2019 Pelly River Chinook Salmon Sonar Program

Prepared For
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ENVIRONMENTAL DYNAMICS INC.
Down to Earth Biology

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EXECUTIVE SUMMARY

In 2019, Selkirk First Nation conducted the fourth year of a Chinook salmon sonar enumeration program on the Pelly River at the Pelly River Chinook salmon sonar site located 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;
- collect age, sex, and length data from captured Chinook; and
- build capacity for sonar and fisheries research projects in Pelly Crossing.

An ARIS Explorer 1200 multi-beam sonar system and an ARIS Explorer 1800 multi-beam sonar system were used to enumerate Chinook salmon passing the sonar site between July 10 and August 26, 2019. In conjunction with the sonar data collection, set netting was conducted near the sonar site to determine the extent adult freshwater fish used the sonar site during the period of sonar operation. Local Selkirk First Nation technicians assisted with the fieldwork for this program and received technical training on the operation of a sonar system, fisheries data management, and test netting.

A net raw[1] upstream total of 6,389 fish targets were counted during the period of operation of this program. Set netting between July 20 and August 8 captured a single Chinook salmon and no chum salmon or freshwater fish. It is believed that no co-migrating chum salmon were present in the area during operation of the sonar program. Sonar 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 6,641 for the period between July 10 and August 26. Run expansion of the Chinook sonar counts was conducted for pre- and post-program periods; an additional 181 Chinook salmon are estimated to have migrated past the sonar site before the field program operations, which began on July 10, and an additional 105 Chinook salmon are estimated to have migrated past the sonar site after operations ceased on August 26. Including run expansion data, a final interpolated estimate of 6,927 Chinook salmon migrated past the Pelly River sonar site in 2019.

[1] Raw total is the unprocessed field data total.

ACKNOWLEDGEMENTS

Funding for this project was provided by the Yukon River Panel Restoration and Enhancement Fund. Eugene Alfred and Ellie Marcotte of the Selkirk First Nation Government provided general project direction and assistance with logistics. Fisheries and Oceans Canada provided two ARIS Explorer sonar units in-kind to the project. Vesta Mather, Marina Milligan and Joel Harding (Fisheries and Oceans Canada) provided technical advice during this project.

AUTHORSHIP

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TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF TABLES

LIST OF FIGURES

LIST OF MAPS

ACRONYMS AND UNITS

ADFG ..... Alaska Department of Fish and Game

ASL ..... Age, Sex, Length

APE ..... Average Percent Error

DFO ..... Department of Fisheries and Oceans Canada

EDI ..... EDI Environmental Dynamics Inc.

NAS ..... Network-Attached Storage

RAID ..... Redundant Arrays of Inexpensive Disks

SFN ..... Selkirk First Nation

TB ..... Terabyte

QA/QC ..... Quality Assurance/Quality Control

SYMBOLS

°C ..... degrees Celsius

in ..... inches

m ..... metres

cm ..... centimetres

1 INTRODUCTION

The Pelly River is a major tributary to the Yukon River and supports the Selkirk First Nation's (SFN) Chinook salmon (*Oncorhynchus tshawytscha*) 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 indicate 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[2] (JTC 2016).

The Chinook salmon enumeration weir on Blind Creek (near Faro, Yukon; no longer operational) provided an index of escapement on an important spawning tributary to the upper Pelly River. However, this weir was located approximately 350 km upstream of the community of Pelly Crossing and did not provide an in-season estimate of Chinook salmon in the lower Pelly River (vicinity of Pelly Crossing). Until the establishment of the Pelly River Chinook sonar program, no stock assessment of Chinook salmon in the lower Pelly River existed 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. The first enumeration was run between July 1 and August 3, 2016, with a final Chinook salmon passage estimate of 5,807. The second season of sonar enumeration was completed between July 1 and August 15, 2017, with an estimated 9,081 Chinook salmon migrating past the sonar site. The third year of sonar enumeration estimated 9,751 from July 10 to August 25, 2018. The fourth year of the Pelly River sonar enumeration was completed between July 10 and August 26, 2019.

1.1 OBJECTIVES

SFN is committed to improving the management capacity for Chinook salmon in the Pelly River. SFN were recipients of funding from the Yukon River Panel's Restoration and Enhancement Fund to complete the 2019 Chinook salmon sonar enumeration program. The field portion of this program included up to eight weeks of enumeration completed between the beginning of July and end of August.

The primary objectives of the 2019 Pelly River Chinook salmon sonar program were to:

[2] 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).

- develop an accurate, in-season stock assessment tool to estimate the annual passage rates for Chinook salmon in the Pelly River;
- foster a stronger understanding of the Chinook salmon run in the community through community engagement; and,
- build local capacity, through technical training and full-time employment for local SFN citizens throughout the program.

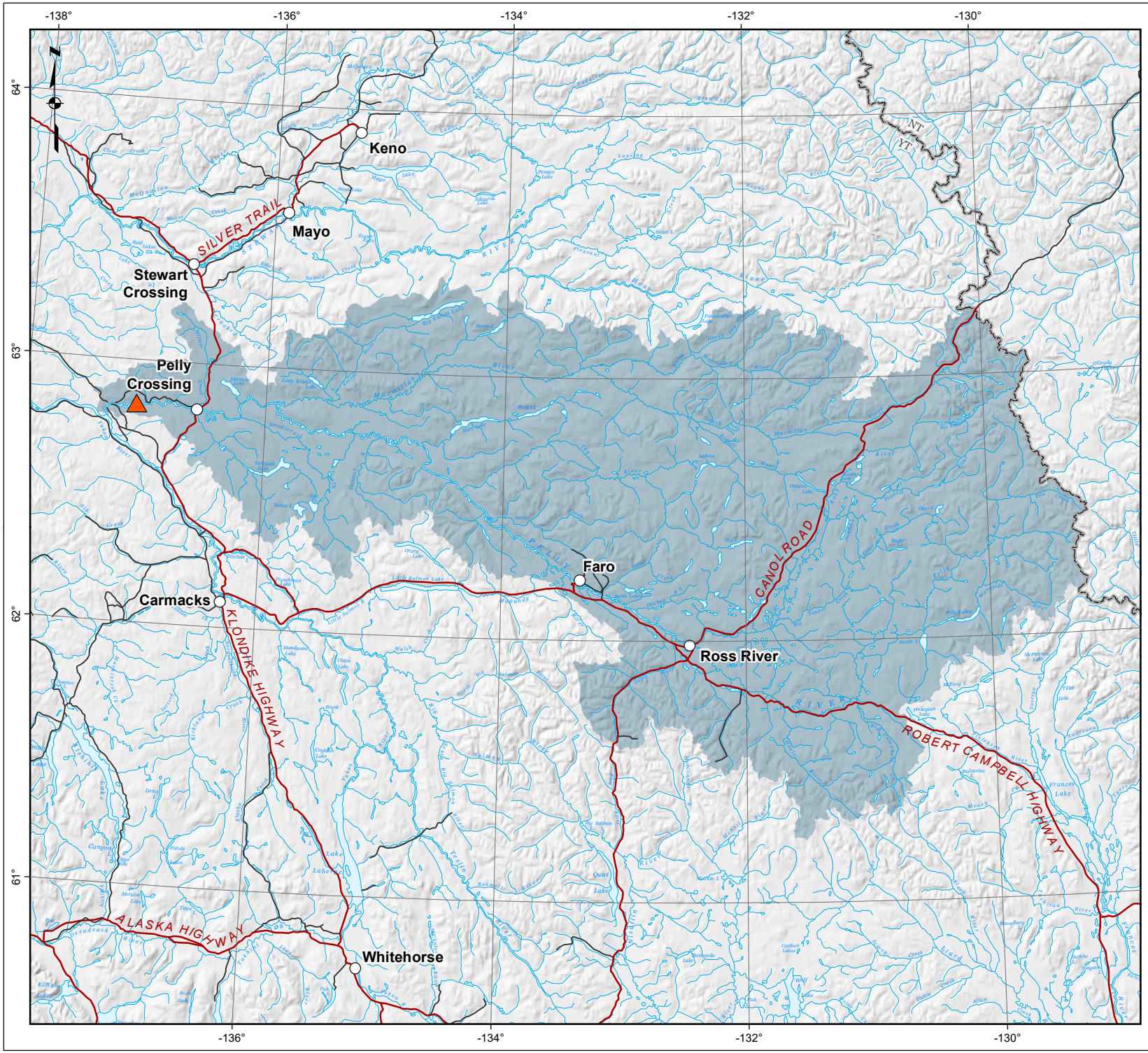
Additional objectives of the project include:

- conduct test netting to confirm the type of species in the sonar count data between Chinook salmon and all other fish species (including chum salmon [*Oncorhynchus keta*] and larger freshwater fish species); and
- collect age, sex and length (ASL) data from Chinook salmon captured in the test fishery.

1.2 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 of 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 people, the majority of which are SFN citizens.

The Pelly River Chinook salmon sonar site (Pelly River sonar site) is located on the lower Pelly River approximately 24 km downstream of the community of Pelly Crossing and 24 km upstream from the confluence of the Pelly and Yukon Rivers (Map 2). 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 data 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

- Pelly River Chinook Salmon Sonar Location
- Pelly Watershed

Overview of the Pelly Watershed

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. (2018) 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 20 40 60 80 100
Kilometres

Map scale 1:2,250,000 (printed at 8.5x11)
Map Projection: NAD 1983 Yukon Albers

Drawn:	Checked:	Date:	
HG	SC	2019-01-31	MAP 1

EDI

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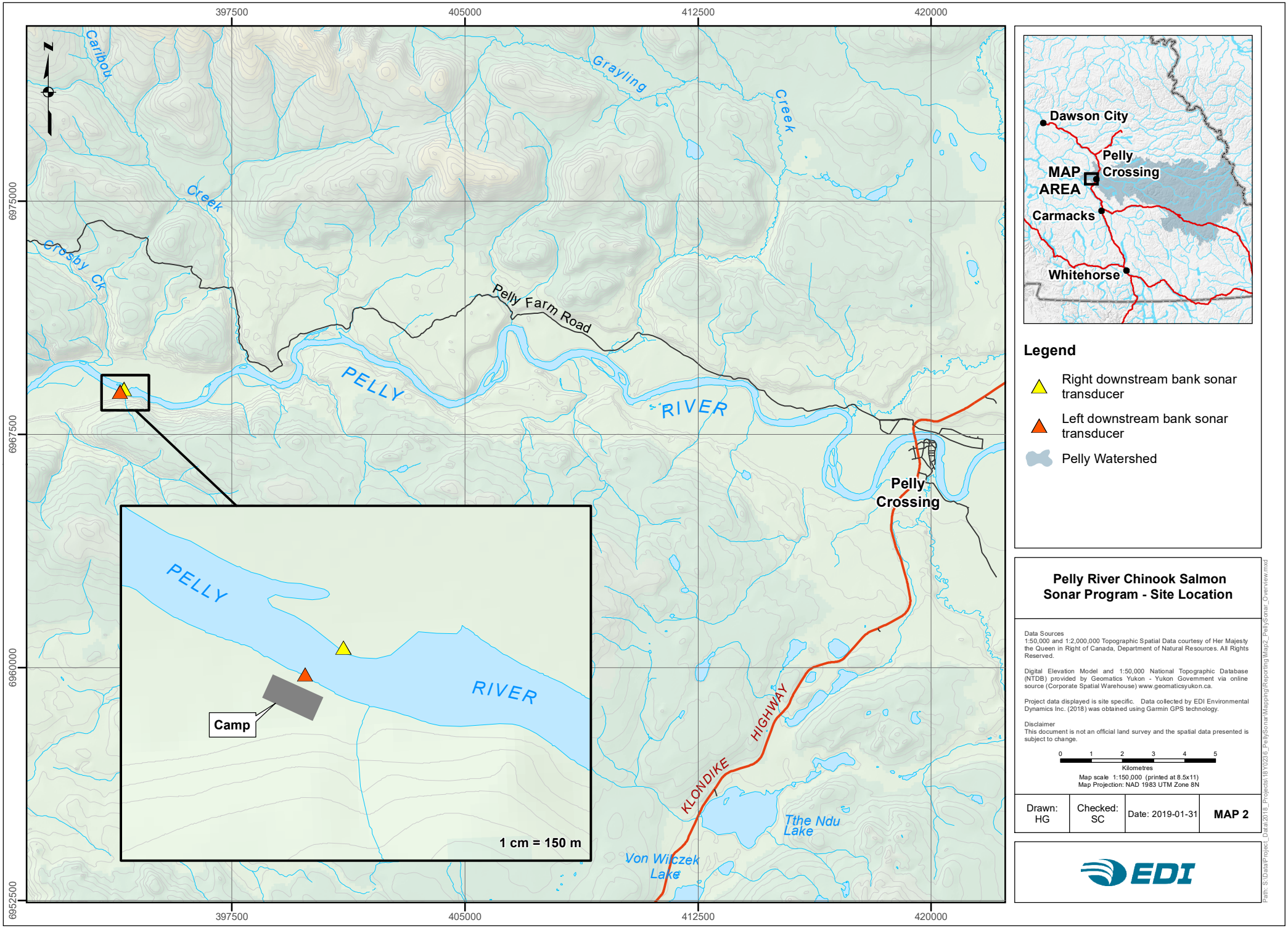

Pelly River Chinook Salmon Sonar Program - Site Location

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. (2018) 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: SC	Date: 2019-01-31	MAP 2

EDI

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2 METHODS

2.1 FIELD CREW AND CAMP SETUP

A crew of three people travelled to the Pelly River sonar site on July 4, 2019, to set up the field camp. This crew consisted of two experienced technicians from EDI as well as a local SFN technician.

Following initial setup, two EDI technicians and two local SFN technicians conducted the day-to-day operations of the field program, with offsite support from EDI biologists in Whitehorse. EDI and SFN staff operated on a rotation-based schedule for the duration of the program, with at least one EDI and SFN technician on-site at all times.

2.2 SONAR DEPLOYMENT

On July 10, 2019, an ARIS Explorer 1200 multi-beam sonar system and an ARIS Explorer 1800 multi-beam sonar system were deployed across the Pelly River from each other on the left and right banks, respectively (one system on each bank). Each sonar system consisted of a sonar transducer, power/data cable, and a command module. The power/data cable carried the sonar data from the submerged transducers to the command module, which was located on shore and allowed for control of the system power (on/off switch) as well as interfacing with a laptop computer through an Ethernet cable connection. The sonar transducers were affixed to aluminum 'goal post' type mounts, which were purchased, and custom built-in Whitehorse for this project. The mounts allowed for easy adjustment of the transducer pitch and depth within the water column.

On each bank of the Pelly River, sonar data were transmitted from the sonar 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 were 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 two portable 2000-watt gas-powered generators on each bank.

This sonar setup allowed for ensonification of approximately 90 m of the river channel (30 m from the left bank, 60 m from the right bank). The width of the wetted portion of the Pelly River at the sonar site was estimated to be approximately 130 m using a range finder at the initial onset of the project, which meant that approximately 40 m of the channel was not ensonified. The section of the river that was not ensonified was primarily across the thalweg (i.e., deepest part) of the river.

2.2.1 TARGET TESTING

At the initial onset of sonar operation, target testing was conducted to make sure 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 at various distances from the sonar transducer. A reflective target (lead downrigger weight) 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 make sure fish did not migrate behind the sonar or the ensonified area, 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 riverbed to secure the fence. After the fencing was erected, field staff keyed the bottom of the fence into the riverbed material, to make sure that no salmon could pass underneath. The approximate total length of fence was 3 to 4 m on the left bank and up to 25 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 typically placed a minimum of 2 m back from the end of each fence (towards the shore) to make sure 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 readily detected.

2.2.3 SONAR SOFTWARE SETUP AND DATA COLLECTION

The proprietary data collection software for the ARIS sonar system is ARIScope (version 2.4.7013.0), which 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 sonars were set to record data continuously (24 hours per day), and all sonar data were recorded to a NAS drive. Data recorded to the NAS drive were stored on two 4 TB drives, which were configured in a mirrored RAID-array, to provide data redundancy. This array made sure that all recorded sonar data were 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 were collected from July 10 to August 26, 2019. A total of 170 hours of data (totaled for both left and right bank sonar units) was not recorded throughout the program. Much of this missing data in 2019 was due to difficulties with network connections during the initial start-up and a faulty command

module that began to malfunction on the evening of July 14, 2019. A new command module was brought out to camp on July 17, 2019. On August 20, 2019, the crew was unable to return to camp due to mechanical issues with the boat, leaving the sonars to run out of fuel and eventually shut down. The remainder of the missing data was due to temporary generator failures, equipment maintenance and updates, sonar reposition and movement.

Table 1. Summary of ARIS Explorer 1200 and 1800 data collection parameter values and settings used during the 2019 Pelly River Chinook salmon sonar program.

Parameters	Left Bank Sonar	Right Bank Sonar
Model	ARIS Explorer 1800	ARIS Explorer 1200
Frequency Low/High (kHz)	High (1.8 MHz)/Low (1.1 MHz)	High (120 kHz)
Beam Width (Horizontal/Vertical)	8° H/14° V	9.5° H/2.5° V
Window Range	30 m	60 m

2.3 ENUMERATION OF CHINOOK SALMON

Sonar data were reviewed using Echotastic version 3.0b1, a software package developed by Carl Pfisterer of the Alaska Department of Fish and Game (ADFG). 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 colour echograms from recorded ARIS 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 2019 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 2019 Pelly River Chinook salmon sonar program.

Processing Option	Setting Used	Explanation of Setting	Rationale
Colour Map	Simrad/Amber	Provides a full colour spectrum picture of echogram	Ease of viewing, personal preference
Colour by Angle	On	Colours 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
Colour 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 are generally 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 Figure 1 and Figure 2.

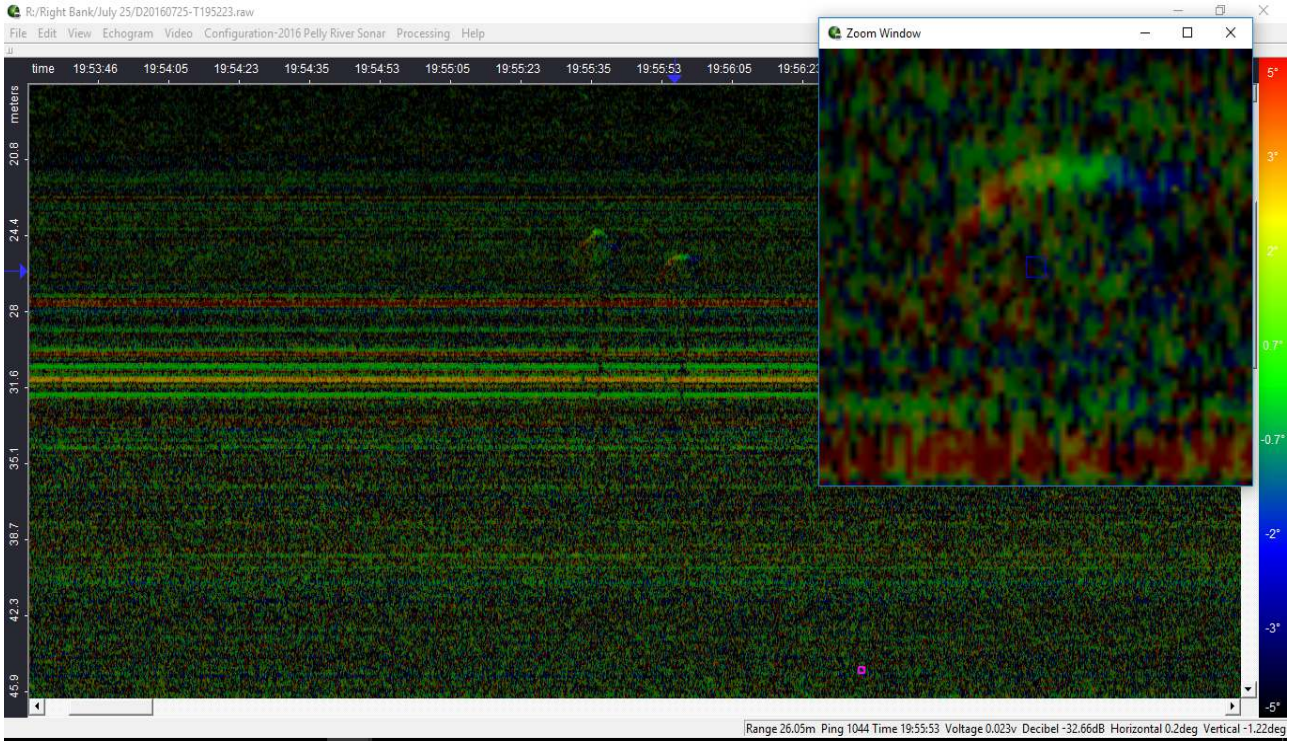

Figure 1. Echotastic echogram showing the crescent shaped sonar target and shadowing typical of a fish target. Image is from the Pelly River right bank sonar unit.

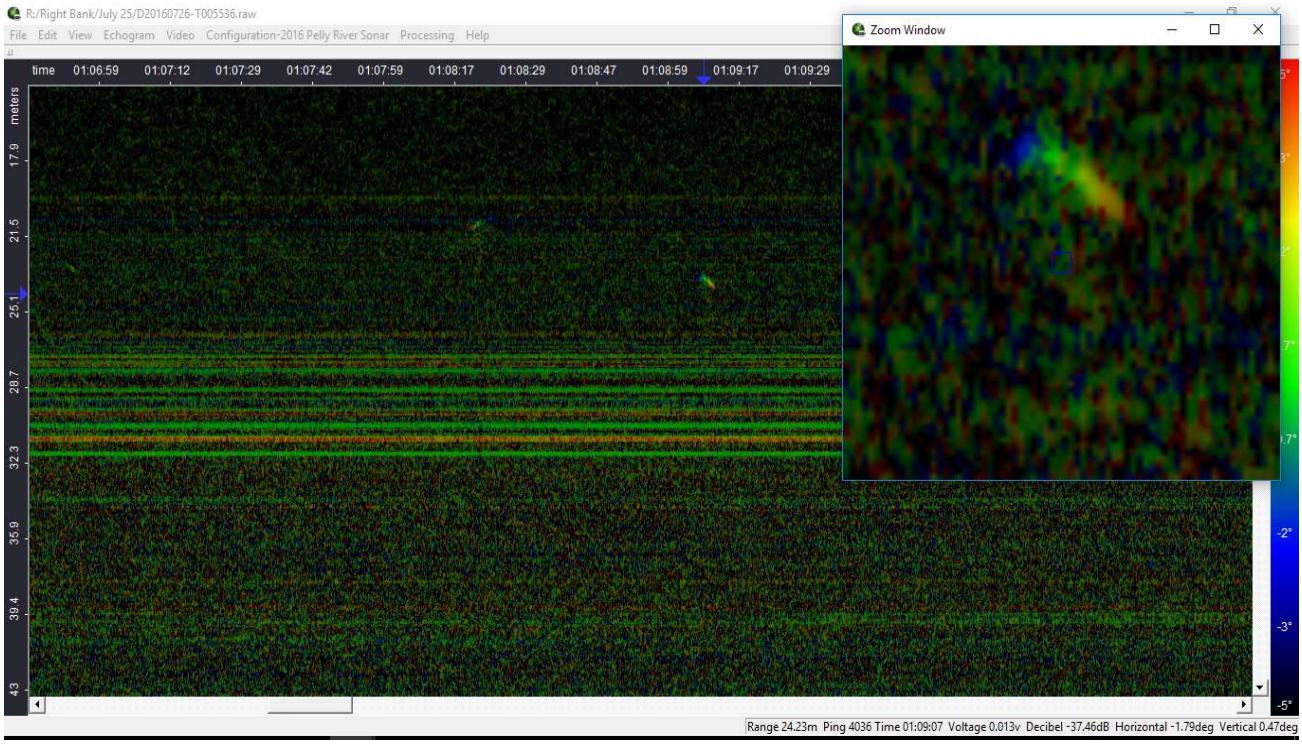

Figure 2. Echotastic echogram window showing two fish travelling in opposite directions. The fish on the left of the screen is traveling upstream and the fish on the right is traveling downstream. Image is from the Pelly River right bank sonar unit.

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

The ability to detect and discern fish targets is a skill developed through practice. At the beginning of the 2019 season, sonar technicians completed a comprehensive training module, created by Fisheries and Oceans Canada (DFO) biologist Elizabeth MacDonald in 2016. This training module was comprised of example data files and practice enumeration tests to develop the ability of the sonar technicians 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 the EDI project technician and all staff were tested on the training files to make sure 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 technician. Throughout the training program, staff were encouraged to work as a team and to maintain dialogue and consultation with the project technicians 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.

2.3.4 DETERMINING DIRECTION OF TRAVEL

The direction of travel (upstream or downstream) was determined for each salmon identified on the sonar 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 (from positive to negative degrees) 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 colour by angle option in Echotastic, the echogram colour scale provides a visual representation of the changes in angular position. Hot colours (reds or yellows) represent movement in one direction while cold colours (blues or blacks) represent movement in the opposite direction. In this manner, fish moving upstream can be easily identified since they possess the opposite colour spectrum orientation to those fish moving downstream (Figure 2).

Once onsite technicians were confident that a detected acoustic target was a migrating salmon, the salmon target in question was marked on the Echotastic echogram. This 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 and 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 were not collected. For in-season reporting, missing data were interpolated by multiplying raw daily counts by the percentage of the day that was missing. If five hours of data were missing, data were 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 delivered to fisheries managers.

Post-season (i.e. in this report), missing data were 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 left as decimals until our final number where they were rounded down (to be conservative) to a full number.

2.3.6 SONAR DATA QUALITY ASSURANCE/QUALITY CONTROL AND RELIABILITY

To provide a high-quality data set, quality assurance/quality control (QA/QC) measures were implemented for review of the sonar files during the field component of the program. Sonar technicians 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 a second technician on site. 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. The average percent error (APE) was calculated using a formula used by DFO (Mather and Milligan 2018, pers. comm. available upon request). 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 among technicians and sonar programs to provide the most accurate and consistent data.

Post season analysis was done to quantify variability (reliability) in counts by each technician. Post season analysis included: sample variance ($Var\ (\hat{Y})$), standard deviation ($SD_{TotalCount}$) and confidence interval (Mather and Milligan 2018, pers. comm.).

Sample variance ($Var\ (\hat{Y})$) was calculated using the formula:

$$Var(\hat{y}) = \frac{\Sigma(X_i - X)^2}{(n-1)}$$

Where X_i is the estimated hourly passage, X is the mean estimated hourly passage for the day and n is the number of files counted in the day.

The standard deviation ($SD_{TotalCount}$) was calculated using the formula:

$$SD_{TotalCount} = \sqrt{Var(\hat{Y}) + APE}$$

Where $Var(\hat{Y})$ is the sum of the daily variance in counts and APE is the average percent error.

The 95% confidence interval for the Chinook salmon estimate was calculated by multiplying the standard deviation by ± 1.96.

2.4 TEST NETTING

The 2019 test netting program was reduced from previous years to decrease crew size and associated costs of the sonar program, while providing accurate and continuous collection of sonar data. The test netting program included set netting to confirm sonar count data among Chinook salmon, larger freshwater fish (inconnu [*Stenodus leucichthys*] and northern pike[*Esox lucius*]), and any other salmon species that have the potential to co-migrate with the Chinook salmon. The test netting was done only when sufficient time and crew members were available.

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 salmon (five scales per individual) and delivered to DFO for aging analysis. Salmon were also sexed, measured, and released. Genetic samples (axillary process clippings) were also collected and were delivered to DFO for analysis. All other captured fish were identified to species, measured and released. Test netting used nets that were hung at a relatively loose ratio of 3:1.

2.4.1 SET NETTING

Set netting was conducted between July 12 and August 18, 2019, over three days. Set netting occurred on both banks of the river in the vicinity of the sonar site. Nets were set as time allowed during the day and checked on a frequent and regular basis to limit potential mortalities. The net field crews had a mesh size of 7.5 inches (19.1 cm) stretch diameter specifically to target Chinook salmon and any larger freshwater fish. The net was 100 feet (30.5 m) long, with mesh depths equivalent to net depths of 16 feet (4.9 m).

2.4.2 DRIFT NETTING

No drift netting was completed during the 2019 sonar program.

2.4.3 CHINOOK SALMON AGE ANALYSIS

Scales were collected from Chinook salmon captured during set netting and provided to DFO for age analysis. Methods for scale collection followed protocols provided by DFO and included the collection of five scales from each Chinook salmon, taken from just above the lateral line between the dorsal and anal fins of the fish. Scales were placed in scale card books (also provided by DFO) and allowed to dry each day.

3 RESULTS

3.1 SONAR DATA

3.1.1 RAW WEEKLY SONAR COUNTS

A raw net total of 6,389 upstream moving fish were identified from the collected sonar data over the duration of the sonar program (Table 3, APPENDIX B). This number is lower than the number released at the end of the sonar program (6,494) due to data corrections. 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.

During all program weeks, the number of fish moving upstream substantially exceeded the number of fish moving downstream on both the right and left banks. The majority (66%, net upstream total) were counted on the right bank of the sonar site (Table 3). The peak of the run occurred during the week of July 21–July 27, with a net upstream total of 2,530, approximately 39% of the total run.

Table 3. Raw weekly counts of salmon at the Pelly River sonar site from July 10 to August 26, 2019.

Program Week	Left Bank			Right Bank			Net Upstream Total
	Upstream	Downstream	Net Upstream Total	Upstream	Downstream	Net Upstream Total	
July 10-13 [A]	88	0	88	213	0	213	301
July 14-20 [B]	103	3	100	237	0	237	337
July 21-27	701	6	695	1274	77	1197	1892
July 28 - Aug 3 [C]	578	0	578	1223	50	1173	1751
Aug 4-10 [D]	520	0	520	846	0	846	1366
Aug 11-17	84	0	84	427	17	410	494
Aug 18-24 [E]	76	5	71	107	8	99	170
Aug 25-26	34	1	33	48	3	45	78
Total	**2184**	**15**	**2169**	**4375**	**155**	**4220**	**6389**

[A] Missing 15 hours of data from left bank.
[B] Missing 103 hours of data, both banks combined.
[C] Missing 4 hours of data from left bank.
[D] Missing 9 hours of data from left bank.
[E] Missing 39 hours of data, both banks combined.

Daily counts suggest the sonar site was in operation after the initial onset of the Chinook migration. On the first day of counting (July 10), a total of 68 Chinook salmon were recorded and the total count for the following days continued to rise. Although the data indicate the peak (July 21–July 27) of the Chinook run had passed, the daily counts show Chinook salmon were still migrating past the sonar site after the program

operations ceased. On August 26, the final day of sonar operation, a total of 43 upstream moving fish targets were counted (APPENDIX B).

3.1.2 SONAR DATA QUALITY ASSURANCE/QUALITY CONTROL AND RELIABILITY

A total of 358 sonar files were re-counted for QA/QC purposes: 176 on the right bank and 182 on the left bank. A total of 99 files (56%) from the right bank and 77 files (42%) from the left bank differed in the count of fish. Typically, the targeted difference in the original versus the QA/QC files is less than a 10% difference, therefore, additional QA/QC was completed on the sonar count data to investigate how this may have affected the overall total estimated Chinook salmon counts.

Of the QA/QC files that had discrepancies, there was a difference of -130 for the right bank and 39 for the left bank. The total number of fish counted in the original files was 1,142 and the total number of fish counted in the QA/QC files was 1,233. This constituted a difference of +91 fish or 7.4% of the total number of fish counted in the QA/QC files. The left bank had an APE of 20.86% and right bank had an APE of 19.76%. This means the mean difference in the original count versus the two QA/QC counts was 20.86% on left bank and 19.76% on right bank.

It is important to note that sonar technicians are encouraged to be conservative in their counts, meaning if they are unsure of a target, they should not mark it as a salmon. After reviewing the sonar data, it appears some sonar technicians were quite conservative in their counts, which resulted in a larger number of targets not being counted. The large variance in counts is also believed to be due to the number of crew members that rotated through the project. Having more crew members rotating throughout shifts on the project may have reduced crew consistency in fish counts.

3.2 TEST NETTING

The amount of netting done during the 2019 project was greatly reduced from the amount of netting done in previous years. This is due to having a smaller crew size and focussing on quality, continuous data collection for the duration of the sonar program. Due to lower water levels than previously encountered on the Pelly River, a number of hazards existed in the river at locations previously used for netting. As well, boating in areas not frequented by the crew increased the risk of running into hazards while boating.

3.2.1 SET NETTING

A total of six nets were set during the 2019 field season (Table 4, APPENDIX C). Nets were set for as long as time allowed following sonar data review and completion of other tasks. A low amount of test netting was completed in 2019 due to numerous factors including technical sonar issues, crew make-up and low water levels creating several hazards in close vicinity to the sonar camp. A total of 15.25 hours of set netting was completed. Over the 2019 netting program a single male Chinook salmon was captured. The fish

measured 95.5 cm and appeared to be good condition. No other fish species were captured in any of the net sets (Table 4, APPENDIX C).

Table 4. Summary of set netting effort and catches at the Pelly River sonar site in 2019.

Date	Set ID	Netting Effort (hours)	Chinook Salmon Captured	Chum Salmon Captured	Total Fish Captured
12-Jul-19	PR1.1	4.58	0	0	0
17-Aug-19	PR2.1	2.12	0	0	0
17-Aug-19	PR2.2	2.08	0	0	0
18-Aug-19	PR3.1	0.63	0	0	0
18-Aug-19	PR3.2	2.80	1	0	1
18-Aug-19	PR4.1	3.03	0	0	0
Total	-	**15.25**	**1**	**0**	**1**

3.2.2 DRIFT NETTING

No drift netting was conducted during the 2019 field season. During the 2016 field season, a total of 93 offshore drifts were completed capturing a single Chinook salmon (EDI2017). In 2017 a total of 209 offshore drifts were completed with no fish captured. During the 2018 field season, a single Chinook salmon was captured in seven drifts. When comparing these data with the sonar data, it appears that very few, if any, Chinook migrated through the non-ensonified portion of the river.

3.2.3 CHINOOK SALMON AGE ANALYSIS

At the time this report was written, results from the 2019 test netting samples were not available.

4 DISCUSSION

4.1 INTERPOLATION OF RUN DATA

4.1.1 INTERPOLATION OF MISSING COUNT DATA

Interpolation of 170 hours of missing sonar data was required (90 hours from left bank and 80 hours from right bank. Much of this missing data in 2019 was due to difficulties with network connections during the initial start-up and a faulty command module that began to malfunction on the evening of July 14, 2019. A new command module was brought out to camp on July 17, 2019. During this time, the functioning command module was rotated from bank to bank to continue to capture data from both banks. On August 20, 2019, the crew was unable to return to camp due to mechanical issues with the boat, leaving the sonars to run out of fuel and eventually shut down. The remainder of the missing data was due to temporary generator failures, equipment maintenance and updates, sonar reposition and movement. Interpolation was conducted according to the methods outlined in Section 2.3.5 and interpolated net upstream sonar counts were calculated for each week of program operation (Table 5). Daily interpolated count data are included in Appendix B.

After interpolating missing count data, an estimate of 251 salmon were believed to have passed the sonar site (54 salmon on left bank and 197 on right bank). Subsequently, a total of 6,641 salmon were estimated to have passed the sonar site between July 10 and August 26, 2019 (Table 5). The general trends in fish passage rates and relative distribution of counts (right versus left bank) were unchanged from the raw weekly sonar counts (Table 3). Overall, the sonar system operated well, although a larger amount of data was missed compared to the previous year of operation.

Table 5. Interpolated net upstream weekly counts of Chinook salmon at the Pelly River sonar site between July 10 and August 26, 2019.

Program Week	Left Bank	Right Bank	Both Banks Combined Interpolated Net Upstream Total
July 10-13	103	213	316
July 14-20	135	345	479
July 21-27	695	1,197	1,892
July 28 - Aug 3	578	1,195	1,773
Aug 4-10	520	896	1,416
Aug 11-17	84	410	494
Aug 18-24	76	116	192
Aug 25-26	33	45	78
Total	**2,223**	**4,417**	**6,641**

4.1.2 CHUM SALMON RUN OVERLAP

It is understood, through anecdotal information from SFN members, that the Pelly River is not known to be a spawning destination for fall chum salmon; however, chum salmon 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 salmon within the lower Pelly River, an estimate of the total chum salmon that passed the sonar site must be subtracted from the total count of Chinook salmon. Due to the potential for chum to be present in the Pelly River and co-migrate with the Chinook in early to late August, onshore drift netting was conducted as part of the test netting program in 2017 to target chum with no catches. Throughout each project no chum salmon have been captured in any drift netting or set netting (EDI 2017, 2018).

It is suspected that chum salmon were not present during the 2019 sonar operation; however, to further support this notion, the run timing of chum salmon in 2019 was reviewed. Travel rates of chum within the Yukon River were used 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 salmon has been estimated at 25 miles per day (40.2 km/day; ADFG 2019). The fall chum salmon count began at the Eagle sonar site on August 15, 2019 with a daily count of 268 chum (ADFG 2019). Based on this information, the first arrival of chum at the Pelly River sonar site was estimated to be approximately August 26 to August 29. Given that the last day of sonar operation was August 26th, there is a very low probability that chum were counted by the sonar units.

For the purposes of estimating the final Chinook salmon 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 the operation of the 2019 Pelly River sonar program, given the lack of chum salmon captures during test netting and the estimated arrival of chum at the sonar site (post-operation). It is assumed that all net upstream sonar targets counted and estimated were Chinook salmon.

4.1.3 FINAL CHINOOK SALMON PASSAGE ESTIMATE

The 2019 program ran approximately the same amount of time as the 2018 program (48 and 46 days, respectively). In 2019, Chinook salmon were observed on the first day of sonar counting (July 10) and still observed to be migrating past the sonar site on August 26 when the sonar shut down. To gather an estimate of the total escapement of Chinook salmon in the lower Pelly River, a pre- and post-season estimate was calculated as part of the goals of the program.

Expansion of Chinook salmon counts for the period prior to the beginning of this project (i.e. early July) was required as the total number of Chinook salmon migrating past the sonar site was 68 on the first day of operation (July 10, 2019). A total of 43 Chinook salmon were counted in the final day of sonar operations (August 26, 2019). As conducted for the previous years of sonar operation, post-season estimate, 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 have followed similar patterns

throughout the program years. The peak in daily counts at the Pelly River sonar site generally occurred approximately five days after the peak daily count at the Eagle sonar site. The Chinook count ended at the Eagle sonar site on August 14, 2019 with a daily count of 282 Chinook (ADFG 2019). Using the second-order polynomial equation below (MacDonald pers. comm. 2017; same methods as all Pelly River sonar program reports), the final daily count from Eagle sonar was extrapolated to determine the date of the final Chinook passage at the Pelly sonar site. After extrapolation, it is estimated that the final Chinook passage at Eagle sonar was August 28, 2019. 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 no later than September 2, 2019.

The preliminary period of September 1 to September 4 was used to extrapolate Chinook salmon passage rates past the end date of the 2019 sonar program (after August 25). Extrapolated Chinook counts were calculated for the period of August 27 to September 4 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 ith 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 181 Chinook salmon are estimated to have passed the sonar site before the sonar operations began, the total extrapolated daily Chinook salmon passage estimates began on July 3, 2018 with three Chinook (Table 6). On July 9, 2018, the day before sonar operation began, a total of 58 Chinook salmon are estimated to have migrated past the sonar site (Table 6). A total of 105 Chinook salmon are estimated to have passed the site after sonar operations ceased (Table 7). When added to the interpolated total estimate of 6,641 (Table 5), these post-season expansion data result in a final Chinook salmon passage estimate of 6,927.

Using the formulas explained in Sections 2.3.5 and 2.3.6, the confidence interval was calculated for each bank (APPENDIX B). The left bank counted ±23 fish and the right bank counted ±32 fish with 95% confidence. The total confidence interval is ±55 Chinook salmon over the entire program. Based on the test netting data collected during the previous years of program operation and the local knowledge of salmon species present in the Pelly River, this estimate is fully apportioned as Chinook salmon.

Table 6. Extrapolated daily Chinook salmon counts at the Pelly River sonar site between July 1 and July 9, 2019.

Date	Both Banks Combined Extrapolated Net Upstream Total
July 1	0
July 2	0
July 3	3
July 4	8
July 5	14
July 6	22
July 7	32
July 8	44
July 9	58
Total	**181**

Table 7. Extrapolated daily Chinook salmon counts at the Pelly River sonar site between August 27 and September 3, 2019.

Date	Both Banks Combined Extrapolated Net Upstream Total
August 27	33
August 28	26
August 29	19
August 30	13
August 31	8
September 1	4
September 2	2
September 3	0
Total	**105**

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 was the fourth year of operation for this program, the data presented in the following sections cannot yet be used to determine long-term trends; however, it 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 2019 Pelly River sonar program (fourth season of sonar operation) provides additional insight on the run timing and strength of the lower Pelly River Chinook salmon migration and will provide important information on these aspects of the Chinook run in future years.

Upstream Chinook salmon were recorded at the Pelly River sonar site on the first day of sonar recording (July 10), with a total of 68 upstream migrating Chinook salmon counted. This indicates that the 2019 project did not capture the very start of the Pelly River Chinook salmon run. Daily counts increased until July 12 before they began to drop from July 14 to 15. It should be noted that during this time, there was a large amount of data missed due to technical difficulties, which may account for the drop in numbers. The daily counts began to spike around July 20 and 21 and this increasing trend continued throughout the sonar operation (Figure 3 to Figure 5; APPENDIX B). The peak of the 2019 Chinook salmon run was observed on July 27, 2019, five days after the peak at the Eagle sonar site on July 23, 2019. Daily counts reached a high of 402 on July 27 and dropped back down to 286 on July 29. On July 30, the daily total dropped to 179 salmon before increasing up to 240 on August 1. On August 6 daily counts were 243 and began a downward trend. Following the peak of the run the daily totals had a few spikes but overall had a consistent decrease. However, two small pulses were recorded in mid-late August, which may also be related to missing sonar data on August 20 and 21. On August 22 daily counts had decreased to 17 before increasing back up to 43 on August 26. On the final day of sonar operation (August 26), 43 Chinook salmon were recorded, approximately 10% of what was observed on the day the run peaked, indicating the project captured the majority of the run. The Pelly sonar was successful in capturing a comprehensive data set for the 2019 Chinook salmon run, pre- and post-season expansions accounting for approximately 4% of the total run estimate.

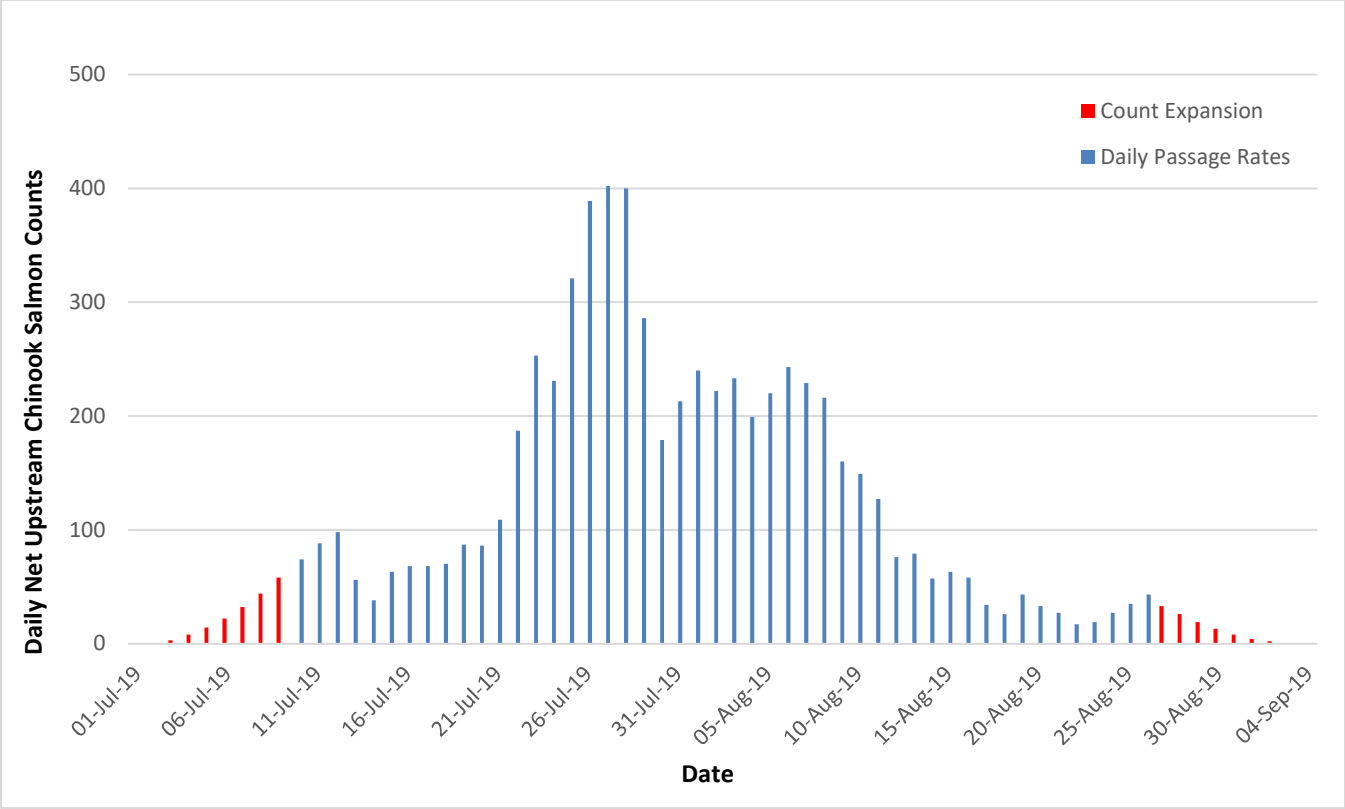

Figure 3. Daily net upstream Chinook salmon counts at the Pelly River Chinook sonar site in 2019, including the pre- and post-season extrapolated data.

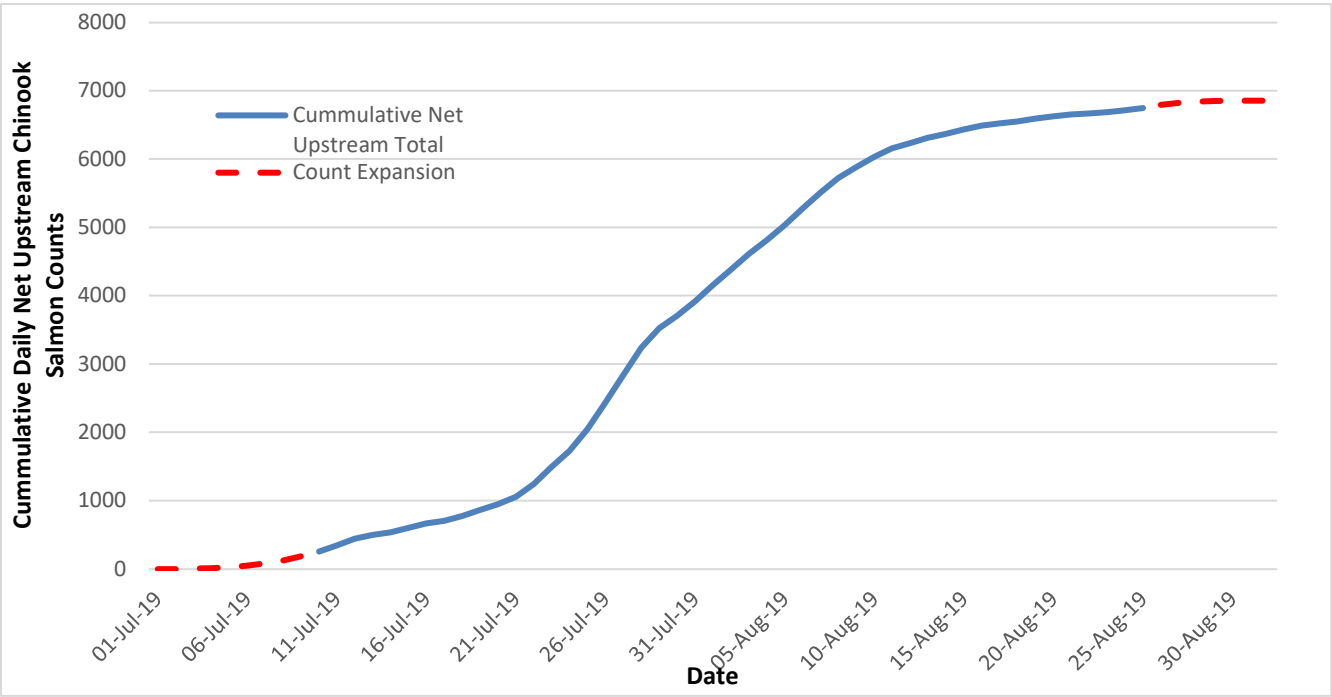

Figure 4. Daily cumulative net upstream Chinook salmon counts at the Pelly River sonar site in 2019, including pre- and post-season extrapolated data.

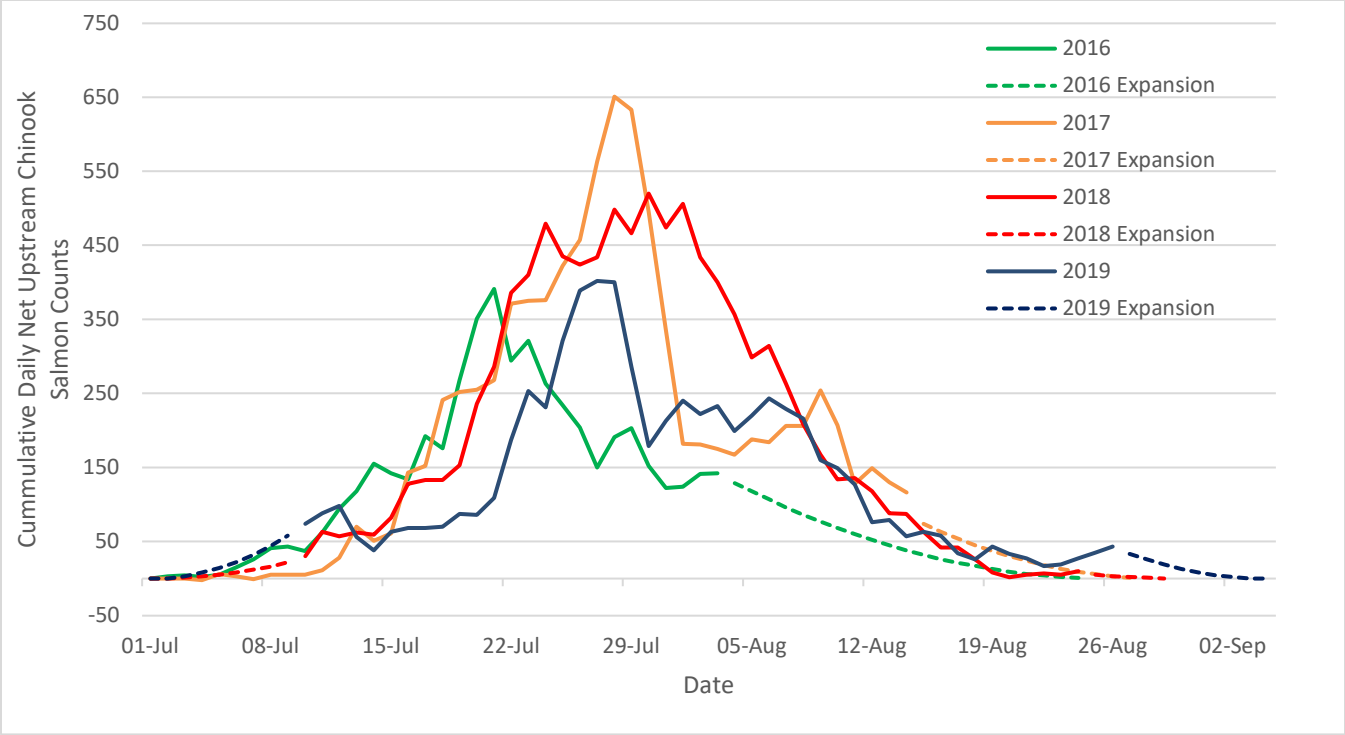

Figure 5. Yearly comparison of daily cumulative net upstream Chinook salmon counts at the Pelly River sonar site in 2016 to2019, including pre- and post-season extrapolated data.

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. These 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 were 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 (Figure 6 and Figure 7). Several factors may affect the spatial migration patterns of Chinook salmon including river discharge, water clarity, and water temperature. A 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.

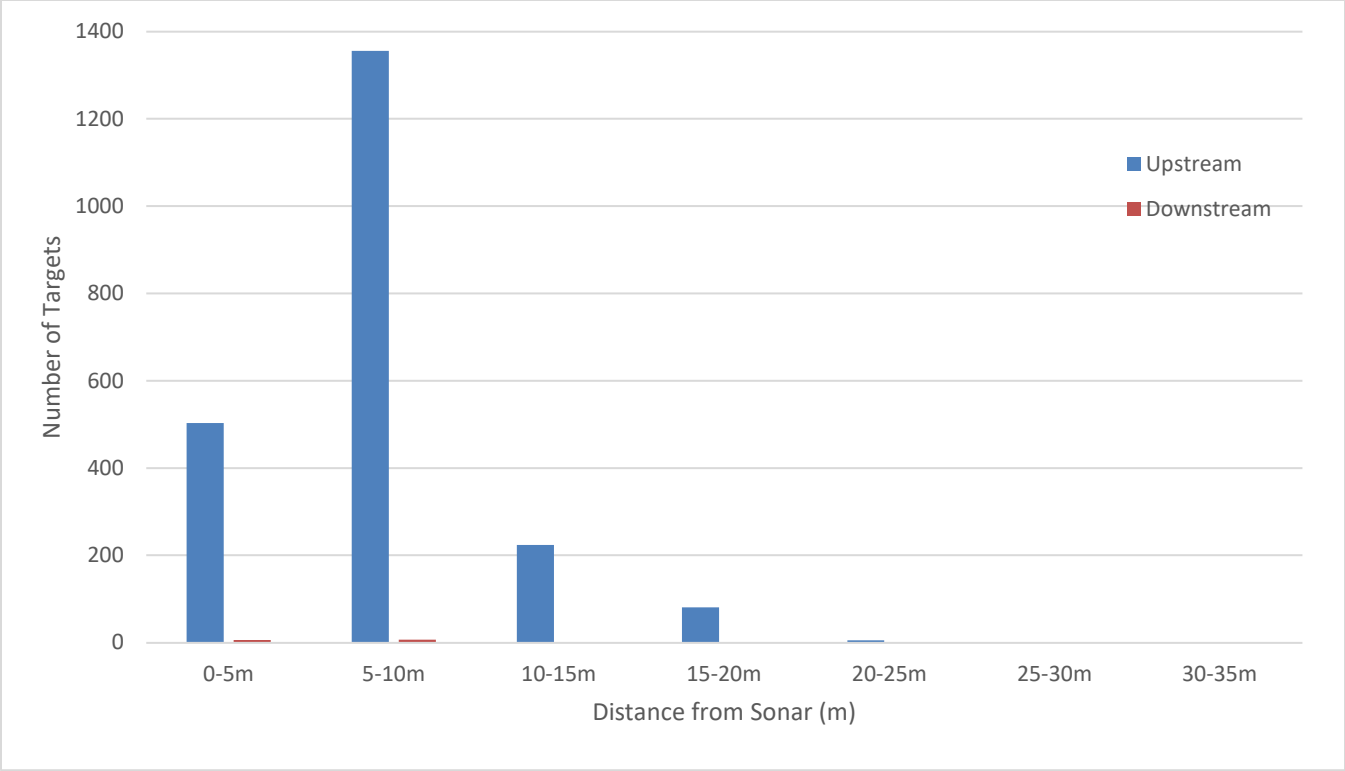

Figure 6. Ranges of upstream and downstream moving fish targets detected on the left bank of the Pelly River sonar site in 2019.

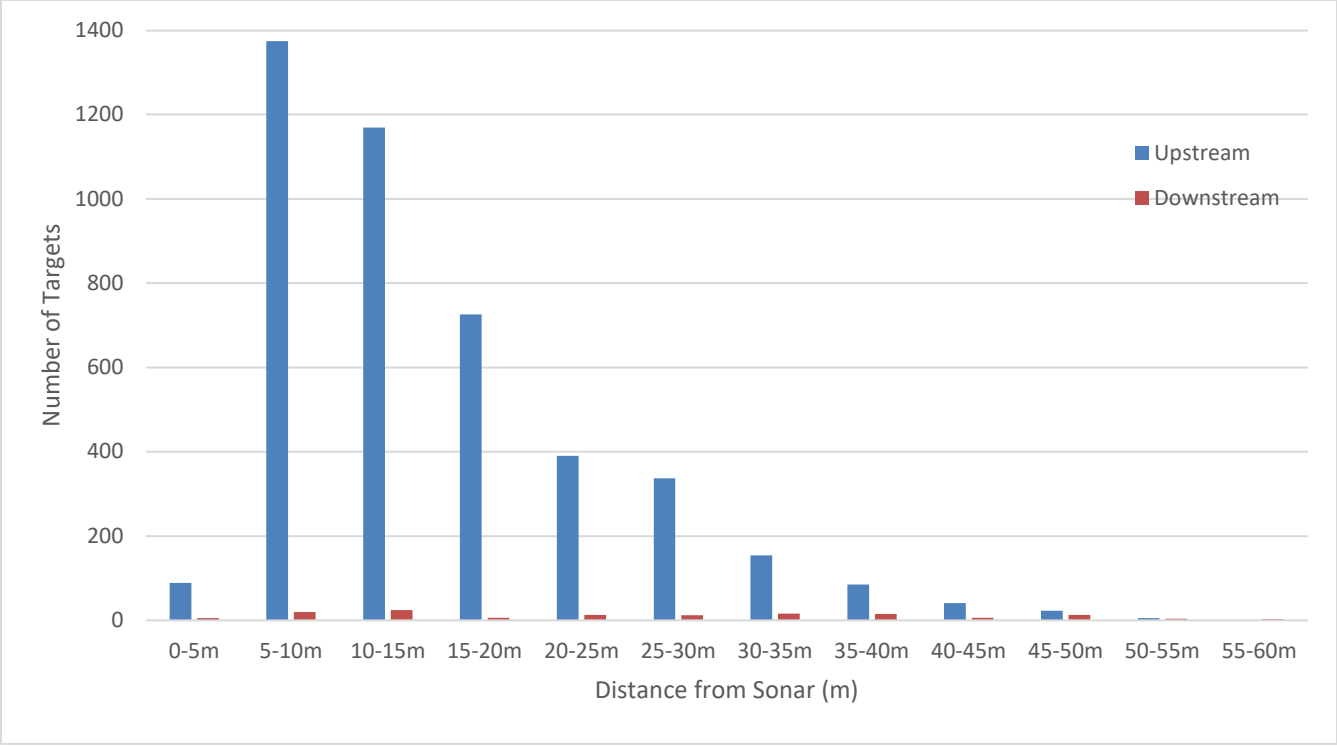

Figure 7. Ranges of upstream and downstream moving fish targets detected on the right bank of the Pelly River sonar site in 2019.

The target range data suggest that upstream migrating fish targets were strongly bank oriented in the vicinity of the Pelly River sonar site during operation in 2019, which is consistent with previous years' data. A total of 6,564 upstream moving targets were analyzed[3]; 33% were observed on the left bank and 67% on the right bank (Table 8, Table 9, Figure 6 and Figure 7). The majority of upstream moving sonar targets were detected within 5 to 10 m of the sonar transducers for both banks. None of the upstream moving targets on the left bank were detected beyond 15-20 m (note the limit of ensonified area on the left bank is 35 m). On the right bank, seven percent of the total upstream moving targets were beyond 30 m. This number is down from 10% in 2018 and may be connected to lower water levels and higher water temperatures in 2019. Downstream moving targets on the left bank also appeared to be bank oriented with all but two fish being detected within 10 m (Table 8). However, on the right bank there did not appear to be any pattern to downstream targets and bank orientation. A large amount (32%) were observed in the 5-10 m and 10-15 m range; however, 60% of the targets were observed beyond 20 m of the sonar transducer (Table 9, Figure 7).

Given the low number of offshore, upstream moving targets on the left bank, and that only two Chinook salmon have been captured during drift netting within the non-ensonified area between 2016 and 2018, the Pelly River sonar project can be successfully run with one long-range and one short-range sonar unit.

Table 8. Ranges of upstream and downstream moving fish targets detected on the left bank of the Pelly River sonar site in 2019.

Target Range	Upstream Targets		Downstream Targets	
	Number of Targets	Proportion of Total Targets (%)	Number of Targets	Proportion of Total Targets (%)
0-5 m	503	23.2	6	40.0
5-10 m	1356	62.5	7	46.7
10-15 m	224	10.3	1	6.7
15-20 m	81	3.7	1	6.7
20-25 m	5	0.2	0	0
25-30 m	1	0.0	0	0
30-35 m	0	0	0	0
Total	**2170**	**100**	**15**	**100**

[3] Note that 6,564 is the total raw, net moving target count of upstream targets before subtracting downstream targets. This total is higher than what was reported as there is some error in saving of the text files following review of each sonar file.

Table 9. Ranges of upstream and downstream moving fish targets detected on the right bank of the Pelly River sonar site in 2019.

Target Range	Upstream Targets		Downstream Targets	
	Number of Targets	Proportion of Total Targets (%)	Number of Targets	Proportion of Total Targets (%)
0-5 m	89	2.0	5	3.6
5-10 m	1374	31.3	20	14.6
10-15 m	1169	26.6	24	17.5
15-20 m	726	16.5	6	4.4
20-25 m	390	8.9	13	9.5
25-30 m	337	7.7	12	8.8
30-35 m	154	3.5	16	11.7
35-40 m	85	1.9	15	10.9
40-45 m	41	0.9	6	4.4
45-50 m	23	0.5	13	9.5
50-55 m	5	0.1	4	2.9
55-60 m	1	0.0	3	2.2
Total	**4394**	**100**	**137**	**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.

4.2.3 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 are 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; Government of Canada 2019). This station operates on a continuous basis and no major watercourses 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 were 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 2019; Figure 8).

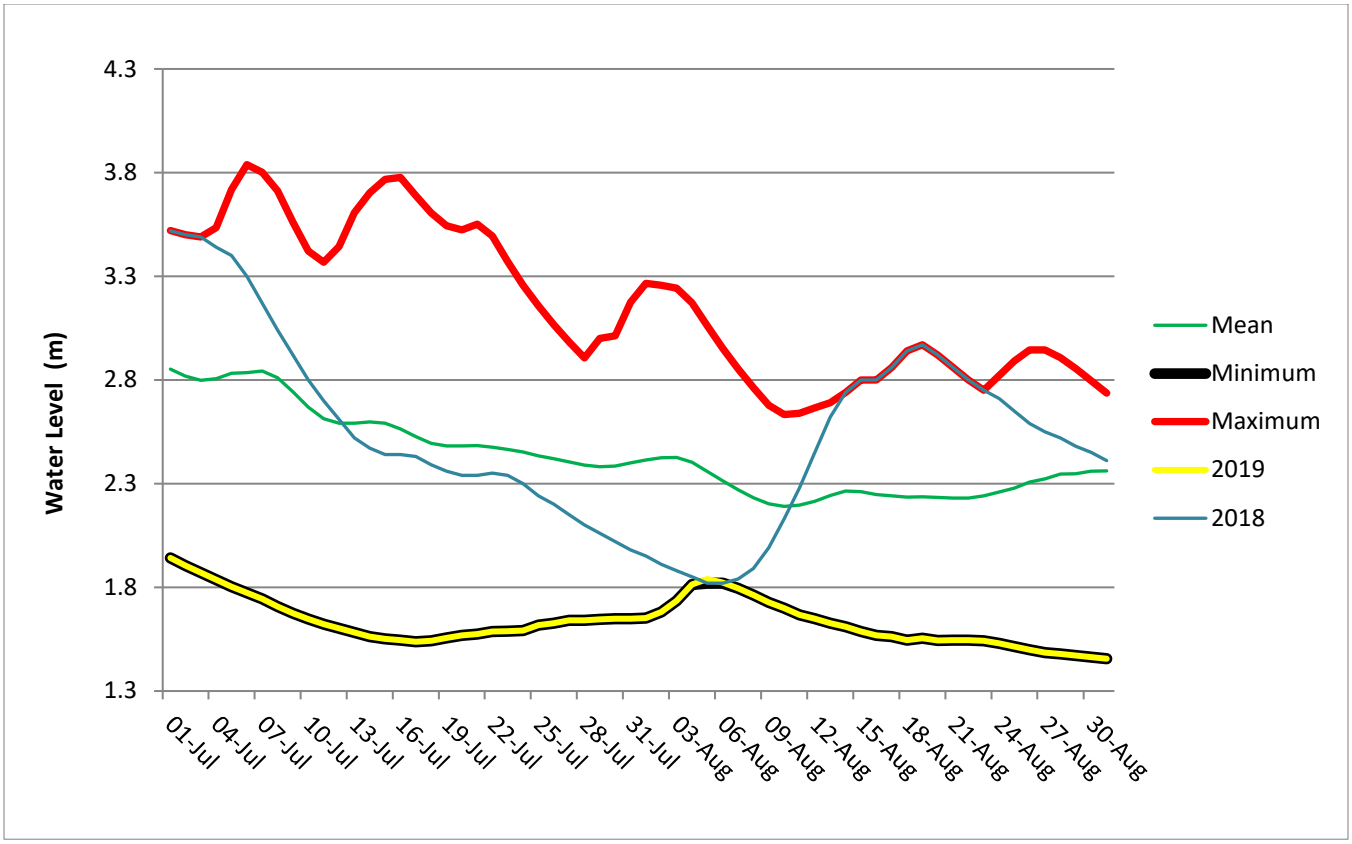

Figure 8. **July 1 to August 31, 2019 Pelly River water levels as compared to the mean, minimum, and maximum daily raw water levels from 2011 to 2019. Water levels measured at Water Survey of Canada gauging station 09BC001 near the community of Pelly Crossing. The earliest year available for water levels at this station was 2011.**

As shown in Figure 8, water levels observed at the sonar site were the lowest observed water levels during all years of sonar operation. The recorded water levels during sonar operation in 2019 are equal to the lowest water levels from 2011 to 2019. During the 2019 sonar program, the maximum water levels observed occurred during the initial onset of the program on July 1, 2019. Water levels began to steadily decrease until July 18, 2019 before rising steadily until reaching its maximum level on August 6, 2019. Water levels then began to decrease for the remainder of the program.

Due to the low water levels observed, the backchannel behind the right bank island was not connected to the mainstem of the Pelly River during the 2019 sonar operation. Therefore, no salmon were able to migrate behind the right bank sonar during the enumeration period (Photo 9, APPENDIX A).

4.3 TEST NETTING EFFECTIVENESS

The two primary goals of test netting in 2019 were to:

1. 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); and
2. collect age, sex and length (ASL) data from Chinook salmon captured in the test fishery.

A test netting program was completed in 2019; however, since the test netting portion of the project was reduced, the amount of data collected was much less than in previous years. Onshore drift netting was no longer conducted at the Pelly River sonar site as no chum salmon have been captured in either drift or set netting in the previous three years. Onshore drift netting was also removed from the program to focus time and resources on other areas of the project. The number of chum salmon that co-migrated with Chinook salmon during the operational period of this program is believed to be zero, as speculated from the run timing of chum salmon at Eagle sonar site. This assumption is further supported by the fact that no chum salmon were captured in any portion netting program over the four years the program has been running.

Observations in the sonar count files (of inconnu and northern pike) indicated a presence of larger freshwater species in the vicinity of the Pelly River sonar site in 2016 through 2018. Compared to previous years, no freshwater fish (particularly inconnu) were captured during the set netting program in 2019. This is likely a result of the reduced test netting effort in 2019 compared to the 2016 and 2017 projects. Field crews noted several upstream targets exhibited slow movements across the sonar beams and behaviours not typical of migrating salmon; it was presumed these were freshwater fish, and therefore not counted. These observations highlight the importance of the test netting program in confirming what is being recorded in the sonar files and developing a stronger understanding of the local conditions at the sonar site.

4.4 DEVELOPMENT OF LOCAL CAPACITY

An important goal of the 2019 Pelly River Chinook sonar program was to continue developing local capacity within the SFN and community of Pelly Crossing to conduct fisheries research programs. This program provided approximately seven weeks of fisheries-related work for two local technicians, including the opportunity to gain skills in the operation of sonar systems and conduct set and drift netting. Two local field technicians were trained and participated in this program, one of which was a returning SFN employees from the previous years of sonar operation. There remains a strong interest within the community of Pelly Crossing to pursue future sonar programs for Chinook salmon stock assessment purposes and to continue building skills and experience amongst SFN community members. SFN and EDI continue to collaborate to expand the roles and build the responsibilities of SFN employees. The 2020 Chinook sonar program is again proposing the use of two full-time local technicians for the field component of the program, as well as looking to increase the office-based task and preparation duties for SFN members. Currently, the long-term goal of the Chinook sonar program is to develop it into a

permanent stock assessment initiative, entirely operated by SFN and local field technicians with professional assistance and support provided as needed.

5 RECOMMENDATIONS

Despite some challenges with low water, technical failures and staffing, the 2019 Pelly River Chinook Salmon Sonar Program was successful in meeting the goals and objectives as outlined in the 2019 Pelly River Chinook Salmon Sonar Program Proposal submitted to the Yukon River Panel Restoration and Enhancement Fund. Recommendations for future Pelly River Chinook salmon sonar programs are listed below.

- Increase collaboration between the SFN and EDI to increase local capacity in other roles and responsibilities in addition to the field program (i.e., SFN technician involvement in field preparation and post field reporting).
- Dedicate more time for sonar training of sonar technicians prior to the initial start of the program.
- Discuss with DFO to get a longer power cord for the left bank sonar unit. If low water levels persist, the 30 m cable may not be long enough;
- Continue to improve the data QA/QC protocols by making sure field personnel are regularly re-counting 10% of the daily sonar files throughout the entire duration of the sonar operation and that crew members are communicating to maintain counting consistency.
- Increase community involvement through the encouragement of site visits by locals, including youth and Elders, to the sonar camp.

6 REFERENCES

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APPENDIX A. PHOTOGRAPHS

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Photo 1. View of Pelly River Chinook sonar camp

Photo 2. View of inside the sonar tent and field office

Photo 3. View of the right bank ARIS sonar in the Pelly River, facing upstream

Photo 4. View of the right bank sonar, network and internet electrical setup

Photo 5. View of the left bank ARIS sonar in the Pelly River

Photo 6. View of technician holding male Chinook salmon captured during test netting

Photo 7. View of a set net located at PR 2 near sonar camp, facing downstream

Photo 8. View of boat launch and net racks at Pelly Sonar Camp

Photo 9. Aerial view of right bank showing the back channel cut off at the upstream end (left side of photo)

Photo 10. Aerial overview photo of the Pelly River Chinook sonar camp location facing upstream

APPENDIX B. RAW AND INTERPOLATED PELLY RIVER DAILY SONAR COUNTS

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Table B1. Daily interpolated and expanded sonar counts from the 2019 Pelly River Chinook salmon sonar program.

Date	Left Bank				Right Bank				Both Banks Combined Net Total Upstream
	Raw Upstream	Raw Downstream	Upstream Interpolated	New Total Upstream	Raw Upstream	Raw Downstream	Upstream Interpolated	New Total Upstream	
01-Jul	-	-	-	-	-	-	-	-	0
02-Jul	-	-	-	-	-	-	-	-	0
03-Jul	-	-	-	-	-	-	-	-	3
04-Jul	-	-	-	-	-	-	-	-	8
05-Jul	-	-	-	-	-	-	-	-	14
06-Jul	-	-	-	-	-	-	-	-	22
07-Jul	-	-	-	-	-	-	-	-	32
08-Jul	-	-	-	-	-	-	-	-	44
09-Jul	-	-	-	-	-	-	-	-	58
10-Jul	14	0	6.3	20.3	54	0	0	54	74
11-Jul	15	0	9.2	24.2	64	0	0	64	88
12-Jul	37	0	0	37	61	0	0	61	98
13-Jul	22	0	0	22	34	0	0	34	56
14-Jul	17	0	7.8	24.8	14	0	0	14	38
15-Jul	5	0	11.2	16.2	21	0	26.3	47.3	63
16-Jul	13	0	5.8	18.8	23	0	26.3	49.3	68
17-Jul	1	0	11.7	12.7	56	0	0	56	68
18-Jul	16	0	0	16	38	0	16.8	54.8	70
19-Jul	28	0	0	28	19	0	40.7	59.7	87
20-Jul	23	3	0	20	66	0	0	66	86
21-Jul	34	0	0	34	75	0	0	75	109
22-Jul	90	0	0	90	97	0	0	97	187
23-Jul	123	0	0	123	130	0	0	130	253
24-Jul	93	0	0	93	138	0	0	138	231
25-Jul	102	0	0	102	219	0	0	219	321

Date	Left Bank				Right Bank				Both Banks Combined Net Total Upstream
	Raw Upstream	Raw Downstream	Upstream Interpolated	New Total Upstream	Raw Upstream	Raw Downstream	Upstream Interpolated	New Total Upstream	
26-Jul	128	6	0	122	299	32	0	267	389
27-Jul	131	0	0	131	316	45	0	271	402
28-Jul	134	0	0	134	300	34	0	266	400
29-Jul	86	0	0	86	214	14	0	200	286
30-Jul	41	0	0	41	138	0	0	138	179
31-Jul	74	0	0	74	140	1	0	139	213
01-Aug	95	0	0	95	145	0	0	145	240
02-Aug	28	0	0	28	195	1	0	194	222
03-Aug	120	0	0	120	91	0	22.3	113.3	233
04-Aug	53	0	0	53	96	0	50.1	146.1	199
05-Aug	84	0	0	84	136	0	0	136	220
06-Aug	88	0	0	88	155	0	0	155	243
07-Aug	87	0	0	87	142	0	0	142	229
08-Aug	86	0	0	86	130	0	0	130	216
09-Aug	70	0	0	70	90	0	0	90	160
10-Aug	52	0	0	52	97	0	0	97	149
11-Aug	18	0	0	18	115	6	0	109	127
12-Aug	8	0	0	8	73	5	0	68	76
13-Aug	4	0	0	4	77	2	0	75	79
14-Aug	7	0	0	7	53	3	0	50	57
15-Aug	23	0	0	23	40	0	0	40	63
16-Aug	13	0	0	13	45	0	0	45	58
17-Aug	11	0	0	11	24	1	0	23	34
18-Aug	11	0	0	11	16	1	0	15	26
19-Aug	15	2	0	13	30	0	0	30	43
20-Aug	20	2	0	18	12	0	3.5	15.5	33
21-Aug	6	0	5	11	2	0	14.8	16.8	27

Date	Left Bank				Right Bank				Both Banks Combined Net Total Upstream
	Raw Upstream	Raw Downstream	Upstream Interpolated	New Total Upstream	Raw Upstream	Raw Downstream	Upstream Interpolated	New Total Upstream	
22-Aug	5	0	0	5	16	4	0	12	17
23-Aug	11	1	0	10	12	3	0	9	19
24-Aug	8	0	0	8	19	0	0	19	27
25-Aug	11	0	0	11	24	0	0	24	35
26-Aug	23	1	0	22	24	3	0	21	43
27-Aug	-	-	-	-	-	-	-	-	33
28-Aug	-	-	-	-	-	-	-	-	26
29-Aug	-	-	-	-	-	-	-	-	19
30-Aug	-	-	-	-	-	-	-	-	13
31-Aug	-	-	-	-	-	-	-	-	8
01-Sep	-	-	-	-	-	-	-	-	4
02-Sep	-	-	-	-	-	-	-	-	2
03-Sep	-	-	-	-	-	-	-	-	0
04-Sep	-	-	-	-	-	-	-	-	0
Total	**2184**	**15**	**57**	**2226**	**4375**	**155**	**200.8**	**4420.8**	**6927**

Table B2. Results from average percent error, variance, standard deviation and confidence intervals for Chinook salmon counts.

	APE	Variance	SD	CI
Left Bank	20.86	126.57	12.14	23.79
Right Bank	19.76	249.42	16.40	32.15

APE = average percent error; SD = standard deviation; CI = confidence intervals.

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APPENDIX C. TEST NETTING CAPTURE

Table C1. Net locations from the 2019 Pelly River Chinook Salmon Sonar Program.

Name	Location	Description
PR1	08V 390220 6967560	Downstream of camp on left bank, big eddy near gravel bar
PR 2	08V 391188 6969295	Approximately 2 km upstream of camp, left bank
PR3	08V 392656 6969629	Upstream of camp on right bank near big rocks
PR4	08V 391265 6969087	Upstream of camp, left bank, near rock point

Table C2. Set netting effort and fish captures from the 2019 Pelly River Chinook Salmon Sonar Program.

Date	Set Number	Net Location	Net in	Net Out	Effort (hours)	Mesh Size	Fish Species	Length (cm)	Sex
12-Jul-2019	1.1	PR1	10:50	15:25	4.6	7.5	NFC		
17-Aug-2019	2.1	PR2	11:23	13:30	2.1	7.5	NFC		
17-Aug-2019	2.2	PR3	16:25	18:30	2.1	7.5	NFC		
18-Aug-2019	3.1	PR4	12:52	13:30	0.6	7.5	NFC		
18-Aug-2019	3.2	PR2	13:37	16:25	2.8	7.5	CH	95.5	Male
18-Aug-2019	4.1	PR2	15:28	18:30	3.0	7.5	NFC		

NFC = no fish caught; CH = Chinook salmon