2009 CHINOOK SALMON SONAR ENUMERATION ON THE BIG SALMON RIVER

CRE-41-09

Prepared For: The Yukon River Panel
Restoration and Enhancement Fund

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ABSTRACT

A long range dual frequency identification sonar was used to enumerate the Chinook salmon escapement to the Big Salmon River in 2009, as well as determine associated run timing and diel migration patterns. This was the fifth 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. Transport of equipment, partial weir placement and camp setup began on July 15. Sonar operation began on July 18 and operated continuously through to August 23. A total of 9,261 targets identified as Chinook salmon was counted past the sonar station between July 18 and August 23, 2009. The peak daily count of 808 fish occurred on July 31, at which time 39% of the run had passed the sonar station; 90% of the run had passed the station on August 10. A carcass pitch was conducted over approximately 120 km of the Big Salmon River. A total of 182 Chinook carcasses was collected. Of the 182 fish sampled, 97 (53%) were female and 85 (47%) were male. The mean fork length of females and males sampled was 822 mm and 763 mm, respectively. Age data was determined from 145 fish sampled. Age 1.4 (69.0%) was the dominant age class, followed by age 1.3 (23.4%) fish. Age 1.2 and age 1.5 fish represented 6.2% and 1.4% 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). In 2005, 2006, 2007 and 2008, the Big Salmon River sonar counts were 5,618, 7,308, 4,452 and 1,431. These counts represented 18%, 20%, 10.6% and 9.3% of the total upper Yukon River spawning escapement point estimate for these years (JTC 2008).

Due to high flow rates, First Nation concerns, and wilderness recreational use in 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.

The Yukon River Panel (YRP) has indicated that obtaining accurate estimates of spawning escapements is required for the management of the Yukon River Chinook stocks. In the 2007 YRP Framework, determination of escapement estimates is ranked as a high priority as there is strong public and Joint Technical Committee (JTC) interest in quantifying escapement information. This information is important for run reconstruction and the establishment of scientifically based escapement objectives.

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, 2009).

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 2009. The proposal was accepted and financial support was received from the R&E fund. This report is a summary of the 2009 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.

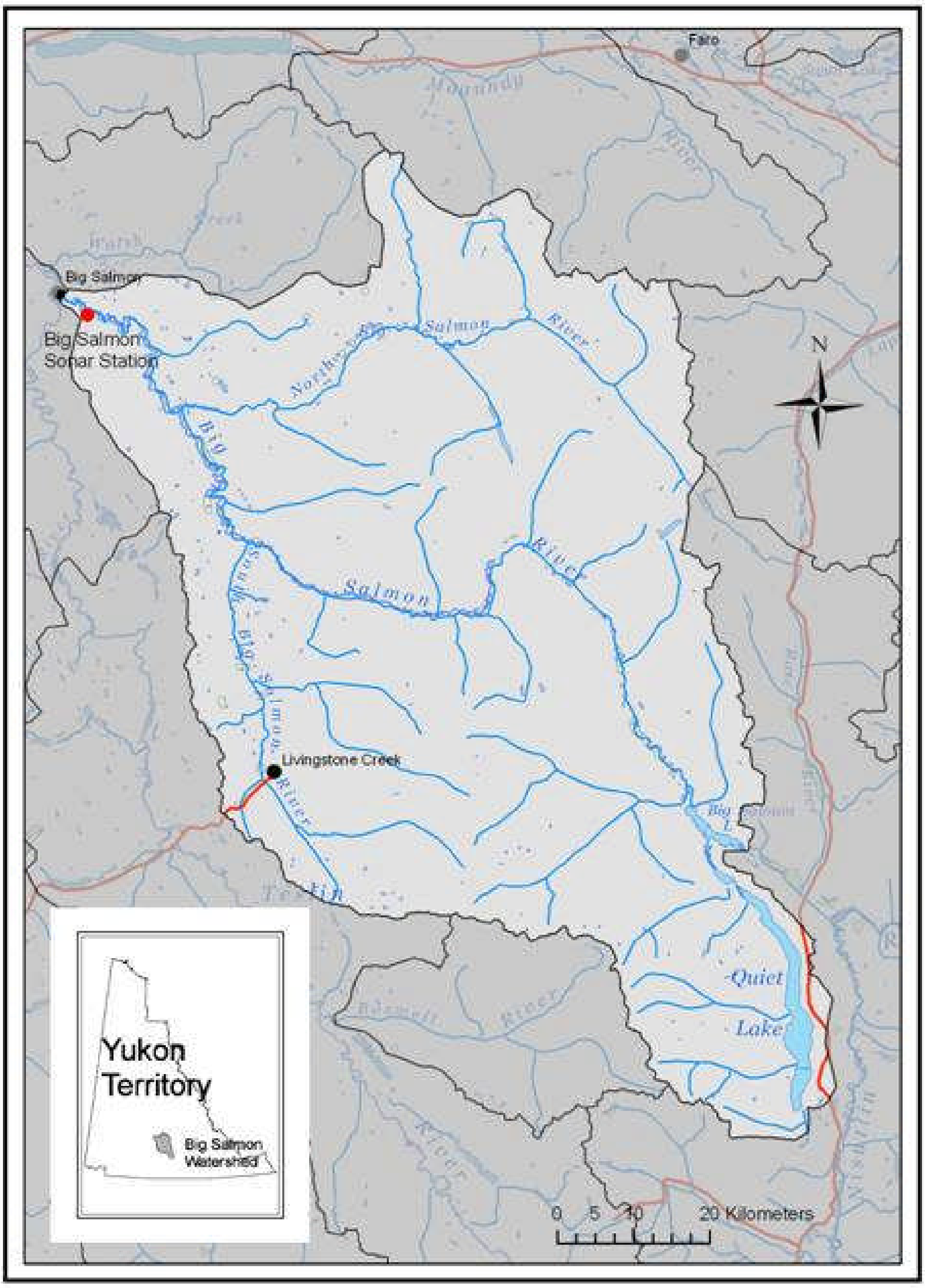

Figure 1. Big Salmon River Watershed and location of the 2009 Big Salmon sonar station.

Objectives

The objectives of the 2009 Big Salmon River sonar project were:

1. To build and transport new weir structures to the project site.

2. 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.

3. 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 to 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

An application was submitted to Yukon Energy, Mines & Resources, Lands Branch for a licence of occupation for the sonar camp on the lower Big Salmon River on a long term basis. A 5 year licence of occupation (with option of renewal) was granted and supersedes the previous annual land use permit.

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

Weir Materials

In mid May 2009 a reconnaissance trip was made into the Big Salmon project site by riverboat in an attempt to retrieve some of the weir materials that were lost to flooding events that occurred during the course of the 2008 project. No materials were found or recovered at this time.

Seven metal tripods and 17 prefabricated conduit panels were constructed in Whitehorse and transported by riverboat and aircraft to the project site prior to commencement of the project. These materials along with the remaining weir equipment were used to construct the partial weirs for the 2009 project. The newly fabricated metal tripods were larger and stronger than those originally used and should withstand the occasional high water events that are experienced on the system.

Camp and Sonar Station Set-up

Construction of the camp and sonar station was initiated on July 15. 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 16 and in place by July 18. The diversion weirs were constructed as in previous years (Figures 2 and 3). As well as the seven new metal tripods, three smaller tripods used in the previous years projects were incorporated into the weir structures. 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.

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.

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 4. Sonar transducer unit and mounting stand.

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

For the 2009 project an 8° concentrator lens was acquired from Sound Metrics Corp. for mounting on the DIDSON sonar unit. The existing lens of the LR DIDSON unit was machine drilled in order to attach the concentrator lens. 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. The rationale for installing the concentrator lens is to increase the resolution of targets in the farther reaches of the ensonified area.

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 to a depth of approximately 12 cm below the surface of the river and angled downward approximately 4° from horizontal, which resulted 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 Toshiba 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

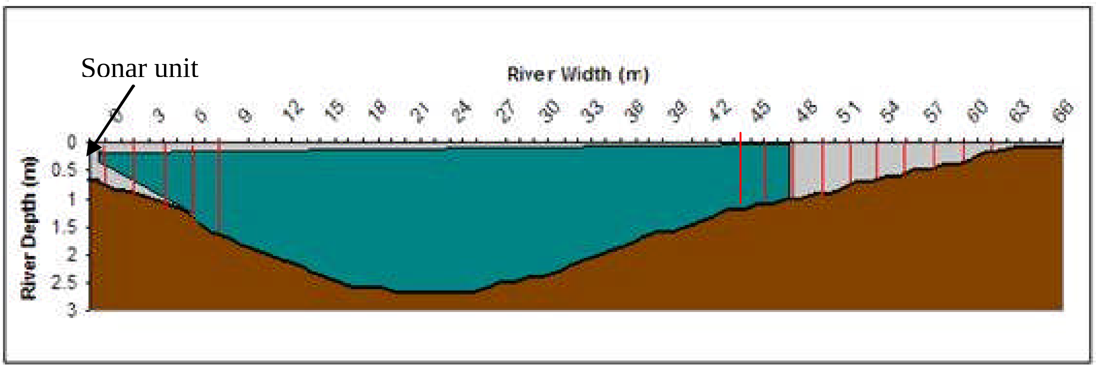

Figure 6. Schematic diagram of river profile and sonar and weir configuration.
Red bars denote weir structures and blue bars the ensonified portion of the water column.
Note: Vertical scale is exaggerated.

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 morning 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 30 and 40 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 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 construed to 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. Fish identified as Chinook salmon moving downstream were subtracted from the file total. A record of each 20 minute file count as well as hourly, daily and cumulative counts was maintained throughout the run.

Carcass Pitch

The upper reaches of the Big Salmon River were accessed using a 5.5 m open skiff powered by a 60 hp outboard jet motor. The crew made one extended trip upriver on August 24-27 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.

Carcass sampling consisted of collecting five scales per fish placed in prescribed scale cards and recording sex and mid-eye-fork lengths (to the nearest 0.5cm).

RESULTS

Chinook Salmon Counts and Run Timing

The first Chinook salmon was observed on July 19 at 24:00. The peak passage was on August 2, and 90% of the run had passed the station on August 10. Daily and cumulative counts are presented in Table 1. A total of 9,261 targets identified as Chinook salmon was counted past the sonar station from July 18 through to August 23. The peak daily count of 808 fish occurred on July 31 at which time 39% of the run had passed the sonar station. The daily counts exhibited a pronounced peak, which corresponded to average run timing from previous years (Figure 7). The cumulative daily run pattern exhibited the same normal distribution as occurred in 2005 through 2008 (Figure 8).

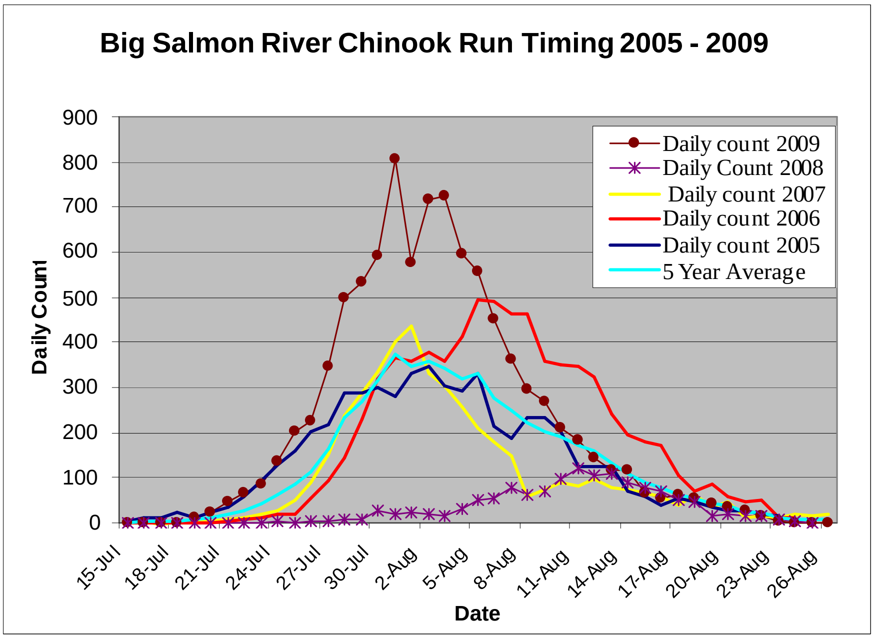

Figure 7. Daily counts of Chinook salmon passing the Big Salmon River sonar station in 2005, 2006, 2007, 2008 and 2009.

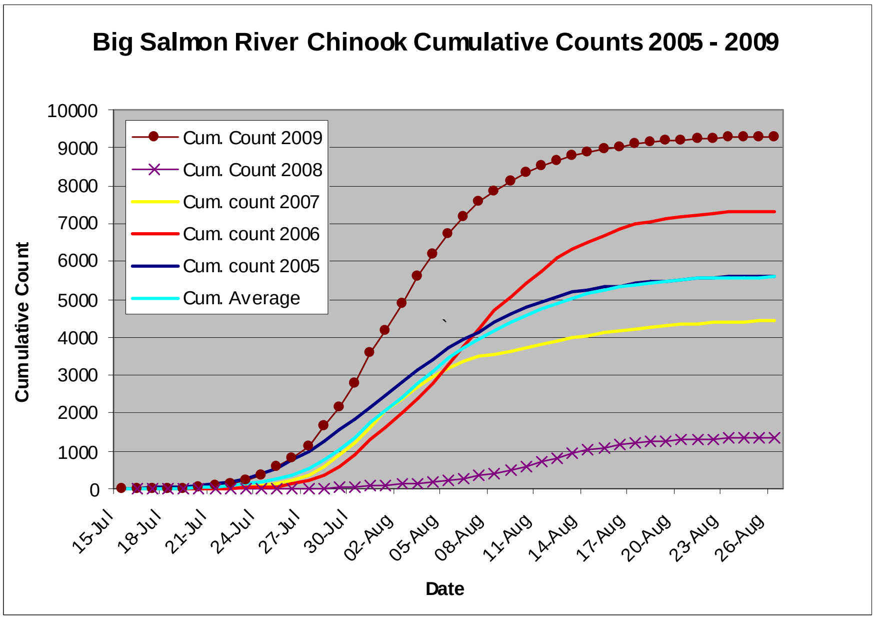

Figure 8. Cumulative counts of Chinook salmon passing the Big Salmon River sonar station in 2005, 2006, 2007, 2008 and 2009.

Table 1. 2009 daily and cumulative counts of Chinook salmon at the Big Salmon River sonar site.

DATE	DAILY COUNT	CUMULATIVE	SONAR OPERATION TIME/COMMENTS
July 18	0	0	Sonar starts recording 15:50
19	11	11	
20	22	33	
21	47	80	
22	68	148	
23	85	233	
24	135	368	
25	201	569	
26	226	795	
27	346	1141	
28	498	1639	
29	532	2171	
30	594	2765	
31	808	3573	
Aug-01	578	4151	
2	715	4866	
3	725	5591	
4	595	6186	
5	559	6745	
6	452	7197	
7	364	7561	
8	295	7856	
9	270	8126	
10	209	8335	
11	183	8518	
12	146	8664	
13	118	8782	
14	117	8899	
15	65	8964	
16	55	9019	
17	63	9082	
18	55	9137	
19	43	9180	
20	35	9215	
21	28	9243	
22	14	9257	
23	4	9261	Sonar stops recording 8:00 a.m.

Diel Migration

As occurred in previous years at this site, there was no significant diel migration pattern observed in the 2009 Chinook salmon migration in the Big Salmon River (Single factor ANOVA, tested for homogeneity of variance: df=23, F=0.72, F*crit.* = 1.54, α=0.05, *p*=0.82). However, the 2009 hourly counts exhibited greater random variance than was observed in previous years (Figure 9). As the hourly count data set increases with each successive year the mean hourly variance has been decreasing. This suggests that each successive year of data will more definitively demonstrate that a diel Chinook migration pattern at the Big Salmon sonar site is not present.

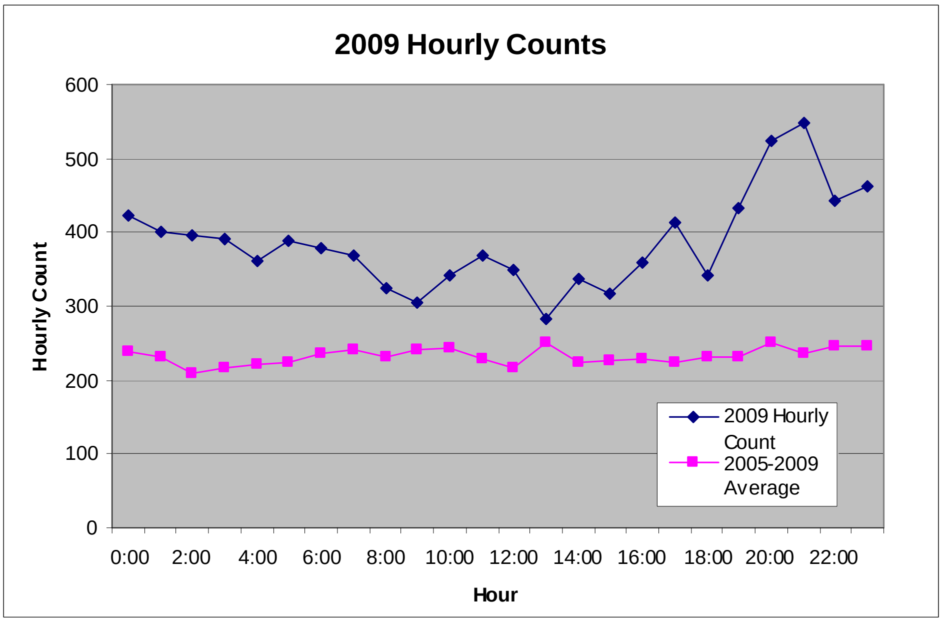

Figure 9. Total hourly counts of Chinook salmon passing the Big Salmon River sonar station in 2009 and the 2005 – 2009 average.

Carcass Pitch

A total of 182 carcasses was recovered during the carcass pitch. Of the 182 fish sampled, 97 (53%) were female and 85 (47%) were male. Age, length, and sex data are summarized in Table 2. The mean mid-eye fork length of females and males sampled was 822 mm and 763 mm, respectively with an overall average of 795 mm. Complete age data was determined from 144 fish sampled; the other 38 samples yielded partial ages due to regenerate scales. Age 1.4[1] (69.0%) was the dominant age class, followed by age 1.3 (23.4%) fish. Age 1.2 and age 1.5 represented 6.2% and 1.4% of the sample, respectively. Complete age, length and sex data from these fish are presented in Appendix 2.

[1] European age format; e.g. 1.4 denotes 1 year freshwater residence and 4 year marine residence.

Table 2. Age, length, and sex of Chinook sampled from the Big Salmon River, 2009.

SEX	AGE	Data	Total	% of Total
Female	1.4	Average of MEF (mm)	825	
		Count of AGE	72	50.3%
	1.3	Average of MEF (mm)	776	
		Count of AGE	6	4.1%
	1.5	Average of MEF (mm)	730	
		Count of AGE	1	0.7%
Female Average MEF (mm)			820	
Number of females			80	55.2%
Male	1.4	Average of MEF (mm)	850	
		Count of AGE	27	18.6%
	1.3	Average of MEF (mm)	715	
		Count of AGE	27	18.6%
	1.2	Average of MEF (mm)	582	
		Count of AGE	9	6.2%
	2.4	Average of MEF (mm)	840	
		Count of AGE	1	0.7%
	2.2	Average of MEF (mm)	625	
		Count of AGE	1	0.7%
Male Average MEF (mm)			753	
Number of males			65	44.8%
Average MEF both sexes (mm)			790	
Number samples aged			145	100.0%

Note: The total sample size was 182 but only 144 were fully aged, 38 samples provided partial ages and were not included in the above data.

DISCUSSION

The 2009 Eagle sonar project on the Yukon River downstream of the Canada/U.S. border yielded a border[1] escapement estimate of 61,876 Chinook salmon (JTC 2009 in prep.). The mean weighted proportional contribution of the Big Salmon River stock based on GSI samples obtained from drift net sampling at the Eagle sonar site was 16.9%, (SD 3.6). 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 54,875 (95% CI +/- 17,923). The 2009 Big Salmon origin proportion (16.9%) is somewhat higher than proportions observed from Bio-Island fish wheel caught samples during the period 2005 through 2008 (10.8%, 9.7%, 10.6%, and 9.3% respectively; cited in Mercer & Wilson 2008). However, the 2009 GSI based proportion is concordant with those obtained from radio telemetry studies which ranged from 9.2% to 16.4% (Osborne et al. 2003, Mercer and Eiler 2004, Mercer 2005).

[1] Border escapement is the number of potential spawners estimated to have passed the Canada/U.S. border and entered the Upper Yukon River drainage in Canada.

The accuracy of the Big Salmon sonar counts has been discussed in detail in previous Big Salmon River sonar reports (Mercer and Wilson 2006 through 2009). Unlike the high water events experienced in 2008, the 2009 project did not encounter any significant operational problems. The rebuilt weir structures performed as expected and coupled with the existing weir material enabled the building of longer weir structures on each side of the river. This resulted in the creation of a narrower migration corridor of approximately 36 m. This precluded having to use the outermost range of the ensonified field where the target resolution is lowest in the operational field of view. The use of the 8° concentrator lens further increased the resolution and positive identification of targets in the outer limits of the sonar range.

The Big Salmon program has been ongoing annually for the past five 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. 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 in 2009. This precludes the requirement of annual land use permits and will permit the construction of upgraded and more permanent facilities at this site. This will somewhat 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. Given the probable ongoing nature of the program it is the intent of the contractor to begin construction of improved facilities in 2010.

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ACKNOWLEDGEMENTS

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Appendix 1. 2009 Big Salmon River water and weather conditions.

Date	Time	Air Temp.	Water Temp.	Water Level	Comments
18-Jul	6:00 AM	-1°C			Cool morning, hot and sunny all day
19-Jul	8:00 AM	3°C	15°C	70cm	Few clouds, sunny, slight breeze. Put in staff guage
20-Jul	9:00 AM	11°C	12°C	68cm	Overcast but warm
21-Jul	9:00 AM	6°C	11°C	65cm	Sunny and breezy with a few clouds
22-Jul	9:00 AM	8°C	12°C	64cm	Overcast and breezy
23-Jul	9:00 AM	8.5°C	12°C	62cm	Sunny, 20% cloud. Windy
24-Jul	9:00 AM	9.5°C	11°C	60cm	Sunny and breezy
25-Jul	9:00 AM	9°C	11°C	58cm	Sunny, 10% cloud
26-Jul	9:00 AM	7°C	12°C	55cm	Overcast and smoky
27-Jul	9:00 AM	10°C	12°C	54cm	Sunny and hot
28-Jul	9:00 AM	12°C	14°C	53cm	Sunny, 30% cloud, slight smoke haze
29-Jul	9:00 AM	12°C	14°C	51cm	Sunny, clear, and very hot
30-Jul	9:00 AM	13°C	15°C	49cm	Smoky but clear skies
31-Jul	9:00 AM	13°C	16°C	48cm	Sunny and hot. Clear sky
01-Aug	9:00 AM	12°C	16°C	47cm	Very smoky
02-Aug	9:00 AM	9°C	14°C	46cm	Very smoky again, low visibility, overcast, cool outside
03-Aug	9:00 AM	4°C	11°C	45cm	Cold morning, smoky
04-Aug	9:00 AM	6°C	12°C	44cm	Sun breaking through smoke, cool morning
05-Aug	9:00 AM	10°C	13°C	44cm	Sunny with some smoke to the West
06-Aug	9:00 AM	9°C	12°C	42cm	Sunny with smoke
07-Aug	9:00 AM	10°C	14°C	41cm	Rainy and overcast
08-Aug	9:00 AM	10°C	12°C	40cm	Rainy and overcast
09-Aug	9:00 AM	9°C	12°C	40cm	Partly cloudy, smoky
10-Aug	9:00 AM	6°C	12°C	41cm	Rainy and overcast
11-Aug	9:00 AM	8°C	10°C	55cm	Sun with 70% cloud
12-Aug	9:00 AM	11°C	12°C	60cm	Sunny, clear sky
13-Aug	9:00 AM	11°C	12°C	52cm	Sunny and clear
14-Aug	9:00 AM	10°C	12°C	52cm	Sunny with some cloud
15-Aug	9:00 AM	8°C	12°C	44cm	Overcast
16-Aug	9:00 AM	11°C	13°C	42cm	Windy with mixed sun and cloud
17-Aug	9:00 AM	9°C	11°C	42cm	Mostly cloud
18-Aug	9:00 AM	7°C	11°C	45cm	Overcast and rainy, rained very hard all last night
19-Aug	9:00 AM	7°C	11°C	75cm	Sunny in morning clouding over. Periods of heavy rain last night.
20-Aug	9:30 AM	9°C	11°C	74cm	Cloudy with sunny breaks, moderate rain prevous night
21-Aug	10:00 AM	10°C	11°C	65cm	Cloudy with light rain starting in morning
22-Aug	10:00 AM	12°C	11°C	62cm	Overcast
23-Aug	9:00 AM	10°C	11°C	67cm	Overcast with periods of light rain
24-Aug	-	-	-	78cm	Cloudy with rain starting in evening
25-Aug	-	-	-	-	Rain showers during the day
26-Aug	-	-	-	-	Sunny
27-Aug	-	-	-	73cm	Clear and cold overnight, mix sun and cloud during the day

Appendix 2. Age, sex, and length of sampled Chinook on the Big Salmon River, 2009.

DATE	FISH #	SEX	MEF (mm)	AGE
23-Aug	1	F	765	1.4
24-Aug	2	M	925	1.4
24-Aug	3	M	910	1.4
24-Aug	4	M	640	1.3
24-Aug	5	F	845	1.4
24-Aug	6	F	890	M4
24-Aug	7	M	860	1.4
24-Aug	8	M	765	1.4
24-Aug	9	F	825	1.4
24-Aug	10	F	835	1.4
24-Aug	11	M	845	M4
24-Aug	12	M	520	1.2
24-Aug	13	F	815	1.4
24-Aug	14	M	910	1.4
24-Aug	15	M	745	1.3
24-Aug	16	M	550	1.2
24-Aug	17	F	840	1.4
24-Aug	18	M	870	1.4
24-Aug	19	M	815	1.4
24-Aug	20	M	855	1.3
24-Aug	21	M	800	
24-Aug	22	F	875	1.4
24-Aug	23	M	815	M4
24-Aug	24	M	630	1.3
24-Aug	25	F	835	1.4
24-Aug	26	M	720	1.3
24-Aug	27	F	840	M4
24-Aug	28	F	805	1.4
24-Aug	29	M	600	1.2
24-Aug	30	M	890	1.4
24-Aug	31	F	765	1.4
24-Aug	32	F	810	1.4
24-Aug	33	M	765	1.4
24-Aug	34	F	820	1.4
24-Aug	35	F	800	1.4
24-Aug	36	F	890	1.4
24-Aug	37	M	875	1.3
24-Aug	38	F	795	1.4
24-Aug	39	F	805	1.4
24-Aug	40	M	810	1.4
24-Aug	41	M	910	1.4
24-Aug	42	M	790	
24-Aug	43	M	885	M3
24-Aug	44	F	755	1.4
24-Aug	45	F	895	1.4

DATE	FISH #	SEX	MEF (mm)	AGE
25-Aug	46	M	775	1.3
25-Aug	47	F	780	1.4
25-Aug	48	M	895	1.4
25-Aug	49	M	640	1.3
25-Aug	50	F	790	1.4
25-Aug	51	M	865	M4
25-Aug	52	M	755	1.4
25-Aug	53	F	785	1.4
25-Aug	54	F	820	1.4
25-Aug	55	F	830	1.4
25-Aug	56	M	645	1.3
25-Aug	57	F	815	1.4
25-Aug	58	M	555	1.2
25-Aug	59	F	945	1.4
25-Aug	60	F	780	1.4
25-Aug	61	F	875	1.4
25-Aug	62	F	800	M4
25-Aug	63	F	795	1.4
25-Aug	64	M	665	M3
25-Aug	65	F	785	1.4
25-Aug	66	M	730	
25-Aug	67	F	760	1.3
25-Aug	68	M	965	1.4
25-Aug	69	F	795	1.4
25-Aug	70	M	850	1.3
25-Aug	71	M	895	1.4
25-Aug	72	F	780	1.4
25-Aug	73	M	750	
25-Aug	74	M	765	M4
25-Aug	75	M	885	1.4
25-Aug	76	M	885	1.3
25-Aug	77	M	665	1.3
25-Aug	78	F	840	1.4
25-Aug	79	F	835	1.4
25-Aug	80	M	660	1.3
25-Aug	81	M	840	2.4
25-Aug	82	M	585	1.2
25-Aug	83	F	790	
25-Aug	84	M	845	1.4
25-Aug	85	M	690	1.4
25-Aug	86	F	825	1.4
25-Aug	87	M	925	1.4
25-Aug	88	M	735	1F
25-Aug	89	M	880	
25-Aug	90	F	810	1F
25-Aug	91	F	800	1.4
25-Aug	92	F	915	M5
25-Aug	93	F	810	1.4
25-Aug	94	F	785	M4

DATE	FISH #	SEX	MEF (mm)	AGE
26-Aug	95	M	645	1.2
26-Aug	96	F	870	1.4
26-Aug	97	F	890	1.4
26-Aug	98	M	695	1.3
26-Aug	99	F	805	1.4
26-Aug	100	F	790	1.4
26-Aug	101	F	820	M4
26-Aug	102	M	815	1.4
26-Aug	103	F	820	1.4
26-Aug	104	M	590	1.2
26-Aug	105	M	700	1.3
26-Aug	106	M	605	1.2
26-Aug	107	F	840	M4
26-Aug	108	F	880	1.4
26-Aug	109	M	685	1.3
26-Aug	110	M	695	1.4
26-Aug	111	F	810	
26-Aug	112	M	750	1.3
26-Aug	113	F	815	1.4
26-Aug	114	M	645	1.3
26-Aug	115	M	805	M4
26-Aug	116	F	815	1.4
26-Aug	117	F	855	1.4
26-Aug	118	F	815	1.4
26-Aug	119	M	695	
26-Aug	120	M	695	1.3
26-Aug	121	M	810	1.4
26-Aug	122	M	795	1.4
26-Aug	123	F	810	1.4
26-Aug	124	F	810	1.4
26-Aug	125	F	830	1.4
26-Aug	126	F	825	M4
26-Aug	127	F	845	1.4
26-Aug	128	F	820	1.4
26-Aug	129	F	880	M4
26-Aug	130	M	695	M3
26-Aug	131	F	845	1.4
26-Aug	132	F	785	1.3
26-Aug	133	F	770	1.4
26-Aug	134	F	795	1.4
26-Aug	135	F	830	1.4
26-Aug	136	F	805	1.4
26-Aug	137	F	845	1.3
26-Aug	138	F	805	M4
26-Aug	139	F	870	1.4
26-Aug	140	F	800	1.4
26-Aug	141	F	905	1.4
26-Aug	142	F	850	1.4
26-Aug	143	F	805	1.4

DATE	FISH #	SEX	MEF (mm)	AGE
26-Aug	144	M	715	1.3
26-Aug	145	F	775	1.4
26-Aug	146	F	865	
26-Aug	147	M	925	M3
26-Aug	148	F	845	1.4
26-Aug	149	M	975	1.4
26-Aug	150	M	855	1.3
26-Aug	151	F	815	M4
26-Aug	152	F	740	1.3
26-Aug	153	M	705	1.3
26-Aug	154	F	820	
26-Aug	155	M	600	1.3
26-Aug	156	F	850	1.4
26-Aug	157	F	860	1.4
26-Aug	158	F	875	1.4
26-Aug	159	M	885	M4
26-Aug	160	M	585	1.2
26-Aug	161	M	695	1.3
26-Aug	162	M	855	1.4
26-Aug	163	M	675	1.3
26-Aug	164	M	715	M4
26-Aug	165	F	815	1.4
26-Aug	166	F	730	1.5
26-Aug	167	F	835	1.4
26-Aug	168	M	670	1.3
26-Aug	169	F	880	1.4
26-Aug	170	F	840	1.4
26-Aug	171	F	790	M4
26-Aug	172	F	745	1.3
26-Aug	173	M	645	1.3
26-Aug	174	M	845	M4
26-Aug	175	M	825	M4
26-Aug	176	F	875	1.4
26-Aug	177	F	780	1.3
26-Aug	178	F	835	1.4
26-Aug	179	F	795	1.4
26-Aug	180	M	885	1.4
27-Aug	181	M	625	2.2
27-Aug	182	M	840	1.4

Appendix 3. Daily and average Chinook salmon counts in the Big Salmon River, 2005-2009.

DATE	Daily Count 2005	Daily Count 2006	Daily Count 2007	Daily Count 2008	Daily Count 2009	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	**10**
21-Jul	36	3	7	0	47	**19**
22-Jul	58	8	11	0	68	**29**
23-Jul	92	11	18	1	85	**41**
24-Jul	130	21	26	2	135	**63**
25-Jul	158	20	52	1	201	**86**
26-Jul	204	53	88	3	226	**115**
27-Jul	219	95	153	5	346	**164**
28-Jul	287	146	237	9	498	**235**
29-Jul	290	230	287	9	532	**270**
30-Jul	299	321	337	29	594	**316**
31-Jul	279	368	400	21	808	**375**
01-Aug	333	357	435	23	578	**345**
02-Aug	346	379	331	18	715	**358**
03-Aug	303	358	304	16	725	**341**
04-Aug	292	413	258	31	595	**318**
05-Aug	331	496	210	51	559	**329**
06-Aug	214	490	178	55	452	**278**
07-Aug	188	464	147	78	364	**248**
08-Aug	232	464	59	61	295	**222**
09-Aug	234	360	74	70	270	**202**
10-Aug	203	349	90	98	209	**190**
11-Aug	124	348	82	122	183	**172**
12-Aug	126	324	98	107	146	**160**
13-Aug	125	243	77	109	118	**134**
14-Aug	72	196	74	89	117	**110**
15-Aug	57	180	66	78	65	**89**
16-Aug	40	172	56	70	55	**79**
17-Aug	53	104	40	49	63	**62**
18-Aug	47	69	64	45	55	**56**
19-Aug	35	87	37	17	43	**44**
20-Aug	29	59	47	18	35	**38**
21-Aug	26	45	11	15	28	**25**
22-Aug	19	50	16	16	14	**23**
23-Aug	17	12	23	9	4	**13**
24-Aug	13	10	17	2		**11**
25-Aug	9		14	1		**8**
26-Aug	6		14			**10**
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**	

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