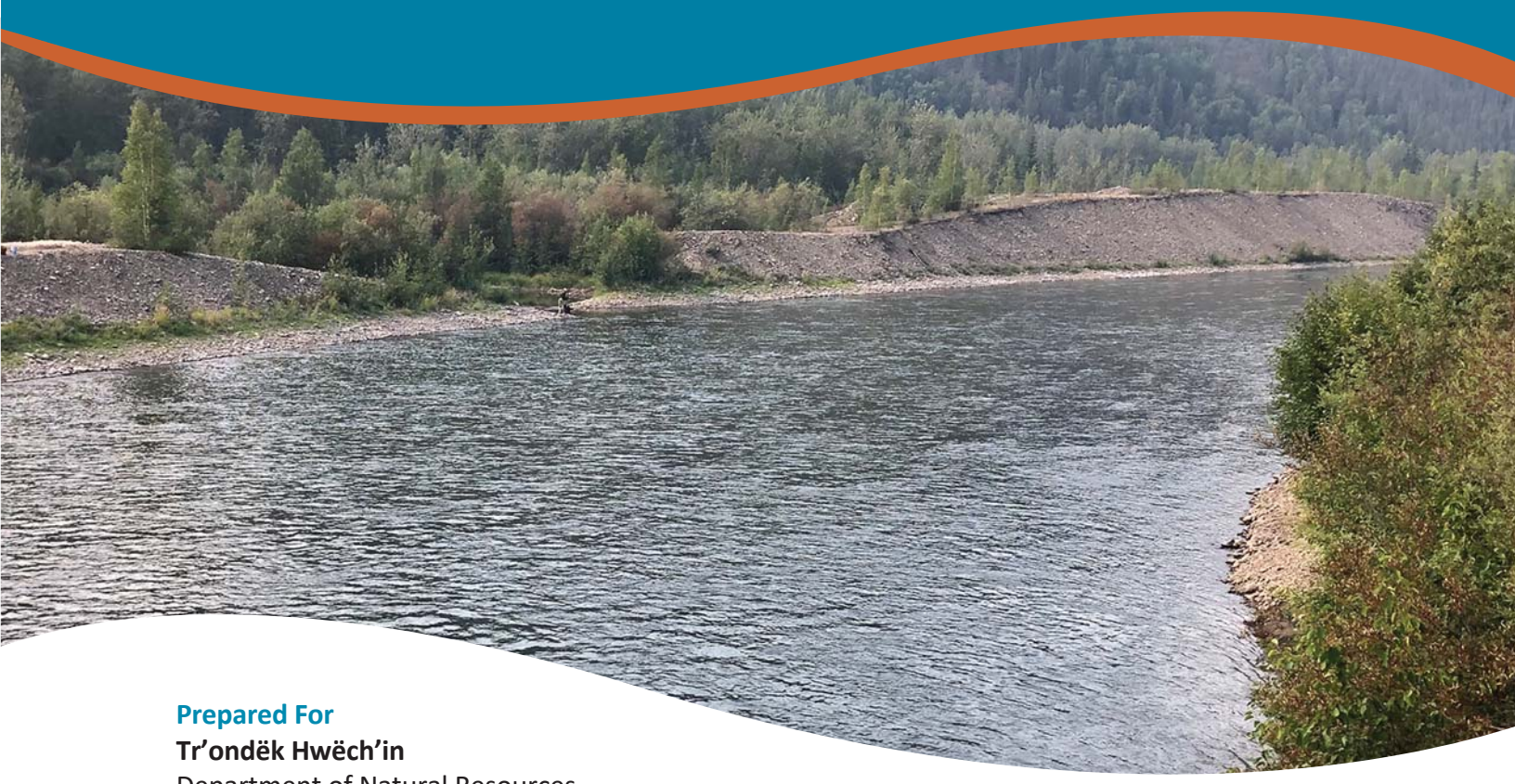
2019 Klondike River Chinook Salmon Sonar Investigation



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EXECUTIVE SUMMARY

In 2019, EDI Environmental Dynamics Inc. was retained by Tr'ondëk Hwëch'in to conduct a reconnaissance level survey of the Klondike River to locate a candidate site for the future deployment of a scientific-grade echosounder (sonar). The purpose of this sonar deployment would be to conduct an annual enumeration of adult Chinook salmon as they migrate up the Klondike River.

During July 23 to 25, 2019, ground-based surveys were completed at three candidate sites for future sonar use. Candidate sites were judged on multiple characteristics including: accessibility, river characteristics and morphology, ease of sonar operation and the suitability to set up a temporary camp with the potential for a long-term camp to be built.

Two of the three sites visited in 2019 were investigated due to their use and/or identification of the site by B. Mercer & Associates Ltd. during a 2008 sonar feasibility assessment. The first site visited was the site used by B. Mercer & Associates Ltd. from 2009 to 2011 to successfully enumerate Chinook salmon in the Klondike River. This site did meet the criteria for a suitable sonar site. The river profile and morphology were conducive to sonar use and the site had easy access. However, this site is located directly adjacent to a private residence. After discussion with the owners, it was determined the future use and set up of a sonar camp in this area would not be feasible. The second site visited was an alternate site identified during 2008. This site is easily accessible; however, the site is not suitable for sonar operation due the presence of a shallow gravel bar in the middle of the river channel. This would allow for migrating Chinook salmon to pass the sonar without being detected, resulting in an inaccurate final passage estimate.

The final site investigated is the recommended future site for sonar deployment. This site is located immediately downstream of the Klondike River bridge and is directly adjacent to Tr'ondëk Hwëch'in's asset compound. The section of river at this site is ideal for sonar deployment with a gradual sloping bank, and is free of any trenches, steep drop offs or large boulders. Due to the slight bend in the river, the main flow will be on the opposite bank from the sonar unit, allowing for the easy construction and maintenance of the fish deflection weir on the right downstream bank. It is recommended the sonar camp be set up on the east side of the compound and ideally run off city power from existing buildings at the location. It is believed that this location is suitable for the successful use of Chinook salmon sonar enumeration on the Klondike River.

ACKNOWLEDGEMENTS

Funding for this project was provided by the Yukon River Panel Restoration and Enhancement Fund, Newmont Goldcorp's community investment program and the Pacific Salmon Foundation's Community Salmon Program. Natasha Ayoub and Alice McCulley of the Tr'ondëk Hwëch'in Government provided general project direction and assistance with logistics.

AUTHORSHIP

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1 INTRODUCTION

Tr'ondëk Hwëch'in (TH) citizens are physically, culturally and spiritually connected to the Yukon River salmon fishery. This fishery has been a major contributor to the traditional economy since time immemorial and the Tr'ondëk Hwëch'in, or People of the River, have historically focused salmon harvest at the confluence of the Yukon and Klondike Rivers, or Tr'ochëk. As a primary stakeholder in subsistence and commercial salmon fisheries, TH has a vested interest in the health of salmon stocks found within their Traditional Territory. Klondike River Chinook salmon have faced declining populations for a number of decades and TH has been involved with and have supported salmon restoration projects in their Traditional Territory.

The Klondike River Chinook Restoration Plan (EDI and TH 2018) indicates that the re-establishment of the sonar on the Klondike River is a high priority task for TH. Sonar enumeration of Klondike Chinook will provide an indicator of Chinook escapement, which will be important for a number of reasons. With TH becoming more actively involved in restoration, the long-term operation of this sonar is desirable for tracking future changes in abundance. The Klondike stock is also known to migrate relatively early compared to other stocks in the Yukon River, which makes them more vulnerable to harvest, as many of the spawners move through the lower Yukon River before managers have strong confidence in escapement numbers.

1.1 BACKGROUND

In 2008, a Klondike River Sonar Feasibility Study was completed by B. Mercer & Associates Ltd. A candidate site was located approximately 4 km upstream from the confluence with the Yukon River (Mercer 2009). This site was chosen because:

- access to the site is easy via road;
- the river profile is conducive to sonar and weir operation; and,
- the location is far enough upstream from the Yukon River, but also located downstream of known spawning habitat (Mercer 2009).

From 2009 through 2011, the sonar was operated successfully at the Klondike River site during which time the escapement ranged from 1,181 to 5,147 spawners (Mercer 2009, 2010, 2011, 2012).

1.2 OBJECTIVES

Tr'ondëk Hwëch'in is committed to Chinook salmon stock restoration in the Klondike River, and the annual operation of sonar will be important to establish a current baseline of escapement and determine the effectiveness of long-term restoration efforts. During 2019, TH secured funding to purchase an ARIS sonar to be used on the Klondike River to enumerate Chinook spawners, and conducted a reconnaissance to set the stage for full-scale operation of the sonar during the summer of 2020. The objectives of the 2019 Klondike River sonar investigation were to:

- revisit the sonar site used from 2009 to 2011 to confirm its suitability for continued sonar operation;
- conduct a boat and ground-based survey to visit other potential sonar sites (if the previously used sonar site is deemed no longer suitable due to river morphology or site access issues);
- record a small amount of sonar files to confirm suitable river profile and target visibility; and,
- collect bathymetric data to conduct stream channel cross-sections for candidate sonar sites.

1.3 STUDY AREA

The Klondike River is a large tributary in the Yukon River Watershed (Map 1). It flows into the Yukon River just upstream of Dawson City, Yukon. The Klondike River has a number of tributaries, the largest of which is the North Klondike River that also contains a spawning population of Chinook salmon. The 2019 sonar site investigation focused on the lower 4.5 km of the Klondike River as this portion of the watershed represents the most suitable area to operate a sonar with the goal of monitoring future spawner escapement. This is based on a number of variables described in detail by Mercer (2009), most notably river channel morphology and the location being downstream of known spawning areas in the watershed.

Map 1. Overview of Candidate Sonar Sites in the Klondike River Watershed

Legend

- Candidate Sonar Site
- Highway
- Secondary Road
- Klondike River Watershed

0 5 10 15
Kilometres

Map Scale = 1:600,000 (printed on 11 x 17)
Map Projection: NAD 1983 UTM Zone 7N

Data Sources
Digital Elevation Model and 1:250,000 National Topographic Database (NTDB) provided by Geomatics Yukon - Yukon Government via online source (Corporate Spatial Warehouse) www.geomaticsyukon.ca.

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2 METHODS

2.1 SONAR SITE SELECTION

Upon initial reception of funding for the project, TH and EDI were confident that the site used in previous years by B. Mercer & Associates Ltd. for the enumeration of Klondike River Chinook would still be suitable for sonar use. The Klondike River has an active floodplain; however, the previously used sonar site is located in a portion of the floodplain where the river is somewhat confined and has a straight channel. In the event that the previously used sonar site was deemed to no longer be suitable, field crews planned to locate and test a new site on the lower Klondike River. Crews would also assess a site previously documented to be suitable for sonar use by B. Mercer & Associates Ltd. during their feasibility study (Mercer 2009).

Site assessments were conducted on the Klondike River from July 23 to 25, 2019, with the use of a small jetboat or by road access, where feasible. The ARIS Explorer 1200 sonar unit purchased by TH during 2019 was deployed at suitable sites to record a maximum of 48 hours of continuous data. These data were collected at candidate sonar sites to confirm that the river profile was suitable for sonar deployment. Bathymetric data were collected using a Garmin echoMAP 44cv depth sounder mounted to a jetboat to collect depth measurements in the river channel adjacent to the candidate sites. Bathymetric data were converted to Microsoft Excel and processed in ArcGIS using the Spatial Analyst extension.

Candidate sonar sites were assessed based upon the following characteristics:

- ease of accessibility;
- river characteristics, including channel morphology and presence of eddies, back channels or side channels;
- streambank profile, preferably with a gradual sloping bank with limited or no trenches, drop offs or large boulders;
- ease of sonar operation and weir construction in the nearshore portion of the river; and,
- suitability to set up and operate a temporary camp with potential for long-term infrastructure to be built.

2.2 SONAR SETUP AND DATA COLLECTION

During July 23 to 25, 2019, an ARIS multi-beam sonar system was deployed at candidate sonar site locations. The sonar system consisted of a sonar transducer, power/data cable, and 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) and interfacing with a laptop computer (Photo 1). The sonar transducers were affixed to aluminum 'goal post' type mounts, which were purchased and custom built for this project. The mounts allowed for easy adjustment of the transducer pitch and depth

within the water column. The equipment was powered using a portable 2000-watt gas-powered generator on the bank of the river.

Photo 1. Sonar deployed on the Klondike River at KR-Site-1. Note the sonar mount in the background of the photo.

2.3 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 software provides a means to generate color 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 (Figure 1). The echogram image generated by Echotastic can be confirmed with the use of the video window (Figure 2).

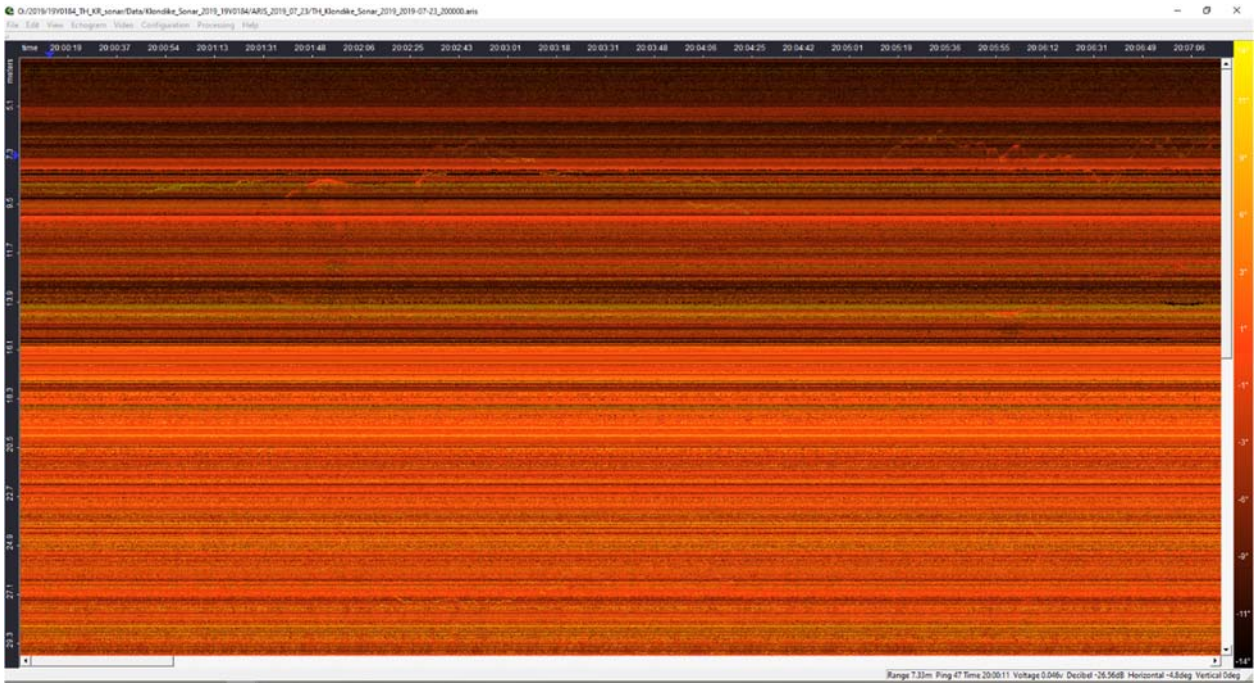


Figure 1. Echotastic echogram showing good bottom profile on the Klondike River. Note: the long "wavy" lines are small freshwater fish milling in front of the sonar unit.

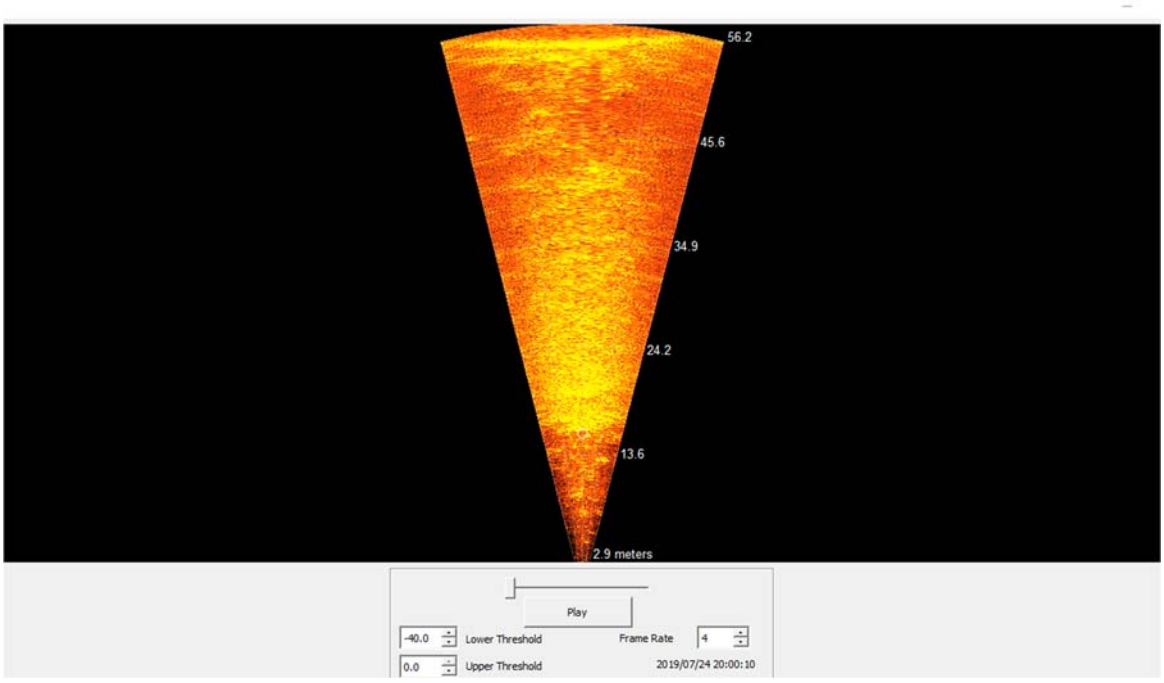


Figure 2. Echotastic video showing bottom profile (yellow marks) on the Klondike River.

Migrating salmon can be identified from Echotastic echograms based on shape/shadowing and movement patterns. Salmon generally appear as characteristic crescents or "wavy" traces on the echogram that are usually oriented parallel to the river current (Figure 3). 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, with the salmon traces generally being brighter and larger than freshwater fish. Larger salmon also block a portion of the sonar beam as they travel through it, causing a shadowing of the area of the echogram directly behind the fish. Shadowing is visible on an echogram as a dark vertical line behind the fish, extending away from the transducer. This shadowing effect is visible behind the fish in the example echogram in Figure 3.

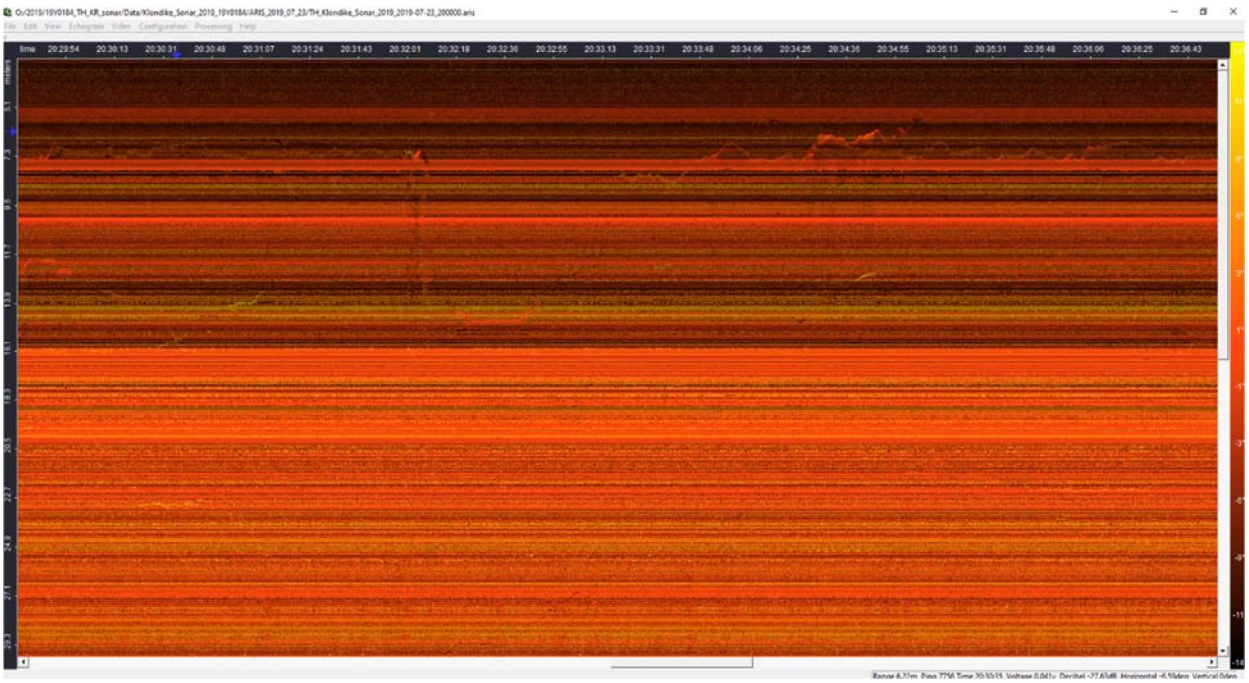


Figure 3. Echotastic echogram showing the crescent shaped sonar target and shadowing typical of a salmon target (left side of image) compared to the smaller, longer targets typical of small freshwater fish (right side of image).

3 RESULTS

3.1 SITE SELECTION

Three potential sonar deployment sites were visited during July: the site previously used by B. Mercer & Associates Ltd. (KR-Site-1), a site previously documented as a backup site by B. Mercer & Associates Ltd. (KR-Site-2), and a new site chosen during the 2019 field visit (KR-Site-3). Each of the sites are discussed in detail below from the perspective of establishing a site for long-term operation of Chinook salmon enumeration sonar on the Klondike River.

3.1.1 KR-SITE-1

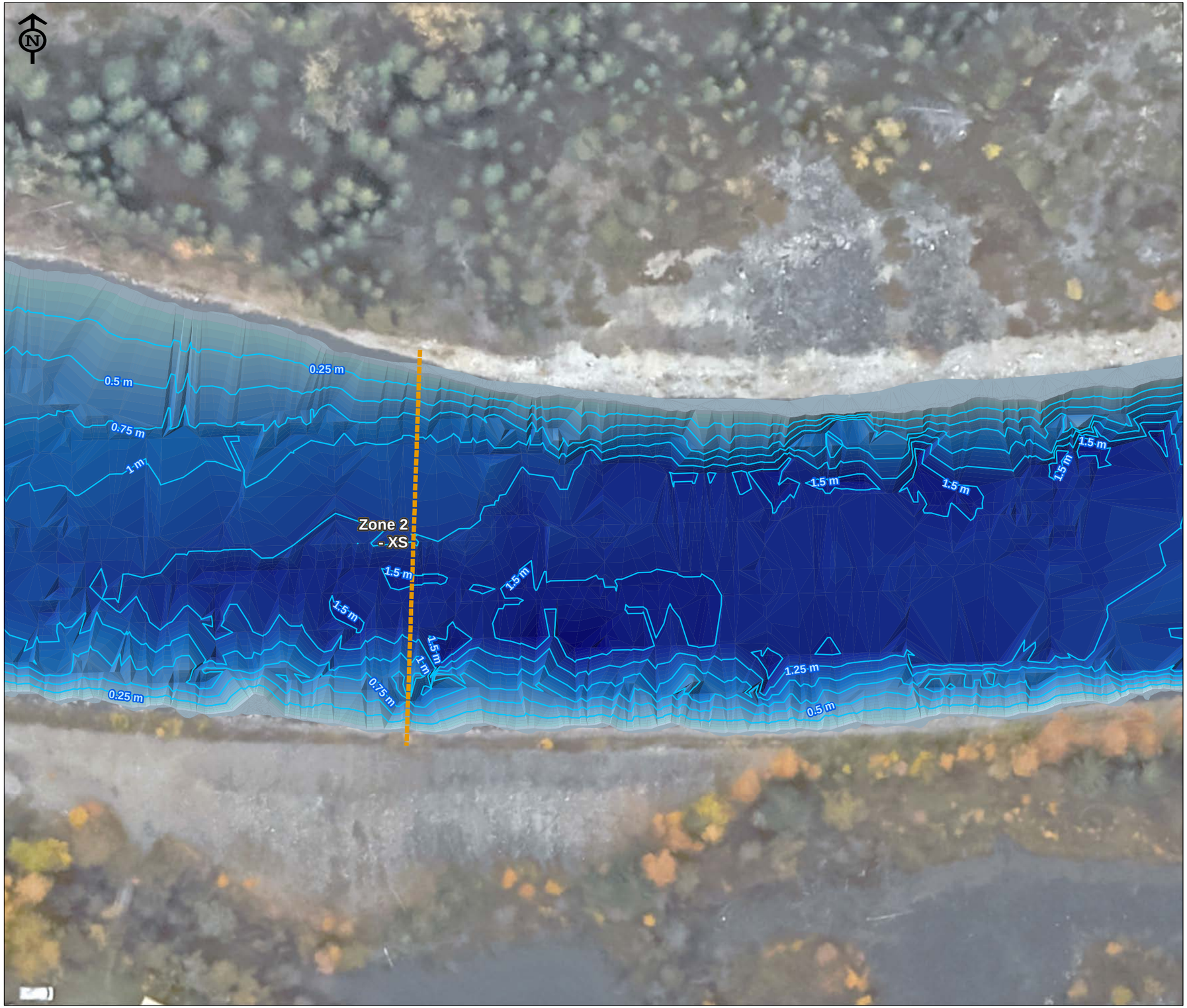
The first site visited during the July field investigation was the site previously used by B. Mercer & Associates Ltd. from 2008 to 2011 (Mercer 2012). This site is accessed via a public road. Access to the river is limited and requires walking across private property; permission was provided for the purpose of this assessment. Initial investigations of the river deemed this site suitable for sonar use with the absence of eddies or back/side channels. The streambank profile appeared to be suitable with gradual sloping banks, no visible gravel bars or large amounts of boulders, which was confirmed by bathymetry data (Photos 2 and 3; Map 2; Figure 4). The channel in this section of river is quite uniform and straight, which is ideal for sonar operation. However, because of the uniform river channel, flows in this section are quite high. High flow rates can make sonar work challenging as moving the sonar and weir can be difficult. As well, the materials used for weir construction need to be very robust and could be costly.

Crews were able to successfully set up the sonar unit and deploy it into the river at this site. The crew began recording at 15:00 on July 23, 2019 and ended 13:00 on July 24, 2019. After reviewing the sonar files, crews counted a total of 35 upstream targets and one downstream target all believed to be Chinook salmon (a net total of 34 upstream Chinook salmon). Crews also noticed large numbers of smaller freshwater fish – presumably Arctic grayling - milling around the sonar in this area.

Access to the site requires movement across private property and a temporary sonar camp would be located directly adjacent to a private dwelling. After discussion with the residents, it was found the future operation of sonar at the site would not be possible at the site due to the site access and privacy limitations. For these reasons, no addition work was conducted at the site and investigations for an alternative site were initiated.

Photo 2. An aerial photo, looking upstream, of KR-Site-1. The sonar unit is visible on the right side of the picture (left downstream bank). Photo taken July 25, 2019.

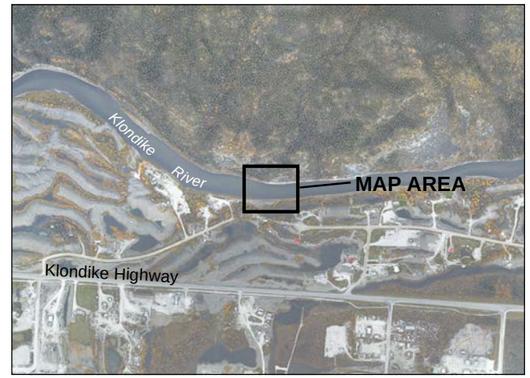
Photo 3. Photo from left downstream bank of the ARIS sonar unit deployed in the river at KR-Site-1.



Map 2. Overview of KR-Site-1.

Legend

- Bathymetric Contour (0.25 metre)
- Cross Section



0 5 10 15 20 25
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Data Sources
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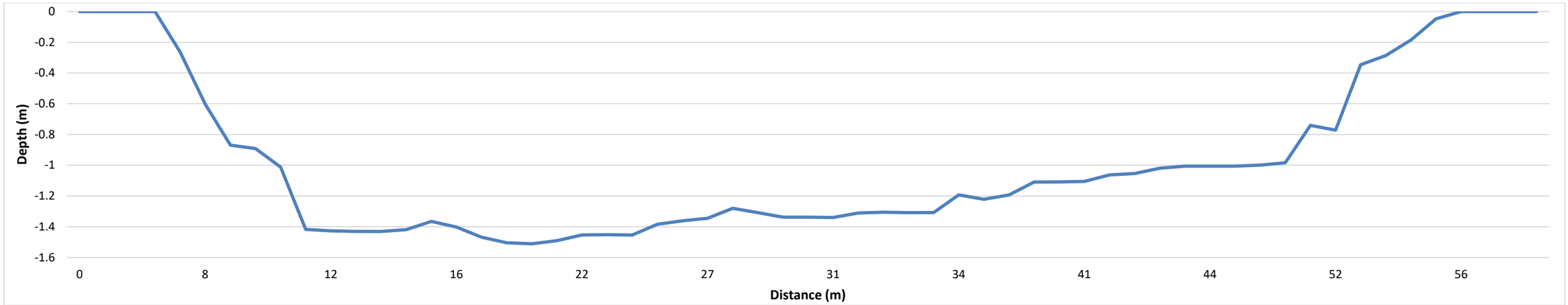


Figure 4. Cross section profile at KR-Site-1; sonar deployment on the left downstream bank (left side of the figure).

3.1.2 KR-SITE-2

After KR-Site-1 was deemed unsuitable for future sonar use, crews visited a backup site identified by B. Mercer & Associates Ltd., KR-Site-2, during their 2008 feasibility study (Mercer 2009). KR-Site-2 is located approximately 2.5 km downstream from KR-Site-2 and approximately 2 km upstream from the Klondike River and Yukon River confluence (Mercer 2009). KR-Site-2 is located just upstream of the Klondike River bridge on the left downstream bank. This site has road access via a public road and a suitable site to set up camp, which could be used for a more permanent camp in the future. However, it was easy to see the streambed profile at this site is not suitable for sonar use. A large shallow gravel bar could be seen running down the middle of the river channel with two deeper channels along each riverbank (Photo 4). This shallow gravel bar will cause issues with sonar use as it will block the sonar from ensonifying the far riverbank. Having unensonified areas will allow salmon to pass by without being recorded by the sonar. This can be mitigated with deflection weirs; however, the length of the weir would be quite long and would need to be very sturdy and robust against the strong current in the area. Based upon these observations, the sonar was not deployed at this area, nor were bathymetric data collected.

Photo 4. **View of KR-Site-2 from the left downstream bank; the shallow gravel bar is visible in the middle of the river channel.**

3.1.3 KR-SITE-3

The final site visited by field crews was KR-Site-3, a location recommended for investigation by TH personnel, largely due to the proximity to TH's asset compound. This site is located immediately downstream of the Klondike River bridge on the right downstream bank (Photos 5 and 6). The land adjacent to the site is owned by TH and the temporary set up of a sonar camp with the potential of building a long-term camp is feasible. Furthermore, the option to run power from the compound to the sonar camp is an ideal situation to avoid use of generators and associated fuel costs.

The river characteristics in this area are suitable for sonar deployment. In this area the river has a slight bend to the right, which causes the thalweg to run along the left downstream bank. Combined with the gradual sloping bank on the right downstream bank, this would make for easy construction and maintenance of a deflection weir. Due to the long range of the ARIS sonar (i.e., 80 m) and the steep bank on the left downstream bank, a deflection weir on the far bank will not be required (Figure 5).

Three different cross sections were investigated in this area (Map 3, Figure 6 to Figure 8) with XS3 determined to be the most suitable for sonar deployment. The gradual sloping bank from the sonar will allow for appropriate esonification of the entire riverbed. The left downstream bank does have a small back channel across from the site that could be used by migrating Chinook salmon. However, flows into the back channel are minimal and could be easily blocked off using T-posts and snow fencing if required.

Crews successfully set up and deployed the sonar unit at this site on July 25, 2019, at cross section XS3 (Map 3). Due to time constraints, crews could only record a total of three hours of continuous data. During these three hours of data collection, a single upstream target was observed and believed to be a Chinook salmon.

Photo 5. Upstream view from right downstream bank at KR-Site-3. Photo taken October 3, 2019.

Photo 6. Downstream view from right downstream bank at KR-Site-3. Photo taken October 3, 2019.

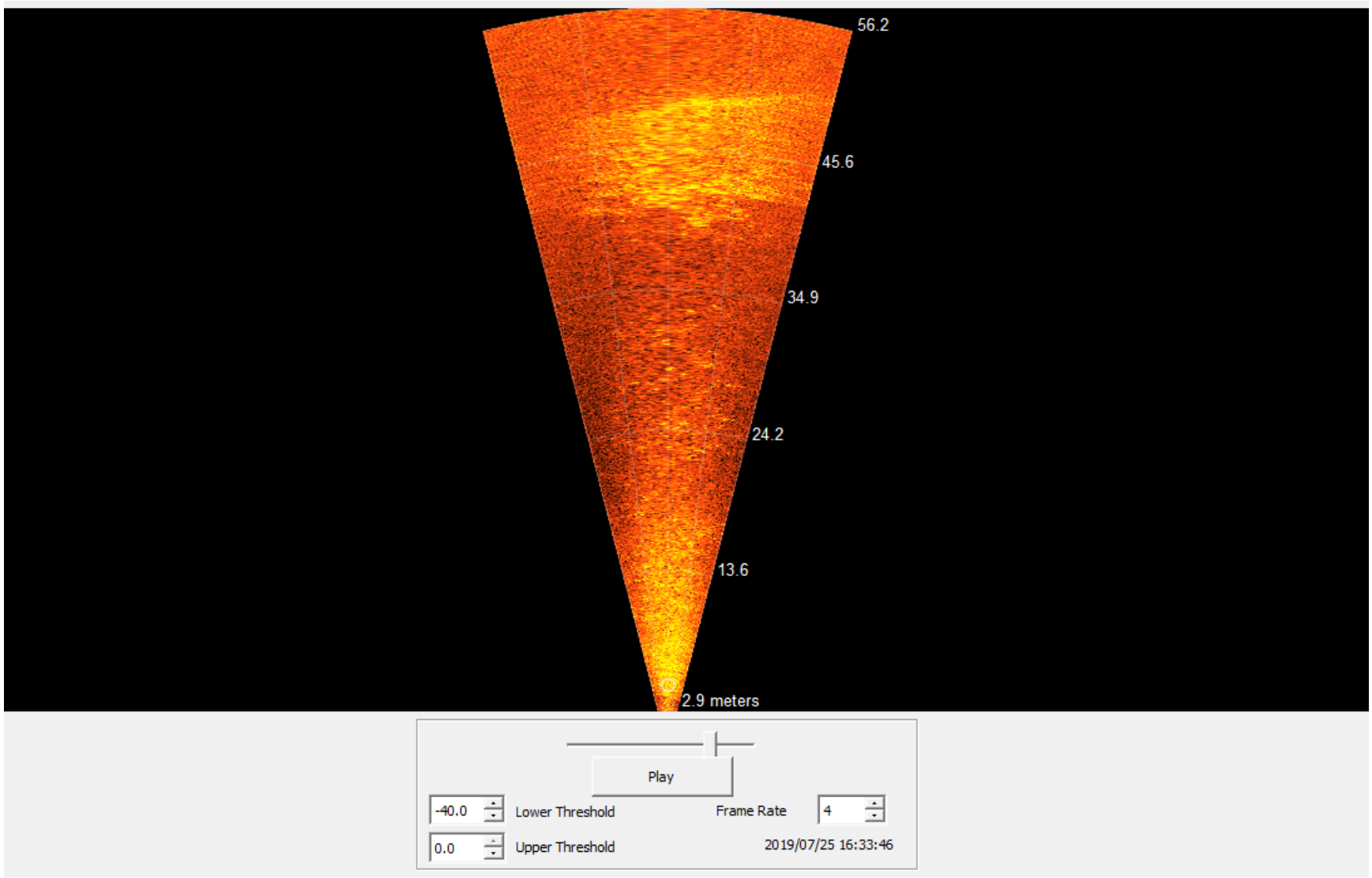
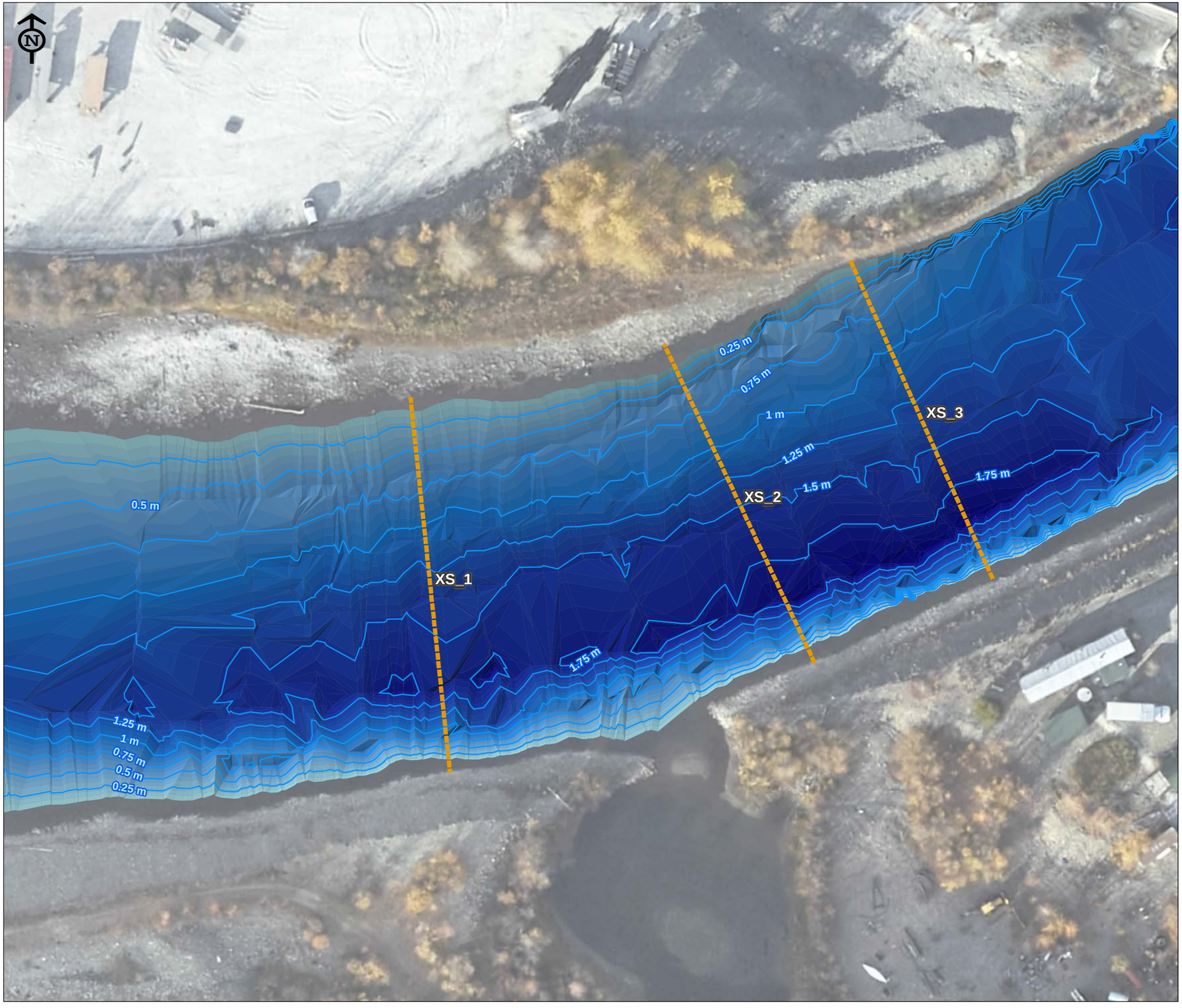


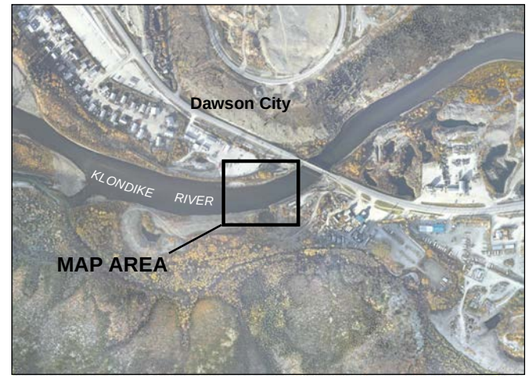
Figure 5. Echotastic video showing bottom profile at KR-Site-3.



Map 3. Overview of of KR-Site-3.

Legend

- Bathymetric Contour (0.25 metre)
- Cross Section



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Data Sources
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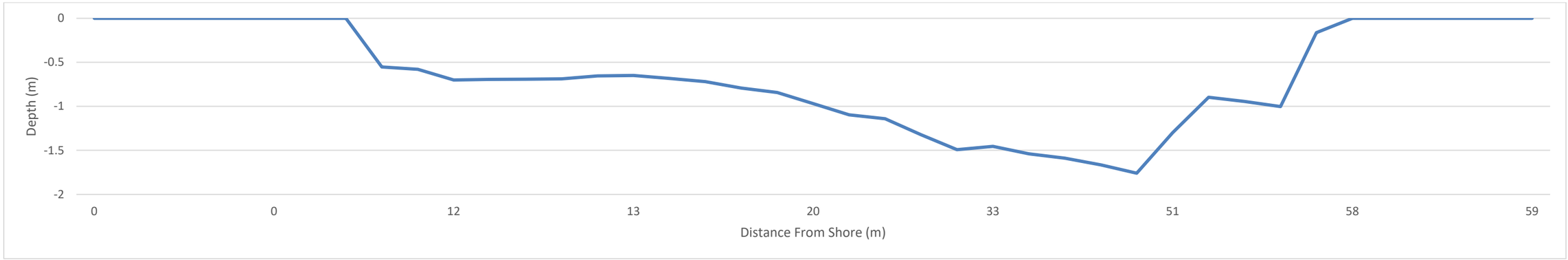

Figure 6. Cross section data from XS1; sonar deployment on the right downstream bank represented on the left side of the cross section profile.

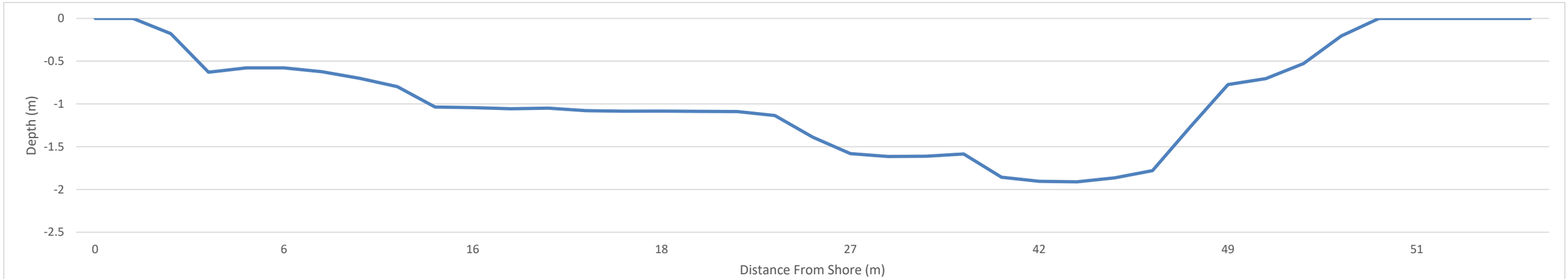

Figure 7. Cross section data from XS2; sonar deployment on the right downstream bank represented on the left side of the cross section profile.

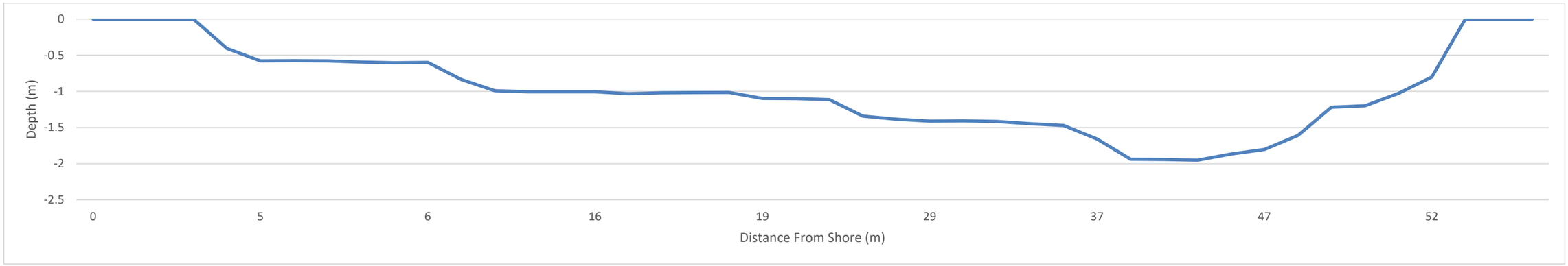

Figure 8. Cross section data from XS3; sonar deployment on the right downstream bank represented on the left side of the cross section profile.

4 DISCUSSION

After review of the data collected at each site, it is recommended that KR-Site-3 be chosen for the future use as the Klondike River sonar site with camp and the sonar set up on the right downstream bank. Out of the three sites visited, KR-Site-3 has the most suitable site characteristics for successful sonar operation. The river profile in this section, cross section XS3 in particular, is favorable for sonar use with the absence of steep banks, trenches and large boulders. The uniform river morphology in this section is suitable for salmon migration and doesn't allow for any milling and holding that can be seen in and around eddies. The lower flow rate on the right downstream bank, where it is recommended the sonar be set up, will allow for easy construction of a fish deflection weir. Additionally, the fish deflection weir can be built using T-posts and stiff snow fencing, which has been used on other sonar sites included the Porcupine and Pelly River sonars. These weirs are easy to build and move in response to water level changes and cost much less than the weirs previously used on the Klondike River by B. Mercer & Associates Ltd. The sonar used on the Klondike River from 2009 to 2011 was a DIDSON with a maximum range of 50 m. Due to this range, heavy duty deflection weirs were required to make sure that the entire river channel could be ensonified.

Having the sonar camp within the Tr'ondëk Hwëch'in asset compound will allow for easy setup and use of the sonar camp. This will avoid the disturbance of any local residents and the need to clear a new site location. The option to run power from the existing buildings on the compound would be an ideal option to avoid the use of generators. The use of generators on other sonar sites has proven to be costly with the additional costs of maintenance, fuel/oil and the initial cost of the unit itself. It appears a sonar camp could easily be setup on the east side of the compound with easy access to/from the river.

4.1 RECOMMENDATIONS

The 2019 Klondike River Chinook Salmon Sonar Investigation was successful in meeting the goals and objectives of the project. The investigation proved valuable given that the previously used sonar site was no longer available for future sonar use due to site access constraints. A new site was located, and it is believed that future Chinook salmon enumeration through the use of sonar is feasible at this site.

Recommendations and considerations for future Klondike River Chinook salmon sonar programs are as follows:

- The training of sonar technicians will be important on future Klondike River sonar programs. During the review of sonar files large numbers of small freshwater fish were observed in every file. It will be important that technicians can distinguish the difference between freshwater fish and migrating Chinook salmon.
- Due to the close proximity to town, the easy access to the sonar site, and the public use of the river and riverbank in this area, it is recommended someone be on site 24/7. Valuable equipment will be on site and someone should be present at all times to monitor the site.

- Further discussion about the viability and need for a test netting program versus a carcass pitch should be considered. Based upon previous discussion with DFO, it has been recommended that test netting would be preferable. However, conducting a test netting program will require more consistent and continuous use of a jet boat; experienced workers and suitable netting locations would need to be located. This may also increase the number of workers needed if someone is to stay at the sonar camp at all times. The use of a boat and more workers will increase the cost of future projects. Additional discussions with DFO are recommended on this topic during the planning stage of the 2020 sonar program.
- A large berm can be found between the TH compound and the river, which will need to be flattened out. This will allow for technicians to easily monitor the sonar and weir from camp and for safe and easy access to/from the river.
- A backup power source may be needed if the sonar camp is to run off city power. In the event of a power outage, it would be beneficial to have an available generator to keep the sonar recording. This does not have to be a part of the project, but if a generator was available for emergency use from the TH Lands and Resource Department that would maintain continuous data collection during a temporary power outage.

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