 | M4 |
| 28-Aug | 30 | M | 745 | 660 | 1.3 |
| 28-Aug | 31 | F | 800 | 710 | 1.4 |
| 28-Aug | 32 | M | 680 | 595 | 1.3 |
| 28-Aug | 33 | F | 775 | 690 | 1.4 |
| 28-Aug | 34 | F | 795 | 705 | 1.4 |
| 28-Aug | 35 | M | 700 | 610 | 1.3 |
| 28-Aug | 36 | M | 855 | 755 | 1.4 |
| 28-Aug | 37 | M | 785 | 685 | 1F |
| 28-Aug | 38 | F | 900 | 790 | M4 |
| 28-Aug | 39 | M | 705 | 615 | 1.3 |
| 28-Aug | 40 | F | 850 | 760 | 1.5 |
| 28-Aug | 41 | M | 740 | 655 | 1.3 |
| 28-Aug | 42 | M | 760 | 665 | 1.3 |
| 28-Aug | 43 | F | 760 | 685 | 1.4 |
| 28-Aug | 44 | F | 865 | 755 | 1.4 |
| 28-Aug | 45 | M | 730 | 635 | 1.4 |

| DATE | FISH # | SEX | MEF (mm) | POHL (mm) | AGE * |
|---|---|---|---|---|---|
| 28-Aug | 46 | F | 740 | 655 | 1.4 |
| 28-Aug | 47 | M | NM | 650 | 1F |
| 28-Aug | 48 | M | 660 | 575 | 1.3 |
| 28-Aug | 49 | F | NM | 770 | 1.5 |
| 28-Aug | 50 | M | 545 | 480 | 1.2 |
| 28-Aug | 51 | M | 660 | 570 | 1.3 |
| 28-Aug | 52 | F | 775 | 695 | 1.4 |
| 28-Aug | 53 | M | 665 | 585 | 1.3 |
| 28-Aug | 54 | F | 870 | 765 | 1.5 |
| 29-Aug | 55 | M | 800 | 700 | M3 |
| 29-Aug | 56 | M | 1005 | 870 | 1.5 |
| 29-Aug | 57 | F | 875 | 775 | NA |
| 29-Aug | 58 | F | 850 | 755 | 1.4 |
| 29-Aug | 59 | F | 900 | 795 | NA |
| 29-Aug | 60 | M | 910 | 800 | 1.4 |
| 29-Aug | 61 | F | 910 | 810 | 1.5 |
| 29-Aug | 62 | M | 770 | 680 | M4 |
| 29-Aug | 63 | M | 730 | 635 | 1.3 |
| 29-Aug | 64 | M | 705 | 620 | 1.3 |
| 29-Aug | 65 | M | 780 | 690 | 1.3 |
| 29-Aug | 66 | F | 740 | 655 | M4 |
| 29-Aug | 67 | M | 730 | 635 | 1.3 |
| 29-Aug | 68 | M | 625 | 545 | M3 |
| 29-Aug | 69 | M | 860 | 760 | 1.4 |
| 29-Aug | 70 | F | 845 | 760 | 1.4 |
| 29-Aug | 71 | M | NM | 580 | 1.3 |

*Scale age analysis was conducted under the aegis of DFO Whitehorse by the Pacific Biological Station, Fish Ageing Lab, Nanaimo. British Columbia.
**European age format; e.g. 1.3 denotes 1 year freshwater residence and 3 year marine residence.

Appendix 3. Estimated proportion of Big Salmon River Chinook in the Yukon River Chinook border escapement, 2002 through 2010.

| Year | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Method | Telemetry | Telemetry | Telemetry | Fishwheel GSI Sampling | Fishwheel GSI Sampling | Fishwheel GSI Sampling | Fishwheel GSI Sampling | Gillnet GSI Sampling | Gillnet GSI Sampling | Mean | SD |
| Estimated % proportion of border escapement | 9.2 | 15.1 | 10.4 | 10.8 | 9.7 | 10.6 | 9.3 | 16.9 | 11.7 | 11.5 | 2.7 |

Sources: Osborne et al. 2003; Mercer and Eiler 2004; Mercer 2005; JTC reports 2005 through 2010; unpublished DFO Whitehorse data.

Appendix 4. Daily and average Chinook salmon counts in the Big Salmon River, 2005-2010.

| DATE | Daily Count 2005 | Daily Count 2006 | Daily Count 2007 | Daily Count 2008 | Daily Count 2009 | Daily Count 2010 | Daily Average |
|---|---|---|---|---|---|---|---|
| 13-Jul | 0 | | | | | | **0** |
| 14-Jul | 0 | | | | | | **0** |
| 15-Jul | 2 | 1 | | | | | **2** |
| 16-Jul | 12 | 0 | 2 | 0 | | | **4** |
| 17-Jul | 13 | 1 | 0 | 0 | | | **4** |
| 18-Jul | 23 | 0 | 2 | 0 | 0 | | **5** |
| 19-Jul | 13 | 0 | 5 | 1 | 11 | | **6** |
| 20-Jul | 23 | 1 | 5 | 0 | 22 | 0 | **9** |
| 21-Jul | 36 | 3 | 7 | 0 | 47 | 7 | **17** |
| 22-Jul | 58 | 8 | 11 | 0 | 68 | 14 | **27** |
| 23-Jul | 92 | 11 | 18 | 1 | 85 | 12 | **37** |
| 24-Jul | 130 | 21 | 26 | 2 | 135 | 7 | **54** |
| 25-Jul | 158 | 20 | 52 | 1 | 201 | 12 | **74** |
| 26-Jul | 204 | 53 | 88 | 3 | 226 | 14 | **98** |
| 27-Jul | 219 | 95 | 153 | 5 | 346 | 27 | **141** |
| 28-Jul | 287 | 146 | 237 | 9 | 498 | 46 | **204** |
| 29-Jul | 290 | 230 | 287 | 9 | 532 | 83 | **239** |
| 30-Jul | 299 | 321 | 337 | 29 | 594 | 123 | **284** |
| 31-Jul | 279 | 368 | 400 | 21 | 808 | 141 | **336** |
| 01-Aug | 333 | 357 | 435 | 23 | 578 | 159 | **314** |
| 02-Aug | 346 | 379 | 331 | 18 | 715 | 182 | **329** |
| 03-Aug | 303 | 358 | 304 | 16 | 725 | 216 | **320** |
| 04-Aug | 292 | 413 | 258 | 31 | 595 | 226 | **303** |
| 05-Aug | 331 | 496 | 210 | 51 | 559 | 215 | **310** |
| 06-Aug | 214 | 490 | 178 | 55 | 452 | 221 | **268** |
| 07-Aug | 188 | 464 | 147 | 78 | 364 | 227 | **245** |
| 08-Aug | 232 | 464 | 59 | 61 | 295 | 242 | **226** |
| 09-Aug | 234 | 360 | 74 | 70 | 270 | 248 | **209** |
| 10-Aug | 203 | 349 | 90 | 98 | 209 | 183 | **189** |
| 11-Aug | 124 | 348 | 82 | 122 | 183 | 207 | **178** |
| 12-Aug | 126 | 324 | 98 | 107 | 146 | 174 | **163** |
| 13-Aug | 125 | 243 | 77 | 109 | 118 | 181 | **142** |
| 14-Aug | 72 | 196 | 74 | 89 | 117 | 134 | **114** |
| 15-Aug | 57 | 180 | 66 | 78 | 65 | 114 | **93** |
| 16-Aug | 40 | 172 | 56 | 70 | 55 | 82 | **79** |
| 17-Aug | 53 | 104 | 40 | 49 | 63 | 80 | **65** |
| 18-Aug | 47 | 69 | 64 | 45 | 55 | 53 | **56** |
| 19-Aug | 35 | 87 | 37 | 17 | 43 | 40 | **43** |
| 20-Aug | 29 | 59 | 47 | 18 | 35 | 24 | **35** |
| 21-Aug | 26 | 45 | 11 | 15 | 28 | 18 | **24** |
| 22-Aug | 19 | 50 | 16 | 16 | 14 | 38 | **26** |
| 23-Aug | 17 | 12 | 23 | 9 | 4 | 24 | **15** |
| 24-Aug | 13 | 10 | 17 | 2 | | 20 | **12** |
| 25-Aug | 9 | | 14 | 1 | | 17 | **10** |
| 26-Aug | 6 | | 14 | | | 6 | **9** |
| 27-Aug | 4 | | 13 | | | | **9** |
| 28-Aug | 2 | | 11 | | | | **7** |
| 29-Aug | | | 9 | | | | **9** |
| 30-Aug | | | 8 | | | | **8** |
| 31-Aug | | | 6 | | | | **6** |
| 01-Sep | | | 4 | | | | **4** |
| 02-Sep | | | 3 | | | | **3** |
| TOTAL: | **5618** | **7308** | **4506** | **1329** | **9261** | **3817** | |

Note: shaded areas denote sonar operation start and end date – values in dotted areas obtained through extrapolation of counts.