2016 Pelly River Chinook Salmon Sonar Program

Prepared For
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EXECUTIVE SUMMARY

In 2016, Selkirk First Nation conducted the first year of a Chinook salmon sonar enumeration program at a location on the Pelly River approximately 24 km downstream of the community of Pelly Crossing, Yukon. The objectives of this project were to enumerate Chinook salmon in the lower Pelly River, conduct test netting to confirm sonar counts between Chinook and other fish species, to collect age, sex and length data from captured Chinook and to build capacity for sonar and fisheries research projects in Pelly Crossing.

Two Simrad EK60 split-beam sonar systems were used to enumerate Chinook salmon passing the sonar site from July 1 to August 3, 2016. In conjunction with the sonar data collection, set netting and drift netting were conducted near the sonar site to determine the extent of the utilization of sonar site by adult freshwater fish during the period of operation. A local Selkirk First Nation technician assisted with much of the field work for this program, and received technical training related to the operation of a split-beam sonar, fisheries data management, and test netting.

A net upstream total of 4,633 fish targets were counted during the period of operation of this program. Set netting from July 3 to August 2 captured a total of 16 Chinook salmon, 4 adult freshwater fish and no chum salmon. Drift netting was conducted from July 21 to August 2 to specifically target early migrating chum salmon; no chum salmon were captured. It is believed that no co-migrating chum salmon occurred during operation of the sonar program. Test netting data indicated that adult freshwater fish were present in small numbers relative to the amount of migrating Chinook salmon.

Post-season interpolation of missing data periods increased the net upstream Chinook salmon passage estimate to 4,800 for the period from July 1 to August 3. Given the 2016 Pelly River sonar program was a pilot project, capturing the end of the Chinook run was not an objective of the 2016 sonar program. After reviewing the sonar count data, it is presumed that a significant portion of the end of the run was not covered by this program. Run expansion of the Chinook sonar counts was conducted and estimated that an additional 1,007 Chinook salmon migrated past the sonar site after program operations ceased on August 3. Including run expansion data, a final interpolated estimate of 5,807 Chinook salmon migrated past the Pelly River sonar site in 2016.

ACKNOWLEDGEMENTS

Funding for this project was provided by the Yukon River Panel Restoration and Enhancement Fund. Eugene Alfred and Jennifer Lee of the Selkirk First Nation Government provided general project direction and assistance with logistics. Trix Tanner and Elizabeth MacDonald (Fisheries and Oceans Canada) provided technical support during this project. Local field crew members Daniel Jules, Delaney Alfred, Jimmy Hager, Thor Harper, and Jimmy Simon provided field support to ensure the project's success. Ben Snow (formerly with EDI) was the lead project biologist and provided technical and logistical support throughout the entire project duration.

AUTHORSHIP

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1 INTRODUCTION

Information on background, objectives, and study area are presented in the following sections.

1.1 BACKGROUND

The Pelly River is major tributary to the Yukon River and supports the Selkirk First Nation's (SFN) Chinook salmon (*Oncorhynchus tshawtychya*) fishery. This river is a large contributor of Canadian origin Yukon River Chinook salmon as determined from genetic sampling at the Eagle, Alaska sonar site just downstream of the Canada/U.S. border. Genetic samples collected at the border indicates that on average, 12.9% of the Chinook salmon entering the Canadian portion of the Yukon River are destined for spawning areas within the Pelly River[1] (JTC 2016).

A Chinook salmon enumeration weir on Blind Creek (near Faro, Yukon) provides an index of escapement on an important spawning tributary to the upper Pelly River; however, the weir is located approximately 350 km upstream of the community of Pelly Crossing and does not provide an in-season estimate of Chinook salmon in the Pelly River downstream of Pelly Crossing (hereafter referred to as the lower Pelly River). Until this sonar program, there was no stock assessment of Chinook salmon in the lower Pelly River to gauge the accuracy of the estimate produced through genetic stock identification. The results of genetic analyses are not available until after the Chinook run has finished; therefore, this technique cannot be used to manage harvest in-season. Current in-season harvest management is dictated by the Canada/U.S. border escapement estimates. This system does not allow for localized management of specific salmon stocks that may have higher or lower returns than what is indicated by the border estimates.

SFN has taken an active role in the management and conservation of Chinook salmon in the Pelly River through a locally developed Salmon Management Plan. A significant component of the plan includes developing an SFN operated stock assessment program for Chinook salmon on the Pelly River. In support of this goal, SFN located a candidate site in 2015 and completed the first season of sonar enumeration for Chinook salmon from July 1 to August 3, 2016 (this project). This was the first year the sonar program operated and was a pilot project to determine the feasibility of enumerating Chinook salmon at this location.

1.2 OBJECTIVES

SFN is committed to improving the management capacity for Chinook salmon in the Pelly River. SFN applied for and received funding from the Yukon River Panel's Restoration and Enhancement Fund to complete the 2016 Chinook salmon sonar enumeration program. The field portion of this program was planned for up to six weeks and was conducted from the end of June to early August. The primary objectives of the 2016 Pelly River Chinook salmon sonar program were to:

[1] Proportion of Canadian origin Chinook salmon destined for the Pelly River averaged 12.9% from 2008 to 2014; the minimum and maximum range was 9.3% to 23.9%, respectively, since 2005; and was 18.2% in 2015 (JTC 2016).

- Provide an accurate, in-season and post season estimate of Chinook salmon passage at the selected sonar site over a five to six week period during the Chinook salmon run;
- Provide local capacity building, including technical training and full-time employment for a local community member for approximately six weeks; and
- Conduct test netting to confirm species in the sonar count data between Chinook salmon and all other fish species (including chum salmon [*Oncorhynchus keta*] and larger freshwater fish species).

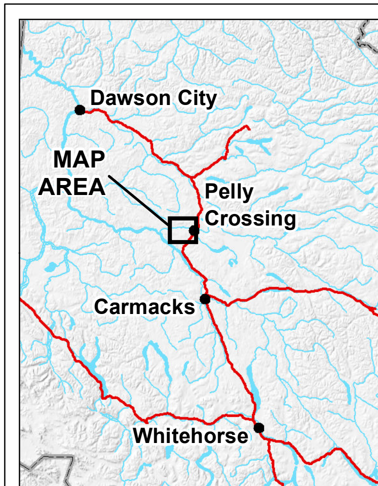
Additional objectives of the project include:

- Collect age, sex and length (ASL) data from Chinook salmon that are captured in the test fishery; and
- Foster a stronger understanding of the Chinook salmon run in the community through community engagement.

1.3 STUDY AREA

The Pelly River is a large tributary in the Yukon River Watershed (Map 1). It joins the Yukon River just upstream of the settlement Fort Selkirk, Yukon. The Pelly River has a number of large tributaries, including the Macmillan, Tay, Lapie, and Ross rivers. Communities located within the Pelly River watershed include Pelly Crossing, Faro, and Ross River. Pelly Crossing has a population of approximately 300.

The Pelly River Chinook salmon sonar site (Pelly River sonar site) is located in the lower Pelly River approximately 24 km downstream of the community of Pelly Crossing and 12 km upstream of the Pelly River Farm; 24 km upstream from the confluence of the Pelly and Yukon Rivers (Map 1). This location was selected following a 2015 study that evaluated a number of potential sonar sites in the lower Pelly River (EDI 2015). Cross-sectional bathymetry showed that the site was suitable for the operation of sonar, with a shallow and even sloped river bottom on both the right and left banks of the site.



Legend

- Left downstream bank sonar transducer
- Right downstream bank sonar transducer
- Major Road
- Secondary Road

Overview of the 2016 Pelly River Chinook Salmon Sonar Program - Site Location

Data Sources
1:50,000 and 1:2,000,000 Topographic Spatial Data courtesy of Her Majesty the Queen in Right of Canada, Department of Natural Resources. All Rights Reserved.

Digital Elevation Model and 1:50,000 National Topographic Database (NTDB) provided by Geomatics Yukon - Yukon Government via online source (Corporate Spatial Warehouse) www.geomaticsyukon.ca.

Project data displayed is site specific. Data collected by EDI Environmental Dynamics Inc. (2016) was obtained using Garmin GPS technology.

Disclaimer
This document is not an official land survey and the spatial data presented is subject to change.

0 1 2 3 4 5
Kilometres
Map scale 1:150,000 (printed at 8.5x11)
Map Projection: NAD 1983 UTM Zone 8N

Drawn: HG	Checked: MP/JL	Date: 1/25/2017	MAP 1

EDI

Path: O:\2016\16Y0137_PellyRiverSonar\Mapping\FinalMaps\Map1_PellySonar_Overview.mxd

2 METHODS

Methods are presented by project component in the below sections.

2.1 FIELD CREW AND CAMP SETUP

A crew of three people travelled to the Pelly River sonar site on June 27, 2016, to construct the field camp. This crew consisted of a technician from EDI Environmental Dynamics Inc. (EDI) and two local SFN technicians. The EDI project biologist later joined the crew to setup the sonar equipment.

Following initial setup, an EDI technician and a local SFN technician conducted the day to day operations of the field program, with offsite support from EDI biologists in Whitehorse. EDI staff operated on a rotation-based schedule for the duration of the program.

2.2 SONAR DEPLOYMENT

Two Simrad EK60 split-beam sonar systems were deployed on the left and right banks of the Pelly River sonar site (one system on each bank). The sonar systems were deployed across the river from one another. Each Simrad sonar system consisted of a sonar transducer, power/data cable and command module. The Simarad power/data cable carries the sonar data from the submerged transducers to the command module, which is located onshore and allows for control of the system power (on/off switch) and interfacing with a laptop computer through an Ethernet cable connection. The Simrad transducers were affixed to an aluminum 'goal post' type mount, which was purchased and custom built in Whitehorse for this project. The mount allowed for easy adjustment of the transducer pitch and depth within the water column.

On each bank of the river, sonar data was transmitted from the Simrad command module to a laptop computer, to allow for data capture and review. On the left bank (when looking in a downstream direction), the command module was connected to the laptop computer by wired Ethernet connection. On the right bank, the command module was connected to a wireless Ethernet bridge, and data was transmitted across the river wirelessly to a second laptop computer on the left bank. This configuration allowed all equipment to be operated from the left bank. The equipment was powered using one portable 2000 watt gas powered generator on each bank.

The Simrad allowed for ensonification of approximately 150 m of the river channel (50 m from the left bank, 100 m from the right bank). The width of the wetted portion of the Pelly River at the sonar site was estimated to be approximately 145 m using a range finder at the initial onset of the project, which meant the sonar systems overlapped by approximately 5 m and the entire width of the river was ensonified. Only a small section in the center of the channel was outside the area of ensonification due to a dip in the river bottom below the sonar beams.

2.2.1 TARGET TESTING

At the initial onset of sonar operation, target testing was conducted to ensure that targets in all areas of the water column were covered adequately by the sonar beam. Target testing consisted of one crew member watching the sonar screen in real time, while the other crew members drifted through the sonar beam in a boat and various distances from the sonar transducer. A reflective target (bottle filled with rocks and air) was drifted beneath the boat to determine if it could be seen on the sonar. Targets were drifted at various depths from surface to bottom. Surface detection was also confirmed by visual detection of the hull of the boat in some cases. Once complete, any major gaps in sonar coverage were noted and adjustments to the sonar aim were made where feasible.

2.2.2 FISH DEFLECTION FENCE

To ensure fish did not migrate behind the sonar emplacement, a fish deflection fence was set up to force fish away from the shore and out in front of the transducer. Flexible plastic link fencing was erected perpendicular to the river channel to extend the fence out into deeper water (to a depth of approximately 1 m; see Appendix A for site photos). The fencing was supported using steel T-rail type stakes, which were pounded into the river bed to secure the fence. After the fencing was erected, field staff keyed the bottom of the fence into the river bed material, to ensure that no salmon could pass underneath. The approximate total length of fence was 5 m on the left bank and 10 m on the right bank. The fence was deployed approximately 1 m downstream of the sonar transducer on both banks). The transducers and mounts were placed a minimum of 3 m back from the end of each fence (towards the shore) to ensure that all fish passing in front of the fence were a sufficient distance away from the face of the transducer to allow them to be easily detected.

2.2.3 SONAR SOFTWARE SETUP AND DATA COLLECTION

The proprietary data collection software for the Simrad sonar system, Simrad EK60 Scientific Echo Sounder (version 2.4.0), was used to control the operation of the two sonars and to record all collected sonar data. The relevant settings of this software that were used during this project are shown in Table 1. Both Simrad sonars were set to record data continuously (24 hours per day), and all sonar data was recorded to a network-attached storage (NAS) drive. Data recorded to the NAS drive was stored on two 3 TB hard drive, which was configured in a mirrored RAID-array, to ensure data redundancy. This array ensured that all recorded sonar data was secured in the event of a hard drive failure.

The sonar systems were powered on after the initial setup was completed, the sonar aim was checked, and fine scale pitch and depth adjustments were made to optimize the sonar positioning. Periodic adjustments to the sonar positioning were made throughout the field program, primarily in response to changing water levels. Sonar data was collected from July 1 to August 3, 2016.

Table 1. Summary of Simrad EK60 data collection parameter values and settings used during the 2016 Pelly River Chinook salmon sonar program.

Parameters	Left Bank Sonar	Right Bank Sonar
Simrad Model	EK60	EK60
Frequency Low/High (kHz)	High (120 kHz)	High (120 kHz)
Beam Width (Horizontal/Vertical)	9º H/4.4º V	9.5º H/2.5º V
Window Range	50 m	100 m

2.3 ENUMERATION OF CHINOOK SALMON

Sonar data was reviewed using Echotastic version 3.0b1, a software package developed by Carl Pfisterer of the Alaska Department of Fish and Game. Echotastic allows for sonar data files to be reviewed and for detected fish targets to be tallied. The enumeration methods used for this project consisted of reviewing an echogram of each collected sonar file, identifying fish targets with upstream and downstream motion and tallying all such targets within each file. An explanation of the enumeration process is detailed in the following sections.

2.3.1 ECHOGRAM INTERPOLATION

An echogram is the visual representation of sonar data; it provides an image based on the intensity of returned echoes and time of reception. Echotastic provides a means to generate color echograms from recorded Simrad sonar data files. Time can be displayed on the horizontal axis of the image, and the distance from the front of the sonar transducer can be displayed on the vertical axis of the image. When using the echogram configuration described above to enumerate riverine fish, the series of horizontal lines through the Echogram indicates ensonification of the river bottom.

2.3.2 DATA PROCESSING PARAMETERS

Echotastic allows the user to specify a number of data processing options, to assist in viewing and interpreting the echogram data. A summary of the processing options used during the 2016 Chinook sonar program and the rationale for each option, are presented in Table 2. The field crew found these settings to be the most suitable for review of the collected data.

Table 2. Echotastic data processing options used during the review of sonar data collected during the operation of the 2016 Pelly River Chinook salmon sonar program.

Processing Option	Setting Used	Explanation of Setting	Rationale
Color Map	Simrad	Provides a full color spectrum picture of echogram	Ease of viewing
Color By Angle	On	Colors echogram data based on direction of horizontal travel of fish targets	Allows differentiation of upstream and downstream moving sonar targets.
Lower Threshold	-50 dB	Displays all sonar data stronger than -50 dB	Excludes sonar signals of lower intensity than -50 dB from the echogram; removes noise from image.
Color Background	Black	Displays sonar data against a black background.	Ease of viewing

2.3.3 DISTINGUISHING MIGRATING SALMON ON ECHOGRAM

Migrating salmon can be identified from Echotastic echograms based on shape and shadowing. Salmon generally appear as characteristic crescents or "wavy" traces on the echogram that are usually oriented parallel to the river current (Figure 1). This shape and orientation can aid in the separation of salmon targets from non-salmon targets. In addition to the shape, the relative size of the target on the echogram and intensity (brightness) of the trace on the echogram were also used to help distinguish between salmon and non-salmon traces; salmon traces generally being brighter and larger than freshwater fish. Larger salmon also block a portion of the sonar beam as they travel through it, causing a shadowing of the area of the echogram directly behind the fish. Shadowing is visible on an echogram as a dark vertical line behind the fish, extending away from the transducer. This shadowing effect is visible behind the fish in the example echograms in Figures 1 and 2.

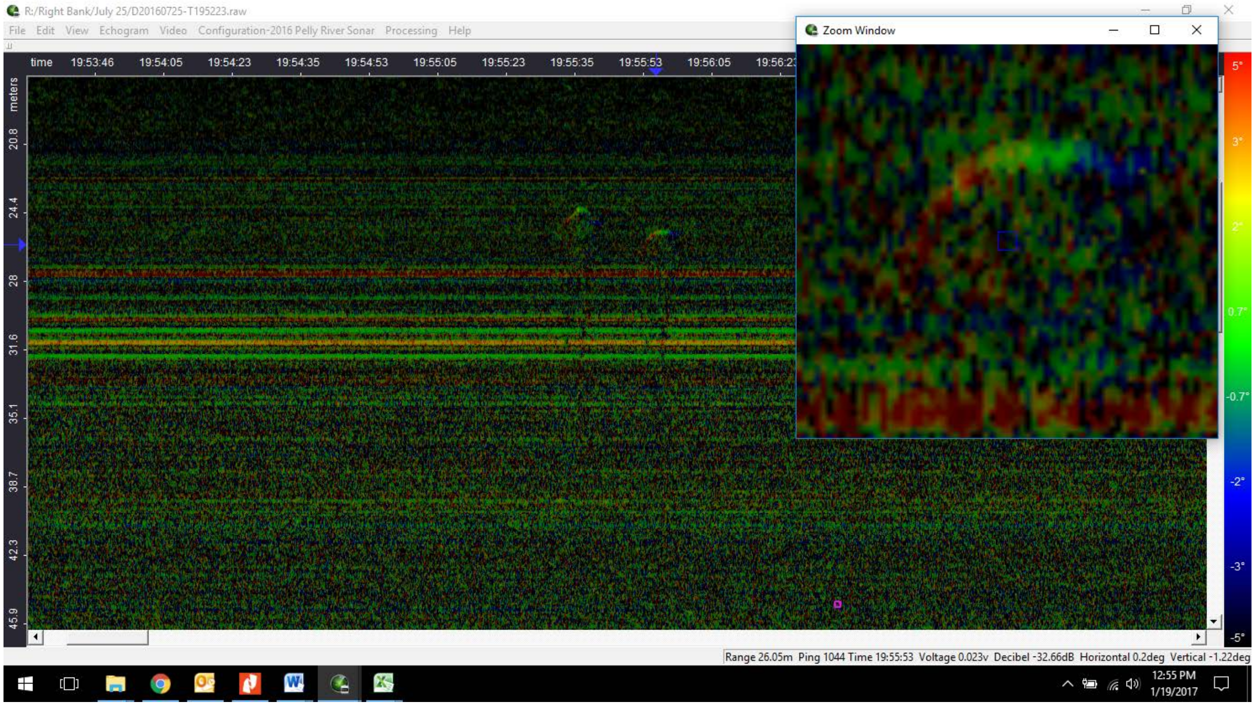


Figure 1. Echotastic echogram showing the crescent shaped sonar target and shadowing typical of a fish target. Image is from the Pelly River right bank sonar unit.

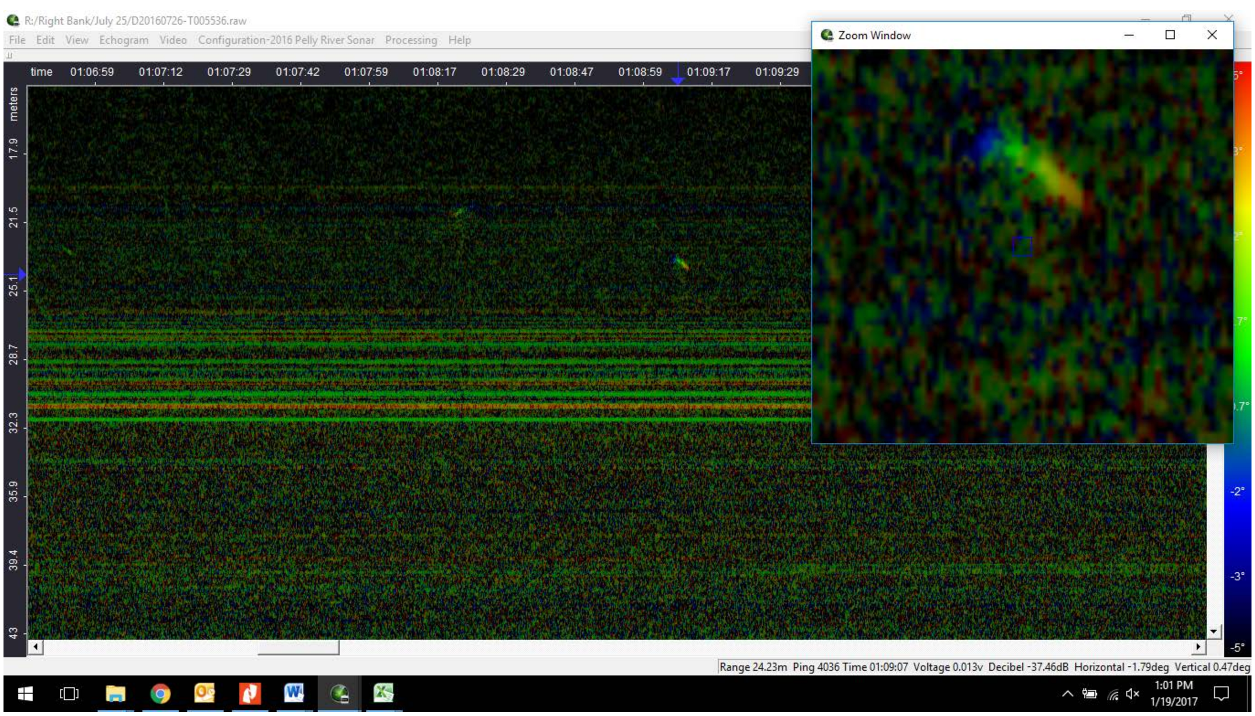


Figure 2. Echotastic echogram window showing two fish travelling in opposite directions. Note the left fish is traveling upstream and the right fish is traveling downstream. Image is from the Pelly River right bank sonar unit.

Instream debris (non-fish targets) can be distinguished from fish targets based on the fact that debris is always downstream moving with the current. Instream debris and animals such as a beaver or muskrat often shows a fainter, longer trace on the echogram than fish targets.

The ability to detect and discern fish targets is a skill that must be developed through practice; sonar technicians completed a comprehensive training module created by Whitehorse Fisheries and Oceans Canada (DFO) biologist Elizabeth MacDonald at the beginning of the season prior to reviewing the Pelly River sonar data. This training module was comprised of example data files and practice enumeration tests to develop sonar technician's ability to distinguish salmon targets, freshwater fish targets, and non-fish targets on the sonar echograms. This module was designed to help standardize the training and review techniques used across Yukon salmon sonar programs.

Staff training was supervised by an EDI biologist and all staff were tested on the training files to ensure that they could effectively differentiate between different sonar targets (salmon, freshwater fish, and instream debris). Additional training was conducted when deemed necessary by the supervising biologist. Throughout the training program, staff were encouraged to work as a team and to maintain dialogue and consultation with the project biologist if challenging and/or unclear data files were encountered during the review process. Staff were also instructed to be conservative when enumerating salmon targets; if the identity of a particular trace was still questionable after consultation with other project staff, it was not counted as a migrating salmon. The training also included basic instruction on weir building and maintenance, software and equipment troubleshooting, data entry, and other operational tasks.

2.3.4 DETERMINING DIRECTION OF TRAVEL

The direction of travel (upstream or downstream) was determined for each salmon identified during review of the collected sonar data. Direction of travel is determined by the change in the horizontal angular position of a fish as it passes through the area of ensonification, relative to the center of the acoustic beam (measured in degrees). The change of angle position for a fish moving upstream is the opposite of that for a fish moving downstream and can be used to differentiate between directions of travel.

When the reviewer enables the color by angle option in Echotastic, the echogram color scale provides a visual representation of the changes in angular position. Hot colors (reds) represent movement in one direction while cold colors (blues) represent movement in the opposite direction. In this manner, fish moving upstream can be easily identified since they possess the opposite color spectrum orientation to those fish which are moving downstream (Figure 2).

Once onsite technician(s) were confident that a detected acoustic target was a migrating salmon, the salmon target in question was marked on the Echotastic echogram. The was done by left clicking on the location of the fish on the echogram window and marking the upstream migrating salmon target with a pink square. In the same manner, if the reviewer identified a salmon target that was moving downstream, they would right click on the location of the fish, which marked the target with a blue square. Echotastic records the total number of marks in either direction. Field staff recorded these totals for each file, as well as a net total of upstream salmon migrants (total number of upstream salmon targets minus the total number of downstream salmon targets). These counts were then entered into a Microsoft Excel spreadsheet as well as a paper backup copy. Saved marks on the Echotastic echogram were then output to a text file for post-season processing and data analysis.

2.3.5 INTERPOLATION OF COUNT DATA

During the operation of the sonar program, equipment malfunctions and maintenance requirements resulted in periods when sonar data was not collected. For in-season reporting, missing data was interpolated by multiplying raw daily counts by the percentage of the day that was missing. If five hours of data was missing, data was interpolated by taking an average of the preceding and following five hours of count data. This method provided a simple means for field staff to generate preliminary adjusted counts in time for in-season updates to be delivered to fisheries managers.

Post-season (i.e. in this report), missing data was interpolated using different methods. The post-season methods of interpolation for periods when portions of a day's data were missing, followed the methods used at the Eagle sonar station in Alaska (Crane and Dunbar 2009). Three different interpolation methods were used depending on how much data was being interpolated. All three methods are detailed below (Crane and Dunbar 2009):

> "When a portion of a sample was missing, on either bank, passage was estimated by expansion based on the known portion of the sample. The number of minutes in a complete sample period (m_s) was divided by the number of minutes counted (m_i), and then multiplied by the number of fish counted (x) in that period (i). Passage (y_i) was estimated as:
>
> $$\hat{y}_i = \left(m_s / m_i\right) x_i$$
>
> If data from one or more complete sample periods was missing, passage for that portion of the day (y_m) was estimated by averaging passage from the [equivalent number of] sample periods immediately before (y_b) and after (y_a) the missing sample period(s), and then multiplying by the number of sample periods missing (n) [n is generally 1 if the equivalent number of sample periods is available]:
>
> $$\hat{y}_m = \left(\frac{y_b + y_a}{2}\right) n$$
>
> When multiple days were missing on only one side of the river, passage for the period of missing days was estimated by determining a proportion of fish passing one bank, compared to the amount of fish passing the other bank, and averaging the proportions for the amount of days missing immediately before and after the missing sample period(s)."

In cases where interpolation formulas resulted in non-integer values (i.e. counts with decimals), these values were lowered to the nearest integer value.

2.3.6 SONAR DATA QUALITY ASSURANCE/QUALITY CONTROL

To ensure a high quality data set, quality assurance and quality control (QA/QC) measures were implemented for review of the sonar files during the field component of the program. To verify that onsite staff were counting files in the same manner, sonar technicians completed a training module at the beginning of the season prior to reviewing the Pelly River sonar data to develop their ability to distinguish fish and non-fish targets on the sonar echograms. This module was created by DFO biologist Elizabeth MacDonald and was designed to help standardize the training and review techniques used across Yukon sonar programs.

Sonar technicians also reviewed a subset of each other's count data as a means to QA/QC the data in the field. Approximately 10% of the daily files (i.e. three files per bank, per day) were re-opened without saved fish marks and re-counted by the second technician onsite. Any differences in counts were recorded, but no changes were made to the original counts as the goal was to quantify person to person variability. Some subjectivity exists when interpreting sonar target data and differences in interpretation between technicians is expected; therefore it is important the counting and review process is standardized amongst technicians and sonar programs to provide the most accurate and consistent data.

2.4 TEST NETTING

The 2016 test netting program included both set netting and drift netting to confirm sonar count data between Chinook salmon, larger freshwater fish, and any other salmon species that have the potential to co-migrate with the Chinook. The test netting program included set netting during the entire program's operation to target Chinook salmon and larger freshwater fish species, while drift netting was completed only in the final two weeks of the program.

Out of respect for Doòli, SFN's way of respecting and living in harmony with the natural world, all captured fish were handled as gently and minimally as possible, quickly removed from nets, and placed in a water filled tote to recover while sampling. Scale samples were collected from all captured Chinook (three scales per individual) and delivered to DFO for processing; all salmon were sexed, measured, and released. All other captured fish were identified to species, measured and released. Both set netting and drift netting used nets that were hung at a relatively loose ratio of 3:1.

2.4.1 SET NETTING

Set netting was conducted from July 3 to August 2, 2016. Set netting was conducted on both banks of the river in the vicinity of the sonar site, however the most suitable sites were located on the right bank upstream from the sonar. Nets were set for a targeted 8 hours per day and checked on a frequent and regular basis. Net mesh sizes included 5.25, 6.75, 7.5, and 8.5 inches (13.3, 17.1, 19.1, and 21.6 cm stretch diameter) specifically to target Chinook and any larger freshwater fish. Nets were 100 feet (30.5 m) long, with mesh depths equivalent to net depths of 12 to 16 feet. Net mesh sizes were chosen to replicate the sampling methods used for the Eagle sonar program (Lozori and Borden 2015). However, a 6.5 inch mesh size is typically used at the Eagle sonar site, but due to stock availability, a 6.5 inch net would not be available prior to start of the program so the closest mesh size (6.75 inch) was purchased.

2.4.2 DRIFT NETTING

Drift netting began in the third week of the project (July 21). Although the Pelly River is not known to be a major chum salmon spawning destination, drift netting was conducted with the goal of capturing any early migrating chum salmon that may co-migrate with the Chinook salmon past the sonar site in late July/early August. Drift netting has been used successfully to capture chum salmon at the Porcupine River and Eagle sonar sites (EDI 2014; Lozori and Borden 2015). The choice of the July 21 start date for the drift netting program was based on the timing of earliest running fall chum salmon as observed at the Porcupine River sonar program near Old Crow, Yukon.

Drift netting was conducted from July 21 to August 2, 2016, in an attempt to capture any early migrating chum salmon. Drift netting was conducted closer to the left bank of the river downstream of the sonar site. The river current patterns are more laminar closer to the left bank of the river downstream of the sonar site and are better suited to drift netting than the right bank. Both onshore and offshore (mid-channel) drift netting was conducted. Onshore drifts were conducted at the edges of the river channel; one end of the net was affixed to the drifting boat while a field crew member pulled the other end downstream along the water's edge. The majority of the drift netting was conducted offshore downstream of the sonar site.

Net mesh sizes used were the same as the set netting program and included 5.25, 6.75, 7.5, and 8.5 inches. Drift nets were 100 feet long with mesh depths equivalent to net depths of 12 to 16 feet.

3 RESULTS

Results are presented by project component in the below sections.

3.1 SONAR DATA

3.1.1 RAW WEEKLY SONAR COUNTS

A summary of unadjusted, weekly sonar counts is presented in Table 3; daily count data is provided in Appendix B. The weekly net upstream count is calculated by subtracting the total weekly count of fish moving downstream from the total weekly count of fish moving upstream. A raw net total of 4,633 upstream moving fish were identified from the collected sonar data. During all program weeks, the number of fish moving upstream substantially exceeded the number of fish moving downstream (inclusive of both the right and left banks). The majority of both upstream and downstream moving fish were counted on the right bank of the sonar site (Table 3). The highest weekly upstream and downstream fish passage counts on the right bank occurred during the fourth week of program operation from July 22 to July 28. On the left bank, upstream weekly counts peaked the third week of the program from July 15 to July 21.

Table 3. Raw weekly counts of fish at the Pelly River sonar site from July 1 to August 3, 2016.

Program Week	Right Bank			Left Bank			Both Banks Combined
	Upstream	Downstream	Net Upstream Total	Upstream	Downstream	Net Upstream Total	Net Upstream Total
July 1-7[A]	41	4	37	17	2	15	52
Jul 8-14	411	14	397	171	18	153	553
Jul 15-21[B]	1153	56	1097	591	35	556	1653
Jul 22-28[C]	1433	94	1339	332	41	291	1630
Jul 29-Aug 3[D]	667	0	667	81	0	81	748
Totals	**3,705**	**168**	**3,537**	**1,192**	**96**	**1,096**	**4,633**

[A]Sonar power failure on right bank; missing data for 3 hours on July 7
[B]Sonar power failure on right bank; missing data for 1 hour on July 16
[C]Sonar shifted in the river on right bank; missing data for 3 hours on July 28
[D]Sonar shifted in the river and power failed on right bank; missing data for 3 hours on July 29, 2 hours on July 31, 8 hours August 1, 7 hours Aug 2. Includes only a partial week

Daily counts suggest the sonar site was in operation just prior to, or at the very initial onset of the Chinook migration; no Chinook were recorded on the first partial day of operation (July 1) and the total daily count for the subsequent four days was less than five upstream targets. Although the data indicates the peak (July 21) of the Chinook run had passed, the daily counts show Chinook were still migrating passed the sonar site after program operations ceased. On August 3, the final day of sonar operation, a total of 104 upstream moving Chinook were counted (Appendix B).

3.1.2 SONAR DATA QUALITY ASSURANCE/QUALITY CONTROL

The QA/QC included re-counting three sonar files (i.e. three hours of data) daily for both the left and right banks. Due to time constraints and limited field personnel in the last 16 days of the program, sonar files were unable to be reviewed on a regular basis, therefore the results of the QA/QC review is based on re-counted files completed at the beginning of the program (July 1 to 18, 2016).

A total of 104 sonar files were re-counted for QA/QC purposes; 53 on the right bank and 51 on the left bank. Of these files, five from the right bank and four from the left bank were counted differently by the technicians, resulting in a 9.4% and 7.5% difference in counts, respectively. These values included differences in counts for both upstream and downstream targets; therefore, it is difficult to judge if there would have been an under or overestimate of the overall counts. However, no significant errors in counting procedures were documented. During the initial sonar file reviews, field personnel worked together to properly identify fish targets and followed the steps outlined in the sonar training module provided by DFO to maintain consistent counting procedures throughout the entirety of the program.

3.2 TEST NETTING

3.2.1 SET NETTING

A summary of the weekly set netting sampling effort and results is presented in Table 4; daily set netting results are included in Appendix C. One set net was deployed each day of the field program; the field crew rotated through the four mesh net sizes, using a different size of net each day. A total of 180.3 hours of set netting was completed, resulting in an average of 5.8 hours per set. The majority of fish captured during the set netting program were Chinook salmon (16 or 80% of the total catch). Three inconnu (*Stenodus leucichthys*) and one northern pike (*Esox lucius*) were captured (Table 4; Appendix C). No chum salmon were captured. Freshwater fish were captured periodically throughout the set netting program, except during the first week and the fourth week (Table 4).

Table 4. Summary of weekly set netting effort and catches at the Pelly River sonar site in 2016.

Program Week	Number of Net Sets	Set Netting Effort (Hours)	Chinook Salmon Captured	Chum Salmon Captured	Other Fish Species Captured	Total Fish Captured
July 1-7[A]	4	24.5	0	0	0	0
Jul 8-14	7	48.6	3	0	1	4
Jul 15-21	9	48.8	3	0	1	4
Jul 22-28[B]	6	37.8	7	0	0	7
Jul 29-Aug 2[C]	5	20.6	3	0	2	5
Total	**31**	**180.3**	**16**	**0**	**4**	**20**

[A] No set netting on July 1, 2, and 6
[B] No set netting on July 28 due to significant debris in river
[C]No set netting on July 30

Sex ratios and fork lengths of captured Chinook during the set netting program between July 1 and August 3, 2016 were recorded (Table 5; Appendix C). The average fork length of captured male Chinook was 81.6 cm, while the fork length of the only confirmed female Chinook salmon was 86.5 cm. The sex of two Chinook was unconfirmed; the fork lengths of these two salmon were 77 cm and 74 cm. Scales were collected from all captured Chinook; at the time that this report was written, analysis of scale samples was not yet available from DFO.

Table 5. Weekly summary of sex and fork length data from Chinook salmon captured by set netting during the 2016 Pelly River Chinook sonar program.

Program Week[A]	Male			Female		
	Total Weekly Captures	% of Weekly Total	Mean Length (cm)	Total Weekly Captures	% of Weekly Total	Mean Length (cm)
Jul 8-14	2	100	74.3	-	-	-
Jul 15-21	2	100	83.0	-	-	-
Jul 22-28	7	100	86.4	-	-	-
Jul 29-Aug 2	2	67	71.0	1	33	86.5
Program Mean	**-**	**92.9**	**81.6**	**-**	**7.1**	**86.5**

[A] No Chinook were caught July 1-7; this week is not shown. Due to unknown sex, these values do not include the data for two Chinook salmon captured on July 13 and 17

3.2.2 DRIFT NETTING

A summary of the weekly drift netting sampling effort and results is presented in Table 6; daily drift netting results are included in Appendix C. A total of 91 six minute long drift net sets were completed between July 21 and August 2, 2016. This sampling included approximately 9.1 drift netting hours (Table 6). During the drift netting program, a single Chinook salmon was captured (104 cm long male on July 24; Appendix C). No other fish species were captured during the drift netting program.

Table 6. Summary of weekly drift netting effort and catches at the Pelly River sonar site in 2016.

Program Week	Number of Drift Net Sets	Drift Netting Effort (Hours)	Chinook Salmon Captured	Chum Salmon Captured	Other Fish Species Captured	Total Fish Captured
Jul 21-27	61	6.1	1	0	0	1
Jul 28-Aug 2	30	3.0	0	0	0	0
Total	**91**	**9.1**	**1**	**0**	**0**	**1**

4 DISCUSSION

Results are discussed in the following sections.

4.1 INTERPOLATION OF RUN DATA

4.1.1 INTERPOLATION OF MISSING COUNT DATA

Interpolation of several hours of missing sonar data was required due to periodic power failures with the generators and movement of the sonar systems during high water events. Interpolation was conducted according to the methods outlined in Section 2.4.5 and interpolated net upstream sonar counts were calculated for each week of program operation (Table 7). Daily interpolated count data is included in Appendix B.

After interpolating missing count data, a total of 4,800 fish were estimated to have passed the sonar site from July 1 to August 3, 2016 (Table 7). The general trends in fish passage rates and relative distribution of counts (right vs. left bank) were unchanged from the raw weekly sonar counts (Table 3). Overall, the sonar systems operated well and minimal data was interpolated during operation of the sonars. A total of 33 hours of right bank sonar data was interpolated, resulting in 158 estimated fish counts. Power failures and sonar system outages accounted for 27 hours and 129 estimated fish counts; while 6 hours and 29 estimated fish counts were a result of interpolating the remaining hours of the day on August 3 after the sonar was removed, signifying the end of the program. Only one hour of left bank data was interpolated as a result of a power failure; zero fish were estimated to have passed the sonar during that hour. Following removal of the sonar on August 3, seven hours of sonar data were interpolated, resulting in nine estimated fish counts for the left bank (Appendix B).

Table 7. Interpolated net upstream weekly counts at the Pelly River sonar site from July 1 to August 3, 2016.

Program Week	Right Bank	Left Bank	Both Banks Combined Interpolated Net Upstream Total
July 1-7	40	15	55
Jul 8-14	397	153	550
Jul 15-21	1,098	556	1,654
Jul 22-28	1,366	291	1,657
Jul 29-Aug 3	794	90	884
Totals	**3,695**	**1,105**	**4,800**

4.1.2 CHUM SALMON RUN OVERLAP

It is understood, through anecdotal information from Selkirk First Nation members that the Pelly River is not known to be a spawning destination for fall chum; however, chum are known to travel and spawn in the mainstem of the Yukon River near the confluence with the Pelly River. To accurately estimate the escapement of Chinook within the lower Pelly River, an estimate of the total chum that passed the sonar site must be subtracted from the total count of Chinook. Due to the potential for chum to be present in the Pelly River and co-migrate with the Chinook in late July/early August, drift netting was conducted as part of the test netting program to target chum. Drift netting was completed in the last two weeks of the sonar program (July 22 to August 3). No chum salmon were captured in any of the test netting, including both set and drift netting from program start to end (Appendix C).

Further supporting that chum were not likely present during operation of the Pelly River sonar program, the run timing and travel rates of chum within the Yukon River were reviewed to estimate the approximate arrival date of chum at the sonar site. The distance from the Eagle sonar site to the Pelly River sonar site is approximately 456 km. The travel rate for chum has been estimated at 29 miles per day (46.7 km/day) (Zuray 2015). The fall chum count began at the Eagle sonar site on August 18, 2016 with a daily count of 80 chum (ADF&G 2017). Based on this information, the first arrival of chum at the Pelly River sonar site is estimated to be approximately August 25 to 28.

For the purposes of estimating the final Chinook counts to the end of the migration after the sonar program was no longer operating, it has been assumed that no chum were present during operation of the 2016 Pelly River sonar program and that all net upstream sonar targets counted and estimated were enumerated as Chinook salmon.

4.1.3 FINAL CHINOOK SALMON PASSAGE ESTIMATE

Given the 2016 Pelly River sonar program was a pilot project, capturing the end of the Chinook run was not an objective of the 2016 sonar program; however, calculating the estimated post-season total escapement of Chinook salmon in the lower Pelly River was one of the goals of the program. In subsequent years, the end date for the Pelly River sonar program will be refined as the Chinook migration at the sonar site is better understood.

Expansion of Chinook counts for the period prior to the beginning of this project (i.e. late June) was not required as the program effectively captured the beginning of the run. Following a discussion with DFO, it was suggested that the 2016 Blind Creek weir (located upstream of the sonar site) data be reviewed to estimate the final date that Chinook salmon would have passed the Pelly River sonar site. However, the 2016 weir operation ceased prior to the end of the Chinook run so an average end date of August 17 was calculated using count data from 1998 to 1999 and 2003 to 2016 (Wilson 2017). Given the estimated 6 days for Chinook to travel from the Pelly River sonar site to the Blind Creek weir[2], the approximate date of the last Chinook to pass the Pelly River sonar site would have been August 11, 2016. However, local and traditional knowledge of the Chinook timing and migration within the lower Pelly River suggests the

[2] Chinook salmon travel rates are estimated at 38 miles/day (61.2 km/day) (Zuray 2015). The Pelly River sonar site is located approximately 350 km downstream from the Blind Creek weir, resulting in approximately 6 days for Chinook salmon to travel between these two sites.

Chinook run extends past August 11 and typically finishes between August 15 and 22 (Alfred pers. comm. 2017).

Instead, the final passage date of Chinook for the Pelly River sonar site was chosen by comparing to the Chinook counts recorded at the Eagle sonar site since the migration patterns at these two sites followed similar patterns throughout the season. It was noted that the peak in daily counts at the Pelly River sonar site generally occurred seven days after the peak daily count at the Eagle sonar site. In addition, a pulse was observed later in the season at both sonar sites, also occurring seven days apart. The Chinook count ended at the Eagle sonar site on August 17, 2016 with a daily count of 101 Chinook (ADFG 2017). The distance from the Eagle sonar site to the Pelly River sonar site is approximately 456 km, resulting in approximately 7.5 days travel days. The final passage of Chinook at the Pelly River sonar site is estimated to be August 24.

The preliminary period of August 4 to August 24 was used to extrapolate Chinook salmon passage rates past the end date of the 2016 sonar program (after August 3). Extrapolated Chinook counts were calculated for the period of August 4 to 24 using the following second order polynomial equation (MacDonald pers. comm. 2017):

$$y_i = \frac{L}{d^2} \times (x_i - d)^2$$

Where y_i is the *i*th daily salmon passage estimate at the sonar site, *L* is the count on the last day of the period of extrapolation, *d* is the total number of days that are being extrapolated and x_i is the number of the day that is being estimated (i.e. day number within the period of extrapolation).

A total of 1,007 Chinook are estimated to have passed the site after sonar operations ceased; the total extrapolated daily Chinook salmon passage estimates are shown below (Table 8). When added to the interpolated total estimate of 4,800 (Table 7), this post-season expansion data results in a final Chinook salmon passage estimate of 5,807. Based on the test netting data collected during the 2016 program and the local knowledge of salmon species present in the Pelly River, this estimate is fully apportioned as Chinook salmon.

Table 8. Extrapolated daily Chinook salmon counts at the 2016 Pelly River sonar site from August 4 to 24, 2016.

Date	Both Banks Combined Extrapolated Net Upstream Total
August 4	129
August 5	118
August 6	107
August 7	96
August 8	86
August 9	77
August 10	68
August 11	60
August 12	52

Date	Both Banks Combined Extrapolated Net Upstream Total
August 13	45
August 14	38
August 15	32
August 16	26
August 17	21
August 18	17
August 19	13
August 20	9
August 21	6
August 22	4
August 23	2
August 24	1
Total	**1,007**

4.2 PELLY RIVER CHINOOK SALMON MIGRATION DYNAMICS

The following sections include data on the migration dynamics observed, including run timing and run strength, bank orientation, and water levels. As this is the first year of operation for this program, the data presented in the following sections cannot yet be used to determine long-term trends, but is presented here as baseline information with the intention that these components will be further developed in future years.

4.2.1 RUN TIMING AND RUN STRENGTH

Sonar data collected during the 2016 Pelly River sonar program provides a starting point for the analysis of the lower Pelly River Chinook salmon run timing and strength and will provide important information on these aspects of the run in future years. The daily and cumulative net upstream Chinook counts are shown in Figures 3 and 4.

The first Chinook salmon recorded at the Pelly River sonar site was on July 2, 2016. During the first four days of sonar operation, less than five salmon were recorded to have passed the sonar site each day, indicating the project successfully captured the start of the Chinook run. On July 6, 2016, a small spike in the daily counts was observed and this trend continued throughout the sonar operation (Figure 3; Appendix B). The peak daily upstream count of 391 Chinook salmon occurred on July 21, 2016. The distribution of the daily counts is relatively unimodal with only one major peak in the data. While some minor pulses were observed on either end of the peak on July 21, the cumulative net upstream counts indicate the Chinook salmon passage rates were relatively consistent throughout the run (Figures 3 and 4). The final day of sonar operation (August 3, 2016) recorded a raw count of 104 Chinook salmon (with an interpolated total daily count of 142 Chinook); approximately 26% of what was observed on the day the run peaked, indicating the project did not capture a significant portion of the end of the run.

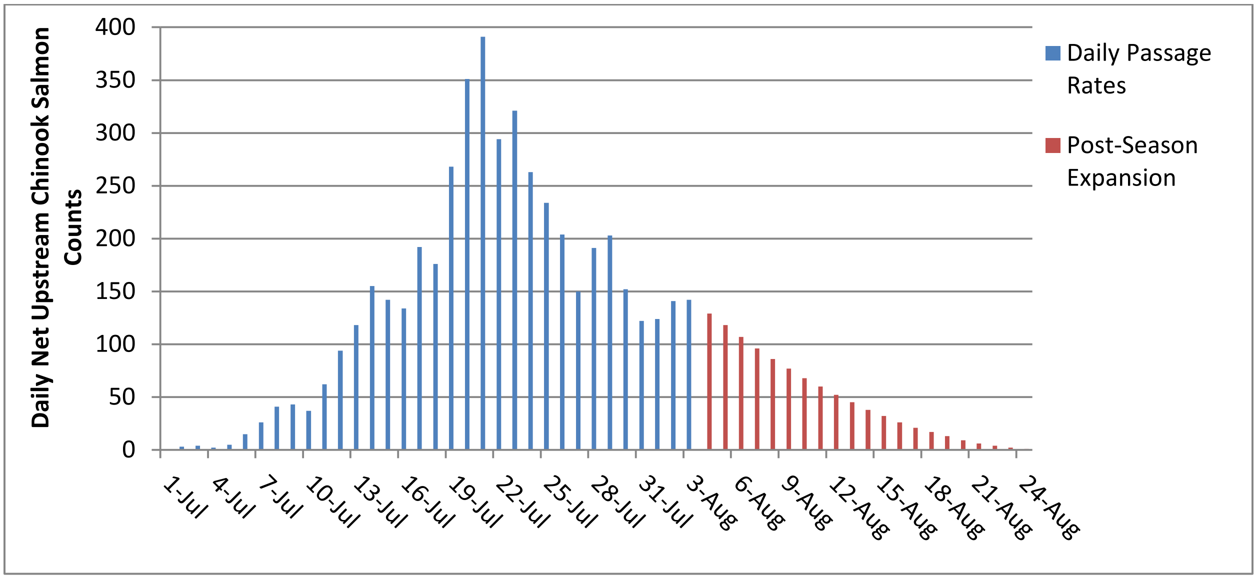


Figure 3. Daily net upstream Chinook salmon counts at the Pelly River Chinook sonar site in 2016, including the post-season extrapolated data.

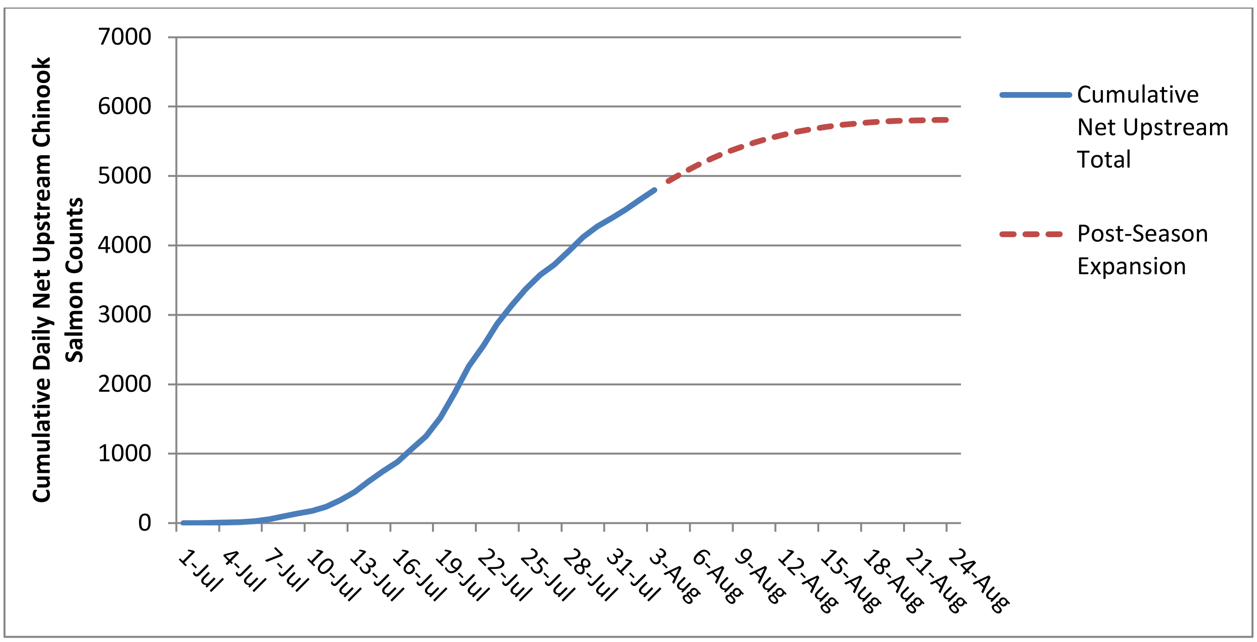


Figure 4. Daily cumulative net upstream Chinook salmon counts at the Pelly River sonar site in 2016, including post-season extrapolated data.

4.2.2 CHINOOK SALMON BANK ORIENTATION

The review of collected sonar data using Echotastic produces a text file record which includes a measurement of the distance of each fish target from the sonar transducer. This data can be used to detect patterns in fish movements; for example, whether salmon are bank oriented at a particular location within the river. The target range data was graphed separately for each bank of the river to investigate potential patterns in the movement of Chinook as they pass through the zones of ensonification on each side of the river (Figures 5 and 6). It should be noted there could be several factors that may affect the spatial migration patterns of Chinook salmon (e.g. river discharge, water clarity, water temperature). Review of the target range data is intended as a preliminary assessment of the spatial distribution of fish targets with the understanding that additional years of data collection are required to determine if identified trends are consistent over a multi-year period.

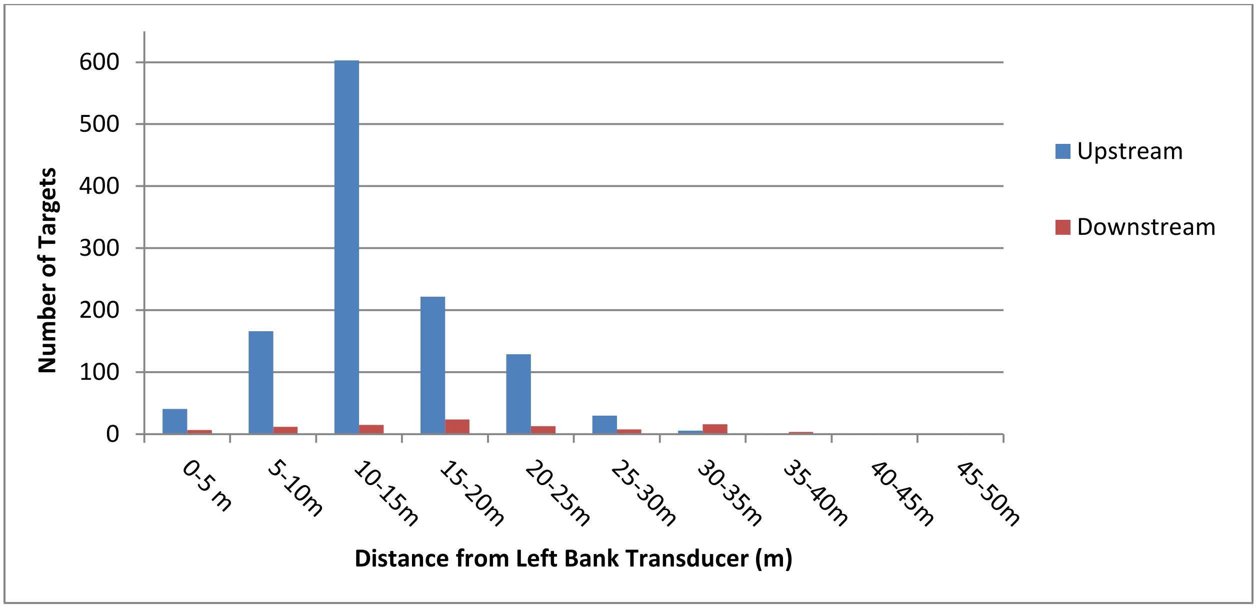


Figure 5. Ranges of upstream and downstream moving fish targets detected on the left bank of the Pelly River sonar site in 2016.

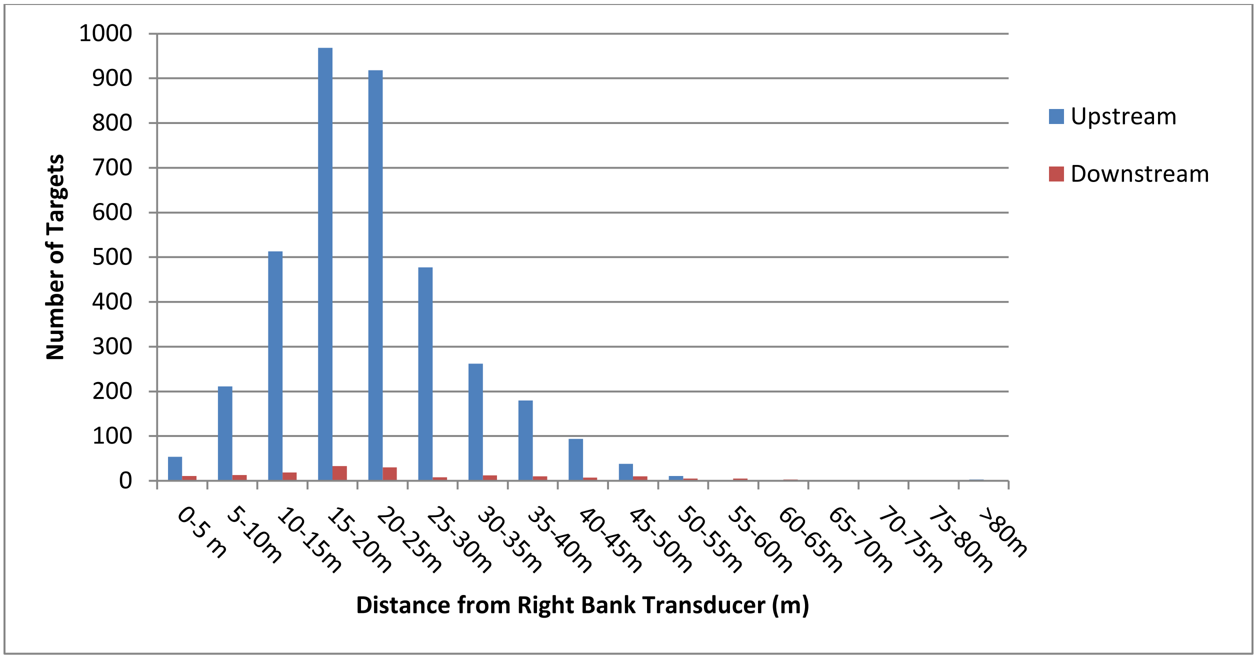


Figure 6. Ranges of upstream and downstream moving fish targets detected on the right bank of the Pelly River sonar site in 2016.

The target range data suggests that upstream migrating fish targets were strongly bank oriented in the vicinity of the Pelly River sonar site during operation in 2016. A total of 4,930 upstream moving targets were analyzed[3]; 76% were observed on the right bank and 24% on the left bank (Tables 9 and 10; Figures 5 and 6). The majority of upstream moving sonar targets were detected within 15 m and 25 m of the sonar transducers on the left and right banks, respectively. Very few (<1%) of the upstream moving targets were detected beyond 30 m from the sonar transducer on the left bank and 50 m on the right bank. Downstream moving targets also appeared to be bank oriented with the majority (63% and 71%, left and right banks, respectively) of the targets observed within 25 m of the sonar transducers (Tables 9 and 10; Figures 5 and 6).

Table 9. Ranges of upstream and downstream moving fish targets detected on the left bank of the Pelly River sonar site in 2016.

	Upstream Targets		Downstream Targets	
Target Range	Number of Targets	Proportion of Total Targets (%)	Number of Targets	Proportion of Total Targets (%)
0-5 m	41	3.4	7	7.1
5-10 m	166	13.8	12	12.1
10-15 m	603	50.3	15	15.2
15-20 m	222	18.5	24	24.2
20-25 m	129	10.8	13	13.1
25-30 m	30	2.5	8	8.1

[3] Note that 4,930 is the total raw moving target count, including upstream and downstream targets. This total is lower than what was reported in Section 3.1.1 as there is some error in saving of the text files following review of each sonar file.

	Upstream Targets		Downstream Targets	
Target Range	Number of Targets	Proportion of Total Targets (%)	Number of Targets	Proportion of Total Targets (%)
30-35 m	6	0.5	16	16.2
35-40 m	1	0.1	4	4.0
40-45 m	1	0.1	0	0
45-50 m	1	0.1	0	0
Total	**1,200**	**100**	**99**	**100**

Table 10. Ranges of upstream and downstream moving fish targets detected on the right bank of the Pelly River sonar site in 2016.

	Upstream Targets		Downstream Targets	
Target Range	Number of Targets	Proportion of Total Targets (%)	Number of Targets	Proportion of Total Targets (%)
0-5 m	54	1.5	11	6.6
5-10 m	211	5.7	13	7.8
10-15 m	513	13.8	19	11.5
15-20 m	968	26.0	33	19.9
20-25 m	918	24.6	30	18.1
25-30 m	477	12.8	8	4.8
30-35 m	262	7.0	12	7.2
35-40 m	180	4.8	10	6.0
40-45 m	94	2.5	7	4.2
45-50 m	38	1.0	10	6.0
50-55 m	11	0.3	5	3.0
55-60 m	1	<0.1	5	3.0
60-65 m	0	0	3	1.8
65-70 m	0	0	0	0
70-75 m	0	0	0	0
>80 m	0	0	0	0
Total	**3,730**	**100**	**166**	**100**

Differences in the slope of the shoreline between the left and right banks at the Pelly River sonar site were observed by the field crew (see photos in Appendix A) and were documented during the 2015 Pelly River sonar reconnaissance survey (EDI 2015). Both banks near shore were characterized by a shallow, even slope; however, the left bank was noted as being steeper than the right. The thalweg of the river at the sonar site was oriented closer to the left bank (EDI 2015), indicating flows are likely higher towards the left bank. This may have influenced the Chinook in their migration patterns as they were oriented more towards the right bank where velocities were lower.

4.2.1 PELLY RIVER WATER LEVELS

Water levels can have an important effect on salmon run timing; higher water levels and corresponding increased river discharge can slow migration rates, and vice versa. Daily water level data is recorded at a Water Survey of Canada gauging station on the Pelly River near the community of Pelly Crossing, approximately 24 km upstream from the Pelly River sonar site (Station Number: 09BC001). This station operates on a continuous basis and there are no major watercourses that enter the Pelly River between this station and the sonar site. The proximity of this station to the sonar site provides a good indication of the water level at the sonar site during summer months. The available water level data was reviewed to investigate the water levels during the operation of the sonar, as compared to the mean, minimum and maximum levels over the same period (including data from 2011 to 2016; Figure 7).

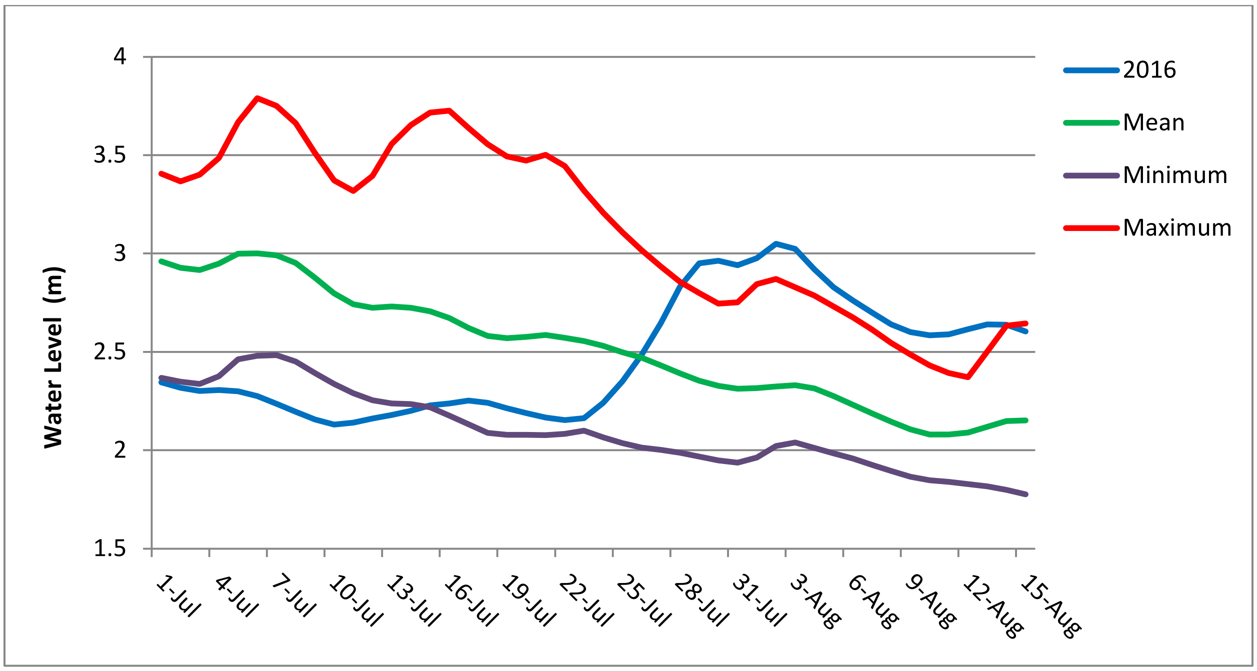


Figure 7. July 1 to August 15, 2016 Pelly River water levels as compared to the mean, minimum, and maximum daily raw water levels from 2011 to 2015. Water levels measured at Water Survey of Canada gauging station 09BC001 near the community of Pelly Crossing. Earliest year available for water levels at this station was 2011.

As shown in Figure 7, water levels in the early part of the 2016 sonar program were lower than the mean and close to the minimum water levels recorded for the same period from 2011 to 2015. In general, mean water levels during the month of July and August consistently lowered over the period of record (Figure 7). The data shows however high water events do occur during summer months. The high water event shown from around July 26 to August 5, 2016 was observed by field staff and interfered with the operation of the right bank sonar system. It was during this high water event that the side channel behind the right bank island became connected to the mainstem of the Pelly River. Water levels were sufficient to allow for the passage of salmon through the side channel behind the right bank sonar (see photos 11 and 12 in

Appendix A). As shown in Figure 7, high water events larger in magnitude than what occurred in 2016 are possible of occurring during the period of sonar operation. These high water events can be challenging for the operation of the sonar program; however, viable sonar counts can be maintained as long as field staff are alert and responsive to the changing water levels.

During the high water event from July 26 to August 5, 2016, field personnel conducted visual monitoring observations for migrating salmon in the side channel behind the right sonar system. Two set nets were deployed at the downstream extent of the side channel in an attempt to block passage of upstream migrating Chinook salmon and re-route them in front of the right bank sonar system. The width of the side channel was greater than the combined length of the nets so the entire width of the side channel was unable to be completely blocked off. No salmon were observed migrating upstream in the side channel and one northern pike was captured in the nets.

4.3 TEST NETTING EFFECTIVENESS

The 2016 Pelly River test netting program had two primary goals:

- Provide data on the extent of chum salmon co-migration, if any, during the latter part of the Chinook salmon run (after July 21); and
- Provide data on the extent of larger freshwater fish species that may be present during the Chinook salmon run (late June to early August).

The test netting program achieved both of these goals. Drift netting has been demonstrated to be effective in capturing chum salmon at other sonar projects such as the Porcupine River and Eagle sonar sites (EDI 2013; EDI 2014), provided chum are present in the river in substantial numbers. Given that no chum were captured in 91 drift net sets completed late in the sonar operation, the number of chum that co-migrated with Chinook salmon during the operational period of this program appeared to be low, if any occurred at all. This assumption is further supported by the fact that no chum salmon were captured in the set netting program. Considering the amount of drift and set netting conducted, the Chinook and chum salmon overlap was likely negligible.

With regards to the presence of larger freshwater fish species, set netting capture data provides an indication that few large freshwater fish were counted as upstream sonar targets during the period of operation of this program. Only four freshwater fish were captured during the test netting program and all other captured fish were Chinook salmon. A total of 180.3 hours of set netting between July 1 and August 2 and 9.1 hours of drift netting from July 21 to August 2 were conducted. Freshwater fish captures included three inconnu and one northern pike. Taken together, the fish capture data from the two programs shows that the numbers of Chinook salmon were far greater than comparably sized freshwater fish during the sonar operation. While it is generally understood that targeted set netting can be biased towards the species of interest (in this case Chinook salmon), the target range data from the sonar indicate the majority of observed fish targets were bank oriented. If freshwater fish were present in substantial numbers in the near shore area, they would undoubtedly have been more represented in the set netting catch data.

The life histories of the larger freshwater fish species in the Pelly River also suggest that they constitute a very small portion of the upstream moving fish observed on the sonar. Based on fish species distribution in the Yukon River, comparable sized adult freshwater fish that are likely found in the Pelly River include inconnu, northern pike, broad whitefish (*Coregonus nasus*), lake whitefish (*C. clupeaformis*), longnose sucker (*Catostomus catostomus*), and burbot (*Lota lota*) (DFO 2017). None of these species spawn during July or August (MacPhail 2007), and therefore it can be hypothesized that these species would have no reason for a directed upstream migration during the summer months. They are therefore as likely to be observed moving downstream through the sonar site as upstream and the net upstream fish passage estimate will essentially remove them from the upstream count (by subtracting the downstream count from the upstream count). By contrast, Chinook salmon migrating toward their spawning areas are far more likely to be counted as upstream moving fish targets.

4.4 DEVELOPMENT OF LOCAL CAPACITY

An important goal of the 2016 Pelly River Chinook sonar program was to continue developing local capacity within the Selkirk First Nation and community of Pelly Crossing to conduct fisheries research programs. This program provided approximately 5.5 weeks of fisheries related work for local technicians, including the opportunity to gain skills in the operation of sonar systems and conduct set and drift netting. Four local field technicians were trained and participated in this program. It should be noted that some of the technicians that participated in this program had limited fisheries related work, and this project provided all of the local technicians with their first exposure to the operation of a hydro-acoustic enumeration. There is currently a strong interest within the community of Pelly Crossing to pursue future sonar programs for Chinook salmon stock assessment purposes. The 2017 Chinook sonar program is currently proposing the use of two full time local technicians for a program 6.5 weeks in duration, further increasing capacity of local involvement. If the current Chinook sonar program develops into a permanent stock assessment initiative, there is potential for the program to eventually be run entirely using local field technicians with professional assistance and support provided as needed.

5 RECOMMENDATIONS

Overall, the 2016 Pelly River Chinook Salmon Sonar Program was successful in meeting the goals and objectives as outlined in the 2016 Pelly River Chinook Salmon Sonar Program Proposal submitted to the Yukon River Panel Restoration and Enhancement Fund. The site proved to be a suitable location for enumerating Chinook salmon with full coverage of the river during average water level conditions. A local technician was present onsite for the full duration of the sonar program (5.5 weeks) and test netting was achieved and successful at capturing Chinook and other freshwater fish species. This sonar program provided a count that is local to Pelly Crossing, is accurate, and available in-season.

Recommendations for future Pelly River Chinook salmon sonar programs include:

- Extension of the final end date for the sonar operation to at least August 15 in an attempt to capture the vast majority of the Chinook salmon migration. Extending the end date of the field program will refine the data, in particular when extrapolating the end of the Chinook migration, and provide a more accurate escapement estimate for the Chinook salmon migration, as well as help identify if a chum run is present within the lower Pelly River;
- Discuss and develop a plan with SFN and DFO that outlines how the sonar data will be used for in-season management of the Pelly River Chinook salmon, that aligns with the goals of SFN's Salmon Management Plan;
- Continue drift netting to capture any potentially co-migrating chum salmon in the next sonar year operation. EDI recommends the start date of the drift netting be adjusted to a later date to better coincide with the fall chum migration in this section of the Yukon River watershed. Consultation with DFO should be conducted prior to the start of the field component of the sonar program and the results of the fall chum counts at the Pilot, Alaska sonar station be monitored in-season for the most appropriate start date;
- Additional netting and/or fencing material should be available onsite in preparation for high water events. Fencing should be long enough to span the width of the side channel behind the right sonar system to prevent upstream fish passage during high water events;
- A new 6.5 inch net should be ordered to replace the existing 6.75 inch net for the 2017 program to replicate the methods being conducted at the Eagle sonar program. Set nets should be deployed with large, heavy anchors to allow for effective sampling in swift currents;
- Improve upon local capacity building by employing an additional technician to improve efficiency of the field crew, test netting, and timely delivery of daily sonar counts to fishery managers. SFN plans to employ an adult technician (as conducted in 2016), as well as provide a fisheries technician position specifically for a high school student to involve more local youth citizens;

- Improve the data QA/QC protocols by ensuring field personnel are regularly re-counting 10% of the daily sonar files throughout the entire duration of the sonar operation. In addition, field technicians should be sending a pre-determined subset of sonar data back to Whitehorse for review by an experienced biologist to ensure sonars are properly aimed and counts are being reviewed correctly and accurately. The data should include an equal amount of sonar files from both the left and right bank sonars. Previous discussions with DFO have already indicated DFO will be available for technical and logistical support during the 2017 Pelly River sonar program. SFN and EDI should consult with DFO regarding the feasibility of working with one of DFO's experienced sonar biologists for support in the data review and QA/QC;

- Increased community involvement through the encouragement of site visits by locals, including youth and Elders,to the sonar camp and display of the daily count updates on the Pelly Crossing community TV monitor system; and

- The local fishery should be monitored and information communicated with the EDI biologist and Pelly River sonar personnel. This will provide valuable data to assist in documenting the beginning and end of the Chinook migration in the lower Pelly River and will be used to refine the extrapolated data for more accurate total escapement estimates. Communication between SFN members and the sonar camp personnel will also assist in fostering community engagement.

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APPENDIX A. PHOTOGRAPHS

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Photo 1. View of fish deflection fence on the right bank of the Pelly River, facing upstream (July 15, 2016)

Photo 2. View of right bank fish deflection fence and sonar transducer on the Pelly River (July 11, 2016)

Photo 3. View of the right bank sonar transducer in the Pelly River, facing upstream (July 11, 2016)

Photo 4. View of the left bank Simrad transducer attached to the sonar mount (July 11, 2016)

Photo 5. View of the Pelly River Chinook sonar camp along the left bank, facing upstream (July 13, 2016)

Photo 6. View inside the sonar tent and field office (July 4, 2016)

Photo 7. View of the net storage along the left bank near camp (July 13, 2016)

Photo 8. View of a set net in an eddy located on the right bank, upstream of the sonar unit (July 8, 2016)

Photo 9. View of a male Chinook salmon captured during set netting near the sonar camp (July 18, 2016)

Photo 10. View of a Chinook salmon captured during test netting (July 21, 2016)

Photo 11. View of the right bank sonar equipment during the high water event (August 4, 2016)

Photo 12. View of the right bank island and side channel (right) during the high water event (August 4, 2016)

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APPENDIX B. RAW AND INTERPOLATED PELLY RIVER DAILY SONAR COUNTS

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Table B1. Daily raw sonar counts from the 2016 Pelly River Chinook Salmon Sonar Program.

Date	Right Bank			Left Bank			Both Banks Combined Net Total Upstream
	Upstream	Downstream	Net Total Upstream	Upstream	Downstream	Net Total Upstream	
1-Jul-2016	0	0	0	0	0	0	0
2-Jul-2016	2	0	2	1	0	1	3
3-Jul-2016	4	0	4	0	0	0	4
4-Jul-2016	1	0	1	1	0	1	2
5-Jul-2016	4	0	4	1	0	1	5
6-Jul-2016	12	1	11	5	1	4	15
7-Jul-2016	18	3	15	9	1	8	23
8-Jul-2016	30	0	30	11	0	11	41
9-Jul-2016	32	0	32	16	5	11	43
10-Jul-2016	36	2	34	5	1	4	38
11-Jul-2016	48	0	48	15	1	14	62
12-Jul-2016	74	1	73	24	2	22	95
13-Jul-2016	83	7	76	50	8	42	118
14-Jul-2016	110	4	106	50	0	50	156
15-Jul-2016	110	2	108	37	3	34	142
16-Jul-2016	73	5	68	73	8	65	133
17-Jul-2016	108	4	104	92	4	88	192
18-Jul-2016	86	1	85	100	9	91	176
19-Jul-2016	199	7	192	81	5	76	268
20-Jul-2016	278	25	253	103	5	98	351
21-Jul-2016	299	12	287	105	1	104	391
22-Jul-2016	221	13	208	98	12	86	294
23-Jul-2016	282	20	262	72	13	59	321
24-Jul-2016	269	31	238	37	12	25	263
25-Jul-2016	207	26	181	56	3	53	234

Date	Right Bank			Left Bank			Both Banks Combined Net Total Upstream
	Upstream	Downstream	Net Total Upstream	Upstream	Downstream	Net Total Upstream	
26-Jul-2016	176	2	174	31	1	30	204
27-Jul-2016	132	2	130	20	0	20	150
28-Jul-2016	146	0	146	18	0	18	164
29-Jul-2016	169	0	169	11	0	11	180
30-Jul-2016	148	0	148	4	0	4	152
31-Jul-2016	106	0	106	6	0	6	112
1-Aug-2016	71	0	71	13	0	13	84
2-Aug-2016	87	0	87	29	0	29	116
3-Aug-2016	86	0	86	18	0	18	104
Total Estimate	**3,707**	**168**	**3,539**	**1,192**	**95**	**1,097**	**4,636**

Table B2. Daily interpolated sonar counts from the 2016 Pelly River Chinook Salmon Sonar Program.

DATE	Right Bank				Left Bank				Both Banks Combined Net Total Upstream
	Raw Upstream Count	Raw Downstream Count	Upstream Interpolated	Net Total Upstream Interpolated	Raw Upstream Count	Raw Upstream Count	Upstream Interpolated	Net Total Upstream Interpolated	
1-Jul-2016	0	0	-	0	0	0	-	0	0
2-Jul-2016	2	0	-	2	1	0	-	1	3
3-Jul-2016	4	0	-	4	0	0	-	0	4
4-Jul-2016	1	0	-	1	1	0	0	1	2
5-Jul-2016	4	0	-	4	1	0	-	1	5
6-Jul-2016	12	1	-	11	5	1	-	4	15
7-Jul-2016	18	3	3	18	9	1	-	8	26
8-Jul-2016	30	0	-	30	11	0	-	11	41
9-Jul-2016	32	0	-	32	16	5	-	11	43
10-Jul-2016	34	1	-	33	5	1	-	4	37
11-Jul-2016	48	0	-	48	15	1	-	14	62
12-Jul-2016	74	1	-	73	24	3	-	21	94
13-Jul-2016	83	7	-	76	50	8	-	42	118
14-Jul-2016	110	5	-	105	50	0	-	50	155
15-Jul-2016	110	2	-	108	37	3	-	34	142
16-Jul-2016	73	5	1	69	73	8	-	65	134
17-Jul-2016	108	4	-	104	92	4	-	88	192
18-Jul-2016	86	1	-	85	100	9	-	91	176
19-Jul-2016	199	7	-	192	81	5	-	76	268
20-Jul-2016	278	25	-	253	103	5	-	98	351
21-Jul-2016	299	12	-	287	105	1	-	104	391
22-Jul-2016	221	13	-	208	98	12	-	86	294
23-Jul-2016	282	20	-	262	72	13	-	59	321
24-Jul-2016	269	31	-	238	37	12	-	25	263

DATE	Right Bank				Left Bank				Both Banks Combined Net Total Upstream
	Raw Upstream Count	Raw Downstream Count	Upstream Interpolated	Net Total Upstream Interpolated	Raw Upstream Count	Raw Upstream Count	Upstream Interpolated	Net Total Upstream Interpolated	
25-Jul-2016	207	26	-	181	56	3	-	53	234
26-Jul-2016	176	2	-	174	31	1	-	30	204
27-Jul-2016	132	2	-	130	20	0	-	20	150
28-Jul-2016	146	0	27	173	18	0	-	18	191
29-Jul-2016	169	0	23	192	11	0	-	11	203
30-Jul-2016	148	0	-	148	4	0	-	4	152
31-Jul-2016	106	0	10	116	6	0	-	6	122
1-Aug-2016	71	0	40	111	13	0	-	13	124
2-Aug-2016	87	0	25	112	29	0	-	29	141
3-Aug-2016	86	0	29	115	18	0	9	27	142
Total	**3,705**	**168**	**158**	**3,695**	**1,192**	**96**	**9**	**1,105**	**4,800**

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APPENDIX C. TEST NETTING CAPTURES

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Table C1. Set netting effort and fish captures from the 2016 Pelly River Chinook Salmon Sonar Program.

Date	Set #	Net Location	Net In	Net Out	Effort (Hours)	Mesh Size	Fish Species[A]	Length (cm)	Sex
3-Jul-2016	1	Right Bank Upstream 1	13:05	17:45	4:40	6.75	NFC	-	-
4-Jul-2016	2	Right Bank Upstream 1	14:35	18:15	3:40	8.5	NFC	-	-
5-Jul-2016	3	Left Bank Downstream	11:50	20:00	8:10	5.25	NFC	-	-
7-Jul-2016	4	Right Bank Upstream 2	10:49	13:03	2:14	7.5	NFC	-	-
7-Jul-2016	5	Right Bank Upstream 3	13:18	19:01	5:43	7.5	NFC	-	-
8-Jul-2016	6	Right Bank Upstream 3	11:20	19:08	7:48	6.75	NFC	-	-
9-Jul-2016	7	Right Bank Upstream 3	10:35	18:15	7:40	5.25	Inconnu	70.0	F
9-Jul-2016	7	Right Bank Upstream 3	10:35	18:15	7:40	5.25	Chinook	72.5	M
9-Jul-2016	7	Right Bank Upstream 3	10:35	18:15	7:40	5.25	Chinook	76.0	M
10-Jul-2016	8	Right Bank Upstream 3	14:22	16:20	1:58	8.5	NFC	-	-
11-Jul-2016	9	Right Bank Upstream 3	10:40	19:10	8:30	8.5	NFC	-	-
12-Jul-2016	10	Right Bank Upstream 1	10:54	18:50	7:56	7.5	NFC	-	-
13-Jul-2016	11	Right Bank Upstream 3	10:05	14:55	4:50	5.25	Chinook	77.0	Unknown
13-Jul-2016	11	Right Bank Upstream 3	17:24	19:20	1:56	5.25	NFC	-	-
14-Jul-2016	12	Right Bank Upstream 3	11:48	19:45	7:57	6.75	NFC	-	-
15-Jul-2016	13	Right Bank Upstream 1	10:42	13:30	2:48	7.5	NFC	-	-
15-Jul-2016	14	Right Bank Upstream 4	14:13	19:00	4:47	7.5	NFC	-	-
16-Jul-2016	15	Left Bank Upstream 1	10:45	11:52	1:07	8.5	Inconnu	-	-
16-Jul-2016	16	Right Bank Upstream 3	15:25	18:43	3:18	8.5	NFC	-	-
17-Jul-2016	17	Left Bank near Camp	11:15	18:25	7:10	5.25	Chinook	74.0	
18-Jul-2016	18	Left Bank Upstream 5	9:45	19:25	9:40	6.75	Chinook	87.0	M
19-Jul-2016	19	Left Bank near Camp	16:00	20:00	4:00	7.5	NFC	-	-
20-Jul-2016	20	Left Bank Upstream 5	9:45	17:40	7:55	8.5	NFC	-	-
21-Jul-2016	21	Left Bank near Camp	10:00	18:00	8:00	5:25	Chinook	79.0	M
22-Jul-2016	22	Right Bank Upstream 3	10:30	19:10	8:40	6.75	Chinook	89.0	M
22-Jul-2016	22	Right Bank Upstream 3	10:30	19:10	8:40	6.75	Chinook	70.0	M
23-Jul-2016	23	Left Bank Upstream 5	9:30	17:45	8:15	8.5	Chinook	94.0	M
23-Jul-2016	23	Left Bank Upstream 5	9:30	17:45	8:15	8.5	Chinook	93.0	M
24-Jul-2016	24	Left Bank near Camp	9:30	17:30	8:00	5.25	NFC	-	-

Date	Set #	Net Location	Net In	Net Out	Effort (Hours)	Mesh Size	Fish Species[A]	Length (cm)	Sex
25-Jul-2016	25	Right Bank Upstream 3	9:15	12:00	2:45	6.75	Chinook	84.0	M
26-Jul-2016	26	Right Bank Upstream 3	9:10	14:45	5:35	6.75	Chinook	91.0	M
26-Jul-2016	26	Right Bank Upstream 3	9:10	14:45	5:35	6.75	Chinook	84.0	M
27-Jul-2016	27	Right Bank Upstream 3	9:15	13:45	4:30	7.5	NFC	-	-
29-Jul-2016	28	RB Across from Camp	11:57	16:00	4:03	8.5	NFC	-	-
30-Jul-2016	29	Right Bank Downstream of Island	10:06	12:20	2:14	5.25	Northern pike	-	-
30-Jul-2016	30	Right Bank Upstream 3	13:50	18:23	4:33	5.25	NFC	-	-
1-Aug-2016	31	Left Bank Upstream 5	14:25	18:30	4:05	6.75	Chinook	86.5	F
1-Aug-2016	31	Left Bank Upstream 5	15:25	19:30	4:05	6.75	Chinook	67.0	M
2-Aug-2016	32	Right Bank Upstream 3	11:17	17:00	5:43	7.5	Inconnu	-	-
2-Aug-2016	32	Right Bank Upstream 3	11:17	17:00	5:43	7.5	Chinook	75.0	M
2-Aug-2016	32	Right Bank Upstream 3	11:17	17:00	5:43	7.5	NFC	-	-

[A]NFC = No Fish Caught

Table C2. Drift netting effort and fish captures from the 2016 Pelly River Chinook Salmon Sonar Program.

Date	Drift #	Net In	Net Out	Effort (Hours)	Mesh Size	Fish Species[A]	Length (cm)	Sex
21-Jul-2016	1	11:20	11:26	0:06	6.75	NFC	-	-
21-Jul-2016	2	11:50	11:56	0:06	6.75	NFC	-	-
21-Jul-2016	3	13:18	13:24	0:06	6.75	NFC	-	-
21-Jul-2016	4	13:38	13:44	0:06	6.75	NFC	-	-
21-Jul-2016	5	15:25	15:31	0:06	6.75	NFC	-	-
21-Jul-2016	6	15:45	15:51	0:06	6.75	NFC	-	-
21-Jul-2016	7	16:10	16:16	0:06	6.75	NFC	-	-
22-Jul-2016	1	18:06	18:12	0:06	8.5	NFC	-	-
22-Jul-2016	2	18:18	18:24	0:06	8.5	NFC	-	-
23-Jul-2016	1	11:10	11:16	0:06	7.5	NFC	-	-
23-Jul-2016	2	11:24	11:30	0:06	7.5	NFC	-	-
23-Jul-2016	3	11:42	11:48	0:06	7.5	NFC	-	-
23-Jul-2016	4	12:02	12:08	0:06	7.5	NFC	-	-
23-Jul-2016	5	13:35	13:41	0:06	7.5	NFC	-	-
23-Jul-2016	6	13:51	13:57	0:06	7.5	NFC	-	-
23-Jul-2016	7	14:00	14:06	0:06	7.5	NFC	-	-
23-Jul-2016	8	14:25	14:31	0:06	7.5	NFC	-	-
23-Jul-2016	9	15:15	15:21	0:06	7.5	NFC	-	-
23-Jul-2016	10	15:29	15:35	0:06	7.5	NFC	-	-
23-Jul-2016	11	16:10	16:16	0:06	7.5	NFC	-	-
23-Jul-2016	12	16:27	16:33	0:06	7.5	NFC	-	-
24-Jul-2016	1	9:41	9:47	0:06	6.75	NFC	-	-
24-Jul-2016	2	9:54	10:00	0:06	6.75	NFC	-	-
24-Jul-2016	3	10:07	10:13	0:06	6.75	NFC	-	-
24-Jul-2016	4	10:20	10:26	0:06	6.75	NFC	-	-
24-Jul-2016	5	10:36	10:42	0:06	6.75	NFC	-	-
24-Jul-2016	6	10:50	10:56	0:06	6.75	NFC	-	-
24-Jul-2016	7	12:30	12:36	0:06	6.75	NFC	-	-
24-Jul-2016	8	12:40	12:46	0:06	6.75	NFC	-	-
24-Jul-2016	9	12:52	12:58	0:06	6.75	Chinook	104	M

Date	Drift #	Net In	Net Out	Effort (Hours)	Mesh Size	Fish Species[A]	Length (cm)	Sex
24-Jul-2016	10	13:12	13:18	0:06	6.75	NFC	-	-
24-Jul-2016	11	13:24	13:30	0:06	6.75	NFC	-	-
24-Jul-2016	12	15:00	15:06	0:06	6.75	NFC	-	-
24-Jul-2016	13	15:14	15:20	0:06	6.75	NFC	-	-
24-Jul-2016	14	15:24	15:30	0:06	6.75	NFC	-	-
24-Jul-2016	15	15:35	15:41	0:06	6.75	NFC	-	-
24-Jul-2016	16	15:45	15:51	0:06	6.75	NFC	-	-
26-Jul-2016	1	9:45	9:51	0:06	5.25	NFC	-	-
26-Jul-2016	2	9:56	10:02	0:06	5.25	NFC	-	-
26-Jul-2016	3	10:07	10:13	0:06	5.25	NFC	-	-
26-Jul-2016	4	10:17	10:23	0:06	5.25	NFC	-	-
26-Jul-2016	5	11:16	11:22	0:06	5.25	NFC	-	-
26-Jul-2016	6	11:26	11:32	0:06	5.25	NFC	-	-
26-Jul-2016	7	11:36	11:42	0:06	5.25	NFC	-	-
26-Jul-2016	8	11:47	11:53	0:06	5.25	NFC	-	-
26-Jul-2016	9	13:45	13:51	0:06	5.25	NFC	-	-
26-Jul-2016	10	13:56	14:02	0:06	5.25	NFC	-	-
26-Jul-2016	11	14:06	14:12	0:06	5.25	NFC	-	-
26-Jul-2016	12	14:15	14:21	0:06	5.25	NFC	-	-
27-Jul-2016	1	11:25	11:31	0:06	8.5	NFC	-	-
27-Jul-2016	2	11:37	11:43	0:06	8.5	NFC	-	-
27-Jul-2016	3	11:49	11:55	0:06	8.5	NFC	-	-
27-Jul-2016	4	12:00	12:06	0:06	8.5	NFC	-	-
27-Jul-2016	5	12:12	12:18	0:06	8.5	NFC	-	-
27-Jul-2016	6	13:48	13:54	0:06	8.5	NFC	-	-
27-Jul-2016	7	14:00	14:06	0:06	8.5	NFC	-	-
27-Jul-2016	8	14:10	14:16	0:06	8.5	NFC	-	-
27-Jul-2016	9	14:20	14:26	0:06	8.5	NFC	-	-
27-Jul-2016	10	14:34	14:40	0:06	8.5	NFC	-	-
27-Jul-2016	11	14:44	14:50	0:06	8.5	NFC	-	-
27-Jul-2016	12	14:55	15:01	0:06	8.5	NFC	-	-

Date	Drift #	Net In	Net Out	Effort (Hours)	Mesh Size	Fish Species[A]	Length (cm)	Sex
28-Jul-2016	1	10:02	10:08	0:06	8.5	NFC	-	-
28-Jul-2016	2	10:14	10:20	0:06	8.5	NFC	-	-
28-Jul-2016	3	10:27	10:33	0:06	8.5	NFC	-	-
28-Jul-2016	4	10:39	10:45	0:06	8.5	NFC	-	-
28-Jul-2016	5	10:54	11:00	0:06	8.5	NFC	-	-
28-Jul-2016	6	14:08	14:14	0:06	8.5	NFC	-	-
28-Jul-2016	7	14:24	14:30	0:06	8.5	NFC	-	-
28-Jul-2016	8	14:48	14:54	0:06	8.5	NFC	-	-
28-Jul-2016	9	15:06	15:12	0:06	8.5	NFC	-	-
28-Jul-2016	10	15:17	15:23	0:06	8.5	NFC	-	-
30-Jul-2016	1	11:03	11:09	0:06	7.5	NFC	-	-
30-Jul-2016	2	11:14	11:20	0:06	7.5	NFC	-	-
30-Jul-2016	3	11:35	11:41	0:06	7.5	NFC	-	-
30-Jul-2016	4	11:48	11:54	0:06	7.5	NFC	-	-
30-Jul-2016	5	12:00	12:06	0:06	7.5	NFC	-	-
30-Jul-2016	6	14:07	14:13	0:06	7.5	NFC	-	-
30-Jul-2016	7	14:18	14:24	0:06	7.5	NFC	-	-
30-Jul-2016	8	14:29	14:35	0:06	7.5	NFC	-	-
30-Jul-2016	9	14:42	14:48	0:06	7.5	NFC	-	-
30-Jul-2016	10	14:54	15:00	0:06	7.5	NFC	-	-
2-Aug-2016	1	11:29	11:35	0:06	6.75	NFC	-	-
2-Aug-2016	2	11:41	11:47	0:06	6.75	NFC	-	-
2-Aug-2016	3	11:53	11:59	0:06	6.75	NFC	-	-
2-Aug-2016	4	12:06	12:12	0:06	6.75	NFC	-	-
2-Aug-2016	5	14:14	14:20	0:06	6.75	NFC	-	-
2-Aug-2016	6	14:26	14:32	0:06	6.75	NFC	-	-
2-Aug-2016	7	14:37	14:43	0:06	6.75	NFC	-	-
2-Aug-2016	8	14:50	14:56	0:06	6.75	NFC	-	-
2-Aug-2016	9	15:02	15:08	0:06	6.75	NFC	-	-
2-Aug-2016	10	15:13	15:19	0:06	6.75	NFC	-	-

[A]NFC = No Fish Caught