

2020 Pelly River Chinook Salmon Sonar Program



Prepared For

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20Y0179
Version: 1
March 2021



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EXECUTIVE SUMMARY

In 2020, Selkirk First Nation conducted the fifth year of a Chinook salmon sonar enumeration program on the Pelly River at the Pelly River Chinook 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 9 and August 24, 2020. 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. Sonar operation was conducted by rotational crews of two EDI staff throughout the duration of the project.

A net raw upstream total of 5,614 fish targets were counted during the period of operation of this program. Set netting conducted between July 23 and August 20 captured four Chinook salmon and one inconnu and no chum salmon. Similar to previous project years, it is believed no chum salmon were present in the area during the operation period of the sonar.

Post-season interpolation of missing data periods increased the net upstream Chinook salmon passage estimate to 5,676 for the period between July 9 and August 24. Run expansion of the Chinook sonar counts was conducted for pre- and post-program periods; no Chinook salmon are estimated to have migrated past the sonar site before the field program operations, which began on July 9, and an additional two Chinook salmon are estimated to have migrated past the sonar site after operations ceased on August 24. Including run expansion data, a final interpolated estimate of 5,678 Chinook salmon migrated past the Pelly River sonar site in 2020, which is the lowest number of enumerated salmon the project has recorded in all project years.



ACKNOWLEDGEMENTS

Funding for this project was provided by the Yukon River Panel Restoration and Enhancement Fund. 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 and Marina Milligan (Fisheries and Oceans Canada) provided technical advice during this project.

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TABLE OF CONTENTS

1	INTRODUCTION	1
1.1	OBJECTIVES.....	1
1.2	STUDY AREA	2
2	METHODS	5
2.1	FIELD CREW AND CAMP SETUP.....	5
2.2	SONAR DEPLOYMENT	5
2.2.1	<i>Fish Deflection Fence</i>	<i>5</i>
2.2.2	<i>Sonar Software Setup and Data Collection</i>	<i>6</i>
2.3	ENUMERATION OF CHINOOK SALMON	7
2.3.1	<i>Echogram Interpolation.....</i>	<i>7</i>
2.3.2	<i>Data Processing Parameters</i>	<i>7</i>
2.3.3	<i>Distinguishing Migrating Salmon on Echogram.....</i>	<i>8</i>
2.3.4	<i>Determining Direction of Travel.....</i>	<i>10</i>
2.3.5	<i>Interpolation of Count Data.....</i>	<i>10</i>
2.3.6	<i>Sonar Data Quality Assurance/Quality Control and Reliability</i>	<i>11</i>
2.4	TEST NETTING	12
2.4.1	<i>Set Netting</i>	<i>12</i>
2.4.2	<i>Drift Netting.....</i>	<i>13</i>
2.4.3	<i>Chinook Salmon Age Analysis</i>	<i>13</i>
3	RESULTS.....	14
3.1	SONAR DATA	14
3.1.1	<i>Raw Weekly Sonar Counts.....</i>	<i>14</i>
3.1.2	<i>Sonar Data Quality Assurance/Quality Control and Reliability.....</i>	<i>14</i>
3.2	TEST NETTING	15
3.2.1	<i>Set Netting</i>	<i>15</i>
3.2.2	<i>Drift Netting.....</i>	<i>15</i>
4	DISCUSSION.....	16
4.1	INTERPOLATION OF RUN DATA	16
4.1.1	<i>Interpolation of Missing Count Data</i>	<i>16</i>
4.1.2	<i>Chum Salmon Run Overlap</i>	<i>16</i>
4.1.3	<i>Final Chinook Salmon Passage Estimate.....</i>	<i>17</i>
4.2	PELTY RIVER CHINOOK SALMON MIGRATION DYNAMICS	18



4.2.1	<i>Run Timing and Strength</i>	18
4.2.2	<i>Chinook Salmon Bank Orientation</i>	20
4.2.3	<i>Pelly River Water Levels</i>	23
4.3	TEST NETTING EFFECTIVENESS	25
4.4	DEVELOPMENT OF LOCAL CAPACITY	25
5	CONCLUSIONS AND RECOMMENDATIONS	27
6	REFERENCES	28
6.1	LITERATURE CITED	28
6.2	PERSONAL COMMUNICATIONS	28

LIST OF APPENDICES

Appendix A	Photographs	A-1
Appendix B	Sonar Count Data	B-1
Appendix C	Test Netting Data	C-1

LIST OF TABLES

Table 1.	Summary of ARIS Explorer 1200 and 1800 data collection parameter values and settings used during the 2020 Pelly River Chinook salmon sonar program.	6
Table 2.	Echotastic data processing options used during the review of sonar data collected during the operation of the 2020 Pelly River Chinook salmon sonar program.	7
Table 3.	Raw weekly counts of salmon at the Pelly River sonar site from July 9 to August 24, 2020.	14
Table 4.	Summary of set netting effort and catches at the Pelly River sonar site in 2020.	15
Table 5.	Interpolated net upstream weekly counts of Chinook salmon at the Pelly River sonar site between July 9 and August 24, 2020.	16
Table 6.	Ranges of upstream and downstream moving fish targets detected on the left bank of the Pelly River sonar site in 2020.	22
Table 7.	Ranges of upstream and downstream moving fish targets detected on the right bank of the Pelly River sonar site in 2020.	23



LIST OF FIGURES

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.	8
Figure 2.	Echotastic echogram window showing two fish traveling 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.	9
Figure 3.	Daily net upstream Chinook Salmon counts at the Pelly River Chinook sonar site in 2020, including pre- and post-season extrapolated data.	19
Figure 4.	Daily cumulative net upstream Chinook salmon counts at the Pelly River sonar site in 2020, including pre- and post-season extrapolated data.	19
Figure 5.	Yearly comparison of daily cumulative net upstream Chinook salmon counts at the Pelly River sonar site in 2016 to 2020, including pre- and post-season extrapolated data.	20
Figure 6.	Ranges of upstream and downstream moving fish targets detected on the left bank of the Pelly River sonar site in 2020.	21
Figure 7.	Ranges of upstream and downstream moving fish targets detected on the right bank of the Pelly River sonar site in 2020.	21
Figure 8.	July 1 to August 31, 2020 Pelly River water levels as compared to the mean, minimum and maximum daily raw water levels from 2011 to 2020. 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.	24

LIST OF MAPS

Map 1.	Overview of the Pelly River Watershed.	3
Map 2.	2020 Pelly River Chinook Sonar Program – Site Location.	4



ACRONYMS AND ABBREVIATIONS

Acronym/Abbreviation	Definition
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



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 River¹ (Joint Technical Committee of the Yukon River U.S./Canada Panel 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 estimated 6,389 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 2020 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.

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 (Joint Technical Committee of the Yukon River U.S./Canada Panel 2016).



The primary objectives of the 2020 Pelly River Chinook salmon sonar program were to:

- 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,
- build local capacity, through technical training and full-time employment for local SFN citizens throughout the program,
- 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 several 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 Environmental Dynamics Inc 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.



Map 1. Overview of the Pelly River Watershed.



Map 2. 2020 Pelly River Chinook Sonar Program – Site Location.



2 METHODS

2.1 FIELD CREW AND CAMP SETUP

A crew of two people from EDI travelled to the Pelly River sonar site on July 6, 2020 to set up the field camp. Following the initial setup, two EDI technicians 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

On July 9, 2020, 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 onshore 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 a 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 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 the 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.

2.2.2 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 9 to August 24, 2020. A total of 39 hours of data (totaled for both left and right bank sonar units) was not recorded throughout the program. Much of this missing data in 2020 was due to equipment maintenance and updates, temporary generator failure and sonar repositioning and movement.

Table 1. Summary of ARIS Explorer 1200 and 1800 data collection parameter values and settings used during the 2020 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 3.0b8, a software package developed by Carl Pfisterer of the Alaska Department of Fish and Game (ADF&G). 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 2020 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 the review of the collected data.

Table 2. Echotastic data processing options used during the review of sonar data collected during the operation of the 2020 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.

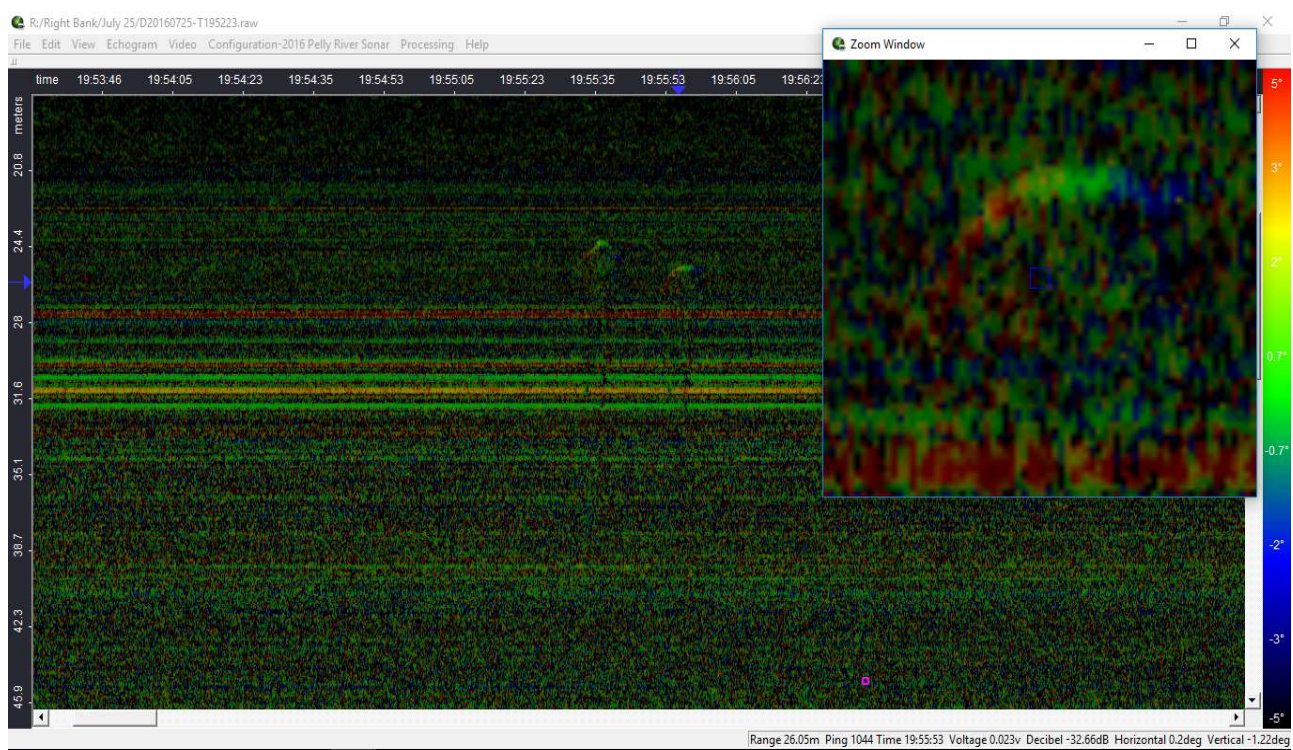


Figure 1. Echotastic echogram showing the crescent-shaped sonar target and shadowing typical of a fish target. Image is from the Pelly River right bank sonar unit.

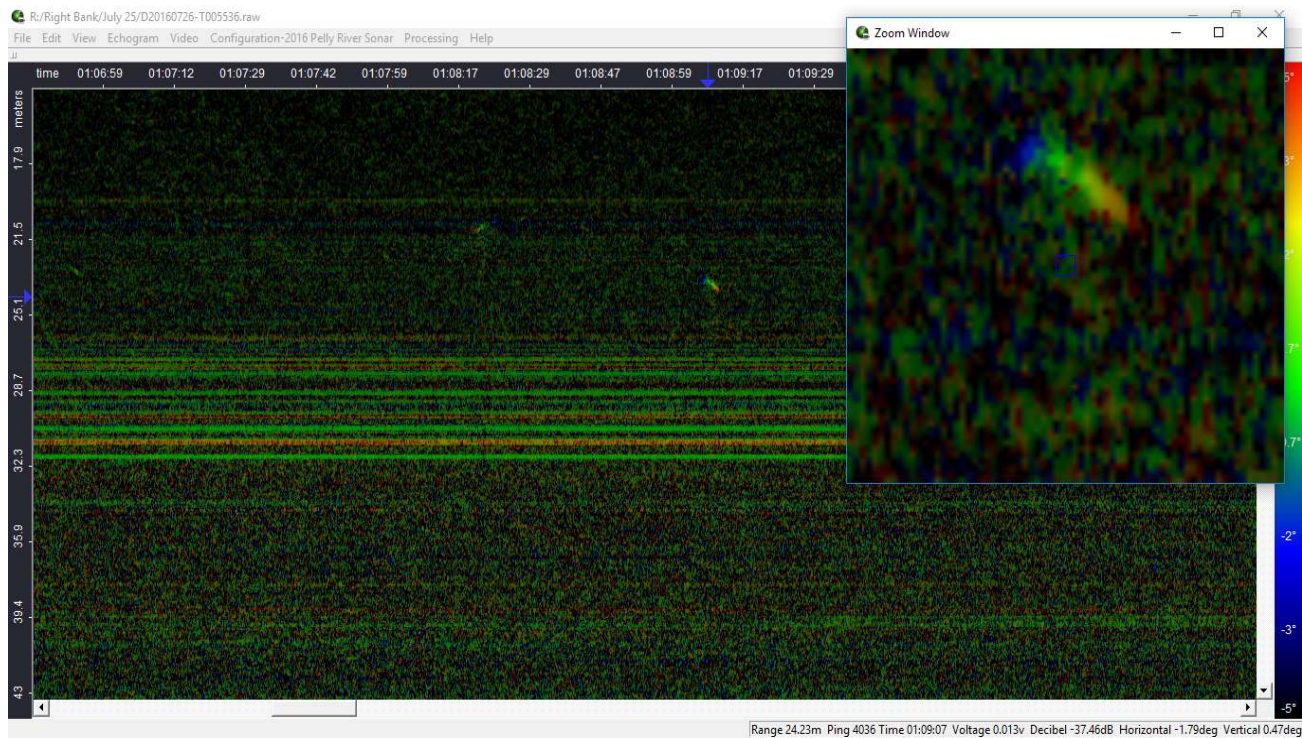


Figure 2. Echotastic echogram window showing two fish traveling in opposite directions. The fish on the left of the screen is traveling upstream and the fish on the right is traveling downstream. Image is from the Pelly River right bank sonar unit.

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 2020 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 the 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_i) in that period (i). Passage (y_i) was estimated as:

$$\hat{y}_i = \left(\frac{x_i}{m_i} \right) m_s$$

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 that 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:

$$Var(\hat{Y}) = \frac{\sum (X_i - \bar{X})^2}{(n-1)}$$

Where X_i is the estimated hourly passage, \bar{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 2020 test netting program included set netting and drift 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. 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 23 and August 20, 2020 and occurred on both riverbanks 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 used incorporated a mesh size of 6.75 inches (17.1 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 10 feet (3.05 m).



2.4.2 DRIFT NETTING

A small amount of drift netting was completed during the 2020 sonar program. When water levels were too high to effectively set nets on the riverbanks, the sonar crew drifted the channel in the vicinity of the sonars. Nets used for drift netting had the same mesh sizes and net dimensions as those used for set netting. Drifts were done for a targeted six minutes before being pulled.

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 5,614 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 (5,676) due to data corrections. The weekly net upstream count is obtained 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 exceeded the number of fish moving downstream on both the right and left banks.

Table 3. Raw weekly counts of salmon at the Pelly River sonar site from July 9 to August 24, 2020.

Program Week	Left Bank			Right Bank			Net Upstream Total
	Upstream	Downstream	Net Upstream Total	Upstream	Downstream	Net Upstream Total	
July 9-12	9	0	9	62	1	61	70
July 13-19	99	0	99	345	2	343	442
July 20-26	161	0	161	800	1	799	960
July 27-Aug 2	386	0	386	858	3	855	1,241
Aug 3-9	372	0	372	1,465	1	1,464	1,836
Aug 10-16	252	0	252	612	1	611	863
Aug 17-24	73	0	73	129	0	129	202
Total	1,352	0	1,352	4,271	9	4,262	5,614

3.1.2 SONAR DATA QUALITY ASSURANCE/QUALITY CONTROL AND RELIABILITY

A total of 269 files were re-counted for QA/QC purposes: 130 on the right bank and 139 on the left bank. A total of 57 files (41%) from the right bank and 28 files (20%) from the left bank differed in the count of fish. Of the QA/QC files that had discrepancies, there was a difference of -1 for the right bank and 7 for the left bank. The total number of fish counted in the original files was 715 and the total number of fish counted in the QA/QC files was 719. This constituted a difference of +4 fish or 0.56% of the total number of fish counted in the QA/QC files. The right bank had an APE of 11.89% and the left bank had an APE of 9.32%. This means the mean difference in the original count versus the two QA/QC counts was 11.89% on the right bank and 9.32% on the left bank.

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. Although the difference between the original counts and the QA/QC counts was much less compared to previous project years, having less crew members rotating throughout



shifts on the project may have likely increased crew consistency in fish counts. The targeted difference in the original versus the QA/QC files is less than a 10% difference.

3.2 TEST NETTING

During the 2020 project, the amount of netting done was increased compared to the previous year. Although only crews of two EDI staff were present at the sonar site this project year, effort was directed toward a successful test fishery. Drift netting was used at first due to high water on the Pelly River, difficult boating conditions and lack of adequate set net locations. Once water levels came down, eddies started to form along the riverbanks and set netting could be carried out.

3.2.1 SET NETTING

A total of 47 nets were set during the 2020 field season (Table 4, Appendix 3). Nets were set for as long as time allowed following sonar counts and completion of other tasks. A total of 24.7 hours of set netting was completed. During the 2020 test fishery, four Chinook salmon and one inconnu were captured. Of those Chinook captured one was a male and three were females. The male salmon had a fork length of 920 mm and was in medium condition, while the two females that were sampled were in good condition and measured 830 mm and 790 mm, respectively. The last captured female released a small number of eggs while being removed from the net, which has not been observed at the Pelly Sonar site during all program years. The remaining female captured during the test netting program was not sampled due to its poor condition once it was removed from the net.

Table 4. Summary of set netting effort and catches at the Pelly River sonar site in 2020.

Week	Netting Effort (Hours)	Chinook Salmon Captured	Other Fish Captured	Total Fish Captured
Jul 23-30	8.5	0	0	0
Jul 31-Aug 6	1.5	0	1	1
Aug 7-13	10.2	4	0	4
Aug 14-20	4.5	0	0	0
Total	24.7	4	1	5

3.2.2 DRIFT NETTING

During the fifth project year, a total of six offshore drifts were complete with no fish caught. Drifts were used to fish the areas of the Pelly River when there was no opportunity/location to set nets. During the 2016 field season, a total of 93 offshore drifts were completed capturing a single Chinook salmon (EDI Environmental Dynamics Inc. 2017). In 2017 a total of 209 offshore drifts were completed with no fish captured (EDI Environmental Dynamics Inc 2018). During the 2018 field season, a single Chinook salmon was captured in seven drifts (EDI Environmental Dynamics Inc 2019).



4 DISCUSSION

4.1 INTERPOLATION OF RUN DATA

4.1.1 INTERPOLATION OF MISSING COUNT DATA

Interpolation of 39 hours of missing sonar data was required (27 hours from the right bank and 12 hours from the left bank). Missing data was due to equipment maintenance and updates, temporary generator failure and sonar repositioning 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. Daily interpolated count data are included in Appendix B.

After interpolating the missing count data, an estimate of an additional 62 salmon were believed to have passed the sonar site during operation (62 on the right bank and 0 on the left bank). Subsequently, a total of 5,676 salmon were estimated to have passed the sonar site between July 9 and August 24, 2020 (Table 5).

Table 5. Interpolated net upstream weekly counts of Chinook salmon at the Pelly River sonar site between July 9 and August 24, 2020.

Program Week	Left Bank	Right Bank	Both Banks Combined Interpolated Net Upstream Total
Jul 9-12	9	62	71
Jul 13-19	99	355	454
Jul 20-26	161	799	960
Jul 27-Aug 2	386	871	1,257
Aug 3-9	372	1,482	1,854
Aug 10-16	252	626	878
Aug 17-24	73	129	202
Total	1,352	4,324	5,676

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 Environmental Dynamics Inc. 2017, 2018, 2019, 2020)



It is suspected that chum salmon were not present during the 2020 sonar operation; however, to further support this notion, the run timing of chum salmon in 2020 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; (Alaska Department of Fish and Game 2020)). The fall chum salmon count began at the Eagle sonar site on August 28, 2020 with a daily count of 76 chum (Alaska Department of Fish and Game 2020). Based on this information, the first arrival of chum at the Pelly River sonar site was estimated to be approximately September 7 to September 9. Given that the last day of sonar operation was August 24th, 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 2020 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 2020 program ran approximately the same amount of time as the 2019 program (47 and 48 days, respectively). In 2020, Chinook salmon were observed on the first day of sonar counting (July 9) and still observed to be migrating past the sonar site on August 24 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.

As conducted for the previous years of sonar operation, the final passage date of Chinook for the Pelly River sonar site was chosen by comparing the Chinook counts recorded at the Eagle sonar site since the migration patterns at these two sites have followed similar patterns throughout program years. The peak in daily counts at the Pelly River sonar site generally occurs approximately seven days after the peak daily count at the Eagle sonar site. The Chinook count ended at the Eagle sonar site on August 27, 2020 with a daily count of 98 Chinook (Alaska Department of Fish and Game 2020). 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 September 3, 2020. 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 10, 2020.

The preliminary period of August 25 to September 10 was used to extrapolate Chinook salmon passage rates past the end date of the 2020 sonar program (after August 24). Extrapolated Chinook counts were calculated



for the period of August 25 to September 10 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 zero Chinook salmon are estimated to have passed the sonar site before the sonar operations began, and a total of two Chinook salmon are estimated to have passed by the sonar site after operations ceased, making the final estimate of Chinook salmon past the Pelly Sonar site 5,678. With this being the case, the run expansion is minimal and shows that the duration of the sonar program captured the majority of the 2020 Pelly Chinook salmon run.

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 fifth 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 STRENGTH

Upstream Chinook salmon were recorded at the Pelly River sonar site on the first day of sonar recording (July 9), with a total of one upstream migrating Chinook salmon counted. This indicates that the 2020 project most likely captured the very start of the Pelly River Chinook salmon run. The daily counts began to spike around July 22, dropping between July 23 and July 29, and then increased steadily from then on. The peak of the 2020 Chinook salmon run was observed at the Pelly Sonar site on Aug 4, 2020, six days after the peak at the Eagle sonar site on July 30, 2020. Daily counts reached a high of 308 on August 4, while decreasing consistently throughout the remainder of the run. On the final day of sonar operation (August 24), two Chinook salmon were recorded swimming past the sonar on the left bank (the right bank sonar was pulled on August 22 due to high water levels). The Pelly sonar was successful in capturing a comprehensive data set for the 2020 Chinook salmon run, as pre- and post-season expansions accounted for a very small portion of the total run estimate.

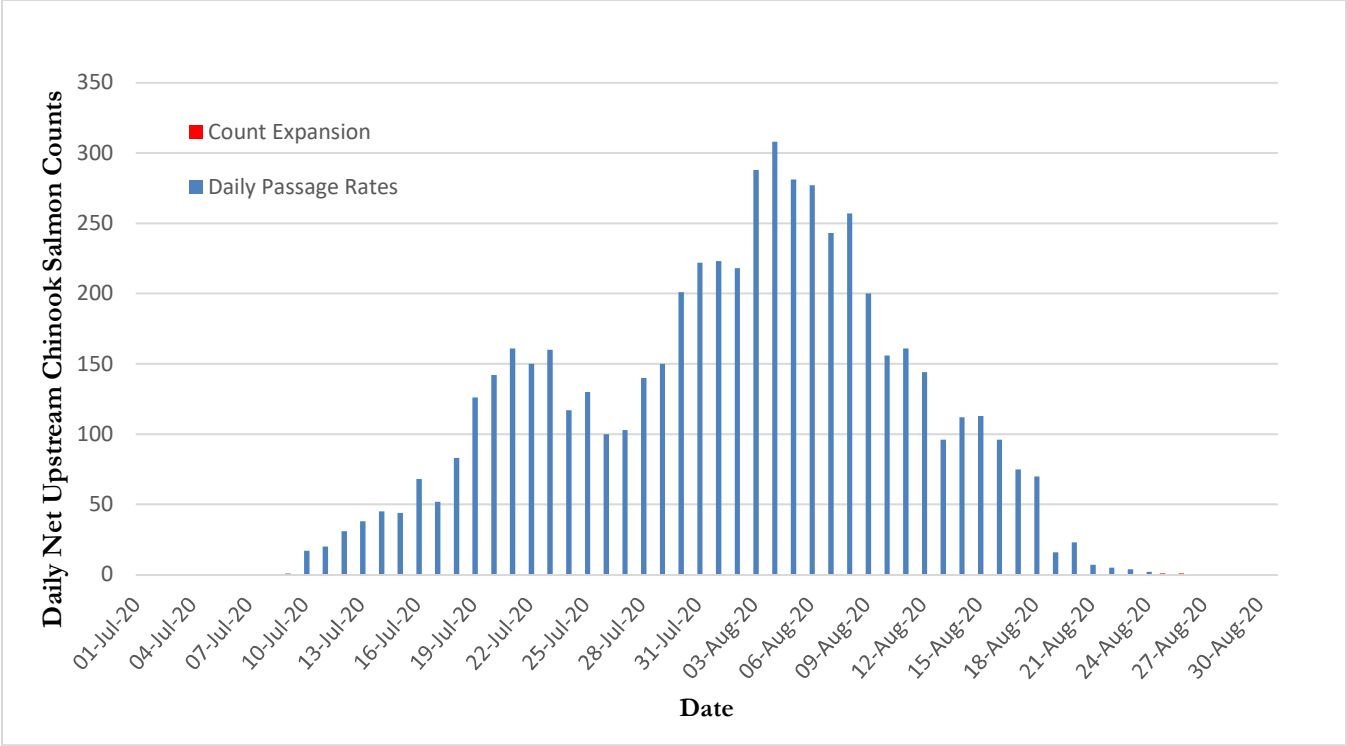


Figure 3. Daily net upstream Chinook Salmon counts at the Pelly River Chinook sonar site in 2020, including pre- and post-season extrapolated data.

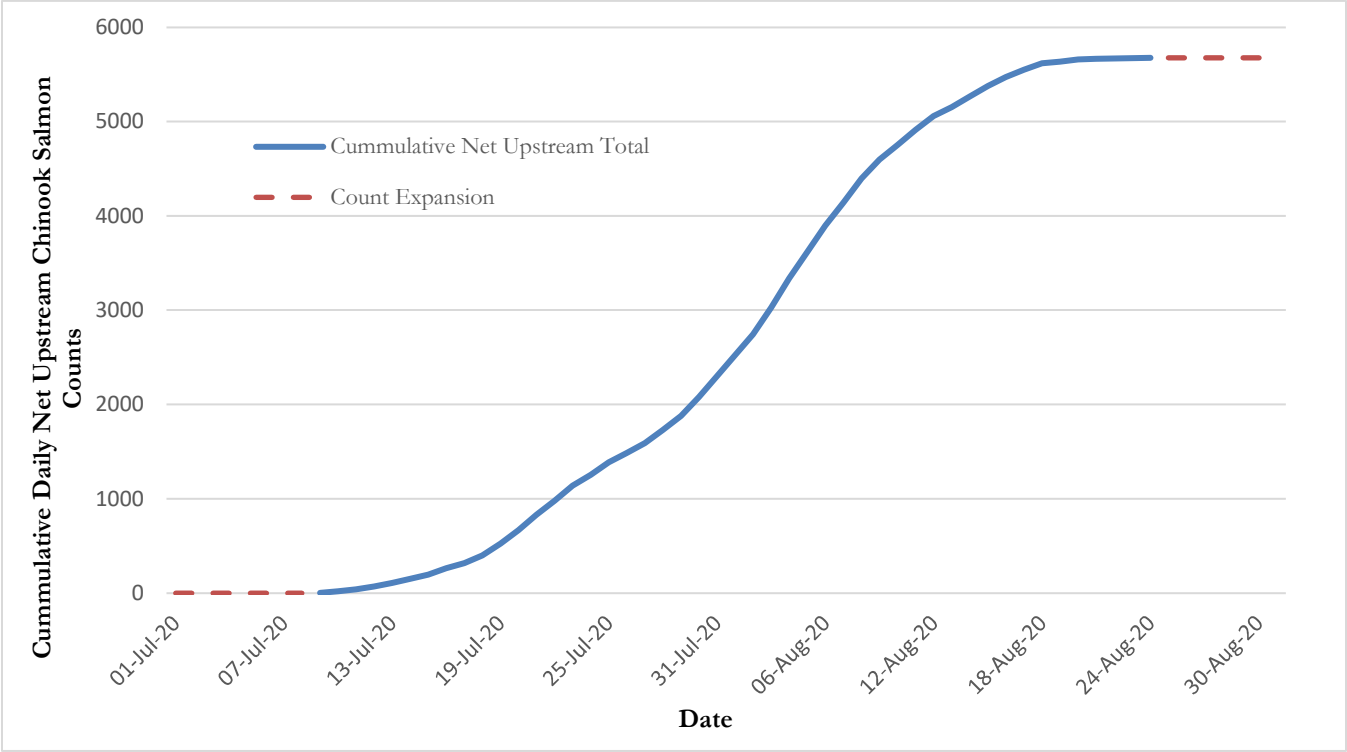


Figure 4. Daily cumulative net upstream Chinook salmon counts at the Pelly River sonar site in 2020, including pre- and post-season extrapolated data.

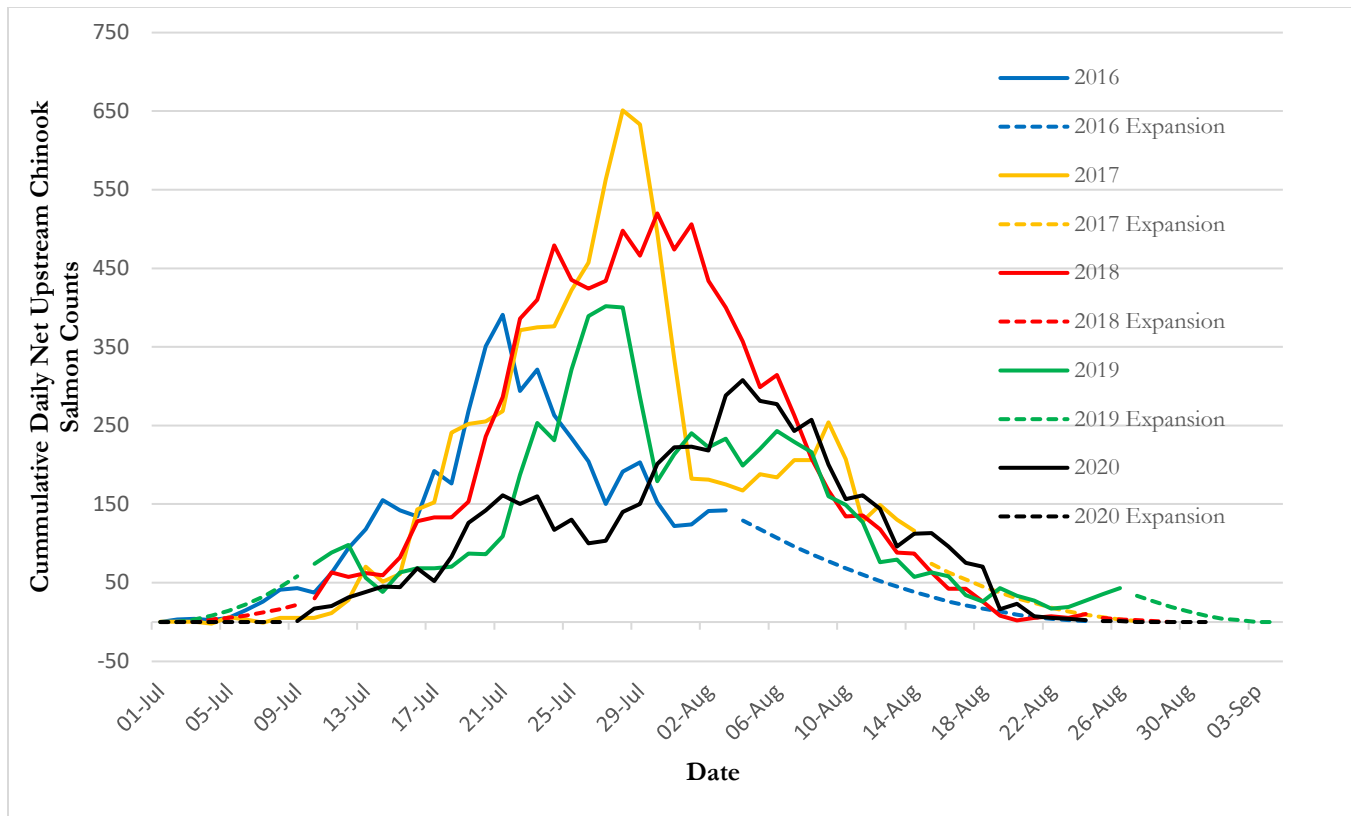


Figure 5. Yearly comparison of daily cumulative net upstream Chinook salmon counts at the Pelly River sonar site in 2016 to 2020, including pre- and post-season extrapolated data.

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.

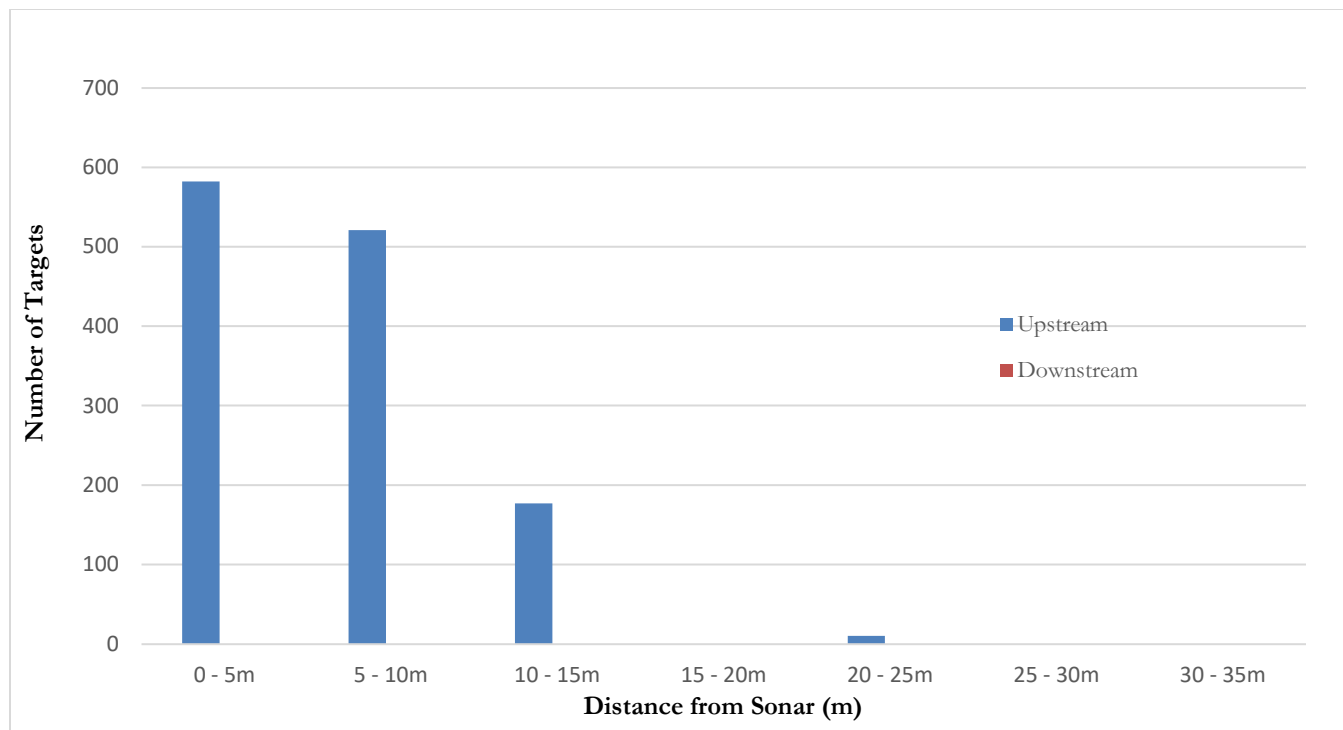


Figure 6. Ranges of upstream and downstream moving fish targets detected on the left bank of the Pelly River sonar site in 2020.

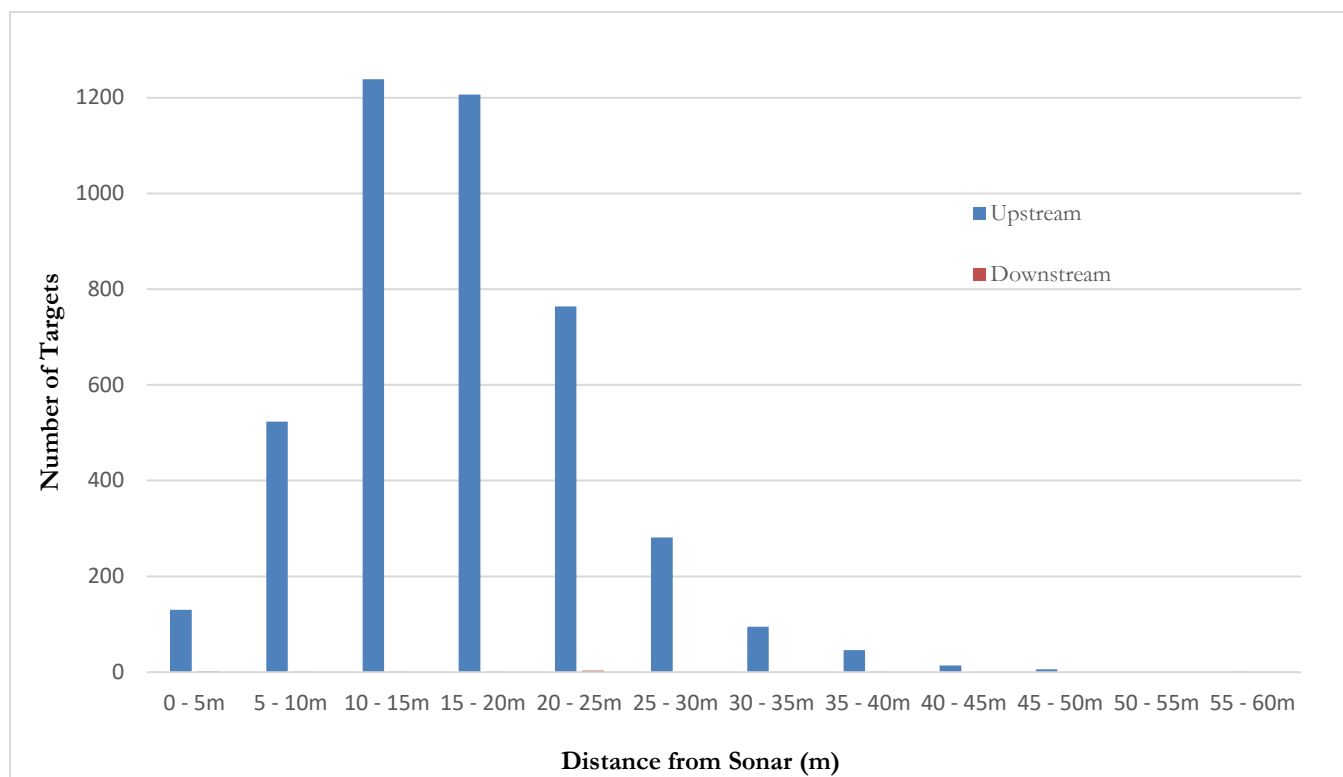


Figure 7. Ranges of upstream and downstream moving fish targets detected on the right bank of the Pelly River sonar site in 2020.



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 2020, which is consistent with previous years of data. A total of 5,594 upstream moving targets² were analyzed, 23% were observed on the left bank and 77% on the right bank (Figure 6, Figure 7, Table 6 and Table 7). The orientation of upstream moving fish in 2020 differed from 2019 where the majority of the upstream targets were detected within 5 to 10 m of the sonar transducers for both banks. In 2020, most left bank targets were detected between the ranges of 0 to 5 m and 5 to 10 m (85.5% of the left bank targets). Whereas on the right bank, most targets were detected between the ranges of 10 to 15 m and 15 to 20 m (56.8% of right bank targets). The differences in proximity to the sonar transducers between 2019 and 2020 project years could be related to the difference in water levels.

Table 6. Ranges of upstream and downstream moving fish targets detected on the left bank of the Pelly River sonar site in 2020.

Target Range	Upstream Targets		Downstream Targets	
	Number of Targets	Proportion of Total Targets (%)	Number of Targets	Proportion of Total Targets (%)
0-5 m	582	45.1	0	0
5-10 m	521	40.4	0	0
10-15 m	177	13.7	0	0
15-20 m	0	0	0	0
20-25 m	10	0.8	0	0
25-30 m	0	0	0	0
30-35 m	0	0	0	0
Total	1,290	100	0	100

² Note that 5,594 is the total, net moving target count of upstream targets before subtracting downstream targets. This total is slightly lower than what was reported as there were some mistakes made during the saving of some sonar files.



Table 7. Ranges of upstream and downstream moving fish targets detected on the right bank of the Pelly River sonar site in 2020.

Target Range	Upstream Targets		Downstream Targets	
	Number of Targets	Proportion of Total Targets (%)	Number of Targets	Proportion of Total Targets (%)
0-5 m	130	3.0	2	22.2
5-10 m	523	12.2	1	11.1
10-15 m	1,238	28.8	1	11.1
15-20 m	1,206	28.0	1	11.1
20-25 m	764	17.8	3	33.3
25-30 m	281	6.5	0	0
30-35 m	95	2.2	0	0
35-40 m	46	1.1	1	11.1
40-45 m	14	0.3	0	0
45-50 m	6	0.1	0	0
50-55 m	0	0.0	0	0
55-60 m	1	0.0	0	0
Total	4,304	100	9	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 and were documented during the 2015 Pelly River sonar reconnaissance survey (EDI Environmental Dynamics Inc 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 Environmental Dynamics Inc 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, especially during the 2020 project with high water levels on the Pelly River.

Given the low number of offshore, upstream moving targets on the left bank, and that only two Chinook salmon have been captured during midchannel drift netting between 2016 and 2020, the Pelly River sonar project can be successfully run with one long-range and one short-range sonar unit.

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 2020). 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 the 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 2020; Figure 8).

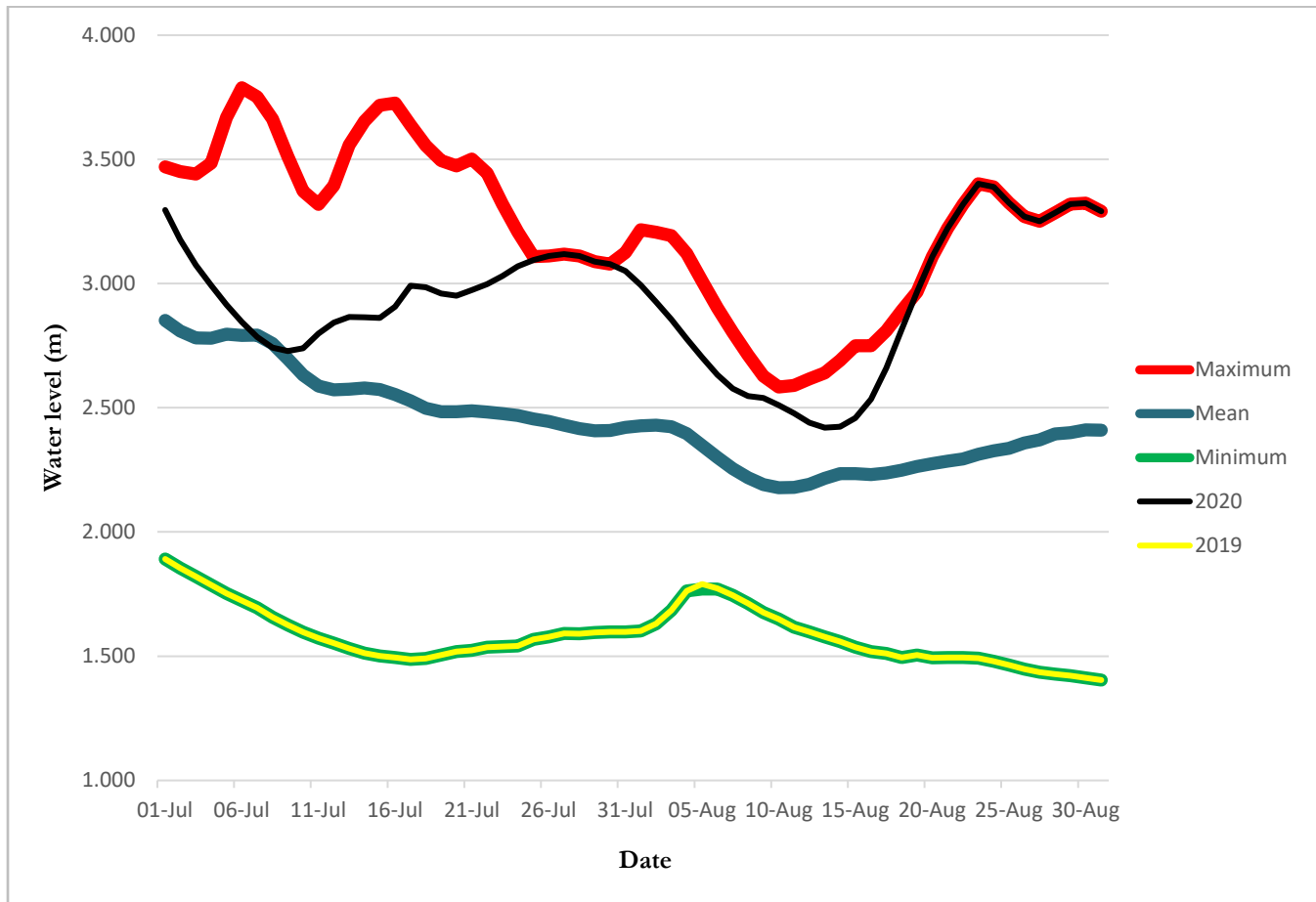


Figure 8. July 1 to August 31, 2020 Pelly River water levels as compared to the mean, minimum and maximum daily raw water levels from 2011 to 2020. Water levels measured at Water Survey of Canada gauging station 09BC001 near the community of Pelly Crossing. The earliest year available for water levels at this station was 2011.

As shown in Figure 8, water levels observed at the sonar site included some of the highest water levels during all years of sonar operation. Water levels reached their lowest point of the program on August 13 before increasing steadily to the highest level observed at the sonar site on August 23. High water had impacts on the availability of set net locations and produced large amounts of instream debris. Sonars and weirs had to be cleaned multiple times a day and checked frequently for large logs or trees that could sweep the sonars downstream (Photo 11 in Appendix A). Large woody debris floating in the vicinity of the transducers and rising water levels made working in the river difficult for sonar staff and forced the 2020 Pelly River sonar program to be shut down earlier than scheduled.

At the beginning of the 2020 program the back channel behind the right bank was connected to the mainstem of the river, and therefore was fenced off so no migrating Chinook could bypass the right bank sonar (Photo



12 in Appendix A). Shortly after the fence was erected water levels rose to a height that stopped the fence from remaining upright in the side channel, and therefore the channel remained open for the duration of the program. Although sonar staff did not observe any fish swimming up the side channel riffle, there is a chance that Chinook salmon could have been present in the channel and bypassed the ensounded section of the mainstem.

4.3 TEST NETTING EFFECTIVENESS

The two primary goals of test netting in 2020 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 2020 and included increased fishing effort compared to the previous project year. The 2020 test fishery captured four adult Chinook salmon and one inconnu over the duration of the Pelly River sonar program (test netting data can be viewed in Appendix C). Three out of the four captured Chinook were sampled for ASL data, while the remaining salmon was released without being sampled due to its poor condition upon release from the net. The other Chinook salmon captured showed no signs of fungus or abrasion and were deemed in medium to good condition. 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 (section 4.1.2). This assumption is further supported by the fact that no chum salmon were captured in any portion of the netting program over the five years the program has been running.

Crew members noted a presence of freshwater fish in the sonar files and around the transducers throughout the duration of the program. Small fish were observed along the right bank hiding in the instream vegetation, but field crews could not identify them to species. On one occasion a staff member was cleaning the weir on the right bank and observed a pike approximately 300 mm in length stuck in the fencing (the pike was removed from the fence and released). One inconnu measuring 810 mm was captured in the 2020 test fishery. It is important to note that this size of inconnu was similar to the size of salmon caught during test netting. These observations highlight the importance of the test netting program in confirming what is being recorded by 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 2020 Pelly River Chinook sonar program was to continue developing local capacity within SFN and the community of Pelly Crossing to conduct fisheries research programs. This season no SFN technicians participated in the sonar program. Two positions were posted and two individuals were selected;



however, eventually declined to participate and replacements could not be found. Likely related to the COVID 19 pandemic there was a general shortage of available workers in Yukon communities including Pelly Crossing during the summer of 2020. The pandemic also appeared to affect the numbers of visitors to the Pelly River sonar site—a pair visitors came in 2020. Going forward, it is important that this project provides opportunity for SFN staff and citizens to participate in all aspects of the project. 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 CONCLUSIONS AND RECOMMENDATIONS

The 2020 Pelly River Chinook count was the lowest recorded in the short history of the program—such results were consistent with the low runs documented throughout the Yukon. The final estimate was 17% of the Yukon border counts at Eagle which is consistent with past years. Despite challenges with high water levels, SFN staffing and the pandemic the 2020 Pelly River Chinook Salmon sonar program was successful in meeting most of the goals and objectives outlined in the 2020 Pelly River Chinook Salmon sonar program proposal submitted to Yukon River Panel Restoration and Enhancement Fund. Recommendations for future Pelly River Chinook salmon sonar programs are listed below:

- Increase collaboration between 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).
- Advertise technician positions as soon as project funding has been secured and logistics for the upcoming project year have been finalized.
- Dedicate more time for training sonar technicians prior to the initial start of the program (counting procedures, sonar maintenance, camp setup and camp maintenance).
- Increase community involvement with data collection by encouraging SFN subsistence fishers to record and submit length and sex data from their catches.
- Increase community involvement through the encouragement of site visits by SFN citizens and locals of Pelly Crossing.



6 REFERENCES

6.1 LITERATURE CITED

- Alaska Department of Fish and Game (ADFG). 2020. Escapement Monitoring, In-Season and Historical Data. Available at:
http://www.adfg.alaska.gov/index.cfm?adfg=commercialbyareayukon.salmon_escapement
[Accessed September 2020]
- Crane, A.B. and Dunbar, R.D. 2009. Sonar Estimation of Chinook and Fall Chum Salmon Passage in the Yukon River near Eagle, Alaska, 2008.
- EDI Environmental Dynamics Inc. 2015. Pelly River Sonar Reconnaissance Survey. Prepared for the Selkirk First Nation. Whitehorse Yukon.
- EDI Environmental Dynamics Inc. 2017. 2016 Pelly River Chinook salmon sonar program. Prepared for the Selkirk First Nation. Whitehorse, Yukon. 59 pp.
- EDI Environmental Dynamics Inc. 2018. 2017 Pelly River Chinook Salmon Sonar Program. Prepared for the Selkirk First Nation. Whitehorse Yukon.
- EDI Environmental Dynamics Inc. 2019. 2018 Pelly River Chinook Salmon Sonar Program. Prepared for the Selkirk First Nation. Whitehorse Yukon.
- EDI Environmental Dynamics Inc. 2020. 2019 Pelly River Chinook Salmon Sonar Program. Prepared for the Selkirk First Nation. Whitehorse Yukon.
- Government of Canada. 2020. Real-Time Hydrometric Data Graph for PELLY RIVER AT PELLY CROSSING (09BC001) [YT] Available at:
https://wateroffice.ec.gc.ca/report/real_time_e.html?stn=09BC001 [Accessed September 2020]
- JTC (Joint Technical Committee of the Yukon River U.S./Canada Panel. 2016. YUKON RIVER SALMON 2015 SEASON SUMMARY AND 2016 SEASON OUTLOOK. Anchorage, Alaska.

6.2 PERSONAL COMMUNICATIONS

- MacDonald, E. 2017. Fisheries and Oceans Canada, Aquatic Science Biologist, personal communication via email January 2017.
- Mather, V and Milligan, M. 2018. Fisheries and Oceans Canada, Aquatic Science Biologists, personal communication January 2018.



APPENDICES



APPENDIX A PHOTOGRAPHS



Photo 1. View of Pelly Sonar camp taken from the right bank bluff overlooking the Pelly River.



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



Photo 3. View of left bank boat landing area in front of Pelly Sonar camp.



Photo 4. View of staff checking a net as part of the test fishery at site PR4.



Photo 5. View of high water on the right bank. Staff had to build a platform to keep the right bank generator and jerry can out of the water.



Photo 6. View of high water on the right bank, looking downstream.



Photo 7. EDI staff holding an Inconnu captured at site PR2 during test netting.



Photo 8. EDI staff holding an adult female Chinook salmon captured at site PR4 during test netting.



Photo 9. Close up view of a male Chinook salmon captured at site PR4 during test netting.



Photo 10. View of foggy conditions on the Pelly River, looking upstream from Pelly Sonar camp.



Photo 11. View of large log caught in the left bank sonar mount and weir (July 13, 2020).



Photo 12. View of the fenced off back channel riffle immediately above the right bank sonar, looking upstream (July 14, 2020).



APPENDIX B SONAR COUNT DATA



Table B1. Daily interpolated and expanded sonar counts from the 2020 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	-	-	-	-	-	-	-	-	0
04-Jul	-	-	-	-	-	-	-	-	0
05-Jul	-	-	-	-	-	-	-	-	0
06-Jul	-	-	-	-	-	-	-	-	0
07-Jul	-	-	-	-	-	-	-	-	0
08-Jul	-	-	-	-	-	-	-	-	0
09-Jul	0	0	0	0	1	0	0	1	1
10-Jul	2	0	0	2	15	0	0	15	17
11-Jul	4	0	0	4	16	0	0	16	20
12-Jul	3	0	0	3	28	1	1	28	31
13-Jul	6	0	0	6	33	1	0	32	38
14-Jul	11	0	0	11	34	0	0	34	45
15-Jul	9	0	0	9	36	1	0	35	44
16-Jul	13	0	0	13	55	0	0	55	68
17-Jul	13	0	0	13	39	0	0	39	52
18-Jul	25	0	0	25	46	0	12	58	83
19-Jul	22	0	0	22	104	0	0	104	126
20-Jul	29	0	0	29	114	1	0	113	142
21-Jul	32	0	0	32	129	0	0	129	161
22-Jul	21	0	0	21	129	0	0	129	150
23-Jul	17	0	0	17	143	0	0	143	160
24-Jul	8	0	0	8	109	0	0	109	117
25-Jul	31	0	0	31	99	0	0	99	130
26-Jul	23	0	0	23	77	0	0	77	100



27-Jul	37	0	0	37	66	0	0	66	103
28-Jul	61	0	0	61	79	0	0	79	140
29-Jul	70	0	0	70	80	0	0	80	150
30-Jul	53	0	0	53	148	0	0	148	201
31-Jul	48	0	0	48	161	3	16	174	222
01-Aug	60	0	0	60	163	0	0	163	223
02-Aug	57	0	0	57	161	0	0	161	218
03-Aug	72	0	0	72	216	0	0	216	288
04-Aug	83	0	0	83	225	0	0	225	308
05-Aug	53	0	0	53	211	1	18	228	281
06-Aug	42	0	0	42	235	0	0	235	277
07-Aug	53	0	0	53	190	0	0	190	243
08-Aug	27	0	0	27	230	0	0	230	257
09-Aug	42	0	0	42	158	0	0	158	200
10-Aug	49	0	0	49	101	0	6	107	156
11-Aug	40	0	0	40	121	0	0	121	161
12-Aug	39	0	0	39	105	0	0	105	144
13-Aug	38	0	0	38	58	0	0	58	96
14-Aug	35	0	0	35	68	0	9	77	112
15-Aug	29	0	0	29	85	1	0	84	113
16-Aug	22	0	0	22	74	0	0	74	96
17-Aug	21	0	0	21	54	0	0	54	75
18-Aug	20	0	0	20	50	0	0	50	70
19-Aug	4	0	0	4	12	0	0	12	16
20-Aug	13	0	0	13	10	0	0	10	23
21-Aug	5	0	0	5	2	0	0	2	7
22-Aug	4	0	0	4	1	0	0	1	5
23-Aug	4	0	0	4	-	-	-	-	4
24-Aug	2	0	0	2	-	-	-	-	2
25-Aug	-	-	-	-	-	-	-	-	1
26-Aug	-	-	-	-	-	-	-	-	1



27-Aug	-	-	-	-	-	-	-	-	0
28-Aug	-	-	-	-	-	-	-	-	0
29-Aug	-	-	-	-	-	-	-	-	0
30-Aug	-	-	-	-	-	-	-	-	0
31-Aug	-	-	-	-	-	-	-	-	0
Total	1352	0	0	1352	4271	9	62	4324	5678

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

	APE	Variance	SD	CI
Left Bank	9.32	69.58	8.88	17.41
Right Bank	11.90	231.29	15.59	30.56

APE = average percent error; SD = standard deviation; CI = confidence interval



APPENDIX C TEST NETTING DATA

**Table C1. Net locations from the 2020 Pelly River Chinook Salmon Sonar Program.**

Name	Location	Description
PR1	62.50003/-137.08263	At Pelly Sonar camp just downstream of boat landing
PR2	62.83311/-137.14734	Just downstream of RB back channel
PR3	62.83179/-137.14973	Small eddy downstream of RB sonar
PR4	62.84085/-137.12769	Upstream of camp on RB river bend
Drift Netting	62.50235/-137.07401	Entire straight stretch of river in front of sonar camp

Table C2. Set netting effort and fish captures from the 2020 Pelly River Chinook Salmon Sonar Program.

Date	Set Number	Net Location	Net in	Net Out	Effort (hours)	Mesh Size	Fish Species	Length (cm)	Sex
23-Jul-2020	1	PR1	14:34	15:05	0.5	6.75	NFC	-	-
23-Jul-2020	2	PR1	15:44	16:44	1.0	6.75	NFC	-	-
23-Jul-2020	3	PR1	16:44	17:44	1.0	6.75	NFC	-	-
26-Jul-2020	4	PR1	16:00	17:00	1.0	6.75	NFC	-	-
26-Jul-2020	5	PR1	17:00	18:00	1.0	6.75	NFC	-	-
27-Jul-2020	6	PR1	14:10	14:40	0.5	6.75	NFC	-	-
27-Jul-2020	7	PR2	14:50	15:20	0.5	6.75	NFC	-	-
28-Jul-2020	8	PR2	15:20	15:50	0.5	6.75	NFC	-	-
28-Jul-2020	9	PR2	16:00	16:30	0.5	6.75	NFC	-	-
29-Jul-2020	10	PR2	13:30	14:00	0.5	6.75	NFC	-	-
29-Jul-2020	11	PR2	14:10	14:40	0.5	6.75	NFC	-	-
29-Jul-2020	12	PR3	15:00	15:30	0.5	6.75	NFC	-	-
29-Jul-2020	13	PR3	15:30	16:00	0.5	6.75	NFC	-	-
06-Aug-2020	14	PR2	13:35	14:05	0.5	6.75	NFC	-	-
06-Aug-2020	15	PR2	14:11	15:11	1.0	6.75	IN	81	Unknown
08-Aug-2020	16	PR4	14:00	14:30	0.5	6.75	CH	83	Female
08-Aug-2020	17	PR4	15:09	15:37	0.5	6.75	NFC	-	-
08-Aug-2020	18	PR4	15:37	16:07	0.5	6.75	NFC	-	-



08-Aug-2020	19	PR4	16:15	16:45	0.5	6.75	NFC	-	-
08-Aug-2020	20	PR4	16:47	17:17	0.5	6.75	NFC	-	-
10-Aug-2020	21	PR4	13:47	14:08	0.5	6.75	CH	92	Male
10-Aug-2020	22	PR4	14:08	14:38	0.5	6.75	NFC	-	-
10-Aug-2020	23	PR4	14:44	15:14	0.5	6.75	NFC	-	-
10-Aug-2020	24	PR4	15:44	16:14	0.5	6.75	CH	-	Female
11-Aug-2020	25	PR4	14:04	14:34	0.5	6.75	NFC	-	-
11-Aug-2020	26	PR4	15:18	15:48	0.5	6.75	NFC	-	-
11-Aug-2020	27	PR4	15:59	16:29	0.5	6.75	NFC	-	-
11-Aug-2020	28	PR4	16:36	17:00	0.4	6.75	CH	79	Female
12-Aug-2020	29	PR4	13:49	14:19	0.5	6.75	NFC	-	-
12-Aug-2020	30	PR4	14:25	14:55	0.5	6.75	NFC	-	-
12-Aug-2020	31	PR4	15:00	15:30	0.5	6.75	NFC	-	-
12-Aug-2020	32	PR4	15:34	16:04	0.5	6.75	NFC	-	-
12-Aug-2020	33	PR4	16:12	16:42	0.5	6.75	NFC	-	-
12-Aug-2020	34	PR4	16:48	17:18	0.5	6.75	NFC	-	-
13-Aug-2020	35	PR4	13:38	14:08	0.5	6.75	NFC	-	-
13-Aug-2020	36	PR4	14:11	14:41	0.5	6.75	NFC	-	-
13-Aug-2020	37	PR4	14:45	15:15	0.5	6.75	NFC	-	-
13-Aug-2020	38	PR4	15:18	15:48	0.5	6.75	NFC	-	-
15-Aug-2020	39	PR4	13:38	14:08	0.5	6.75	NFC	-	-
15-Aug-2020	40	PR4	14:14	14:44	0.5	6.75	NFC	-	-
15-Aug-2020	41	PR4	14:54	15:24	0.5	6.75	NFC	-	-
15-Aug-2020	42	PR4	15:36	16:06	0.5	6.75	NFC	-	-
15-Aug-2020	43	PR4	16:06	16:36	0.5	6.75	NFC	-	-
15-Aug-2020	44	PR4	16:36	17:06	0.5	6.75	NFC	-	-
20-Aug-2020	45	PR4	15:29	15:59	0.5	6.75	NFC	-	-
20-Aug-2020	46	PR4	16:10	16:40	0.5	6.75	NFC	-	-
20-Aug-2020	47	PR4	16:48	17:18	0.5	6.75	NFC	-	-

NFC = no fish caught; CH = Chinook salmon; IN = Inconnu

**Table C3. Drift netting effort and fish captures from the 2020 Pelly River Chinook Salmon Sonar Program.**

Date	Set Number	Net Location	Net in	Net Out	Effort (minutes)	Mesh Size	Fish Species	Length (cm)	Sex
24-Jul-2020	1	Drift Netting	14:50	15:10	20	6.75	NFC	-	-
24-Jul-2020	2	Drift Netting	15:20	15:30	10	6.75	NFC	-	-
24-Jul-2020	3	Drift Netting	17:05	17:29	24	6.75	NFC	-	-
26-Jul-2020	4	Drift Netting	14:00	14:20	20	6.75	NFC	-	-
26-Jul-2020	5	Drift Netting	14:30	14:50	20	6.75	NFC	-	-
26-Jul-2020	6	Drift Netting	15:00	15:20	20	6.75	NFC	-	-